

*** A/C-HEATER SYSTEM UNIFORM INSPECTION GUIDELINES ***

Article Text

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Sunday, March 19, 2000 12:33AM

ARTICLE BEGINNING

GENERAL INFORMATION

A/C-Heater System Motorist Assurance Program
Standards For Automotive Repair

All Makes and Models

INTRODUCTION TO MOTORIST ASSURANCE PROGRAM (MAP)

The Motorist Assurance Program was formed in 1992 by forty (40) companies who were concerned about the image of automotive service establishments. Today, MAP is an industry-wide association dedicated to strengthening consumer satisfaction with the automotive repair industry. MAP's participants represent the majority of the nation's multi-bay retail automotive outlets, their parts and equipment suppliers, independent repair shops, industry associations, car companies, manufacturers representatives, and the trade press. MAP is developing standards of service, uniform inspection procedures and other programs to assure consumers of the industry's professionalism and the commitment to excellence shared by MAP's sponsoring companies.

MAP's achievements to date include production and distribution (over 280,000) of the consumer brochure "How to Find Your Way Under the Hood and Around Your Car", development of a Pledge of Satisfaction to Consumers and Standards of Service and establishment of relationships with regulatory agencies.

As auto repair becomes an issue for federal and state regulators, MAP is working to educate government leaders on the dynamics of automotive service and the self-monitoring efforts MAP has undertaken on the industry's behalf. MAP's sponsoring companies are becoming well-known to government representatives as exemplary businesses working to improve the industry. Media sources also look to MAP to provide information and advice to consumers and on working with automotive technicians and repair establishments.

In the next few months, MAP plans to assist member repair facilities in implementing the MAP Pledge to Customers, establishing an alternate dispute resolution system to help resolve customer complaints within the industry, and developing a shop accreditation program to encourage policies in concert with the MAP Standards of Service and Inspection Guidelines.

MAP has united the aftermarket behind its consumer-oriented goals and has established itself both within and outside of the industry. We welcome you to join us as MAP continues its outreach. With your support, both the automotive repair industry and your customers will reap the benefits. Please contact MAP at:

808 17th Street, NW
Suite 200
Washington, D.C. 20006
202 466 7050

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MAP UNIFORM INSPECTION GENERAL GUIDELINES

OVERVIEW OF SERVICE REQUIREMENTS & SUGGESTIONS

It is MAP policy that all exhaust, brake, ABS, steering and suspension, wheel alignment, tires and wheels, driveline, engine performance and maintenance and heating, ventilation and air conditioning services be offered and performed under the guidelines and procedures specified in these sections.

Before any service is performed on a vehicle, an inspection of the appropriate system must be performed. The results of this inspection must be explained to the customer and documented on an inspection form. The condition of the vehicle and its components will indicate what services/part replacements may be required or suggested. In addition, suggestions may be made to satisfy the needs expressed by the customer.

This section lists the various parts and conditions that indicate required or suggested service or part replacement. Although this list is extensive, it is not inclusive. In addition to this list, a technician may make a suggestion. This suggestion must be based on substantial and informed experience or the vehicle manufacturer's recommended service interval.

Some conditions indicate that service or part replacement is required because the part in question is no longer providing the function for which it is intended, does not meet a vehicle manufacturer's design specification or is missing.

- * Example: An exhaust pipe has corroded severely and has a hole in it through which exhaust gases are leaking. Replacement of the exhaust pipe in this case is required due to functional failure.
- * Example: A brake rotor has been worn to the point where it measures less than the vehicle manufacturer's specifications. Replacement of the rotor is required because it does not meet design specifications.

Some conditions indicate that a service or part replacement is suggested because the part is close to the end of its useful life or to address a customer's need, convenience or request. If a customer's vehicle has one of these conditions, the procedure may only be to suggest service.

- * Example: An exhaust pipe is rusted, corroded or weak, but no leaks are present. In this case, the exhaust pipe has not failed. However, there is evidence that the pipe may need replacement in the near future. Replacement of the pipe may be suggested for the customer's convenience in avoiding a future problem.
- * Example: The customer desires improved ride and/or handling, but the vehicle's shocks or struts have not failed. In this case, replacement may be suggested to satisfy the customer's wishes. In this case, replacement of the shocks or struts may

Condition	3	Procedure	3	Note
Seized	3	Requires replacement	3	
Inoperative	3	Further inspection	3	Check/service state of
	3	required.	3	charge following the
	3		3	manufacturer's recommended
	3		3	service procedures. If the
	3		3	compressor is still
	3		3	inoperative, require
	3		3	repair or replacement.
Noisy	3	Further inspection	3	Check/service oil level and

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EVAPORATOR

EVAPORATOR

AA			
Condition	3	Procedure	3 Note
AA			
Leaking	3	Require repair or	3
	3	replacement.	3
AA			
Internal	3	Require replacement.	3
restriction	3		3
AA			
Air flow	3	Further inspection	3 If fins cannot be cleaned
obstruction	3	required.	3 or straightened, require
	3		3 replacement.
AA			
Damaged	3	Require replacement.	3
connections or	3		3
fittings	3		3
AA			

ACCUMULATOR/DRIER

ACCUMULATOR/DRIER

AA			
Condition	3	Procedure	3 Note
AA			
Leaking	3	Require replacement.	3
AA			
Restricted	3	Require replacement.	3
AA			
Desiccant bag	3	Require replacement.	3
deterioration	3		3
AA			
Moisture in system	3	Require replacement.	3
AA			
System has been	3	Suggest replacement.	3
exposed to air	3		3
AA			
Missing, damaged	3	Require repair or	3
mounting hardware	3	replacement of	3
or brackets	3	hardware or brackets	3
AA			

HOSES/LINES/FITTINGS

HOSES/LINES/FITTINGS

AA			
Condition	3	Procedure	
AA			
Blistered hose	3	Suggest repair or replacement.	
AA			

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Damaged 3 Require repair or replacement.
Routed incorrectly 3 Suggest re-routing.
Leaking 3 Require repair or replacement.
Restricted 3 Require repair or replacement.
Outer covering is cracked to the extent inner fabric of hose is visible 3
Crimped 3 Require repair or replacement.
Missing/damaged mounting hardware or brackets 3 Require repair or replacement of hardware or brackets.

EVAPORATOR FILTER (IF APPLICABLE)

EVAPORATOR FILTER (IF APPLICABLE)
Condition 3 Procedure 3 Note
Air flow 3 Further inspection 3 If filter cannot be cleaned, obstruction 3 required. 3 require replacement.
Missing 3 Require replacement. 3

EXPANSION VALVE/ORIFICE TUBE

EXPANSION VALVE/ORIFICE TUBE
Condition 3 Procedure 3 Note
Leaking 3 Require replacement. 3
Restricted 3 Require repair or replacement. 3
Filter screen torn 3 Require replacement. 3
Inoperative expansion valve 3 Further inspection 3 Inspect capillary tube and ensure proper positioning. 3 Re-check system performance. If still inoperative require replacement of expansion valve. 3

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PRESSURE CONTROL VALVES

NOTE: Includes Evaporator Pressure Regulator (EPR), Pilot Operated Absolute (POA), Suction Throttling Valve (STV), Valves In Receiver (VIR).

PRESSURE CONTROL VALVES

Condition	3	Procedure
Leaking	3	Require repair or replacement.
Restriction	3	Require repair or replacement.
Stuck open or closed	3	Require repair or replacement.
Damaged connections or fittings	3	Require repair or replacement.

SERVICE PORTS

SERVICE PORTS

Condition	3	Procedure
Leaking	3	Require repair or replacement.
Sticking valve core	3	Require repair or replacement
Missing valve cap	3	Require replacement of valve cap.
Damaged threads	3	Require repair or replacement.

DRIVE BELTS

DRIVE BELTS

Condition	3	Procedure	3	Note
Missing	3	Require replacement.	3	
Improper tension	3	Require adjustment.	3	
Improper alignment	3	Further inspection required.	3	Check alignment of pulleys and proper belt installation. Suggest repair or replacement.
Damaged	3	Require replacement.	3	Damaged conditions may include but are not limited to: teeth missing,

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3	3 chunking or excessive
3	3 cracking, missing rib,
3	3 broken or cut, ply
3	3 separation.

AA

Noisy 3 Suggest replacement. 3

AA

Worn	3 Suggest replacement.	3 Worn conditions may
3		3 include: belt worn
3		3 narrower than original
3		3 width, bottom and side-
3		3 wall cracks, protruding
3		3 edge cords.

AA

DRIVE PULLEYS

DRIVE PULLEYS

AA

Condition	3	Procedure
-----------	---	-----------

AA

Damaged	3 Require replacement.
---------	------------------------

AA

Improper alignment	3 Require repair.
--------------------	-------------------

AA

Missing, damaged mounting hardware	3 Require repair or replacement of
	3 bracket of hardware or bracket.

AA

TENSIONERS

TENSIONERS

AA

Condition	3	Procedure
-----------	---	-----------

AA

Missing	3 Require replacement.
---------	------------------------

AA

Noisy	3 Suggest replacement.
-------	------------------------

AA

Damaged	3 Suggest replacement.
---------	------------------------

AA

Improper adjustment	3 Require adjustment or repair.
---------------------	---------------------------------

AA

CONDENSER

CONDENSER

AA

Condition	3	Procedure	3	Note
-----------	---	-----------	---	------

AA

Leaking	3 Require repair or	3
	3 replacement.	3

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[illegible]

Damaged connections or fittings	3	Require replacement.	3
	3		3

[illegible]

Internal restriction ³ Require replacement.³

Air flow obstruction	3	Further inspection	3	If fins cannot be cleaned
	3	required.	3	or straightened, require
	3		3	replacement.

[illegible]

Missing/damaged	3	Require repair or	3
-----------------	---	-------------------	---

mounting hardware/ 3 replacement of 3

brackets 3 hardware or 3

3 brackets. 3

[illegible]

"O" RINGS/GASKETS/SEALS/SPRING LOCKS

"O" RINGS/GASKETS/SEALS/SPRING LOCKS

[illegible]

Condition	3	Procedure
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[illegible]

Leaking ³ Require repair or replacement.

[illegible]

IN-LINE FILTER

IN-LINE FILTER

[illegible]

Condition	3	Procedure
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[illegible]

Leaking ³ Require repair or replacement.

[illegible]

Restricted ³ Require replacement.

[illegible]

Damaged connections or fittings ³ Require repair or replacement.

[illegible]

REFRIGERANT OIL

REFRIGERANT OIL

[illegible]

Condition	3	Procedure	3	Note
-----------	---	-----------	---	------

[illegible]

Overcharge/	3	Require service to	3
-------------	---	--------------------	---

overcharge,
undercharge ³ require service to ³
manufacturer's

3 specifications. 3

specifications:

Contaminated ³ Suggest replacement.³ Particulate material

3 (contaminants) may indicate a

3 need for additional service.

3 Determine cause of contamination

3 Determine cause of contamination
3 and repair or replace affected

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3 components as necessary.
3 Discoloration of oil does not
3 necessarily indicate a system
3 problem.

[illegible]

REFRIGERANT

REFRIGERANT

[illegible]

Condition	3	Procedure
-----------	---	-----------

[illegible]

Overcharge/undercharge	3 Require service to manufacturer's 3 specifications.
------------------------	--

[illegible]

Cross-contamination 3

3. **Refrigerant** _____ Require service following
 Different types of refrigerants 3 manufacturer's procedures and
 in the same system 3 specifications.

AA

Incompatible refrigerants mixed together	3
	3

[illegible]

AIR DISTRIBUTION

PLENUM/EVAPORATOR CASE/HEATER CASE

[illegible]

Condition	3	Procedure	3	Note
-----------	---	-----------	---	------

[illegible]

Cracked	3 Suggest repair or 3 replacement.	3 3
---------	---------------------------------------	--------

[illegible]

Air leaks	3	Require repair or	3
	3	replacement	3

[illegible]

Restricted 3 Suggest cleaning, 3
3 repair or replacement. 3

[illegible]

Odor	3 Further inspection	3 Identify source. Suggest
	3 required.	3 cleaning or repair.

[illegible]

Noisy	3 Further inspection	3 Identify source. Suggest
	3 required.	3 cleaning or repair.

[illegible]

Cold water leak in 3 Further inspection required. 3 Determine source of leak. Leak may be caused due to restricted

passenger	3	3	drain tube, cracked evaporator
compartment	3	3	case, leaking seal or gasket.

3 3 Require repair or replacement.

[illegible]

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ELECTRICAL/VACUUM ACTUATORS (MOTORS)

ELECTRICAL/VACUUM ACTUATORS (MOTORS)

AA		
Condition	3	Procedure
AA		
Leaking vacuum	3	Require replacement.
AA		
Inoperative	3	Require replacement
AA		
Damaged	3	Suggest replacement.
AA		
Missing	3	Require replacement.
AA		
Missing, damaged mounting hardware	3	Require repair of mounting hardware or bracket.
AA		
Corroded, loose terminals	3	Require repair or replacement.
AA		

LINKAGE

LINKAGE

AA		
Condition	3	Procedure
AA		
Broken/damaged or binding	3	Require repair or replacement.
AA		
Missing or disconnected	3	Require repair or replacement.
AA		
Out of adjustment	3	Require adjustment.
AA		

CABLES

CABLES

AA		
Condition	3	Procedure
AA		
Binding	3	Suggest repair or replacement.
AA		
Out of adjustment	3	Require adjustment.
AA		
Broken or seized	3	Require replacement.
AA		
Disconnected	3	Require repair.
AA		

VACUUM HOSES/TUBES

VACUUM HOSES/TUBES

AA		
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Condition	3	Procedure
Missing	3	Require replacement.
Damaged	3	Suggest repair or replacement.
Leaking/restricted	3	Require repair or replacement.
Routed incorrectly	3	Suggest re-routing.

EVAPORATOR DRAIN TUBE

Condition	3	Procedure
Disconnected	3	Require repair.
Missing	3	Require replacement.
Damaged/leaking	3	Require replacement.
Restricted	3	Require repair or replacement.

CONTROLS

Condition	3	Procedure
Inoperative	3	Require repair or replacement.
Malfunctioning	3	Suggest repair or replacement.
Damaged	3	Suggest replacement.
Missing	3	Require replacement.
Missing, damaged mounting hardware	3	Require repair of mounting hardware or bracket.
Corroded, loose terminals	3	Require repair or replacement.

Condition	3	Procedure
Inoperative	3	Require replacement.

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Malfunctioning	3 Suggest repair or replacement.
AAAAA	
Damaged	3 Suggest replacement.
AAAAA	
Missing	3 Require replacement.
AAAAA	
Missing, damaged mounting hardware	3 Require repair of mounting hardware or bracket.
AAAAA	
Corroded, loose terminals	3 Require repair or replacement.
AAAAA	

BLOWER MOTOR

BLOWER MOTOR	
AAAAA	
Condition	3 Procedure
AAAAA	
Inoperative	3 Require replacement.
AAAAA	
Noisy	3 Suggest replacement.
AAAAA	
Damaged	3 Suggest replacement.
AAAAA	
Missing	3 Require replacement.
AAAAA	
Missing, damaged mounting hardware	3 Require repair of mounting hardware or bracket.
AAAAA	
Corroded, loose terminals	3 Require repair or replacement.
AAAAA	

BLOWER FAN

BLOWER FAN	
AAAAA	
Condition	3 Procedure
AAAAA	
Damaged	3 Require replacement.
AAAAA	
Noisy	3 Suggest replacement.
AAAAA	

BLOWER RESISTOR

BLOWER RESISTOR	
AAAAA	
Condition	3 Procedure
AAAAA	
Inoperative	3 Require replacement.
AAAAA	
Malfunctioning	3 Suggest replacement.

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AA
 Damaged 3 Suggest replacement.

Missing ³ Require replacement.

Missing, damaged mounting hardware ³ Require repair of mounting
³ hardware or bracket.

Corroded, loose terminals ³ Require repair or replacement.

[illegible]

SWITCHES

NOTE: Includes, but not limited to: High Pressure Cut-Off, Low Pressure Cut-Off, Thermostatic Fan Control, Ambient, Pressure Cycling, etc.

SWITCHES

AA		
Condition	3	Procedure

AA
Inoperative/intermittent ³ Require replacement.

Malfunctioning ³ Suggest replacement.

Leaking ³ Require repair or replacement.

[illegible]

Missing ³ Require replacement.

Missing, damaged mounting hardware ³ Require repair of mounting
³ hardware or bracket.

Corroded, loose terminals ³ Require repair or replacement.

[illegible]

THERMISTOR/SENSORS

NOTE: Includes, but not limited to: In-car Temperature, Ambient Air Temperature, Sun Load Sensor, etc.

THERMISTOR/SENSORS

Condition			3	Procedure		
-----------	--	--	---	-----------	--	--

AA
Inoperative ³ Require replacement.

Malfunctioning ³ Suggest replacement.

AA
 Damaged 3 Suggest replacement.

[illegible]

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Missing 3 Require replacement.
Missing, damaged mounting hardware 3 Require repair of mounting
3 hardware or bracket.
Corroded, loose terminals 3 Require repair or replacement.

RELAYS

RELAYS
Condition 3 Procedure
Inoperative 3 Require replacement.
Malfunctioning 3 Suggest replacement.
Damaged 3 Suggest replacement.
Missing 3 Require replacement.
Missing, damaged mounting hardware 3 Require repair or replacement of
3 hardware.
Corroded, loose terminals 3 Require repair or replacement.

FUSE/FUSIBLE LINK/CIRCUIT BREAKER

FUSE/FUSIBLE LINK/CIRCUIT BREAKER
Condition 3 Procedure 3 Note
Inoperative/intermittent 3 Require replacement. 3 Determine cause of
3 Further inspection 3 condition & correct
3 required. 3 prior to replacement.
Damaged 3 Suggest repair or 3
3 replacement. 3
Open 3 Require replacement. 3
Missing 3 Require replacement. 3 Refer to OEM owner's
3 manual for proper
3 amperage & location.

WIRING HARNESS/CONNECTORS

WIRING HARNESS/CONNECTORS
Condition 3 Procedure 3 Note
Damaged 3 Suggest repair or 3

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3 replacement. **3**

[illegible]

Routed incorrectly 3 Suggest rerouting of 3

3 of wiring. 3

[illegible]

Open fusible link 3 Require replacement 3 Determine cause of

3 of fusible link. 3

3 prior to replacement.3

[illegible]

Shorted/open	3	Require repair or	3
--------------	---	-------------------	---

3 replacement. 3

[illegible]

Connector terminal bent, ³	Require repair or	3
---------------------------------------	-------------------	----------

broken, corroded or	3	replacement	3
---------------------	---	-------------	---

loose	3	3
-------	---	---

[illegible]

Excessive resistance	3	Require repair or	3
----------------------	---	-------------------	---

Excessive resistance	requires repair or	
3	replacement	3

AAAAAA

Poor ground 3 Require repair. 3

[illegible]

CONTROL MODULE

NOTE: Includes, but not limited to: BOM (Body), ECM (Electronic), PCM (Power), etc.

CONTROL MODULE

[illegible]

Condition	3	Procedure	3	Note
-----------	---	-----------	---	------

[illegible]

Inoperative ³ Require replacement. ³

[illegible]

Malfunctioning ³ Suggest replacement. ³

[illegible]

Code set	3 Further inspection	3 Refer to manufacturer's
	3 required.	3 diagnostic trouble code
	3	3 procedure and repair or
	3	3 replace affected
	3	3 component(s) as necessary.

[illegible]

Damaged/cracked housing	3	Suggest replacement.	3	If moisture enters the module it can reduce life expectancy or impair function.
	3		3	
	3		3	
	3		3	

FUNCTION:

Damaged 3 Suggest replacement. 3

3 Require replacement. 3

Missing, damaged	3	Require repair of	3
------------------	---	-------------------	---

missing, damaged mounting hardware ³ require repair of mounting hardware or ³

3 meaning hardware bracket. 3

BRACKET:

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Corroded, loose	3	Require repair or	3
terminals	3	replacement.	3

[illegible]

CONTROLLERS

NOTE: Includes, but not limited to: IRCM, Coolant Fan Control Module (CFCM), AC Controller, Amplifier, Programmers, Control Heads, Power Modules, etc.

CONTROLLERS

[illegible]

Condition	3	Procedure	3	Note
-----------	---	-----------	---	------

[illegible]

Inoperative **3** Require replacement. **3**

[illegible]

Malfunctioning **3** Suggest replacement. **3**

[illegible]

Damaged/cracked housing	3	Suggest replacement.	3	If moisture enters the
	3		3	controller it can reduce
	3		3	life expectancy or impair
	3		3	function.

[illegible]

Damaged 3 Suggest replacement. 3

[illegible]

Missing 3 Require replacement. 3

[illegible]

Missing, damaged	3	Require repair of	3
------------------	---	-------------------	---

mounting hardware	3	mounting hardware or	3
		3 bracket.	3

[illegible]

Corroded, loose	3	Require repair or	3
-----------------	---	-------------------	---

terminals **3** replacement. **3**

[illegible]

HEATER CORE

HEATER CORE

[illegible]

Condition	3	Procedure	3	Note
-----------	---	-----------	---	------

[illegible]

Leaking	3	Require repair or	3
---------	---	-------------------	---

3 replacement. 3

[illegible]

Damaged fins,	3	Suggest repair or	3
---------------	---	-------------------	---

damaged valves,	suggest repair or	
tubes, fittings	³ replacement.	3

[illegible]

Internal	3	Require repair or	3
----------	---	-------------------	---

restrictions	3	replacement	3
--------------	---	-------------	---

[illegible]

Missing/by-passed	3	Suggest repair or	3
-------------------	---	-------------------	---

3 replacement 3

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Company/Organization _____

Address _____

Phone _____ FAX _____

MAP

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Phone 202 466 7050
Fax 202 223 9569

END OF ARTICLE

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ARTICLE BEGINNING

GENERAL INFORMATION

Brake Systems - Motorist Assurance Program
Standards For Automotive Repair

All Makes & Models

INTRODUCTION TO MOTORIST ASSURANCE PROGRAM (MAP)

OVERVIEW OF MOTORIST ASSURANCE PROGRAM

The Motorist Assurance Program (MAP) is the consumer outreach effort of the Automotive Maintenance and Repair Association, Inc. (AMRA). Participation in the Motorist Assurance Program is drawn from retailers, suppliers, independent repair facilities, vehicle manufacturers and industry associations.

The Motorist Assurance Program was established as an industry-wide effort to address concerns raised by regulators, the media and consumers questioning our ethics and methods of doing business. The automotive repair industry had been bombarded by months of negative stories in the media and scrutiny from state and federal regulators who focused on how the need for repairs is determined. MAP was formed as an industry response to this issue.

Our mission is to strengthen the relationship between the consumer and the auto repair industry. We produce materials that give motorists the information and encouragement to take responsibility for their vehicles - through proper, manufacturer-recommended, maintenance. We encourage participating service and repair shops (including franchisees and dealers) to adopt a Pledge to their Customers and the Motorist Assurance Program developed Standards of Service. All participating service providers have agreed to subscribe to this Pledge and to adhere to the promulgated Standards of Service which demonstrates to their customers that they are serious about customer satisfaction.

These Standards of Service require that an inspection of the vehicle's (problem) system be made according to industry guidelines. After learning that neither the car manufacturers nor any other source had complete guidelines, leading industry organizations, along with other industry participants banded together to address this challenging task. During the past two and a half years, they successfully developed industry inspection guidelines for the following systems: Exhaust, Brakes, ABS, Steering and Suspension, Engine Maintenance and Performance, HVAC, and Electrical systems. Guidelines for Drive Train and Transmission are currently being promulgated. Revisions to the inspection guidelines for Exhaust, Brakes/ABS and Steering and Suspension Systems, which were issued two years ago, are now being published for implementation beginning spring 1997. Participating shops utilize these Uniform Inspection Guidelines as part of the inspection process and for communicating their findings to their customers.

The Motorist Assurance Program continues to work

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cooperatively and proactively with government agencies and consumer groups toward solutions that both benefit the customer and are mutually acceptable to both regulators and industry. We maintain the belief that industry must retain control over how we conduct our business, and we must be viewed as part of the solution and not part of the problem. Meetings with state and other government officials concerned with auto repair and/or consumer protection are conducted. Feedback from these representatives are brought back to members, and the program adjusted as needed.

To assure auto repair customers recourse if they were not satisfied with a repair transaction, the Motorist Assurance Program offers arbitration through MAP/BBB-CARE in cooperation with the Council of Better Business Bureaus and individual participating Bureaus. MAP "piloted" in Indianapolis and Pittsburgh during spring, 1996 - and publicized "roll-outs" in New Jersey, Detroit (MI), Chicago (IL) and Richmond (VA) were conducted. To put some "teeth" in the program, and accreditation requirement for shops was initiated. The requirements are stringent and a self-policing method has been incorporated which includes the "mystery shopping" of outlets. In addition, a committee of service providers had been working diligently developing standards for newspaper, television and Internet advertising.

We welcome you to join us as we continue our outreach ... with your support, both the automotive repair industry and your customers will reap the benefits. Please visit MAP at our Internet site: www.hunter.com/map.htm or contact us at:

808 17th Street, NW Suite 200

Washington, D.C. 20006

Ph. (202) 466-7050 Fax (202) 223-9569

The Motorist Assurance Program was formed in 1992 by forty (40) companies who were concerned about the image of automotive service establishments. Today, MAP is an industry-wide association dedicated to strengthening consumer satisfaction with the automotive repair industry. MAP's participants represent the majority of the nation's multi-bay retail automotive outlets, their parts and equipment suppliers, independent repair shops, industry associations, car companies, manufacturers representatives, and the trade press. MAP is developing standards of service, uniform inspection procedures and other programs to assure consumers of the industry's professionalism and the commitment to excellence shared by MAP's sponsoring companies.

MAP's achievements to date include production and distribution (over 280,000) of the consumer brochure "How to Find Your Way Under the Hood and Around Your Car", development of a Pledge of Satisfaction to Consumers and Standards of Service and establishment of relationships with regulatory agencies.

As auto repair becomes an issue for federal and state regulators, MAP is working to educate government leaders on the dynamics of automotive service and the self-monitoring efforts MAP has undertaken on the industry's behalf. MAP's sponsoring companies are becoming well-known to government representatives as exemplary

*** BRAKE SYSTEM UNIFORM INSPECTION GUIDELINES ***

Article Text (p. 3)

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businesses working to improve the industry. Media sources also look to MAP to provide information and advice to consumers and on working with automotive technicians and repair establishments.

In the next few months, MAP plans to assist member repair facilities in implementing the MAP Pledge to Customers, establishing an alternate dispute resolution system to help resolve customer complaints within the industry, and developing a shop accreditation program to encourage policies in concert with the MAP Standards of Service and Inspection Guidelines.

MAP has united the aftermarket behind its consumer-oriented goals and has established itself both within and outside of the industry. We welcome you to join us as MAP continues its outreach. With your support, both the automotive repair industry and your customers will reap the benefits. Please contact MAP at:

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Ph. (202) 466-7050 Fax (202) 223-9569

MAP UNIFORM INSPECTION GENERAL GUIDELINES

OVERVIEW OF SERVICE REQUIREMENTS & SUGGESTIONS

It is MAP policy that all exhaust, brake, ABS, steering and suspension, wheel alignment, tires and wheels, driveline, engine performance and maintenance and heating, ventilation and air conditioning services be offered and performed under the guidelines and procedures specified in these sections.

Before any service is performed on a vehicle, an inspection of the appropriate system must be performed. The results of this inspection must be explained to the customer and documented on an inspection form. The condition of the vehicle and its components will indicate what services/part replacements may be required or suggested. In addition, suggestions may be made to satisfy the needs expressed by the customer.

This section lists the various parts and conditions that indicate required or suggested service or part replacement. Although this list is extensive, it is not inclusive. In addition to this list, a technician may make a suggestion. This suggestion must be based on substantial and informed experience or the vehicle manufacturer's recommended service interval.

Some conditions indicate that service or part replacement is required because the part in question is no longer providing the function for which it is intended, does not meet a vehicle manufacturer's design specification or is missing.

* Example: An exhaust pipe has corroded severely and has a hole in it through which exhaust gases are leaking. Replacement of the exhaust pipe in this case is required due to functional failure.

* Example: A brake rotor has been worn to the point where it

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Reasons to Require Repair or Replacement			Reasons to Suggest Repair or Replacement		
3	A - Part no longer performs intended purpose		3	1 - Part is close to the end of its useful life (just above discard specifications, or weak; failure likely to occur soon, etc.)	3

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observe safety procedures and equipment requirements established by the vehicle manufacturer to reduce the possibility of serious personal injury.

CAUTION: Most manufacturers prohibit the use of DOT 5 brake fluid in a system equipped with ABS.

NOTE: Intermittent electrical conditions are often caused by a loss of ground, poor connection, or water intrusion into the wiring harness.

Electro-magnetic interference (EMI) may be caused by incorrect installation of accessories or components. EMI can result in improper system operation.

ACCELEROMETERS (G SENSOR OR LATERAL)

Condition	3	Code	3	Procedure
Broken	3	A	3	Require replacement.
Connector loose	3	A	3	Require repair or replacement.
Loose	3	A	3	Require repair or replacement.
Missing	3	A	3	Require replacement.
Out of position	3	A	3	Require re-positioning to vehicle manufacturer's specifications.
Output signal incorrect	3	A	3	Require replacement.

ACCUMULATORS - BRAKE

Condition	3	Code	3	Procedure
Leaking	3	A	3	Require replacement.
Missing	3	A	3	Require replacement.
Pre-charge incorrect	3	A	3	Require replacement.

BACKING PLATES OR ANCHOR PINS

Condition	3	Code	3	Procedure
Anchor pin bent	3	A	3	Require repair or replacement.
Anchor pin broken	3	A	3	Require replacement.

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Anchor pin worn, affecting structural integrity	3	A	3	Require replacement.
	3		3	
	3		3	

AA

Backing plate bent	3	A	3	Require repair or replacement.
--------------------	---	---	---	--------------------------------

AA

Backing plate cracked	3	A	3	Require repair or replacement.
-----------------------	---	---	---	--------------------------------

AA

Backing plate broken	3	A	3	Require replacement.
----------------------	---	---	---	----------------------

AA

Corroded, affecting structural integrity	3	A	3	Require repair or replacement.
	3		3	

AA

Loose	3	A	3	Require repair or replacement.
-------	---	---	---	--------------------------------

AA

Missing	3	A	3	Require replacement.
---------	---	---	---	----------------------

AA

Shoe lands worn	3	A	3	Require repair or replacement.
-----------------	---	---	---	--------------------------------

AA

BRAKE FLUID

DOT 3 and DOT 4 brake fluids are clear or light amber in color. DOT 5 brake fluid is violet in color. Correct fluid required for the brake system is stamped on the master cylinder cover.

It is suggested that the system should be flushed and refilled with correct brake fluid when performing hydraulic brake service.

BRAKE FLUID

AA

Condition	3	Code	3	Procedure
-----------	---	------	---	-----------

AA

Beyond service interval	3	C,3	3	Suggest replacement.
-------------------------	---	-----	---	----------------------

AA

Brake fluid incorrect	3	A	3	Require service. See note (1) below.
-----------------------	---	---	---	--------------------------------------

AA

Contaminated, e.g. fluid other than brake fluid present	3	A or A	3 3 3	Require service. See note (2) below.
---	---	--------------	-------------	--------------------------------------

AA

Rubber master cylinder cover gasket distorted and gummy	3 3 3	A 3	3 3	Require service. See note (2) below.
---	-------------	------------	------------	--------------------------------------

AA

NOTE: (1) If a fluid other than specification brake fluid is present in the brake system, the required service is to flush and fill with the correct brake fluid.

(2) If a fluid other than brake fluid is present in the brake system which DOES affect the rubber parts, the required service is to: a) remove all components having rubber parts from the system, b) flush lines with denatured alcohol or

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brake cleaner, c) repair or replace all components having rubber parts, and d) bleed and flush with correct brake fluid. (Code A)

If a fluid other than brake fluid is present in the brake system which DOES NOT affect the rubber parts, the required service is to flush and fill with the correct brake fluid.

(Code A)

AA

BRAKE FRICTION MATERIAL

NOTE: Original Equipment Manufacturer (OEM) specifications designate replacement at different thicknesses.

CAUTION: It is required that friction material be matched in axle sets for consistent braking characteristics.

BRAKE FRICTION MATERIAL

AA

Condition	3	Code	3	Procedure
-----------	---	------	---	-----------

AA

Contaminated, e.g. fluid	3	A	3	Require replacement.
--------------------------	---	---	---	----------------------

that leaked from caliper,	3		3	
wheel cylinder or axle seal	3		3	

AA

Cracked through	3	A	3	Require replacement.
-----------------	---	---	---	----------------------

AA

Flaking or chunking	3	A	3	Require replacement.
---------------------	---	---	---	----------------------

AA

Glazed (shiny)	3		3	No service suggested or required.
----------------	---	--	---	-----------------------------------

AA

Grooves or ridges	3	B,2	3	No service suggested or required.
-------------------	---	-----	---	-----------------------------------

	3		3	See note (1) below.
--	---	--	---	---------------------

AA

Permanently attached	3	A	3	Require replacement.
----------------------	---	---	---	----------------------

hardware bent	3		3	
---------------	---	--	---	--

AA

Permanently attached	3	A	3	Require replacement.
----------------------	---	---	---	----------------------

hardware broken	3		3	
-----------------	---	--	---	--

AA

Permanently attached	3	A	3	Require replacement.
----------------------	---	---	---	----------------------

hardware loose	3		3	
----------------	---	--	---	--

AA

Permanently attached	3	A	3	Require replacement.
----------------------	---	---	---	----------------------

hardware missing	3		3	
------------------	---	--	---	--

AA

Permanently attached	3	A	3	Require repair or replacement.
----------------------	---	---	---	--------------------------------

hardware seized	3		3	
-----------------	---	--	---	--

AA

Rivets loose	3	A	3	Require replacement.
--------------	---	---	---	----------------------

AA

Separating from backing	3	A	3	Require replacement.
-------------------------	---	---	---	----------------------

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AA

Shoe table or web bent 3 A 3 Require replacement.

AA

Shoe table or web cracked 3 A 3 Require replacement.

AA

Shoe table or web worn 3 A 3 Require replacement.

 affecting performance 3 3

AA

Surface cracking 3 3 No service suggested or required.

 3 3 Further inspection may be

 3 3 necessary.

AA

Tapered wear 3 A 3 Further inspection required.

 3 3 See note (2) below.

AA

Thickness of one pad is 3 B,2 3 Suggested minimum service is to

 greater than opposite pad 3 3 lubricate caliper anchor and

 in the same caliper 3 3 hardware. However, caliper may

 (uneven wear) 3 3 need to be rebuilt or replaced.

 3 3 See note (3) below.

AA

Wear indicator device 3 A 3 Require replacement of

 (electronic) contacts rotor 3 3 appropriate parts. See caution

 3 3 below.

AA

CAUTION: The pad wear indicator light may come on due to other

 electrical problems.

AA

Wear indicator device 3 B,2 3 Further inspection required.

 (mechanical) bent 3 3 See note (4) below.

AA

Wear indicator device 3 B,2 3 Further inspection required.

 (mechanical) broken 3 3 See note (4) below.

AA

Wear indicator device 3 B,2 3 Further inspection required.

 (mechanical) contacts 3 3 See note (4) below.

 rotor 3 3

AA

Worn to minimum 3 A 3 Suggest replacement.

 specification 3 3

AA

Worn below minimum 3 A 3 Require replacement.

 specification 3 3

AA

Worn close to, but above, 3 A 3 Suggest repair or replacement.

 minimum specification 3 3

AA

NOTE: (1) When reconditioning or replacing drums or rotors,
 replacement of friction material may be suggested depending
 on the severity of the grooves or ridges.

(2) This type of wear is normal on some vehicles. Refer to
 specific vehicle application. If not normal, require

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replacement of pads and correction of cause.

- (3) Uneven pad thickness is normal on some vehicles. Refer to specific vehicle applications.

- (4) Explain to the customer that the purpose of the wear indicator is to alert him or her to check for friction wear. Wear indicators may be bent or broken. Therefore, the friction material must be measured. Friction material replacement is determined based upon the conditions stated in this section. Periodic inspection suggested.

AA

BRAKE SHOE HARDWARE

BRAKE SHOE HARDWARE

AA

Condition	3	Code	3	Procedure
-----------	---	------	---	-----------

AA

Broken	3	A	3	Require replacement.
--------	---	---	---	----------------------

AA

Distorted	3	A	3	Require replacement.
-----------	---	---	---	----------------------

AA

Missing	3	A	3	Require replacement.
---------	---	---	---	----------------------

AA

Surfaces are rust-pitted	3	A	3	Suggest replacement.
--------------------------	---	---	---	----------------------

AA

BRAKE STOPLIGHT SWITCHES

BRAKE STOPLIGHT SWITCHES

AA

Condition	3	Code	3	Procedure
-----------	---	------	---	-----------

AA

Bent	3	A	3	Require replacement.
------	---	---	---	----------------------

AA

Broken	3	A	3	Require replacement.
--------	---	---	---	----------------------

AA

Missing	3	A	3	Require replacement.
---------	---	---	---	----------------------

AA

Out of adjustment	3	A	3	Require adjustment or replacement.
-------------------	---	---	---	------------------------------------

AA

Output signal incorrect	3	A	3	Require replacement.
-------------------------	---	---	---	----------------------

AA

CALIPER HARDWARE

CALIPER HARDWARE

AA

Condition	3	Code	3	Procedure
-----------	---	------	---	-----------

AA

Bent	3	A	3	Require repair or replacement.
------	---	---	---	--------------------------------

AA

Broken	3	A	3	Require repair or replacement.
--------	---	---	---	--------------------------------

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Corroded, affecting performance 3 A 3 Require repair or replacement.

Dust boots on slider pin (bolt) are missing 3 B,2 3 Suggest replacement of boots.

Dust boots on slider pin (bolt) are torn 3 B,2 3 Suggest replacement of boots.

Missing 3 A 3 Require replacement.

Shims bent 3 A 3 Require removal or replacement.

Shims (OE standard) missing 3 A 3 Require replacement.
3 3 See note (1) below.

Shims out of position 3 A 3 Require removal or replacement.

Shims worn 3 A 3 Require removal or replacement.

Slider pin (bolt) bent 3 A 3 Require repair or replacement of
3 3 slider pin or bolt & lubricants.

Slider pin (bolt) rust-pitted 3 A 3 Require repair or replacement of
3 3 slider pin or bolt & lubricants.

Slider pin (bolt) worn 3 A 3 Require repair or replacement of
3 3 slider pin or bolt & lubricants.

Threads damaged 3 A 3 Require repair or replacement.

Threads stripped (threads missing) 3 A 3 Require replacement.

Worn, affecting performance 3 A 3 Require replacement.

NOTE: (1) Aftermarket shims may be suggested to reduce noise.

CALIPERS

You are not required to replace or rebuild calipers in axle sets. However, when replacing or rebuilding a caliper due to the conditions that follow, you may suggest servicing, rebuilding, or replacement of the other caliper (on the same axle) for improved performance and preventive maintenance (for example, the part is close to the end of its useful life, replacing the caliper may extend pad life, or contribute to more balanced braking).

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CAUTION: When installing calipers (loaded or unloaded), it is required that friction material be matched in axle sets for consistent braking characteristics.

Determine the need to replace or rebuild based upon the individual caliper conditions that follow.

CALIPERS

AA			
Condition	3	Code	3 Procedure
AA			
Bleeder port damaged (if non-repairable)	3	A	3 Require replacement of caliper.
	3		3
AA			
Bleeder screw plugged	3	A	3 Require repair or replacement of
	3		3 bleeder screw. See note (1) below.
AA			
Bleeder screw broken off in caliper (if non-repairable)	3	A	3 Require replacement of caliper.
	3		3 See note (1) below.
	3		3
AA			
Bleeder screw seized	3	A	3 Require replacement of caliper.
	3		3 See note (2) below.
AA			
Casting damaged - heavy corrosion affecting structural integrity	3	A	3 Require replacement of caliper.
	3		3
	3		3
AA			
Casting damaged - worn by rotor or wheel, affecting structural integrity	3	A	3 Require replacement of caliper.
	3		3
	3		3
AA			
Dust boot around caliper is torn	3	B,2	3 Suggest rebuilding or replacement
	3		3 of caliper.
AA			
Leaking	3	A	3 Require rebuilding or replacement
	3		3 of caliper.
AA			
Mounting pin threads damaged	3	A	3 Require repair or replacement of
	3		3 component with damaged threads.
AA			
Mounting pin threads stripped (threads missing)	3	A	3 Require repair or replacement of
	3		3 component with stripped threads.
AA			
Mounting pin threads stripped in caliper bracket (threads missing)	3	A	3 Require repair or replacement of
	3		3 caliper bracket.
	3		3
AA			
Mounting pin threads stripped in steering knuckle (threads missing)	3	A	3 Require repair or replacement of
	3		3 steering knuckle.
	3		3
AA			

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Pad thickness is greater 3 A 3 Require lubrication of caliper
than opposite pad in the 3 3 anchor and hardware. However,
same caliper (uneven wear) 3 3 caliper and/or hardware may need
3 3 to be rebuilt or replaced.
3 3 See note (3) below.

AA

Pads in one caliper are 3 A 3 Further inspection required.
thinner than pads in the 3 3 See note (4) below.
other caliper on the same 3 3
axle 3 3

AA

Parking brake cable 3 A 3 Require replacement of parts.
support, lever, or return 3 3
spring bent 3 3

AA

Parking brake cable 3 A 3 Require replacement of parts.
support, lever, or return 3 3
spring broken 3 3

AA

Parking brake mechanism in 3 A 3 Require repair or replacement.
caliper inoperative 3 3

AA

Piston anodized finish 3 A 3 Require replacement of piston and
worn off 3 3 rebuilding or replacement of
3 3 caliper.

AA

Piston corroded (pitted or 3 A 3 Require replacement of piston and
peeling chrome plating) 3 3 rebuilding or replacement of
3 3 caliper.

AA

Piston face damaged 3 A 3 Require replacement of piston and
(small scratches, 3 3 rebuilding or replacement of
chips acceptable) 3 3 caliper.

AA

Piston face scored by rotor 3 A 3 Require replacement of piston and
(small scratches, 3 3 rebuilding or replacement of
chips acceptable) 3 3 caliper.

AA

Piston sealing surface 3 A 3 Require replacement of piston and
damaged 3 3 rebuilding or replacement of
3 3 caliper.

AA

Piston sticking 3 A 3 Require rebuilding or replacement
3 3 of caliper.

AA

NOTE: (1) Only required if the hydraulic system must be opened.

(2) Seized is defined as a bleeder screw that cannot be removed
after a practical attempt at removing. Only required if the
hydraulic system must be opened.

(3) Some vehicles are designed with inner and outer pads of
different thicknesses. Refer to specific vehicle
applications.

```

specifications          3          3

```

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Missing 3 A 3 Require replacement.

AA

NOTE: (1) If moisture enters the controller, it can reduce life
expectancy or impair function.

AA

FLUID LEVEL SENSOR SWITCHES BRAKE

FLUID LEVEL SENSOR SWITCHES BRAKE

AA

Condition 3 Code 3 Procedure

AA

Connector loose 3 A 3 Require repair or replacement.

AA

Float saturated 3 A 3 Require replacement.

AA

Missing 3 A 3 Require replacement.

AA

Output signal incorrect 3 A 3 Require replacement.

AA

FOUR WHEEL DRIVE SWITCHES

FOUR WHEEL DRIVE SWITCHES

AA

Condition 3 Code 3 Procedure

AA

Broken 3 A 3 Require replacement.

AA

Connector loose 3 A 3 Require repair or replacement.

AA

Leaking 3 A 3 Require repair or replacement.

AA

Loose 3 A 3 Require repair or replacement.

AA

Missing 3 A 3 Require replacement.

AA

Output signal incorrect 3 A 3 Require replacement.

AA

HOSES

HOSES

AA

Condition 3 Code 3 Procedure

AA

Blistered 3 A 3 Require replacement.

AA

Fitting threads damaged 3 A 3 Require repair or replacement.

AA

Fitting threads stripped 3 A 3 Require replacement.

(threads missing) 3 3

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```

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Incorrectly secured          3   A   3   Require repair.
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Inner fabric (webbing) cut  3   A   3   Require replacement.
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Leaking                      3   A   3   Require replacement.
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Mounting hardware damaged   3   A   3   Require repair or replacement.
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Mounting hardware missing   3   A   3   Require replacement.
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Outer covering is cracked   3   A   3   Require replacement.
to the extent that inner    3       3
fabric of hose is visible   3       3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Restricted                   3   A   3   Require replacement.
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Routed incorrectly          3   A   3   Require routing correction.
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

```

HYDRAULIC MODULATORS BRAKE

Many modulators can only be replaced as complete assemblies. Whenever possible, replace the failed component part. If replacement of the failed part is not possible, then replace the modulator assembly.

HYDRAULIC MODULATORS BRAKE

```

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Condition                    3   Code  3   Procedure
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Disabled                     3   A   3   Require repair or replacement.
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Electrical failure           3   A   3   Require repair or replacement.
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
External leak                3   A   3   Require repair or replacement.
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Housing cracked              3   A   3   Require repair or replacement.
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Internal leak                 3   A   3   Require repair or replacement.
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Missing                      3   A   3   Require replacement.
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Valve stuck                   3   A   3   Require repair or replacement.
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

```

HYDRO-BOOSTERS

Conditions listed assume that the problem has been isolated to the specific component by proper testing procedures.

HYDRO-BOOSTERS

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Condition			3	Code	3	Procedure
Does not apply assist, or inadequate assist			3	A	3	Require repair or replacement.
Leaks fluid at fitting			3	A	3	Require tightening or replacement.
Leaks fluid at unit			3	A	3	Require repair or replacement.
			3		3	See note (1) below.
Leaks fluid from pressure hose(s)			3	A	3	Require replacement of hose(s).
Leaks fluid into passenger compartment			3	A	3	Require repair or replacement.
Wires corroded			3	A	3	Require repair or replacement.
Wires have exposed conductors			3	A	3	Require repair or replacement.
Wires burned			3	A	3	Require repair or replacement.
NOTE: (1) Follow diagnostic procedures as outlined in service manual to determine cause of leak and if unit can be repaired.						

HYDRO-ELECTRIC BOOSTERS (POWERMASTER)

Conditions listed assume that the problem has been isolated to the specific component by proper testing procedures.

HYDRO-ELECTRIC BOOSTERS (POWERMASTER)

Condition			3	Code	3	Procedure
Connector bent			3	A	3	Require repair or replacement.
Connector broken			3	A	3	Require repair or replacement.
Connector loose			3	A	3	Require repair or replacement.
Does not apply assist, or inadequate assist			3	A	3	Require repair or replacement.
Leaks fluid at fitting			3	A	3	Require tightening or replacement.
Leaks fluid at unit			3	A	3	Require repair or replacement.
			3		3	See note (1) below.

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NOTE: (1) Follow appropriate procedure for determined cause.

AA

MASTER CYLINDERS - BRAKE

MASTER CYLINDERS - BRAKE

AA

Condition	3	Code	3	Procedure
-----------	---	------	---	-----------

AA

Brake fluid leaking from	3	A	3	Further inspection required.
rear of master cylinder	3		3	See note (1) below.
bore	3		3	

AA

Brake pedal drops	3	A	3	Further inspection required.
intermittently	3		3	See note (2) below.

AA

Fluid level low	3		3	Further inspection required.
	3		3	See caution below.

AA

CAUTION: DO NOT TOP OFF. Look for disc pad wear or fluid leak.

Refer to OEM procedures for adjusting low fluid level.

AA

Internal valve failure	3	A	3	Require repair or replacement.
	3		3	See note (3) below.

AA

Master cylinder has residue	3	B,2	3	Further inspection required.
in reservoir	3		3	See note (4) below.

AA

Master cylinder leaking	3	A	3	Require repair or replacement.
brake fluid internally	3		3	See note (5) below.

AA

Piston does not return	3	A	3	Require repair or replacement.
------------------------	---	---	---	--------------------------------

AA

Ports plugged	3	A	3	Require repair or replacement.
---------------	---	---	---	--------------------------------

AA

Rubber master cylinder	3	A	3	Require replacement of the gasket.
cover gasket distorted	3		3	See note (6) below.
and gummy	3		3	

AA

NOTE: (1) Check for possible vacuum leak at booster input seal and/or push rod misalignment as possible causes. If neither is the cause, require repair or replacement of master cylinder.

(2) This condition may be normal on some vehicles equipped with anti-lock brakes. If all other possible causes have been eliminated, require repair or replacement of master cylinder.

(3) Require repair or replacement of valve if possible. If not possible, require replacement of the master cylinder.

(4) DO NOT replace master cylinder unless it exhibits conditions listed for replacement. You may suggest fluid change according to OEM service intervals.

(5) Use hose clamp test to determine this condition. Use an

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approved brake hose clamp to avoid damage to the hose.

(6) This condition may indicate contaminated brake fluid. See

Brake Fluid section of the Uniform Inspection Guidelines.

AA

PARKING BRAKE SWITCHES

PARKING BRAKE SWITCHES

AA

Condition	3	Code	3	Procedure
-----------	---	------	---	-----------

AA

Bent	3	A	3	Require replacement.
------	---	---	---	----------------------

AA

Broken	3	A	3	Require replacement.
--------	---	---	---	----------------------

AA

Corroded	3	B,2	3	Suggest repair or replacement as necessary.
----------	---	-----	---	---

AA

Missing	3	A	3	Require replacement.
---------	---	---	---	----------------------

AA

Out of adjustment	3	A	3	Require adjustment or replacement.
-------------------	---	---	---	------------------------------------

AA

Output signal	3	A	3	Require replacement.
---------------	---	---	---	----------------------

incorrect 3 3

AA

PARKING BRAKE SYSTEMS

The parking brake is an integral part of the brake system. It is important that the parking brake function properly when brake service is performed.

PARKING BRAKE SYSTEMS

AA

Condition	3	Code	3	Procedure
-----------	---	------	---	-----------

AA

Cable improperly adjusted	3	A	3	Require cable adjustment.
---------------------------	---	---	---	---------------------------

AA

Cable sticking	3	A	3	Require cable lubrication.
----------------	---	---	---	----------------------------

AA

Cable stuck inside conduit	3	A	3	Require replacement of cable
----------------------------	---	---	---	------------------------------

and cannot be lubricated 3 3 assembly.

so that parking brake 3 3

functions properly 3 3

AA

Cable or individual wires	3	A	3	Require replacement of cable
---------------------------	---	---	---	------------------------------

in the cable are broken 3 3 assembly.

AA

Parking brake parts are	3	A	3	Require replacement of inoperative
-------------------------	---	---	---	------------------------------------

inoperative 3 3 parts.

AA

Parking brake parts are	3	A	3	Require replacement of missing
-------------------------	---	---	---	--------------------------------

missing 3 3 parts.

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AA
Parking brake parts are 3 A 3 Require replacement of broken
broken 3 3 parts.

AA
Parking brake parts bent 3 A 3 Require replacement of bent parts.
AA

PEDAL TRAVEL SWITCHES

PEDAL TRAVEL SWITCHES

AA
Condition 3 Code 3 Procedure
AA
Bent 3 A 3 Require replacement.
AA
Broken 3 A 3 Require replacement.
AA
Corroded 3 B,2 3 Suggest repair or replacement.
AA
Missing 3 A 3 Require replacement.
AA
Out of adjustment 3 A 3 Require adjustment or replacement.
AA
Output signal incorrect 3 A 3 Require replacement.
AA

PRESSURE DIFFERENTIAL SWITCHES

PRESSURE DIFFERENTIAL SWITCHES

AA
Condition 3 Code 3 Procedure
AA
Bent 3 A 3 Require replacement.
AA
Broken 3 A 3 Require replacement.
AA
Corroded 3 B,2 3 Suggest repair or replacement.
AA
Missing 3 A 3 Require replacement.
AA
Output signal incorrect 3 A 3 Require replacement.
AA
Leaking 3 A 3 Require repair or replacement.
AA

PRESSURE SWITCHES

PRESSURE SWITCHES

AA
Condition 3 Code 3 Procedure
AA
Connector loose 3 A 3 Require repair or replacement.

Condition			3	Code	3	Procedure

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Corrosion affecting structural integrity	3	A	3	Require replacement.
	3		3	See (1) note below.
AA				
Cracked	3	A	3	Require replacement.
AA				
Hard spots	3	A	3	Suggest reconditioning or replacement
	3		3	of rotor according to OEM specs.
AA				
Lateral runout (wobble) exceeds OEM specs	3	A	3	Require re-indexing, reconditioning,
	3		3	or replacement according to specs.
AA				
Measured thickness is less than OEM discard specifications	3	A	3	Require replacement.
	3		3	
AA				
Rotor thickness will be less than OEM "machine to" specifications after required reconditioning	3	A	3	Require replacement.
	3		3	See note (2) below.
	3		3	
	3		3	
AA				
Surface is rust-pitted	3	A	3	Require reconditioning or replacement
	3		3	of rotor according to OEM specs.
AA				
Surface is scored	3	A	3	Require reconditioning or replacement
	3		3	of rotor according to OEM specs.
	3		3	See note (3) below.
AA				
Thickness variation (parallelism) exceeds OEM specifications	3	A	3	Require reconditioning or replacement
	3		3	of rotor according to OEM specs.
	3		3	
AA				
NOTE: (1) Examples of severe corrosion are: composite plate separated from friction surfaces and cooling fins cracked or missing.				
(2) If OEM does not supply "machine to" specifications, you may machine to discard specifications.				
(3) Scoring is defined as grooves or ridges in the friction contact surface. Some vehicle manufacturers require machining when scoring exceeds their allowable specifications.				
AA				

SELF-ADJUSTING SYSTEMS

SELF-ADJUSTING SYSTEMS				
AA				
Condition	3	Code	3	Procedure
AA				
Inoperative	3	A	3	Require repair or replacement of
	3		3	inoperative parts.
AA				
Missing	3	A	3	Require replacement.

Condition	3	Code	3	Procedure
-----------	---	------	---	-----------

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Alignment incorrect 3 A 3 Require repair or replacement.
Bent 3 A 3 Require replacement.
Contaminated 3 B,2 3 Suggest cleaning; identify and
3 correct cause.
Cracked 3 A 3 Require replacement.
Incorrect number of teeth 3 A 3 Require replacement.
Loose 3 A 3 Require replacement of worn parts.
Missing 3 A 3 Require replacement.
Teeth broken 3 A 3 Require replacement.
Teeth distorted 3 A 3 Further inspection required.
3 3 See note (1) below.
Teeth missing 3 A 3 Require replacement.
NOTE: (1) No action required unless ABS system performance is
affected. If performance is affected, require replacement.

VACUUM BOOSTERS

VACUUM BOOSTERS

Condition 3 Code 3 Procedure
Auxiliary vacuum pump 3 A 3 Require repair or replacement.
inoperative 3 3
Vacuum booster applies too 3 A 3 Require replacement.
much assist (oversensitive) 3 3
Vacuum booster check valve 3 A 3 Suggest replacement of grommet.
grommet deteriorated 3 3
Vacuum booster check valve 3 A 3 Require replacement of check
leaking 3 3 valve.
Vacuum booster check valve 3 A 3 Require replacement of check
missing 3 3 valve.
stuck closed 3 3 valve.
Vacuum booster check valve 3 A 3 Require replacement of check
stuck open 3 3 valve.

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Vacuum booster does not apply enough assist	3	A	3	Require replacement.
AAAAAA				
Vacuum booster does not release	3	A	3	Require replacement.
AAAAAA				
Vacuum booster fails to store or maintain vacuum	3	A	3	Require replacement.
AAAAAA				
Vacuum hose filter restricted	3	A	3	Require replacement of filter.
AAAAAA				
Vacuum hose filter leaking	3	A	3	Require replacement of filter.
AAAAAA				
Vacuum hoses collapsed	3	A	3	Require repair or replacement of hose.
AAAAAA				
Vacuum hoses leaking	3	A	3	Require repair or replacement of hose.
AAAAAA				
Vacuum hoses missing	3	A	3	Require replacement of hose.
AAAAAA				
Vacuum hoses restricted	3	A	3	Require repair or replacement of hose.
AAAAAA				

VALVES - BRAKE

VALVES - BRAKE				
AAAAAA				
Condition	3	Code	3	Procedure
AAAAAA				
Leaking	3	A	3	Require repair or replacement.
AAAAAA				
Linkage bent (rear load valves)	3	A	3	Require repair or replacement.
AAAAAA				
Linkage broken (rear load valves)	3	A	3	Require repair or replacement.
AAAAAA				
Linkage disconnected (rear load valves)	3	A	3	Require repair or replacement.
AAAAAA				
Pressure incorrect	3	A	3	Require adjustment. If not possible, require replacement.
AAAAAA				
Seized	3	A	3	Require replacement.
AAAAAA				
Sticking	3	A	3	Require replacement.
AAAAAA				

WHEEL ATTACHING HARDWARE

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For conditions noted below, also check conditions of wheel stud holes.

CAUTION: Proper lug nut torque is essential. Follow manufacturer's torque specifications and tightening sequence.
DO NOT lubricate threads unless specified by the vehicle manufacturer.

WHEEL ATTACHING HARDWARE

AA			
Condition	3	Code	3 Procedure
AA			
Bent	3	A	3 Require replacement.
AA			
Broken	3	A	3 Require replacement. See note (1) below.
AA			
Loose	3	A	3 Require repair or replacement of
	3		3 affected component.
AA			
Lug nut installed backward	3	A	3 Require repair.
	3		3
AA			
Lug nut mating type incorrect	3	A	3 Require replacement of nut.
	3		3
AA			
Lug nut mating surface dished	3	A	3 Require replacement of nut.
	3		3
AA			
Lug nut flats rounded	3	A	3 Require replacement of nut. See note (2)
AA			
Lug nut seized	3	A	3 Require replacement of nut and/or stud.
	3		3 See note (2) below.
AA			
Stud incorrect	3	A	3 Require replacement of stud.
AA			
Threads damaged	3	A	3 Require repair or replacement of
	3		3 component with damaged threads.
AA			
Threads stripped (threads missing)	3	A	3 Require replacement of component with
	3		3 stripped threads.
AA			
NOTE: (1) Some manufacturers require replacement of all studs on that			
wheel if two or more studs or nuts on the same wheel are			
broken or missing.			
(2) Only required if removing wheel.			
AA			

WHEEL BEARINGS, RACES, & SEALS

NOTE: When repacking or replacing wheel bearings, grease seal replacement is required. You are not required to replace these components in axle sets. Determine the need to replace based

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upon the individual component conditions that follow.

WHEEL BEARINGS, RACES, AND SEALS

AA			
Condition	3	Code	3 Procedure
AA			
Rear axle seal on rear-wheel drive leaking	3	A	3 Require replacement of seal and inspection of axle, bearing, housing, and vent tube.
AA			
Seal leaking	3	A	3 Require replacement of seal and inspection of bearings.
AA			
Spindle worn	3	A	3 Require replacement of spindle and bearings.
AA			
Wheel bearing assembly feels rough when rotated	3	A	3 Require replacement of bearing assembly.
AA			
Wheel bearing balls are pitted	3	A	3 Require replacement of bearing assembly.
AA			
Wheel bearing balls are worn	3	A	3 Require replacement of bearing assembly.
AA			
Wheel bearing end-play exceeds manufacturer's specifications	3	A	3 Require adjustment of bearing, if possible. If proper adjustment cannot be obtained, require repair or replacement of worn component.
AA			
Wheel bearing race is loose in the hub bore	3	A	3 Require replacement of hub assembly and wheel bearings.
AA			
Wheel bearing races are pitted	3	A	3 Require replacement of bearing assembly.
AA			
Wheel bearing races are worn	3	A	3 Require replacement of bearing assembly.
AA			
Wheel bearing rollers are pitted	3	A	3 Require replacement of bearing assembly.
AA			
Wheel bearing rollers are worn	3	A	3 Require replacement of bearing assembly.
AA			

WHEEL CYLINDERS

You are not required to replace or rebuild wheel cylinders in axle sets. However, when rebuilding or replacing a wheel cylinder due to the conditions that follow, you may suggest rebuilding or replacement of the other wheel cylinder (on the same axle) for

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preventive maintenance, for example, the part is close to the end of its useful life.

Determine the need to rebuild or replace based upon the individual wheel cylinder conditions that follow.

WHEEL CYLINDERS

Condition			3	Code	3	Procedure
Attaching hardware bent						
3	A	3				Require replacement of bent parts.
Attaching hardware broken						
3	A	3				Require replacement of broken
		3				parts.
Attaching hardware corroded						
3	A	3				Require replacement of corroded
affecting structural	3					parts.
integrity	3					
Attaching hardware loose						
3	A	3				Require repair or replacement.
Attaching hardware missing						
3	A	3				Require replacement of missing
		3				parts.
Bleeder port damaged						
3	A	3				Require replacement.
(if non-repairable)	3					
Bleeder screw plugged						
3	A	3				Require repair or replacement of
		3				bleeder screw. See note (1) below.
Bleeder screw broken off						
3	A	3				Require replacement.
in wheel cylinder	3					See note (1) below.
(if non-repairable)	3					
Bleeder screw seized						
3	A	3				Require replacement.
		3				See note (2) below.
Bore corroded (pitted)						
3	A	3				Require replacement.
Bore grooved						
3	A	3				Require replacement.
Bore oversized						
3	A	3				Require replacement.
Casting mounting threads						
3	A	3				Require repair or replacement.
damaged	3					
Casting mounting threads						
3	A	3				Require replacement.
stripped (threads missing)	3					
Dust boot damaged						
3	A	3				Require replacement of dust boot.
		3				See note (3) below.
Dust boot missing						
3	A	3				Require replacement of dust boot.

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3 3 See note (3) below.

Leaking 3 A 3 Require rebuilding or replacement.

3 3 See note (4) below.

Piston anodized finish 3 A 3 Require replacement of piston and worn off 3 3 rebuilding or replacement of wheel 3 3 cylinder.

Piston corroded (pitted) 3 A 3 Require replacement of piston and 3 3 rebuilding or replacement of wheel 3 3 cylinder.

Piston stuck in bore 3 A 3 Require replacement of wheel 3 3 cylinder.

Wheel cylinder loose 3 A 3 Require repair. See note (5) below

NOTE: (1) Only required if the hydraulic system must be opened.

(2) Seized is defined as bleeder screw that cannot be removed after a practical attempt at removing. Only required if the hydraulic system must be opened.

(3) Inspect for related conditions to wheel cylinder.

(4) Leaking is defined as a drop or almost a drop. Dampness is normal.

(5) Further inspection is required to determine whether the attaching hardware may be reused or replaced. This may include screws, clips, rings, or backing plate, depending upon the design.

WHEEL SPEED & VEHICLE SPEED SENSORS

WHEEL SPEED & VEHICLE SPEED SENSORS

WHEEL SPEED & VEHICLE SPEED SENSORS

Condition 3 Code 3 Procedure

Air gap incorrect 3 A 3 Require adjustment to vehicle 3 3 manufacturer's specifications.

3 3 See note (1) below.

Broken 3 A 3 Require replacement.

Housing cracked 3 A 3 Require replacement.

Internal resistance does 3 A 3 Require replacement. not meet specifications 3 3 See note (2) below.

Lead routing incorrect 3 A 3 Require re-routing according to 3 3 vehicle manufacturer's specs.

Loose 3 A 3 Require adjustment to vehicle

[illegible]

END OF ARTICLE

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ARTICLE BEGINNING

GENERAL INFORMATION

Electrical System Motorist Assurance Program
Standards For Automotive Repair

All Makes and Models

INTRODUCTION TO MOTORIST ASSURANCE PROGRAM (MAP)

The Motorist Assurance Program was formed in 1992 by forty (40) companies who were concerned about the image of automotive service establishments. Today, MAP is an industry-wide association dedicated to strengthening consumer satisfaction with the automotive repair industry. MAP's participants represent the majority of the nation's multi-bay retail automotive outlets, their parts and equipment suppliers, independent repair shops, industry associations, car companies, manufacturers representatives, and the trade press. MAP is developing standards of service, uniform inspection procedures and other programs to assure consumers of the industry's professionalism and the commitment to excellence shared by MAP's sponsoring companies.

MAP's achievements to date include production and distribution (over 280,000) of the consumer brochure "How to Find Your Way Under the Hood and Around Your Car", development of a Pledge of Satisfaction to Consumers and Standards of Service and establishment of relationships with regulatory agencies.

As auto repair becomes an issue for federal and state regulators, MAP is working to educate government leaders on the dynamics of automotive service and the self-monitoring efforts MAP has undertaken on the industry's behalf. MAP's sponsoring companies are becoming well-known to government representatives as exemplary businesses working to improve the industry. Media sources also look to MAP to provide information and advice to consumers and on working with automotive technicians and repair establishments.

In the next few months, MAP plans to assist member repair facilities in implementing the MAP Pledge to Customers, establishing an alternate dispute resolution system to help resolve customer complaints within the industry, and developing a shop accreditation program to encourage policies in concert with the MAP Standards of Service and Inspection Guidelines.

MAP has united the aftermarket behind its consumer-oriented goals and has established itself both within and outside of the industry. We welcome you to join us as MAP continues its outreach. With your support, both the automotive repair industry and your customers will reap the benefits. Please contact MAP at:

808 17th Street, NW
Suite 200
Washington, D.C. 20006
202 466 7050

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PLEDGE TO CUSTOMERS

1. That recommendations will be clearly explained and based on system failure, improved system performance or preventive maintenance according to accepted industry standards.

2. That personnel will be properly trained and qualified to identify and perform an accurate and complete inspection and service of vehicle systems.

3. That a written estimate will be provided and no work will be performed without a prior authorization.

4. That a written limited warranty will be included at no additional cost.

STANDARDS OF SERVICE

I. Our recommendations are based upon the following definitions.

A. System Failure - Parts/system indicated are out of manufacturers' specifications, have failed, or are unable to perform their normal function as intended or designed by the manufacturers. Service/replacement is needed now.

B. Preventive/Schedule Maintenance - Parts/system are scheduled for service/replacement per industry standards or are near the end of their useful life and repair/replacement is recommended in advance of parts/system failure. Service/replacement is optional.

C. Improved System Performance (Performance Improvement) - Parts/system indicated are recommended for repair/replacement to enhance/improve the vehicle's ability to perform as intended or designed by the manufacturer, or as requested by the customer. Service/replacement is optional.

II. Training/Criteria

A. Our personnel have acquired auto repair expertise through formal education or work experience.

B. Where appropriate, personnel are moving toward certification (e.g. vehicle manufacturers, ASE, etc.) for the services performed.

C. Continuing education will be supported by all MAP participants.

III. Appropriate Company Approved Inspection - We will perform an appropriate inspection based on MAP Uniform Inspection Guidelines.

IV. Written Estimates - Written estimates based on our inspection, in compliance with state and local regulations, will include parts (dollar amount), labor (dollar amount), and the total

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estimate.

V. Work Authorization - No work will be performed without the customer's prior approval.

VI. Limited Warranty - A minimum limited warranty will be offered of 90 days or 4,000 miles, whichever comes first, covering parts and labor.

VII. Returned Parts - All customers will be entitled to the return of old parts, or if they choose, they may examine the parts prior to leaving the store. Where failed parts are required to be returned to the manufacturer in order to honor the warranty, the customer will be allowed to examine the parts.

VIII. Classification of Parts - Replaced parts will be identified as new, remanufactured, rebuilt or used. MAP participants will inform the customer and indicate on the estimate and invoice whether a part is new, remanufactured, rebuilt or used.

MAP UNIFORM INSPECTION GENERAL GUIDELINES

OVERVIEW OF SERVICE REQUIREMENTS & SUGGESTIONS

It is MAP policy that all exhaust, brake, ABS, steering and suspension, wheel alignment, tires and wheels, driveline, engine performance and maintenance and heating, ventilation and air conditioning services be offered and performed under the guidelines and procedures specified in these sections.

Before any service is performed on a vehicle, an inspection of the appropriate system must be performed. The results of this inspection must be explained to the customer and documented on an inspection form. The condition of the vehicle and its components will indicate what services/part replacements may be required or suggested. In addition, suggestions may be made to satisfy the needs expressed by the customer.

This section lists the various parts and conditions that indicate required or suggested service or part replacement. Although this list is extensive, it is not inclusive. In addition to this list, a technician may make a suggestion. This suggestion must be based on substantial and informed experience or the vehicle manufacturer's recommended service interval.

Some conditions indicate that service or part replacement is required because the part in question is no longer providing the function for which it is intended, does not meet a vehicle manufacturer's design specification or is missing.

- * Example: An exhaust pipe has corroded severely and has a hole in it through which exhaust gases are leaking. Replacement of the exhaust pipe in this case is required due to functional failure.

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- * Example: A brake rotor has been worn to the point where it measures less than the vehicle manufacturer's specifications. Replacement of the rotor is required because it does not meet design specifications.

Some conditions indicate that a service or part replacement is suggested because the part is close to the end of its useful life or to address a customer's need, convenience or request. If a customer's vehicle has one of these conditions, the procedure may only be to suggest service.

- * Example: An exhaust pipe is rusted, corroded or weak, but no leaks are present. In this case, the exhaust pipe has not failed. However, there is evidence that the pipe may need replacement in the near future. Replacement of the pipe may be suggested for the customer's convenience in avoiding a future problem.
- * Example: The customer desires improved ride and/or handling, but the vehicle's shocks or struts have not failed. In this case, replacement may be suggested to satisfy the customer's wishes. In this case, replacement of the shocks or struts may not be sold as a requirement.

A customer, of course, has the choice of whether or not a Shop will service his or her vehicle. He or she may decide not to follow some of your suggestions. The following reasons may be used for required and suggested services:

Reasons to Require Repair or Replacement:

- * component no longer performs intended purpose
- * component does not meet a design specification (regardless of performance)
- * component is missing.

Reasons to Suggest Repair or Replacement

- * component is close to the end of its useful life (just above discard specifications or weak; failure likely to occur soon, etc.)
- * address a customer need, convenience or request (stiffen ride, enhance performance, eliminate noise, etc.)
- * comply with maintenance recommended by the vehicle's Original Equipment Manufacturer (OEM)
- * technician's recommendation based on substantial and informed experience.

ELECTRICAL SYSTEMS

NOTE: When working on electrical systems, if a potentially hazardous condition is observed, require repair or

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replacement of affected components.

BATTERY PREFACE COVER PAGE

Proper operation of any electrical system component can be affected by battery condition. The battery(ies) must meet or exceed minimum specification for vehicle as equipped and test to that specific battery's CCA. Before condemning any component, test vehicle following OEM test and diagnostic procedures.

A battery should meet or exceed the intended vehicle's OEM (Original Equipment Manufacturer) specifications with regard to Cold Cranking Amps for that specific vehicle. A battery should be tested using the test procedures outlined by Battery Council International (BCI) - an association of battery industry companies whose members establish policy and standards for the industry and/or the manufacturer of the battery,

DEFINITION OF TERMS

Cold Cranking Amp (CCA) Rating - The number of amperes a new, fully charged battery at 0°F (-17.8°C) can deliver for 30 seconds and maintain at least a voltage of 1.2 volts per cell (7.2 volts for a 12 volt battery).

Cranking Amps (CA) - The number of amps a new, fully charged battery, typically at 32°F (0°C), can deliver for 30 seconds and maintain at least a voltage of 1.2 volts per cell (7.2 volts for a 12 volt battery).

Hot Cranking Amps - A rating (non-recognized by BCI) used by some battery manufacturers for testing purposes based on 80°F (26.7°C).

OEM Cranking Amps - A number indicating the amount of amps (current) at 0° recommended by the vehicle manufacturer intended to meet the starting requirements for a specific vehicle.

Fails to Accept and Hold a Charge - This term refers a battery that fails to either accept and/or retain a charge using appropriate times listed in the Battery Charging Guide section of the BCI Technical Service Manual or battery manufacturer's specifications.

BATTERY LOAD TESTING

- * Battery Load Testing requirements should be tested at vehicle OEM specifications or battery CCA specifications for pass/fail criteria using the highest rating.
- * Battery Load Testing and OEM specifications are based on testing at the CCA level only. When a battery is rated at any other given temperature (32°F or 80°C), the battery rating should be converted to a corresponding CCA for testing

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purposes.

BATTERY

NOTE: Must meet or exceed OE specs for intended vehicle and component manufacturer's specifications for specific battery.

BATTERY

AA		
Condition	3	Procedure 3 Note
AA		
Fails to accept and hold charge	3	Require replacement. 3
AA		
Discharged battery/ open circuit voltage low/ low specific gravity	3	Further inspection 3 Recharge and retest to manufacturer's specifications if battery fails load test or fails to accept or hold a charge - replacement required.
AA		
Corroded posts/ terminals	3	Require repair. 3
AA		
Burned, melted posts/terminals	3	Require repair or replacement. 3
AA		
Loose posts/ terminals	3	Require replacement. 3
AA		
Loose or missing vent caps	3	Require repair or replacement of vent caps. 3
AA		
Case leaking	3	Require replacement. 3
AA		
Low fluid level	3	Further inspection 3 Determine cause of low fluid level, refill to proper level with water (distilled water preferred). 3 If level was below top of plates, recharge and retest to manufacturer's specifications to verify condition. If battery does not meet specifications, require replacement. 3 If battery is sealed type (non-removable filler caps) and the eye color

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	3	3	indicates low fluid level		
	3	3	require replacement.		
AA					
Swollen casing	3	Further inspection	3	No service suggested or	
	3	required.	3	required unless the	
AAAAAAAAAAAAAAAAAAAAAAAAAAAAA-				3	battery fails load test
Electrolyte	3		3	or fails to accept or	
discoloration/	3		3	hold a charge -	
contamination	3		3	replacement required.	
AA					
Wet/dirty top	3	Clean battery using	3	Check fluid level and	
	3	BCI procedures.	3	adjust to manufacturer's	
	3	Further inspection	3	specification. Check	
	3	required.	3	charging system for	
	3		3	proper operation.	
AA					
Frozen battery	3	Further inspection	3	Do not attempt to charge	
	3	required.	3	a frozen battery. Allow	
	3		3	battery to warm and then	
	3		3	recharge and test to	
	3		3	manufacturer's	
	3		3	specifications.	
AA					

BATTERY TRAY/HOLD DOWN HARDWARE

BATTERY TRAY/HOLD DOWN HARDWARE

AA			
--	--	--	--

CHARGING SYSTEM

NOTE: Inoperative means output does not meet OE specs for the intended vehicle. If components have been added that increase vehicle electrical load requirement (e.g., sound systems, air conditioning, alarm systems, etc.) charging system output must meet the increased demand.

ALTERNATOR/GENERATOR

ALTERNATOR/GENERATOR

AA			
Condition	3	Procedure	

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Article Text (p. 9)

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PULLEYS

AA		
Condition	3	Procedure
AA		
Improper alignment	3	Require repair or replacement.
AA		
Missing, damaged mounting hardware	3	Require repair or replacement of 3 mounting hardware.
AA		
Damaged	3	Require replacement.
AA		

TENSIONERS

TENSIONERS

AA			
Condition	3	Procedure	3 Note
AA			
Missing	3	Require replacement.	3
AA			
Noisy	3	Suggest replacement.	3
AA			
Damaged	3	Suggest replacement.	3
AA			
Improper tension	3	Further inspection	3 Follow manufacturer's 3 recommended adjustment 3 procedures. Suggest 3 replacement if unable to 3 meet OE specifications.
AA			

VOLTAGE REGULATOR

VOLTAGE REGULATOR

AA		
Condition	3	Procedure
AA		
Inoperative/Intermittent	3	Require replacement.
AA		
Output outside of OEM specifications	3	Require repair or replacement.
AA		
Corroded, loose terminal ends	3	Suggest repair or replacement.
AA		
Noisy	3	Suggest repair or replacement.
AA		
Missing, damaged mounting hardware	3	Require repair or replacement 3 of mounting hardware.
AA		
Damaged	3	Suggest replacement.
AA		

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WIRING HARNESS/CONNECTORS

VOLTAGE REGULATOR

AA		
Condition	3	Procedure
AA		
Routed incorrectly	3	Suggest repair.
AA		
Shorted/open	3	Require repair or replacement.
AA		
Connector terminal problem (e.g., bent, corroded, loose)	3	Suggest repair or replacement.
AA		
Excessive resistance	3	Require repair or replacement.
AA		
Poor ground	3	Require repair.
AA		
Damaged	3	Suggest repair or replacement.
AA		

FUSE BOX/BLOCK

FUSE BOX/BLOCK

AA		
Condition	3	Procedure
AA		
Burned/melted	3	Further inspection
	3	required.
	3	
	3	
AA		
Connector, terminal	3	Suggest repair or
problem (e.g., bent,	3	replacement.
corroded, loose)	3	
AA		
Missing, damaged	3	Require replacement
mounting hardware	3	of mounting hardware.
AA		

SYSTEM INDICATOR LIGHTS

SYSTEM INDICATOR LIGHTS

AA		
Condition	3	Procedure
AA		
Light does not come	3	Further inspection
on during bulb check	3	required.
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA		
Fail to function	3	
properly during test	3	
mode	3	
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA		

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On constantly or	3	3
intermittently	3	3
below.	3	3

AA

SYSTEM GAUGE

SYSTEM GAUGE

AA

Condition	3	Procedure	3	Note
-----------	---	-----------	---	------

AA

Inoperative/ intermittent	3	Further inspection required.	3	See service manual for further information
------------------------------	---	---------------------------------	---	---

AA

Indicating out of OEM's specification	3		3	
--	---	--	---	--

AA

Missing, damaged mounting hardware	3	Require replacement of mounting hardware.	3	
---------------------------------------	---	--	---	--

AA

GROUND STRAP

GROUND STRAP

AA

Condition	3	Procedure
-----------	---	-----------

AA

High resistance/open	3	Require repair or replacement.
----------------------	---	--------------------------------

AA

Missing	3	Require replacement.
---------	---	----------------------

AA

Corroded	3	Require repair or replacement.
----------	---	--------------------------------

AA

Loose	3	Require repair.
-------	---	-----------------

AA

Missing, damaged mounting hardware	3	Require replacement of mounting hardware.
------------------------------------	---	--

AA

Damaged	3	Suggest repair or replacement.
---------	---	--------------------------------

AA

STARTER SYSTEMS

To prevent misdiagnosis, care should be taken to eliminate the possibilities of mechanical problems or high resistance in power and/or ground circuits.

STARTER SYSTEMS

AA

Condition	3	Procedure	3	Note
-----------	---	-----------	---	------

AA

Inoperative/	3	Require repair or	3	
--------------	---	-------------------	---	--

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intermittent	3	replacement.	3
AA			
Excessive resistance/	3	Require repair or	3
open	3	replacement.	3
AA			
Amperage does not	3	Require repair or	3
meet OEM	3	replacement.	3
specifications	3		3
AA			
Missing, damaged	3	Require repair or	3
mounting hardware/	3	replacement of	3
brackets	3	mounting hardware.	3
AA			
Noisy	3	Further inspection	3
	3	required.	3
	3		3
AA			
Damaged drive gear	3	Require repair or	3
	3	replacement.	3
			3
AA			
Corroded, loose	3	Require repair or	3
terminals	3	replacement.	3
AA			
Cracked/broken	3	Suggest repair or	3
housing	3	replacement.	3
AA			

SOLENOID

SOLENOID			
AA			
Condition	3	Procedure	3
AA			
Inoperative/	3	Require repair or	3
intermittent	3	replacement.	3
AA			
Excessive resistance/	3	Require repair or	3
open	3	replacement.	3
AA			
Noisy	3	Further inspection	3
	3	required.	3
	3		3
AA			
Missing, damaged	3	Require repair or	3
mounting hardware/	3	replacement of	3
brackets	3	mounting hardware.	3
AA			
Fails to disengage	3	Further inspection	3
	3	required.	3
			3
AA			
Damaged	3	Suggest replacement.	3
AA			

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RELAYS

RELAYS

Condition	3	Procedure
Inoperative/intermittent	3	Require replacement.
Missing	3	Require replacement.
Missing, damaged mounting hardware	3	Require replacement of mounting hardware.
Corroded, loose terminals	3	Suggest repair or replacement.
Damaged	3	Suggest replacement.

IGNITION SWITCH

IGNITION SWITCH

Condition	3	Procedure
Inoperable	3	Require replacement.
Intermittent	3	Suggest replacement.
Malfunctioning (e.g., binding, worn, won't return, etc.)	3	Suggest repair or replacement.
Missing, damaged mounting hardware	3	Require replacement of mounting hardware.
Corroded, loose terminals	3	Suggest repair or replacement.
Damaged (e.g., melted, burned, cracked, etc.)	3	Suggest replacement.

NEUTRAL SAFETY SWITCH/CLUTCH SWITCH

NEUTRAL SAFETY SWITCH/CLUTCH SWITCH

Condition	3	Procedure	3	Note
Inoperative	3	Require replacement.	3	
Intermittent	3	Suggest replacement.	3	
Malfunctioning (e.g.,	3	Suggest repair or	3	

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Condition	3	Procedure	3	Note
AA				
Out of adjustment	3	Further inspection	3	Follow OEM recommended
	3	required.	3	adjustment procedures.
	3		3	Repair or replace if out
	3		3	of specification.
AA				
Inoperative	3	Require replacement.	3	
AA				
Intermittent	3	Require replacement.	3	
AA				
Corroded, loose	3	Suggest repair or	3	
terminals	3	replacement.	3	
AA				
Missing, damaged	3	Require repair or	3	
mounting hardware	3	replacement of	3	
	3	mounting hardware.	3	
AA				
Damaged	3	Suggest replacement.	3	
AA				

BULB SOCKETS

BULB SOCKETS				
AA				
Condition	3	Procedure	3	Note
AA				
Missing, damaged	3	Require repair or	3	
mounting hardware	3	replacement of	3	
	3	mounting hardware.	3	
AA				
Burned/melted	3	Further inspection	3	Determine cause and
	3	required.	3	correct prior to repair
	3		3	or replacement of
	3		3	socket(s).
AA				
Corroded, loose	3	Suggest repair or	3	
terminals	3	replacement.	3	
AA				
Inoperative/ intermittent	3	Require repair or	3	
	3	replacement.	3	
AA				
Damaged	3	Suggest repair or	3	
	3	replacement.	3	
AA				

WIRING HARNESS/CONNECTORS

WIRING HARNESS/CONNECTORS				
AA				
Condition	3	Procedure	3	
AA				

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Routed incorrectly	3	Suggest repair.
Shorted/open		
	3	Require repair or replacement.
Connector terminal problem (e.g., bent, corroded, loose)		
	3	Suggest repair or replacement.
Excessive resistance		
	3	Require repair or replacement.
Poor ground		
	3	Require repair.
Damaged		
	3	Suggest repair or replacement.

FUSE/FUSIBLE LINK/CIRCUIT BREAKER

FUSE/FUSIBLE LINK/CIRCUIT BREAKER				
Condition	3	Procedure	3	Note
Inoperative/intermittent				
	3	Require replacement.	3	Determine cause of
	3	Further inspection	3	condition and correct
	3	required.	3	prior to replacement.
Corroded, loose terminals				
	3	Suggest repair or	3	
	3	replacement.	3	
Missing				
	3	Require replacement.	3	Refer to OEM owner's
	3		3	manual for proper
	3		3	amperage and location.
Damaged (e.g., melted, burned, cracked, etc.)				
	3	Suggest repair or	3	
	3	replacement.	3	

SWITCHES/DIMMERS/TIMERS/DELAYS

SWITCHES/DIMMERS/TIMERS/DELAYS			
Condition	3	Procedure	
Inoperative/intermittent			
	3	Require replacement.	
Missing			
	3	Require replacement.	
Malfunctioning (e.g., binding, worn, won't return, etc.)			
	3	Suggest repair or replacement.	
Missing, damaged mounting hardware/adjusters			
	3	Require repair or replacement	
	3	of mounting hardware/adjusters.	

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Corroded, loose terminals 3 Suggest repair or replacement.
AA
Damaged (e.g., melted, burned, 3 Suggest replacement.
cracked, etc.) 3
AA

LENSES

LENSES
AA
Condition 3 Procedure
AA
Missing 3 Require replacement.
AA
Missing, damaged mounting hardware/ 3 Require repair or replacement
adjusters 3 of mounting hardware/adjusters.
AA
Broken 3 Require replacement.
AA
Damaged 3 Suggest replacement.
AA

ACTUATOR MOTOR/DOOR ASSEMBLY

ACTUATOR MOTOR/DOOR ASSEMBLY
AA
Condition 3 Procedure 3 Note
AA
Inoperative/ 3 Require replacement. 3
intermittent 3
AA
Malfunctioning (e.g. 3 Suggest repair or 3
binding, worn, won't 3 replacement. 3
return, etc.) 3
AA
Missing 3 Require replacement. 3
AA
Out of adjustment 3 Further inspection 3 Follow OEM recommended
3 required. 3 adjustment procedures.
3 Repair or replace if out
3 of specification.
AA
Leaking (vacuum) 3 Suggest repair or 3
3 replacement. 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA 3
Noisy 3
AA
Missing, damaged 3 Require repair or 3
mounting hardware 3 replacement of 3
3 mounting hardware. 3
AA
Corroded, loose 3 Suggest replacement. 3

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```
terminals          3          3
AAAAAAAAAAAAAAAAA  3
Damaged            3          3
AAAAAAAAAAAAAAAAA
```

VEHICLE ACCESSORIES

Vehicle accessories refers to OEM installed equipment, including but not limited to power windows, locks, seats, roof/top, antennas, heated seats, mirrors, windshield/window defrosters, trunk pull down/release, keyless entry, tire pressure monitors, electric mirrors, etc.

**POWER LOCKS, WINDOWS, SEATS, MIRRORS, ROOF/TOPS, ANTENNAS,
SLIDING DOORS**

```
SWITCHES
AAAAAAAAAAAAAAAAA
Condition          3          Procedure
AAAAAAAAAAAAAAAAA
Inoperable         3 Require replacement.
AAAAAAAAAAAAAAAAA
Intermittent       3 Suggest replacement.
AAAAAAAAAAAAAAAAA
Malfunctioning (e.g., binding, worn,  3 Suggest repair or replacement.
won't return, etc.)
AAAAAAAAAAAAAAAAA
Missing            3 Require replacement.
AAAAAAAAAAAAAAAAA
Missing, damaged mounting hardware  3 Require repair or replacement
of mounting hardware.
AAAAAAAAAAAAAAAAA
Corroded, loose terminals  3 Suggest repair or replacement.
AAAAAAAAAAAAAAAAA
Damaged (e.g., melted, burned,  3 Suggest replacement.
cracked, etc.)
AAAAAAAAAAAAAAAAA
```

ACTUATORS/MOTORS/SOLENOIDS/TRANSDUCERS

```
ACTUATORS/MOTORS/SOLENOIDS/TRANSDUCERS
AAAAAAAAAAAAAAAAA
Condition          3          Procedure          3          Note
AAAAAAAAAAAAAAAAA
Inoperative/       3 Require replacement.  3
intermittent       3
AAAAAAAAAAAAAAAAA
Malfunctioning (e.g.  3 Suggest repair or  3
binding, worn, won't  3 replacement.
return, etc.)       3
AAAAAAAAAAAAAAAAA
Missing            3 Require replacement.  3
```

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AA			
Out of adjustment	3	Further inspection	3 Follow OEM recommended
	3	required.	3 adjustment procedures.
	3		3 Repair or replace if out
	3		3 of specification.
AA			
Leaking (vacuum/ fluid/air)	3	Suggest repair or	3
	3	replacement.	3
AA			
Noisy	3		3
AA			
Corroded, loose	3		3
terminals	3		3
AA			
Missing, damaged	3	Require repair or	3
mounting hardware	3	replacement of	3
	3	mounting hardware.	3
AA			
Damaged	3	Suggest repair or	3
	3	replacement.	3
AA			

WIRING HARNESS/CONNECTORS

WIRING HARNESS/CONNECTORS

AA			
Condition	3		Procedure
AA			
Routed incorrectly	3	Suggest repair.	
AA			
Shorted/open	3	Require repair or replacement.	
AA			
Connector terminal problem (e.g., bent, corroded, loose)	3	Suggest repair or replacement.	
AA			
Excessive resistance	3		
AA			
Poor ground	3	Suggest repair.	
AA			
Damaged	3	Suggest repair or replacement.	
AA			

FUSE BOX/BLOCK

FUSE BOX/BLOCK

AA			
Condition	3	Procedure	3 Note
AA			
Burned/melted	3	Require replacement.	3 Determine cause and
	3	Further inspection	3 correct prior to repair
	3	required.	3 or replacement of fuse
	3		3 box.

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[illegible]

Connector, terminal	3	Suggest repair or	3
problem (e.g., bent,	3	replacement.	3
corroded, loose)	3		3

AAAAAAAAAAAAAAAAAAAAA 3

Loose terminals/	3	3
connectors	3	3

[illegible]

Missing, damaged 3 Require replacement 3
mounting hardware 3 of mounting hardware.3

[illegible]

FUSE/FUSIBLE LINK/CIRCUIT BREAKER

FUSE/FUSIBLE LINK/CIRCUIT BREAKER

[illegible]

Condition	3	Procedure	3	Note
-----------	---	-----------	---	------

[illegible]

Inoperative, intermittent	3 Require replacement. 3 Further inspection 3 required.	3 Determine cause of 3 condition and correct 3 prior to replacement.
------------------------------	---	--

[illegible]

Corroded, loose terminals	3	Suggest repair or replacement.	3
---------------------------	---	--------------------------------	---

[illegible]

Missing	3	Require replacement.	3	Refer to OEM owner's
	3		3	manual for proper
	3		3	amperage and location.

[illegible]

Damaged (e.g., melted, burned, cracked, etc.)	3	Suggest repair or replacement.	3
	3		3

[illegible]

RELAYS

RELAYS

AA

Condition	3	Procedure
-----------	---	-----------

[illegible]

Inoperative, intermittent ³ Require replacement.

AAAAAA

Missing ³ Require replacement.

AAAAAA

[illegible][illegible]

Corroded, loose terminals ³ Suggest repair or replacement.

[illegible]

Damaged ³ Suggest replacement.

Damaged: AAAAA
 Suggest Replacement: AAAAA

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CONTROL MODULE

CONTROL MODULE

AA			
Condition	3	Procedure	3 Note
AA			
Inoperative/ intermittent	3	Require replacement.	3
AA			
Malfunctioning (i.e., consistent with expected operations)	3	Suggest replacement.	3
AA			
Code set (if applicable)	3	Further inspection required.	3 Refer to manufacturer's diagnostic trouble code procedure and repair or replacement of affected component(s).
AA			
Damaged	3	Suggest replacement.	3
AA			
Corroded, loose terminals	3		3
AA			
Missing, damaged mounting hardware	3	Require replacement of mounting hardware.	3
AA			

ELECTROCHROMATIC MIRROR

ELECTROCHROMATIC MIRROR

AA			
Condition	3	Procedure	
AA			
Inoperative, intermittent	3	Require replacement.	
AA			
Corroded, loose terminals	3	Suggest repair or replacement.	
AA			
Malfunctioning	3	Suggest replacement.	
AA			
Missing, damaged mounting hardware	3	Require repair or replacement of mounting hardware.	
AA			
Missing	3	Require replacement.	
AA			
Damaged	3	Suggest replacement.	
AA			

HEATING ELEMENTS (DEFROSTER/DEFOGGER - ELECTRIC HEATERS,
MIRRORS, SEATS. ETC.)

HEATING ELEMENTS (DEFROSTER/DEFOGGER - ELECTRIC HEATERS, ETC.)

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AA		
Condition	3	Procedure
AA		
Inoperative, intermittent	3	Require repair or replacement.
AA		
Corroded, loose terminals	3	Suggest repair or replacement.
AA		
Damaged	3	Suggest repair or replacement.
AA		

CLOCK

AA		
Condition	3	Procedure
AA		
Inoperative, intermittent	3	Require repair or replacement.
AA		
Missing, damaged mounting hardware	3	Require repair or replacement of mounting hardware.
AA		
Corroded, loose terminals	3	Suggest repair or replacement.
AA		
Damaged (e.g., melted, burned, cracked, etc.)	3	Suggest repair or replacement.
AA		

CIGARETTE LIGHTER/SOCKET/ELEMENT

AA		
Condition	3	Procedure
AA		
Inoperative, intermittent	3	Require repair or replacement.
AA		
Corroded, loose terminals	3	Suggest repair or replacement.
AA		
Missing	3	Suggest replacement.
AA		
Missing, damaged mounting hardware	3	Require repair or replacement of mounting hardware.
AA		
Damaged	3	Suggest repair or replacement.
AA		

CRUISE CONTROL/LINKAGE/CABLES

AA		
Condition	3	Procedure 3 Note
AA		
Missing	3	Require replacement. 3

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AA		
Out of adjustment	3 Further inspection	3 Follow OEM recommended
	3 required.	3 adjustment procedures.
	3	3 Repair or replace if out
	3	3 of specification.
AA		
Disconnected	3 Further inspection	3 CAUTION: Reconnect and
	3 required.	3 check for proper
	3	3 operation.
AA		
Binding/seized	3 Further inspection	3 Determine cause of
	3 required.	3 binding. Require repair
	3	3 or replacement.
AA		
Broken	3 Require replacement.	3
AA		
Damaged	3 Suggest replacement.	3
AA		
Missing, damaged	3 Require repair or	3
mounting hardware	3 replacement of	3
or brackets	3 mounting hardware	3
	3 or brackets.	3
AA		
Routed incorrectly	3 Suggest repair.	3
AA		

VACUUM HOSES/TUBES/RESERVOIRS

VACUUM HOSES/TUBES/RESERVOIRS

AA		
Condition	3	Procedure
AA		
Missing	3	Require replacement.
AA		
Leaking	3	Require repair or replacement.
AA		
Restricted	3	Require repair or replacement.
AA		
Routed incorrectly	3	Suggest repair.
AA		
Damaged	3	Suggest repair or replacement.
AA		
Missing, damaged mounting hardware	3	Require repair or replacement
or brackets	3	of mounting hardware or
	3	brackets.
AA		

VEHICLE SPEED SENSORS

VEHICLE SPEED SENSORS

AA			
Condition	3	Procedure	3 Note

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AA

Improper output signal	3	Further inspection required.	3	Follow OEM recommended service procedures.
Internal resistance does not meet specifications	3		3	Component failure may be caused by water intrusion into the wiring harness. Always check insulation for damage and wiring for excessive resistance.
	3		3	Require repair or replacement of affected component(s).

AA

Cracked sensor housing	3	Require replacement.	3
------------------------	---	----------------------	---

AA

Lead routed incorrectly	3	Require re-routing according to vehicle manufacturer's specifications.	3
-------------------------	---	--	---

AA

Damaged wire lead	3	Require repair or replacement.	3
-------------------	---	--------------------------------	---

AA

Contamination of surface	3	Further inspection required.	3	Identify and correct source of contamination.
	3		3	Suggest repair (cleaning).

AA

Missing sensor/tip	3	Require replacement.	3
--------------------	---	----------------------	---

AA

Loose	3	Require repair or replacement.	3
-------	---	--------------------------------	---

AA

Damaged	3	Suggest replacement.	3
---------	---	----------------------	---

AA

Missing, damaged mounting hardware or brackets	3	Require repair or replacement of mounting hardware or brackets.	3
--	---	---	---

AA

BRAKE/CLUTCH SWITCH

BRAKE/CLUTCH SWITCH

AA

Condition	3	Procedure	3	Note
-----------	---	-----------	---	------

AA

Inoperative	3	Require replacement.	3
-------------	---	----------------------	---

AA

Intermittent	3		3
--------------	---	--	---

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Article Text (p. 25)

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```

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Malfunctioning (e.g., 3 Suggest repair or 3
binding, worn, won't 3 replacement. 3
return, etc.) 3 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Out of adjustment 3 Further inspection 3 Follow OEM recommended
3 required. 3 adjustment procedure.
3 3 Require repair or
3 3 replacement if out of
3 3 specification.
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Leaking 3 Suggest replacement. 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Missing 3 Require replacement. 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Missing, damaged 3 Require repair or 3
mounting hardware 3 replacement of 3
3 mounting hardware. 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Corroded, loose 3 Suggest repair or 3
terminals 3 replacement. 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Damaged 3 Suggest replacement. 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

```

VACUUM DUMP RELEASE VALVE

```

VACUUM DUMP RELEASE VALVE
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Condition 3 Procedure 3 Note
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Inoperative 3 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA' Require replacement. 3
Intermittent 3 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Out of adjustment 3 Further inspection 3 Follow OEM recommended
required. 3 required. 3 adjustment procedure.
3 3 Require repair or
3 3 replacement if out of
3 3 specification.
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Leaking 3 Suggest replacement. 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Missing, damaged 3 Require repair or 3
mounting hardware 3 replacement of 3
3 mounting hardware. 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Damaged 3 Suggest replacement. 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

```

CELLULAR PHONES/ANTENNA

[illegible]

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Condition	3	Procedure
AAAAA		
Inoperative	3	Require repair or replacement.
AAAAA		
Intermittent	3	
AAAAA		
Malfunctioning	3	Suggest repair or replacement.
AAAAA		
Missing	3	Require replacement.
AAAAA		
Missing, damaged mounting hardware	3	Require repair or replacement
	3	of mounting hardware.
AAAAA		
Corroded, loose terminals	3	
AAAAA		
Damaged	3	Suggest repair or replacement.
AAAAA		

SECURITY/ALARM SYSTEM/SENSORS

SECURITY/ALARM SYSTEM/SENSORS		
AAAAA		
Condition	3	Procedure
AAAAA		
Inoperative	3	Require repair or replacement.
AAAAA		
Intermittent	3	
AAAAA		
Malfunctioning	3	Suggest repair or replacement.
AAAAA		
Missing	3	Require replacement.
AAAAA		
Missing, damaged mounting hardware	3	Require repair or replacement
	3	of mounting hardware.
AAAAA		
Corroded, loose terminals	3	
AAAAA		
Damaged	3	Suggest repair or replacement.
AAAAA		

KEYLESS ENTRY/KEY PAD/TRANSMITTER

KEYLESS ENTRY/KEY PAD/TRANSMITTER		
AAAAA		
Condition	3	Procedure
AAAAA		
Inoperative/intermittent	3	Require repair or replacement.
AAAAA		
Malfunctioning	3	Suggest repair or replacement.
AAAAA		
Missing	3	Require replacement.
AAAAA		

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Missing, damaged mounting hardware 3 Require repair or replacement
3 of mounting hardware.

Corroded, loose terminals ³ Suggest repair or replacement.

AA
 Damaged ³ Suggest replacement.

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

SOUND SYSTEMS/WIRING HARNESS/CONNECTORS

SOUND SYSTEMS/WIRING HARNESS/CONNECTORS

AA		
Condition	3	Procedure

AA
Routed incorrectly ³ Suggest repair.

Shorted/open ³ Require repair or replacement.

Connector terminal problem (e.g., ³ Suggest repair or replacement.

```
bent, broken, corroded, loose)
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
```

Excessive resistance

Poor ground ³ Suggest repair.

Damaged ³ Suggest repair or replacement.

RECEIVER/AMPLIFIER/SPEAKERS/EQUALIZER
SUB-WOOFER VOLUME CONTROL

RECEIVER/AMPLIFIER/SPEAKERS/EQUALIZER/SUB-WOOFER VOLUME CONTROL

Condition			Procedure			Note		
3			3					

Inoperative ³ Require repair or ³

AAAAAAAAAAAAAAAAAAAAAA	replacement	3
Intermittent		3

Malfunctioning 3 Suggest repair or 3

[illegible]

Missing 3 Require replacement. 3

Missing, damaged	3	Require replacement	3
mounting hardware	3	of mounting hardware.	3

AA

Poor sound quality	3	Further inspection	3	Make sure poor sound is
--------------------	----------	--------------------	----------	-------------------------

Foot sound quality	3	Make sure foot sound is
	3	not caused by ignition/
	3	charging system or other

3 charging system or other
3 forms of electrical
3 interference.

INTERFERENCE:

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```

Corroded, loose      3 Suggest repair or      3
terminals            3 replacement.          3
Damaged              3 Suggest replacement.  3

```

TAPE/CD PLAYER

TAPE/CD PLAYER

```

Condition            3 Procedure              3 Note
Inoperative          3 Require repair or      3
                    3 replacement            3
Intermittent         3 Suggest repair or      3
                    3 replacement.          3
Malfunctioning       3
Missing              3 Require replacement.  3
Missing, damaged     3 Require replacement    3
mounting hardware    3 of mounting hardware.  3
Poor sound quality   3 Further inspection     3 Make sure poor sound is
                    3 required.              3 not caused by ignition/
                    3                        3 charging system or other
                    3                        3 forms of electrical
                    3                        3 interference.
Corroded, loose      3 Suggest repair or      3
terminals            3 replacement.          3
Skips                 3
Incorrect speed      3
Damaged              3 Suggest replacement.  3

```

WIPER SYSTEMS/MOTOR

WIPER SYSTEMS/MOTOR

```

Condition            3 Procedure              3 Note
Inoperative/         3 Require repair or      3
intermittent         3 replacement.          3
Malfunctioning (e.g. 3 Suggest repair or      3
binding, worn, won't 3 replacement.          3

```

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return, etc.)	3	3
AA		
Missing	3	Require replacement. 3
AA		
Out of adjustment	3	Further inspection 3 Follow OEM recommended
	3	required. 3 adjustment procedures.
	3	Repair or replace if out
		3 of specification.
AA		
Leaking (vacuum/ fluid/air)	3	Suggest repair or 3
	3	replacement. 3
AA		
Noisy	3	3
AA		
Corroded, loose terminals	3	3
	3	3
AA		
Missing, damaged	3	Require repair or 3
mounting hardware	3	replacement of 3
	3	mounting hardware. 3
AA		
Damaged	3	Suggest repair or 3
	3	replacement. 3
AA		

LINKAGE/ARMS/BLADES

LINKAGE/ARMS/BLADES		
AA		
Condition	3	Procedure
AA		
Inoperative	3	Require replacement.
AA		
Malfunctioning	3	Suggest repair or replacement.
AA		
Missing	3	Require replacement.
AA		
Missing, damaged mounting hardware	3	Require repair or replacement
	3	of mounting hardware.
AA		
Loose	3	
AA		
Noisy	3	Suggest repair or replacement.
AA		
Damaged	3	
AA		

PUMP RESERVOIR

PUMP RESERVOIR		
AA		
Condition	3	Procedure

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must adopt and diligently adhere to MAP's Pledge to Customers and MAP's Standards of Service.

If you are interested in obtaining more information about the Accreditation Program when it is issued, please complete the form below and then FAX it to MAP headquarters at (202) 223 9569.

Please send me information about MAP's accreditation program as soon as it is available.

NOTE: To print information request for Facilities Accreditation Program, print portion of article between dashed lines.

MAP FACILITIES ACCREDITATION PROGRAM

Please send me information about MAP's accreditation program as soon as possible.

Name _____

Company _____

Address _____

Phone _____ FAX _____

END OF ARTICLE

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ARTICLE BEGINNING

GENERAL INFORMATION

Engine Maintenance & Performance
Uniform Inspection Guidelines

All Makes & Models

Last Updated: December, 1994

MAP UNIFORM INSPECTION GENERAL GUIDELINES

OVERVIEW OF MOTORIST ASSURANCE PROGRAM

The Motorist Assurance Program (MAP) is the consumer outreach effort of the Automotive Maintenance and Repair Association, Inc. (AMRA). Participation in the Motorist Assurance Program is drawn from retailers, suppliers, independent repair facilities, vehicle manufacturers and industry associations.

The Motorist Assurance Program was established as an industry-wide effort to address concerns raised by regulators, the media and consumers questioning our ethics and methods of doing business. The automotive repair industry had been bombarded by months of negative stories in the media and scrutiny from state and federal regulators who focused on how the need for repairs is determined. MAP was formed as an industry response to this issue.

Our mission is to strengthen the relationship between the consumer and the auto repair industry. We produce materials that give motorists the information and encouragement to take responsibility for their vehicles - through proper, manufacturer-recommended, maintenance. We encourage participating service and repair shops (including franchisees and dealers) to adopt a Pledge to their Customers and the Motorist Assurance Program developed Standards of Service. All participating service providers have agreed to subscribe to this Pledge and to adhere to the promulgated Standards of Service which demonstrates to their customers that they are serious about customer satisfaction.

These Standards of Service require that an inspection of the vehicle's (problem) system be made according to industry guidelines. After learning that neither the car manufacturers nor any other source had complete guidelines, leading industry organizations, along with other industry participants banded together to address this challenging task. During the past two and a half years, they successfully developed industry inspection guidelines for the following systems: Exhaust, Brakes, ABS, Steering and Suspension, Engine Maintenance and Performance, HVAC, and Electrical systems. Guidelines for Drive Train and Transmission are currently being promulgated. Revisions to the inspection guidelines for Exhaust, Brakes/ABS and Steering and Suspension Systems, which were issued two years ago, are now being published for implementation beginning spring 1997. Participating shops utilize these Uniform Inspection Guidelines as part of the inspection process and for communicating their findings

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to their customers.

The Motorist Assurance Program continues to work cooperatively and proactively with government agencies and consumer groups toward solutions that both benefit the customer and are mutually acceptable to both regulators and industry. We maintain the belief that industry must retain control over how we conduct our business, and we must be viewed as part of the solution and not part of the problem. Meetings with state and other government officials concerned with auto repair and/or consumer protection are conducted. Feedback from these representatives are brought back to members, and the program adjusted as needed.

To assure auto repair customers recourse if they were not satisfied with a repair transaction, the Motorist Assurance Program offers arbitration through MAP/BBB-CARE in cooperation with the Council of Better Business Bureaus and individual participating Bureaus. MAP "piloted" in Indianapolis and Pittsburgh during spring, 1996 - and publicized "roll-outs" in New Jersey, Detroit (MI), Chicago (IL) and Richmond (VA) were conducted. To put some "teeth" in the program, and accreditation requirement for shops was initiated. The requirements are stringent and a self-policing method has been incorporated which includes the "mystery shopping" of outlets. In addition, a committee of service providers had been working diligently developing standards for newspaper, television and Internet advertising.

We welcome you to join us as we continue our outreach ... with your support, both the automotive repair industry and your customers will reap the benefits. Please visit MAP at our Internet site: www.hunter.com/map.htm or contact us at:

808 17th Street, NW Suite 200

Washington, D.C. 20006

Ph. (202) 466-7050 Fax (202) 223-9569

OVERVIEW OF SERVICE REQUIREMENTS & SUGGESTIONS

It is MAP policy that all exhaust, brake, ABS, steering and suspension, wheel alignment, tires and wheels, driveline, engine performance and maintenance and heating, ventilation and air conditioning services be offered and performed under the guidelines and procedures specified in these sections.

Before any service is performed on a vehicle, an inspection of the appropriate system must be performed. The results of this inspection must be explained to the customer and documented on an inspection form. The condition of the vehicle and its components will indicate what services/part replacements may be required or suggested. In addition, suggestions may be made to satisfy the needs expressed by the customer.

This section lists the various parts and conditions that indicate required or suggested service or part replacement. Although this list is extensive, it is not inclusive. In addition to this list, a technician may make a suggestion. This suggestion must be based on substantial and informed experience or the vehicle manufacturer's

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Condition	3	Procedure
AA		
Contaminated	3	Require replacement of oil and filter. 3 See NOTE: (1) below.
AA		
High level	3	Determine source of incorrect level and AAAAAAAAAAAAAAAAAAAAAAAA suggest correction.
Low level	3	
AA		
Maintenance intervals	3	Suggest replacement to comply with vehicles 3 OEM recommended service intervals.
AA		
NOTE: (1) Determine source of contamination, i.e., engine coolant, fuel, metal particles, when changing oil.		
AA		

ENGINE OIL FILTER/CANISTER

Condition	3	Procedure
AA		
Contaminated	3	Require replacement of oil and filter. 3 See NOTE: (1) below.
AA		
Damaged	3	Suggest replacement. Further inspection 3 required. See NOTE: (2) below.
AA		
Leaking	3	Require repair or replacement.
AA		
Maintenance intervals	3	Suggest replacement to comply with vehicles 3 OEM recommended service intervals.
AA		
NOTE: (1) Determine cause of contamination, i.e., engine coolant, fuel, metal particles, when changing oil. (2) Determine cause, i.e., broken motor mount.		
AA		

ENGINE GASKETS/SEALS

Condition	3	Procedure
AA		
Leaking	3	Tighten or suggest replacement as necessary.
AA		

ENGINE OIL DRAIN PLUG/GASKET

Condition	3	Procedure
AA		
Leaking	3	Require repair or replacement.
AA		
Damaged threads	3	Require repair or replacement.
AA		
NOTE: Some OEMs require replacement of drain plug gasket. Inspect		

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AA
Missing/by-passed 3 Further inspection required.
AA
Air flow restriction 3 Suggest repair.
AA
Missing, damaged, deteriorated 3 Require repair or replacement of
mounting hardware and bushings 3 hardware and/or bushings.
AA

ENGINE COOLING SYSTEM

RADIATOR & RADIATOR CAP

AA
Condition - Radiator 3 Procedure
AA
Leaking 3 Require repair or replacement.
AA
Damaged fins, tubes or fittings 3 Suggest repair or replacement.
AA
Internal restrictions 3 Require repair or replacement.
AA
Air flow restriction 3 Suggest repair.
AA
Missing, damaged, deteriorated 3 Require repair or replacement of
mounting hardware and bushings 3 hardware and/or bushings.
AA
Leaking internal trans cooler 3 Require repair or replacement.
AA
Corroded 3 Suggest repair or replacement.
AA
Condition - Radiator Cap 3 Procedure
AA
Missing 3 Require replacement.
AA
Fails to maintain proper pressure 3 Require replacement.
AA
Damaged/bent or corroded 3 Suggest replacement.
AA
Missing gaskets/seals 3 Require replacement.
AA
Coolant recovery check valve inoperative 3 Require replacement.
AA
Improper application 3 Require replacement.
AA

THERMOSTAT/HOUSING

AA
Condition 3 Procedure
AA
Improper installation 3 Require repair or replacement.
AA
Missing/damaged/corroded thermostat 3 Require replacement of

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3 thermostat

Improper application **3** Require replacement.
Inoperative **3** Require replacement.
Damaged/corroded housing **3** Suggest replacement of housing.

COOLANT HOSES/TUBES (RADIATOR, BY-PASS, HEATER, RECOVERY TANK)

Condition **3** Procedure
Leaking **3** Require repair or replacement.
Brittle, hard, cracked, corroded, **3** Suggest repair or replacement.
spongy, soft, oil soaked, **3**
collapsed, swollen, non-automotive **3**
Improper routing **3** Suggest repair or replacement.
Restricted **3** Suggest repair or replacement.
Missing/damaged protective sleeves **3** Suggest replacement of sleeves.
Maintenance intervals **3** Suggest replacement to comply
3 with vehicle's OEM recommended
3 service intervals.

CLAMPS

Condition **3** Procedure
Missing/damaged **3** Require replacement.
Loose **3** Require repair or replacement.
Corroded **3** Suggest replacement.

NOTE: Be sure to inspect hoses for deterioration.

COOLANT RECOVERY TANK/CAP

Condition **3** Procedure
Missing **3** Require replacement.
Leaking **3** Require repair or replacement.
Damaged **3** Suggest repair or replacement.

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AA
Missing, damaged mounting hardware ³ Suggest repair or replacement of
³ hardware.
AA

COOLANT

AA
Condition ³ Procedure

AA
Contaminated ³ Require replacement. Further inspection
³ required. See NOTE: (1).

AA
Low level ³ Require filling to proper level. See
³ NOTE: (2).

AA
Improper mixture/type ³ Require correction or replacement.

AA
Improper acidity (pH) ³ Suggest correction or replacement.

AA
Maintenance intervals ³ Suggest replacement. See NOTE: (3).

AA
NOTE: (1) Determine source of contamination and suggest correction
prior to coolant replacement.

(2) Determine source of incorrect level and suggest repair.

(3) The system should be drained and/or flushed and refilled
with correct coolant according to OEM Recommended Service
Interval and procedure.

AA

WATER PUMP

AA
Condition ³ Procedure

AA
Leaking, damaged ³ Require replacement.

AA
Noisy ³ Suggest replacement.

AA
Inoperative ³ Require replacement.

AA
Broken, missing fasteners ³ Require replacement of fasteners.

AA

SHROUD/BAFFLES/DEFLECTORS

AA
Condition ³ Procedure

AA
Missing/damaged ³ Require replacement.

AA
Missing/damaged mounting hardware ³ Require replacement of hardware.

AA

RADIATOR FAN BLADE & FAN CLUTCH

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Condition - Fan Motor Resistor	3	Procedure
Leaking	3	Require repair or replacement.
Contaminated/corroded	3	Suggest repair or replacement.
Intermittent/inoperative	3	Require replacement.
Damaged	3	Suggest replacement.

ACCESSORY BELTS

Condition	3	Procedure
Missing	3	Require replacement.
Improper tension	3	Require adjustment or repair.
Improper alignment	3	Further inspection required. See note.
Damaged	3	Require replacement.
Noisy	3	Suggest replacement.

NOTE: Check alignment of pulleys and proper belt installation.

ACCESSORY PULLEYS & TENSIONERS

Condition - Pulleys	3	Procedure
Damaged	3	Require replacement.
Improper alignment	3	Require repair.
Missing, damaged mounting hardware	3	Require repair or replacement of hardware.

Condition - Tensioners	3	Procedure
Missing	3	Require replacement
Noisy	3	Suggest replacement.
Damaged	3	Suggest replacement.
Improper adjustment	3	Require adjustment or repair.

GASKETS

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Condition	3	Procedure
Leaking	3	Tighten or suggest replacement as necessary.

HEATER CORE

Condition	3	Procedure
Leaking	3	Require repair or replacement.
Damaged fins, tubes, fittings	3	Suggest repair or replacement.
Internal restrictions	3	Suggest repair or replacement.
Missing/by-passed	3	Suggest repair or replacement.
Air flow restriction	3	Suggest repair or replacement.
Missing, damaged deteriorated mounting hardware/bushing	3	Suggest repair or replacement of hardware/bushing
Corroded	3	Suggest repair or replacement.

HEATER CONTROL VALVE

Condition	3	Procedure
Missing/by-passed	3	Suggest repair or replacement.
Leaking	3	Require replacement.
Inoperative	3	Suggest replacement.
Damaged valve/bracket	3	Suggest repair or replacement of valve/bracket

ENGINE COOLING PASSAGES

Condition	3	Procedure
External/internal leak	3	Require repair or replacement.
Restricted cooling passage	3	Require repair.

CASTING CORE/EXPANSION PLUGS

Condition	3	Procedure
-----------	---	-----------

Condition - Control ³		
Mechanism		Procedure
Inoperative	³ Require repair or replacement. Further inspection required. See NOTE: below.	
Leaking	³ Require repair or replacement.	

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Condition - Control³

Solenoid

³

Procedure

AA

Inoperative ³ Require repair or replacement. Further inspection

³ required. See NOTE: below.

AA

Leaking ³ Require repair or replacement.

AA

NOTE: Inoperative includes intermittent operation or out of OEM

specification.

AA

IDLE AIR CONTROL (IAC)

AA

Condition

³

Procedure

AA

Missing ³ Require replacement.

AA

Inoperative ³ Require repair or replacement. Further inspection

³ required. See NOTE: below.

AA

Damaged ³ Suggest replacement.

AA

Missing/damaged ³ Require repair or replacement of hardware.

mounting hardware ³

AA

NOTE: Inoperative includes intermittent operation or out of OEM

specifications. Some components may be serviceable; check for

accepted cleaning procedure.

AA

CHARGE AIR COOLER "INTERCOOLER" (CAC)

AA

Condition

³

Procedure

AA

Missing ³ Require replacement.

AA

Leaking ³ Require repair or replacement

AA

Damaged ³ Suggest repair or replacement.

AA

Missing/damaged mounting hardware ³ Require repair or replacement of

³ hardware.

AA

INTAKE AIR TEMP SENSOR (IAT)

AA

Condition

³

Procedure

AA

Missing ³ Require replacement.

AA

Inoperative ³ Require repair or replacement. Further inspection

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³ required. See NOTE: below.

AA
Damaged ³ Suggest replacement.

AA
Missing/damaged ³ Require repair or replacement of hardware.
mounting hardware ³

AA
NOTE: Inoperative includes intermittent operation or out of OEM
specifications. Some components may be serviceable; check for
accepted cleaning procedure.

AA

VOLUME AIR FLOW (VAF)

AA
Condition ³ Procedure

AA
Missing ³ Require replacement.

AA
Inoperative ³ Require repair or replacement. Further inspection
³ required. See NOTE: below.

AA
Damaged ³ Suggest replacement.

AA
Missing/damaged ³ Require repair or replacement of hardware.
mounting hardware ³

AA
NOTE: Inoperative includes intermittent operation or out of OEM
specification.

AA

MASS AIR FLOW (MAF)

AA
Condition ³ Procedure

AA
Missing ³ Require replacement.

AA
Inoperative ³ Require repair or replacement. See NOTE: below.

AA
Damaged ³ Suggest replacement.

AA
Missing/damaged ³ Require repair or replacement of hardware.
mounting hardware ³

AA
NOTE: Inoperative includes intermittent operation or out of OEM
specification.

AA

AIR PLENUM/INTAKE MANIFOLD

AA
Condition ³ Procedure

AA
Leaking ³ Require repair or replacement.

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Restricted ³ Require repair or replacement. See NOTE: below.

NOTE: Refer to accepted service procedure.

CARBURETOR/CHOKE (SEE NOTE:)

Condition 3 Procedure

Improper operation ³ Require repair or replacement.

Missing, damaged, binding mounting ³ Require repair or replacement.

```
hardware and other components          3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
```

NOTE: Proper operation of a carburetor includes the ability to control fuel mixtures during all phases of driving operation to comply with all federal and local emission standards.

Adjustments are to be considered repairs.

THROTTLE BODY

Condition			Procedure		
3					

Leaking ³ Require repair or replacement.

Restricted/contaminated ³ Require repair. See NOTE: below.

D Damaged ³ Require repair or replacement.

NOTE: Some components may be serviceable; check for accepted

[illegible]

VACUUM HOSES/TUBES

Condition		3	Procedure	

Missing ³ Require replacement.

[illegible][illegible]

EARLY FUEL EVAPORATION (EFE)

Condition		Procedure	
	3		

Refer to Early Fuel Evaporation Heater/Grid.

[illegible]

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POWERTRAIN CONTROL MODULE (PCM)

AA	
Condition	3 Procedure
AA	
Inoperative	3 Require repair or replacement.
AA	
Damaged	3 Suggest repair or replacement.
AA	

SENSORS/ACTUATORS DEFINITIONS

NOTE: The conditions and procedures apply to, but are not limited to the following list of components (SAE J1930 Terminology).

SENSORS/ACTUATORS DEFINITIONS

AA

Sensor	Abbreviation
02 Sensor	02S
Intake Air Temperature Sensor	IAT
Manifold Absolute Pressure Sensor	MAP
Engine Coolant Temperature Sensor	ECT
Barometric Pressure Sensor	BARO
Crankshaft Position Sensor	CKP
Throttle Positon Sensor	TPS
Camshaft Position Sensor	CMP
Park Neutral Position	PNP
Clutch Pedal Position Switch	CPP
Wide Open Throttle Switch	WOT Switch
Exhaust Gas Recirculation Valve Position Sensor	EGR Valve Position Sensor
Mass Air Flow Sensor	MAF
Volume Air Flow Sensor	VAF
Power Steering Pressure Sensor	PSP
Vehicle Speed Sensor	VSS
Fan Control Sensor	FS
Knock Sensor	KS
Air Conditioning Cycling Switch	AC
Exhaust Gas Recirculating Temperature Sensor	EGRT
Transmission Range Switch	TR Switch

Actuators	Abbreviation
Idle Speed Control Actuator	ISC
Idle Air Control	IAC
Exhaust Gas Recirculation Solenoid	EGR Solenoid
Vacuum Regulator Solenoid	...
Mix Control Solenoid	MC Solenoid
Torque Converter Clutch	TCC
Fuel Injector	...

[illegible]

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TUBES, HOSES, CLAMPS & GROMMETS

AA		
Condition	3	Procedure
AA		
Missing	3	Require replacement.
AA		
Damaged	3	Require repair or replacement.
AA		
Leaking	3	Require repair or replacement.
AA		
Restricted	3	Require repair or replacement.
AA		

ORIFICE

AA		
Condition	3	Procedure
AA		
Missing	3	Require replacement.
AA		
Restricted	3	Require repair or replacement.
AA		
Maintenance intervals	3	Suggest replacement to comply with vehicle's OEM recommended service intervals.
AA		

OIL SEPARATOR/FILTER

AA		
Condition	3	Procedure
AA		
Missing	3	Require replacement.
AA		
Restricted	3	Require repair or replacement.
AA		
Damaged	3	Suggest repair or replacement.
AA		
Maintenance intervals	3	Suggest replacement to comply with vehicle's OEM recommended service intervals.
AA		

IGNITION SYSTEM

BATTERY

AA		
Condition	3	Procedure
AA		
Refer to Starting/Charging System information.		
AA		

BATTERY CABLES/WIRES/CONNECTORS (SEE NOTE:)

AA		
Condition	3	Procedure
AA		

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Damaged 3 Suggest repair or replacement.
Corroded 3 Suggest repair or replacement.
High resistance 3 Require repair or replacement.
Loose 3 Require repair or replacement.
Missing, damaged, deteriorated 3 Require repair or replacement.
mounting hardware 3
NOTE: Cable/wires includes all wires and terminals connected to the
battery.

BATTERY TRAY/HOLD DOWN HARDWARE

Condition 3 Procedure
Missing 3 Require replacement.
Damaged/corroded 3 Suggest repair or replacement. See NOTE:
3 below.
NOTE: If battery tray/hold down hardware no longer performs
intended purpose, require repair or replacement.

FUSIBLE LINK

Condition 3 Procedure
Damaged 3 Suggest repair or replacement.
Open 3 Require replacement.

IGNITION SWITCH

Condition 3 Procedure
Damaged 3 Suggest replacement.
Inoperable/intermittent 3 Require replacement.

PARK NEUTRAL SWITCH (PNP)

Condition 3 Procedure
Inoperable/intermittent 3 Require replacement.

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Damaged 3 Suggest replacement.

AA

Out of specification 3 Require replacement.

AA

Oil soaked 3 Further inspection required. See NOTE: below.

AA

Inoperative 3 Require replacement. See NOTE: below.

AA

NOTE: Inoperative includes intermittent operation or out of OEM
specification. Refer to OEM recommended service procedures.

AA

STATOR/RELUCTOR

AA

Condition 3 Procedure

AA

Damaged 3 Require replacement.

AA

CRANK SENSOR (CKP)

AA

Condition 3 Procedure

AA

Missing 3 Require replacement.

AA

Inoperative 3 Require repair or replacement. Further
inspection required. See NOTE: below.

AA

Damaged 3 Suggest replacement.

AA

Missing/damaged mounting 3 Require repair or replacement of hardware.
hardware 3

AA

NOTE: Inoperative includes intermittent operation or out of OEM
specifications.

AA

CAM SENSOR (CMP)

AA

Condition 3 Procedure

AA

Missing 3 Require replacement.

AA

Inoperative 3 Require repair or replacement. Further
inspection required. See NOTE: below.

AA

Damaged 3 Suggest replacement.

AA

Missing/damaged mounting 3 Require repair or replacement of hardware.
hardware 3

AA

NOTE: Inoperative includes intermittent operation or out of OEM

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specifications.

AA

IGNITION HARNESS (PRIMARY)

AA

Condition ³ Procedure

AA

Damaged ³ Suggest repair or replacement.

AA

Mis-routed ³ Suggest repair.

AA

Open fusible link ³ Require replacement.

AA

Shorted/open ³ Require repair or replacement.

AA

Connector terminal problem ³ Require repair or replacement.

(bent, broken, corroded or loose) ³

AA

Excessive resistance ³ Require repair or replacement.

AA

Poor ground ³ Require repair.

AA

DISTRIBUTOR

AA

Condition ³ Procedure

AA

Bent shaft, worn bushings ³ Further inspection required. See NOTE:

and/or cam lobe ³ below.

AA

Damaged ³ Suggest repair or replacement.

AA

Missing, damaged mounting ³ Require repair or replacement of hardware.

hardware ³

AA

Worn gear ³ Suggest replacement of gear.

AA

Broken gear ³ Require replacement of gear.

AA

Oil soaked ³ Further inspection required. See NOTE:

³ below.

AA

NOTE: Refer to OEM recommended service procedures.

AA

DISTRIBUTOR CAP

AA

Condition ³ Procedure

AA

Damaged ³ Suggest replacement.

AA

Corroded/eroded terminals ³ Suggest replacement.

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AA
Burned/carbon tracked/arcing ³ Require replacement.

Missing carbon button ³ Require replacement.

Loose ³ Suggest repair or replacement.

DISTRIBUTOR ROTOR

Condition	3	Procedure

AA
Damaged ³ Suggest replacement.

Corroded/eroded ³ Require replacement.

Loose ³ Suggest repair or replacement.

Missing, damaged hold down ³ Require repair or replacement of fastener

fastener

[illegible]

IGNITION WIRES/BOOTS/TERMINAL (SECONDARY - SEE NOTE: (1))

AA		
Condition	3	Procedure

DAAAAA
 Damaged 3 Suggest repair or replacement.

Oil soaked ³ Suggest replacement.

Open/shorted ³ Require repair or replacement.

AA
Mis-routed ³ Suggest repair. See NOTE: (2).

Missing/damaged mounting ³ Suggest repair or replacement of hardware.

3 See NOTE: (2).

[illegible]

Corroded ³ Suggest repair or replacement.

High/Low resistance ³ Require repair or replacement.

NOTE: (1) It is not required to replace ignition wires in sets. However, you may suggest replacement of the entire secondary wire set for preventive maintenance.

(2) Proper routing, hardware, heat shields, etc. are intended to prevent premature failure of secondary ignition components.

[illegible]

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Missing	
³	Require replacement.
Leaking	
³	Require replacement.
Damaged	
³	Suggest replacement.

FUEL FILLER NECK/HOSES/CLAMPS/RESTRICTOR

Condition	3	Procedure
Missing	3	Require replacement.
Leaking	3	Require repair or replacement.
Damaged	3	Suggest repair or replacement.
Missing, damaged mounting hardware	3	Require repair or replacement of hardware.

FUEL TANK/CELL

Condition	3	Procedure
Leaking	3	Require repair or replacement.
Loose baffles	3	Require repair or replacement.
Damaged	3	Suggest repair or replacement.
Missing, damaged mounting hardware	3	Require repair or replacement of hardware.
Contaminated	3	Suggest repair. Further inspection required. See NOTE: below.

NOTE: Some components may be serviceable; check for accepted cleaning procedure.

FUEL LEVEL SENDER

Condition	3	Procedure
Inoperative	3	Suggest repair or replacement.
Leaking	3	Require repair or replacement.
Damaged	3	Suggest repair or replacement.

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FUEL PUMP (IN TANK/EXTERNAL - ELECTRICAL OR MECHANICAL)

AA		
Condition	3	Procedure
AA		
Inoperative	3	Require repair or replacement.
AA		
Noisy	3	Suggest replacement.
AA		
Leaking	3	Require repair or replacement.
AA		
Damaged	3	Suggest repair or replacement.
AA		
Missing, damaged mounting hardware	3	Requires repair or replacement of hardware
AA		

ELECTRIC FUEL PUMP CONTROL CIRCUIT

AA		
Condition	3	Procedure
AA		
See Electrical Uniform Inspection Guidelines.		
AA		

LIQUID VAPOR SEPARATOR

AA		
Condition	3	Procedure
AA		
Missing	3	Require replacement.
AA		
Leaking	3	Require replacement.
AA		
Damaged	3	Suggest repair or replacement.
AA		
Inoperative	3	Require repair or replacement
AA		

ROLL-OVER VALVE

AA		
Condition	3	Procedure
AA		
Missing	3	Require replacement.
AA		
Damaged	3	Suggest repair or replacement.
AA		
Inoperative	3	Require replacement.
AA		
Leaking	3	Require replacement.
AA		

INERTIA FUEL SHUT OFF SWITCH

AA		
--	--	--

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Condition	3	Procedure
AA		
Inoperative	3	Require repair or replacement.
AA		
Missing	3	Require replacement.
AA		
Damaged	3	Suggest replacement.
AA		

FUEL LINES/CLAMPS/O-RINGS/CONNECTORS (SEE NOTE)

AA		
Condition	3	Procedure
AA		
Missing	3	Require replacement.
AA		
Leaking	3	Require repair or replacement.
AA		
Restricted	3	Require repair or replacement.
AA		
Routed incorrectly	3	Suggest repair.
AA		
Damaged	3	Suggest repair or replacement.
AA		
NOTE: When replacing fuel lines/hoses, replace with products that meet(s) or exceed(s) OEM design specifications.		
AA		

FUEL FILTER & IN-TANK FUEL STRAINER

AA		
Condition - External Filter	3	Procedure
AA		
Missing	3	Require replacement.
AA		
Restricted/contaminated	3	Require replacement.
AA		
Leaking	3	Require repair or replacement.
AA		
Damaged	3	Suggest replacement.
AA		
Maintenance interval	3	Suggest replacement to comply with OEM recommended service interval.
AA		
Missing, damaged mounting hardware	3	Suggest repair. Further inspection required.
AA		
Condition - In-Tank	3	Procedure
AA		
Missing	3	Require replacement.
AA		
Damaged	3	Require replacement.
AA		
Restricted	3	Require repair or replacement.

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Damaged ³ Suggest replacement.

AA

Restricted/contaminated ³ Suggest repair. Further inspection required.

³ See NOTE: below.

AA

NOTE: Some components may be serviceable; check for accepted
cleaning procedure.

AA

FUEL/COLD START INJECTORS (SEE NOTE: (1))

AA

Condition ³ Procedure

AA

Inoperative ³ Require repair or replacement. Further
³ inspection required. See NOTE: (2) below.

AA

Damaged ³ Suggest repair or replacement.

AA

Missing, damaged mounting ³ Require repair or replacement of hardware.
hardware ³

AA

Leaking ³ Require repair or replacement.

AA

NOTE: (1) It is not required to replace injectors in sets. However,
you may suggest replacement of all injectors for preventive
maintenance.

(2) Inoperative included intermittent operations out of OEM
specifications. Some components may be serviceable; check
for accepted cleaning procedure.

AA

THROTTLE BODY

AA

Condition ³ Procedure

AA

Leaking ³ Require repair or replacement.

AA

Restricted/contaminated ³ Require repair. See NOTE: below.

AA

Damaged ³ Require repair or replacement.

AA

NOTE: Some components may be serviceable; check for accepted
cleaning procedure.

AA

CARBURETOR/CHOKE

AA

Condition ³ Procedure

AA

Improper air/fuel control ³ Require repair or replacement.

AA

Missing, damaged hardware ³ Require repair or replacement of

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3 hardware.

Leaking 3 Require repair or replacement.

Contaminated 3 Require repair or replacement. Further inspection required. See NOTE: below.

Improper mechanical operation 3 Require repair or replacement.

NOTE: Some components may be serviceable; check for accepted cleaning procedure.

EARLY FUEL EVAPORATION VALVE (HEAT RISER ASSEMBLY)

Condition 3 Procedure

Inoperative, binding 3 Require repair or replacement.

Leaking exhaust 3 Require repair or replacement.

Noisy 3 Suggest repair or replacement.

EARLY FUEL EVAPORATION, HEATER/GRID (EFE)

Condition 3 Procedure

Inoperative 3 Require repair or replacement.

Restricted 3 Require repair or replacement.

Damaged 3 Suggest repair or replacement.

EXHAUST GAS RECIRCULATION SYSTEM (EGR)

EGR VALVE

Condition 3 Procedure

Missing 3 Require replacement.

Inoperative 3 Require repair or replacement.

Leaking 3 Require repair or replacement.

Restricted passage 3 Require repair or replacement.

Damaged 3 Suggest repair or replacement.

Maintenance interval 3 Suggest repair or replacement to comply with

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[illegible]

CONTROL SOLENOID

Condition		Procedure
Missing	3	Require replacement.
Damaged	3	Suggest replacement.
Inoperative	3	Require replacement.

EVAPORATIVE SYSTEMS

EVAPORATIVE EMISSION CANISTER (EVAP)

Condition			Procedure		
Damaged	3	Suggest replacement.			
Missing	3	Require replacement.			
Leaking	3	Require replacement.			
Saturated	3	Require replacement.			
Inoperative	3	Require repair or replacement.			

EVAPORATIVE EMISSION CANISTER FILTER (EVAP FILTER)

Condition		Procedure
Missing	3	Require replacement.
Restricted	3	Suggest replacement.
Maintenance interval	3	Suggest repair or replacement to comply with OEM recommended service interval.

HOSES/CLAMPS/TUBES

[illegible]

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Condition	3	Procedure
Missing	3	Require replacement.
Damaged	3	Suggest replacement.
Leaking	3	Require repair or replacement.
Restricted	3	Require repair or replacement.

EVAPORATIVE EMISSION CANISTER PURGE VALVE (ELECTRICAL/VACUUM)

Condition	3	Procedure
Missing	3	Require replacement.
Damaged	3	Suggest replacement.
Inoperative	3	Require replacement.
Leaking	3	Require replacement.

GAS CAP

Condition	3	Procedure
Missing	3	Require replacement.
Leaking	3	Require replacement.
Damaged	3	Suggest replacement.

LIQUID/VAPOR SEPARATOR

Condition	3	Procedure
Missing	3	Require replacement.
Leaking	3	Require replacement.
Damaged	3	Suggest repair or replacement.
Inoperative	3	Require repair or replacement.

ROLL OVER VALVE

Condition	3	Procedure
-----------	---	-----------

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Missing ³ Require replacement.

[illegible]

Damaged **3** Suggest repair or replacement.

[illegible]

Inoperative ³ Require replacement.

[illegible]

Leaking ³ Require replacement.

[illegible]

TRANSMISSION & CLUTCH RELATED INSPECTION INFORMATION

AUTOMATIC TRANSMISSION FILTER

[illegible]

Condition	3	Procedure
-----------	---	-----------

[illegible]

Contaminated	³ Require replacement of fluid and filter.
--------------	---

[illegible]

Maintenance intervals ³ Suggest replacement to comply with OEM

³ recommended service intervals.

[illegible]

TRANSMISSION FLUID

[illegible]

Condition	3	Procedure
-----------	---	-----------

[illegible]

See * TRANSMISSION UNIFORM INSPECTION GUIDELINES *. (1)

[illegible]

(1) - TRANSMISSION UNIFORM INSPECTION GUIDELINES article is not

available at this time.

AAAAA

CLUTCH FLUID

[illegible]

Condition	3	Procedure
-----------	---	-----------

[illegible]

See * TRANSMISSION UNIFORM INSPECTION GUIDELINES *. (1)

[illegible]

(1) - TRANSMISSION UNIFORM INSPECTION GUIDELINES article is not

available at this time.

[illegible]

END OF ARTICLE

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ARTICLE BEGINNING

GENERAL INFORMATION
Exhaust Systems

All Makes & Models

Updated: September, 1996

MAP UNIFORM INSPECTION GENERAL GUIDELINES

OVERVIEW OF MOTORIST ASSURANCE PROGRAM

The Motorist Assurance Program (MAP) is the consumer outreach effort of the Automotive Maintenance and Repair Association, Inc. (AMRA). Participation in the Motorist Assurance Program is drawn from retailers, suppliers, independent repair facilities, vehicle manufacturers and industry associations.

The Motorist Assurance Program was established as an industry-wide effort to address concerns raised by regulators, the media and consumers questioning our ethics and methods of doing business. The automotive repair industry had been bombarded by months of negative stories in the media and scrutiny from state and federal regulators who focused on how the need for repairs is determined. MAP was formed as an industry response to this issue.

Our mission is to strengthen the relationship between the consumer and the auto repair industry. We produce materials that give motorists the information and encouragement to take responsibility for their vehicles - through proper, manufacturer-recommended, maintenance. We encourage participating service and repair shops (including franchisees and dealers) to adopt a Pledge to their Customers and the Motorist Assurance Program developed Standards of Service. All participating service providers have agreed to subscribe to this Pledge and to adhere to the promulgated Standards of Service which demonstrates to their customers that they are serious about customer satisfaction.

These Standards of Service require that an inspection of the vehicle's (problem) system be made according to industry guidelines. After learning that neither the car manufacturers nor any other source had complete guidelines, leading industry organizations, along with other industry participants banded together to address this challenging task. During the past two and a half years, they successfully developed industry inspection guidelines for the following systems: Exhaust, Brakes, ABS, Steering and Suspension, Engine Maintenance and Performance, HVAC, and Electrical systems. Guidelines for Drive Train and Transmission are currently being promulgated. Revisions to the inspection guidelines for Exhaust, Brakes/ABS and Steering and Suspension Systems, which were issued two years ago, are now being published for implementation beginning spring 1997. Participating shops utilize these Uniform Inspection Guidelines as part of the inspection process and for communicating their findings to their customers.

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The Motorist Assurance Program continues to work cooperatively and proactively with government agencies and consumer groups toward solutions that both benefit the customer and are mutually acceptable to both regulators and industry. We maintain the belief that industry must retain control over how we conduct our business, and we must be viewed as part of the solution and not part of the problem. Meetings with state and other government officials concerned with auto repair and/or consumer protection are conducted. Feedback from these representatives are brought back to members, and the program adjusted as needed.

To assure auto repair customers recourse if they were not satisfied with a repair transaction, the Motorist Assurance Program offers arbitration through MAP/BBB-CARE in cooperation with the Council of Better Business Bureaus and individual participating Bureaus. MAP "piloted" in Indianapolis and Pittsburgh during spring, 1996 - and publicized "roll-outs" in New Jersey, Detroit (MI), Chicago (IL) and Richmond (VA) were conducted. To put some "teeth" in the program, and accreditation requirement for shops was initiated. The requirements are stringent and a self-policing method has been incorporated which includes the "mystery shopping" of outlets. In addition, a committee of service providers had been working diligently developing standards for newspaper, television and Internet advertising.

We welcome you to join us as we continue our outreach ... with your support, both the automotive repair industry and your customers will reap the benefits. Please visit MAP at our Internet site: www.hunter.com/map.htm or contact us at:

808 17th Street, NW Suite 200

Washington, D.C. 20006

Ph. (202) 466-7050 Fax (202) 223-9569

OVERVIEW OF SERVICE REQUIREMENTS & SUGGESTIONS

It is MAP policy that all exhaust, brake, ABS, steering and suspension, wheel alignment, tires and wheels, driveline, engine performance and maintenance and heating, ventilation and air conditioning services be offered and performed under the guidelines and procedures specified in these sections.

Before any service is performed on a vehicle, an inspection of the appropriate system must be performed. The results of this inspection must be explained to the customer and documented on an inspection form. The condition of the vehicle and its components will indicate what services/part replacements may be required or suggested. In addition, suggestions may be made to satisfy the needs expressed by the customer.

This section lists the various parts and conditions that indicate required or suggested service or part replacement. Although this list is extensive, it is not inclusive. In addition to this list, a technician may make a suggestion. This suggestion must be based on substantial and informed experience or the vehicle manufacturer's recommended service interval.

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Some conditions indicate that service or part replacement is required because the part in question is no longer providing the function for which it is intended, does not meet a vehicle manufacturer's design specification or is missing.

- * Example: An exhaust pipe has corroded severely and has a hole in it through which exhaust gases are leaking. Replacement of the exhaust pipe in this case is required due to functional failure.
- * Example: A brake rotor has been worn to the point where it measures less than the vehicle manufacturer's specifications. Replacement of the rotor is required because it does not meet design specifications.

Some conditions indicate that a service or part replacement is suggested because the part is close to the end of its useful life or to address a customer's need, convenience or request. If a customer's vehicle has one of these conditions, the procedure may only be to suggest service.

- * Example: An exhaust pipe is rusted, corroded or weak, but no leaks are present. In this case, the exhaust pipe has not failed. However, there is evidence that the pipe may need replacement in the near future. Replacement of the pipe may be suggested for the customer's convenience in avoiding a future problem.
- * Example: The customer desires improved ride and/or handling, but the vehicle's shocks or struts have not failed. In this case, replacement may be suggested to satisfy the customer's wishes. In this case, replacement of the shocks or struts may not be sold as a requirement.

A customer, of course, has the choice of whether or not a shop will service his or her vehicle. He or she may decide not to follow some of your suggestions. When a customer declines to authorize a service or repair indicated in the MAP Uniform Inspection Guidelines as "required," a MAP shop may refuse service on that system, if proceeding with the work could create or continue an unsafe or unsatisfactory condition.

The following reasons may be used for required and suggested services. These codes are shown in the "Code" column of the Uniform Inspection Guidelines that follow.

PART REPLACEMENT CODE IDENTIFICATION

NOTE: Refer to the following tables for definitions of the codes listed in the condition/procedure tables for the specific components that may need to be replaced.

A - PART NO LONGER PERFORMS INTENDED PURPOSE

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CATALYTIC CONVERTERS

CAUTION: Before working on an exhaust system, review EPA regulations on removing and replacing catalytic converters.

NOTE: Any time a converter has failed, further diagnosis is required to determine the reason(s) for converter failure. Advise customer of cause(s).

CATALYTIC CONVERTERS

Condition			Code	Procedure
Air injection tube broken				
Air injection tube burnt				
Air injection tube damaged				
Air injection tube leaking				
Air injection tube loose				
Air injection tube restricted				
Air injection tube threads damaged				
Air injection tube threads stripped (threads missing)				
Body cracked				
Converter empty				
Converter fill plug missing				
Converter missing				
Exhaust gases leaking				
Flanges leaking				
Inlet pipes cracked				
Internal rattle (except pellet-type)				
Mounting brackets that are				

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part of converter broken 3 3
Obvious overheating 3 3 Further inspection required.
3 3 See note (2) below.
Outlet pipes cracked 3 B 3 Require repair or replacement.
Pieces of catalyst material 3 A,1 3 Suggest replacement.
found downstream 3 3
Plugged 3 A 3 Require replacement. See note (3)
Testing has determined that 3 A 3 Require repair or replacement.
existing converter has been 3 3
lead-poisoned, contaminated 3 3
or failed testing 3 3

NOTE: (1) If the converter is breaking up, suggest converter replacement. If an object has fallen into the converter, remove the object.
(2) Further diagnosis is required to determine the cause of the overheating. Replacement of the converter may not be necessary.
(3) Determine cause and correct to ensure that new converter will not become plugged.

EXHAUST & TAIL PIPES

NOTE: For pipes with resonators, also refer to the section on Mufflers and Resonators.

EXHAUST & TAIL PIPES

Condition 3 Code 3 Procedure
Bracket broken 3 A 3
Pipe bent out of position 3 B 3
Require repair or replacement.
Pipe broken 3 A 3
Pipe cracked 3 B 3
Pipe leaking 3 A 3
Pipe missing 3 C 3 Require replacement.
Pipe plugged 3 A 3
Pipe weak due to corrosion, 3 A,1 3 Suggest replacement.
but no leaks present 3 3

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weld(s) broken ³ A ³ Require repair or replacement.

EXHAUST CONNECTIONS

EXHAUST CONNECTIONS

Condition	Code	Procedure
Attaching hardware incorrect	B	Require replacement of hardware.
Corroded, affecting structural integrity	A,1	Suggest replacement.
Incorrect type (i.e. flange, ball & socket etc.)	B	Require replacement.
Leaking	A	Require repair.
Loose	A	Require repair.

HANGERS

HANGERS

Condition	3	Code	3	Procedure
Broken	3	A	3	Require replacement.
Corroded, affecting structural integrity	3	A,1	3	Suggest replacement.
Incorrect type	3	B	3	Require replacement.
Loose	3	A	3	Require repair or replacement.
Missing	3	C	3	Require replacement.
Out of position	3	B	3	Require repair or replacement.
Rubber deteriorated	3	A,1	3	Suggest replacement.

HEAT RISERS

HEAT RISERS

Condition			3	Code	3	Procedure		

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Broken	3	A	3	Require replacement of affected
	3		3	parts.
AA				
Diaphragm inoperative	3	A	3	Further inspection required.
	3		3	See note (1) below.
AA				
Leaking	3	A	3	Require repair or replacement.
AA				
Rattles	3	B,2	3	Suggest replacement of affected
	3		3	parts.
AA				
Seized	3	A	3	Require replacement of affected
	3		3	parts.
AA				
Spring(s) broken	3	B	3	Require replacement of spring(s).
AA				
Spring(s) inoperative	3	A	3	Require replacement of spring(s).
AA				
NOTE: (1) If the inoperative diaphragm is separate from the heat				
riser, then require replacement of the inoperative				
diaphragm. If the inoperative diaphragm is part of the heat				
riser, then replace the heat riser.				
AA				

HEAT SHIELDS

HEAT SHIELDS				
AA				
Condition	3	Code	3	Procedure
AA				
Bent	3	B	3	Require repair or replacement.
AA				
Broken	3	A	3	Require replacement.
AA				
Corroded, affecting	3	A,1	3	Suggest replacement.
structural integrity	3		3	
AA				
Loose	3	A	3	Require repair.
AA				
Missing	3	C	3	Require replacement.
AA				

MANIFOLDS: CAST & TUBE TYPE

MANIFOLDS: CAST & TUBE TYPE				
AA				
Condition	3	Code	3	Procedure
AA				
Air injection tube in	3	A	3	Require repair of injection tube
manifold broken	3		3	or replacement of manifold.
AA				
Air injection tube in	3	A,1	3	Suggest replacement of injection

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manifold corroded,	3	3	tube or manifold.
affecting structural	3	3	
integrity	3	3	
AA			
Air injection tube in	3	A	3 Require repair of injection tube
manifold leaking	3	3	or replacement of manifold.
AA			
Air injection tube in	3	A	3 Require repair.
manifold loose	3	3	
AA			
Air injection tube in	3	A	3 Require replacement of injection
manifold restricted	3	3	tube or manifold.
AA			
Air injection tube in	3	A	3 Require repair of injection tube
manifold threads damaged	3	3	manifold.
AA			
Air injection tube in	3	A	3 Require replacement of injection
manifold threads stripped	3	3	tube or manifold.
(threads missing)	3	3	
AA			
Bolt(s) broken	3	A	3 Require replacement.
AA			
Bolt(s) loose	3	A	3 Require tightening or replacement
	3	3	of bolts.
AA			
Bolt(s) missing	3	C	3 Require replacement.
AA			
Gasket leaking	3	A	3 Require tightening or replacement
	3	3	of gasket.
AA			
Heat stove bent	3	B	3 Require repair or replacement
	3	3	of stove. See note (1) below.
AA			
Heat stove broken	3	A	3 Require replacement of stove.
	3	3	See note (1) below.
AA			
Heat stove corroded,	3	A,1	3 Suggest replacement of stove.
affecting structural	3	3	See note (1) below.
integrity	3	3	
AA			
Heat stove missing	3	C	3 Require replacement of stove.
	3	3	See note (1) below.
AA			
Manifold broken	3	A	3 Require repair or replacement.
AA			
Manifold cracked	3	B	3 Require repair or replacement.
AA			
Manifold warped	3	A	3 Require replacement.
AA			
Stud(s) broken	3	A	3 Require replacement of stud.
AA			
Stud(s) missing	3	C	3 Require replacement of stud.

*** EXHAUST SYSTEM UNIFORM INSPECTION GUIDELINES ***

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AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Stud(s) threads damaged      3  A      3  Require repair/replacement of stud
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Stud(s) threads stripped      3  A      3  Require replacement of stud.
(threads missing)            3          3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
NOTE: (1) Stove may not be available separately; this may require
      replacement of manifold.
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

```

MUFFLERS & RESONATORS

MUFFLERS & RESONATORS

```

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Condition                      3  Code  3      Procedure
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Body shell distorted, affecting 3  A      3
performance or structural integrity 3      3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Corrosion hole                  3  A      3  Require replacement.
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Missing                          3  C      3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Mounting bracket(s) broken      3  A      3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Mounting bracket(s) cracked     3  B      3  Require repair or
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA replacement.
Nipple cracked                  3  A      3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Nipple loose                    3  B      3  Require replacement.
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Outer wrap peeling (exhaust not leaking) 3  A,1  3  Suggest replacement.
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Plugged                          3  A      3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Puncture (other than a drain hole) 3  A      3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA Require replacement.
Rattling or knocking noise from muffler 3  B      3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Seam(s) open (exhaust leaking) 3  A      3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Sound quality unsatisfactory    3  B,2  3  Suggest replacement
                                  3      3  to address customer
                                  3      3  need and/or request.
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Split (exhaust leaking)         3  A      3  Require replacement.
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Weak due to corrosion, but no leaks 3  A,1  3  Suggest replacement.
present                          3      3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

```

END OF ARTICLE

*** STEERING UNIFORM INSPECTION GUIDELINES ***

Article Text

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ARTICLE BEGINNING

GENERAL INFORMATION

Steering & Suspension Systems - (Including Wheels & Tires)

All Makes & Models

Updated: January, 1997

MAP UNIFORM INSPECTION GENERAL GUIDELINES

OVERVIEW OF MOTORIST ASSURANCE PROGRAM

The Motorist Assurance Program (MAP) is the consumer outreach effort of the Automotive Maintenance and Repair Association, Inc. (AMRA). Participation in the Motorist Assurance Program is drawn from retailers, suppliers, independent repair facilities, vehicle manufacturers and industry associations.

The Motorist Assurance Program was established as an industry-wide effort to address concerns raised by regulators, the media and consumers questioning our ethics and methods of doing business. The automotive repair industry had been bombarded by months of negative stories in the media and scrutiny from state and federal regulators who focused on how the need for repairs is determined. MAP was formed as an industry response to this issue.

Our mission is to strengthen the relationship between the consumer and the auto repair industry. We produce materials that give motorists the information and encouragement to take responsibility for their vehicles - through proper, manufacturer-recommended, maintenance. We encourage participating service and repair shops (including franchisees and dealers) to adopt a Pledge to their Customers and the Motorist Assurance Program developed Standards of Service. All participating service providers have agreed to subscribe to this Pledge and to adhere to the promulgated Standards of Service which demonstrates to their customers that they are serious about customer satisfaction.

These Standards of Service require that an inspection of the vehicle's (problem) system be made according to industry guidelines. After learning that neither the car manufacturers nor any other source had complete guidelines, leading industry organizations, along with other industry participants banded together to address this challenging task. During the past two and a half years, they successfully developed industry inspection guidelines for the following systems: Exhaust, Brakes, ABS, Steering and Suspension, Engine Maintenance and Performance, HVAC, and Electrical systems. Guidelines for Drive Train and Transmission are currently being promulgated. Revisions to the inspection guidelines for Exhaust, Brakes/ABS and Steering and Suspension Systems, which were issued two years ago, are now being published for implementation beginning spring 1997. Participating shops utilize these Uniform Inspection Guidelines as part of the inspection process and for communicating their findings to their customers.

*** STEERING UNIFORM INSPECTION GUIDELINES ***

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The Motorist Assurance Program continues to work cooperatively and proactively with government agencies and consumer groups toward solutions that both benefit the customer and are mutually acceptable to both regulators and industry. We maintain the belief that industry must retain control over how we conduct our business, and we must be viewed as part of the solution and not part of the problem. Meetings with state and other government officials concerned with auto repair and/or consumer protection are conducted. Feedback from these representatives are brought back to members, and the program adjusted as needed.

To assure auto repair customers recourse if they were not satisfied with a repair transaction, the Motorist Assurance Program offers arbitration through MAP/BBB-CARE in cooperation with the Council of Better Business Bureaus and individual participating Bureaus. MAP "piloted" in Indianapolis and Pittsburgh during spring, 1996 - and publicized "roll-outs" in New Jersey, Detroit (MI), Chicago (IL) and Richmond (VA) were conducted. To put some "teeth" in the program, and accreditation requirement for shops was initiated. The requirements are stringent and a self-policing method has been incorporated which includes the "mystery shopping" of outlets. In addition, a committee of service providers had been working diligently developing standards for newspaper, television and Internet advertising.

We welcome you to join us as we continue our outreach ... with your support, both the automotive repair industry and your customers will reap the benefits. Please visit MAP at our Internet site: www.hunter.com/map.htm or contact us at:

808 17th Street, NW Suite 200

Washington, D.C. 20006

Ph. (202) 466-7050 Fax (202) 223-9569

OVERVIEW OF SERVICE REQUIREMENTS & SUGGESTIONS

It is MAP policy that all exhaust, brake, ABS, steering and suspension, wheel alignment, tires and wheels, driveline, engine performance and maintenance and heating, ventilation and air conditioning services be offered and performed under the guidelines and procedures specified in these sections.

Before any service is performed on a vehicle, an inspection of the appropriate system must be performed. The results of this inspection must be explained to the customer and documented on an inspection form. The condition of the vehicle and its components will indicate what services/part replacements may be required or suggested. In addition, suggestions may be made to satisfy the needs expressed by the customer.

This section lists the various parts and conditions that indicate required or suggested service or part replacement. Although this list is extensive, it is not inclusive. In addition to this list, a technician may make a suggestion. This suggestion must be based on substantial and informed experience or the vehicle manufacturer's recommended service interval.

*** STEERING UNIFORM INSPECTION GUIDELINES ***

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Some conditions indicate that service or part replacement is required because the part in question is no longer providing the function for which it is intended, does not meet a vehicle manufacturer's design specification or is missing.

- * Example: An exhaust pipe has corroded severely and has a hole in it through which exhaust gases are leaking. Replacement of the exhaust pipe in this case is required due to functional failure.
- * Example: A brake rotor has been worn to the point where it measures less than the vehicle manufacturer's specifications. Replacement of the rotor is required because it does not meet design specifications.

Some conditions indicate that a service or part replacement is suggested because the part is close to the end of its useful life or to address a customer's need, convenience or request. If a customer's vehicle has one of these conditions, the procedure may only be to suggest service.

- * Example: An exhaust pipe is rusted, corroded or weak, but no leaks are present. In this case, the exhaust pipe has not failed. However, there is evidence that the pipe may need replacement in the near future. Replacement of the pipe may be suggested for the customer's convenience in avoiding a future problem.
- * Example: The customer desires improved ride and/or handling, but the vehicle's shocks or struts have not failed. In this case, replacement may be suggested to satisfy the customer's wishes. In this case, replacement of the shocks or struts may not be sold as a requirement.

A customer, of course, has the choice of whether or not a shop will service his or her vehicle. He or she may decide not to follow some of your suggestions. When a customer declines to authorize a service or repair indicated in the MAP Uniform Inspection Guidelines as "required," a MAP shop may refuse service on that system, if proceeding with the work could create or continue an unsafe or unsatisfactory condition.

The following reasons may be used for required and suggested services. These codes are shown in the "Code" column of the Uniform Inspection Guidelines that follow.

PART REPLACEMENT CODE IDENTIFICATION

NOTE: Refer to the following tables for definitions of the codes listed in the condition/procedure tables for the specific components that may need to be replaced.

A - PART NO LONGER PERFORMS INTENDED PURPOSE

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CAUTION: DO NOT use ride height altering or load compensating components, such as variable rate springs and coil over shocks, on vehicles with height or load sensing proportioning valve-equipped braking systems, unless these components are original equipment.

AIR RIDE SUSPENSION

NOTE: Depending on the air suspension design, there are some aftermarket products available to eliminate the air ride suspension on certain vehicles. If the system has been eliminated with one of these products, then no service is suggested or required.

AIR RIDE SUSPENSION - AIR SHOCKS & AIR STRUTS

NOTE: This section covers the air spring portion of the air shock or strut. For dampening portion of shock or strut conditions and procedures, refer to the "Shock Absorbers, Strut Cartridges, and Strut Assemblies" section.

AIR RIDE SUSPENSION - AIR SHOCKS & AIR STRUTS

AA			
Condition	3	Code	3 Procedure
AA			
Inner fabric of air bag damaged	3	A	3 Require replacement.
	3	3	
AA			
Leaking	3	A	3 Require repair or replacement.
AA			
Outer covering of air bag is cracked to the extent that inner fabric of air bag is visible	3	A,1	3 Suggest replacement.
	3	3	
	3	3	
	3	3	
AA			

AIR RIDE SUSPENSION - AIR SPRING VALVES

AIR RIDE SUSPENSION - AIR SPRING VALVES

AA			
Condition	3	Code	3 Procedure
AA			
Attaching hardware incorrect	3	A	3 Require replacement of incorrect
	3	3	part.
AA			
Attaching hardware loose	3	A	3 Require repair or replacement of
	3	3	loose part.
AA			
Attaching hardware missing	3	C	3 Require replacement of missing
	3	3	part.
AA			

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Attaching hardware threads damaged	3	A	3	Require repair or replacement of part with damaged threads.
AA				
Attaching hardware threads stripped (threads missing)	3	A	3	Require replacement of part with stripped threads.
AA				
Blocked	3	A	3	Require repair or replacement.
AA				
Connector bent	3	A	3	Require repair or replacement.
AA				
Connector broken	3	A	3	Require replacement.
AA				
Connector loose	3	A	3	Require repair or replacement.
AA				
Inoperative	3	A	3	Require repair or replacement.
AA				
Leaking	3	A	3	Require repair or replacement.
AA				
Restricted	3	A	3	Require repair or replacement.
AA				

AIR RIDE SUSPENSION - AIR SPRINGS

AIR RIDE SUSPENSION - AIR SPRINGS

AA				
Condition	3	Code	3	Procedure
AA				
Attaching hardware broken	3	A	3	Require replacement of broken part.
AA				
Attaching hardware incorrect	3	A	3	Require replacement of incorrect part.
AA				
Attaching hardware loose	3	A	3	Require repair or replacement of loose part.
AA				
Attaching hardware missing	3	C	3	Require replacement of missing part.
AA				
Attaching hardware threads damaged	3	A	3	Require repair or replacement of part with damaged threads.
AA				
Attaching hardware threads stripped (threads missing)	3	A	3	Require replacement of part with stripped threads.
AA				
Collar cracked	3	A	3	Require replacement.
AA				
End cap cracked	3	A	3	Require replacement.
AA				
Inner fabric of bag damaged	3	A	3	Require replacement.
AA				
Leaking	3	A	3	Require repair or replacement.

*** STEERING UNIFORM INSPECTION GUIDELINES ***

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AA

Outer covering of air bag	3	A,1	3	Suggest replacement.
is cracked to the extent	3		3	
that inner fabric of air	3		3	
bag is visible	3		3	

AA

Piston cracked	3	A	3	Require replacement.
----------------	---	---	---	----------------------

AA

AIR RIDE SUSPENSION - COMPRESSORS

AIR RIDE SUSPENSION - COMPRESSORS

AA

Condition	3	Code	3	Procedure
-----------	---	------	---	-----------

AA

Attaching hardware bent	3	B	3	Require repair or replacement of
	3		3	bent part.

AA

Attaching hardware broken	3	A	3	Require replacement of broken
	3		3	part.

AA

Attaching hardware loose	3	A	3	Require repair or replacement of
	3		3	loose part.

AA

Attaching hardware missing	3	C	3	Require replacement of missing
	3		3	part.

AA

Attaching hardware threads	3	A	3	Require repair or replacement of
damaged	3		3	part with damaged threads.

AA

Attaching hardware threads	3	A	3	Require replacement of part with
stripped (threads missing)	3		3	stripped threads.

AA

Connector bent	3	A	3	Require repair or replacement.
----------------	---	---	---	--------------------------------

AA

Connector broken	3	A	3	Require replacement.
------------------	---	---	---	----------------------

AA

Connector loose	3	A	3	Require repair or replacement.
-----------------	---	---	---	--------------------------------

AA

Does not build pressure	3	A	3	Further inspection required.
	3		3	See note (1) below.

AA

Excessive run time	3	B	3	Further inspection required.
	3		3	See note (2) below.

AA

Inoperative	3	A	3	Require replacement.
-------------	---	---	---	----------------------

AA

Leaking	3	A	3	Require repair or replacement.
---------	---	---	---	--------------------------------

AA

Missing	3	C	3	Require replacement.
---------	---	---	---	----------------------

AA

NOTE: (1) If failure to build pressure is traced to the compressor,

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require replacement.

(2) If excessive run time is traced to the compressor, require replacement.

[illegible]

AIR RIDE SUSPENSION - HEIGHT SENSORS

AIR RIDE SUSPENSION - HEIGHT SENSORS

[illegible]

Condition	3	Code	3	Procedure
-----------	---	------	---	-----------

[illegible]

Attaching hardware bent	3	B	3	Require repair or replacement of bent part.
-------------------------	---	---	---	---

[illegible]

Attaching hardware broken	3	A	3	Require replacement of broken
	3		3	part.

[illegible]

Attaching hardware corroded affecting structural integrity	3 3 3	A	3 3 3	Require replacement of corroded part.
--	-------------	---	-------------	--

[illegible]

Attaching hardware loose	3	A	3	Require repair or replacement of loose part.
--------------------------	---	---	---	--

[illegible]

Attaching hardware missing 3 C 3 Require replacement of missing
3 3 part.

[illegible]

Attaching hardware threads to damaged	3	A	3	Require repair or replacement of part with damaged threads.
---------------------------------------	---	---	---	---

[illegible]

Attaching hardware threads ³ ³ Require replacement of part with
stripped (threads missing)³ ³ stripped threads.

[illegible]

Dust boot missing	3	B,2	3	Suggest replacement. See note (1).
-------------------	---	-----	---	------------------------------------

[illegible]

Dust boot split ³ B,2 ³ Suggest replacement. See note (1).

[illegible]

Dust boot torn 3 B,2 3 Suggest replacement. See note (1).

[illegible]

Housing cracked	3	A	3	Require replacement.
-----------------	---	---	---	----------------------

AAAAAA

Lead routing incorrect	3	B	3	Require re-routing according to
	3		3	vehicle manufacturer's specs.

[illegible]

Loose	3	B	3	Require adjustment to vehicle
	3		3	manufacturer's specifications.

[illegible]

Missing 3 C 3 Require replacement.

[illegible]

Output signal incorrect 3 A 3 Require repair or replacement.

[illegible]

Wire lead damaged ³ A ³ Require repair or replacement.

[illegible]

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Article Text (p. 10)

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Condition	3	Code	3	Procedure
Broken	3	A	3	Require replacement.
Missing	3	C	3	Require replacement.
Output signal incorrect	3	A	3	Require replacement.

AIR RIDE SUSPENSION - TORSION SPRINGS (COUNTER BALANCING)

AIR RIDE SUSPENSION - TORSION SPRINGS (COUNTER BALANCING)				
Condition	3	Code	3	Procedure
Attaching hardware bent	3	B	3	Require repair or replacement of bent part.
Attaching hardware broken	3	A	3	Require replacement of broken part.
Attaching hardware incorrect	3	A	3	Require replacement of incorrect part.
Attaching hardware loose	3	A	3	Require repair or replacement of loose part.
Attaching hardware missing	3	C	3	Require replacement of missing part.
Attaching hardware threads damaged	3	A	3	Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing)	3	A	3	Require replacement of part with stripped threads.
Broken	3	A	3	Require replacement.
Missing	3	C	3	Require replacement.

AIR RIDE SUSPENSION - TUBING

AIR RIDE SUSPENSION - TUBING				
Condition	3	Code	3	Procedure
Attaching hardware incorrect	3	A	3	Require replacement of incorrect part.
Attaching hardware loose	3	A	3	Require repair or replacement of loose part.

chafed) **3** **3**

*** STEERING UNIFORM INSPECTION GUIDELINES ***

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AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA´
Excessive resistance      3  B  3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Fuse blown                3  A  3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA´ Require replacement.
Fusible link blown       3  A  3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Open                      3  A  3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA´ Require repair or replacement.
Poor ground              3  A  3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Routed incorrectly       3  B  3 Require re-routing according to
                        3      3 vehicle manufacturer's specs.
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Shorted                  3  A  3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA´
Terminal bent            3  A  3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA´
Terminal broken          3  A  3 Require repair or replacement.
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA´
Terminal corroded        3  A  3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA´
Terminal loose           3  A  3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

```

BALL JOINTS

Before requiring or suggesting ball joint replacement, the approved OEM procedure must be used to measure ball joint wear. The measurement(s) obtained, along with the vehicle manufacturer's specifications, must be noted on the inspection report. Some states require that these measurements also appear on the invoice.

NOTE: The term "perceptible movement," defined as any visible movement in any direction, has been the industry standard for determining the need for replacement of follower ball joints. Some vehicle manufacturers are now publishing specifications for follower ball joints that were previously diagnosed by the "perceptible movement" standard. Before requiring or suggesting any parts be replaced based on "perceptible movement," consult your repair manual to determine if OEM specifications exist.

You are not required to replace ball joints in axle sets. However, when replacing a ball joint due to wear exceeding manufacturer's specification, you may suggest replacement of the other ball joint if its measurement shows it is close to the end of its useful life, for preventive maintenance.

BALL JOINTS

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AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Condition                3  Code  3          Procedure

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**Article Text (p. 14)**

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Greaseable ball joint will 3 B,2 3 Suggest replacement of grease  
not take grease 3 3 fitting. See note (5) below.  
Nut on ball joint loose 3 A 3 Require repair or replacement.  
3 3 See note (6) below.  
Pre-load adjustment 3 B 3 Require repair or replacement.  
incorrect 3 3  
Seized 3 A 3 Require replacement.  
Stud bent 3 B 3 Require replacement. See note (7).  
Stud broken 3 A 3 Require replacement. See note (7).  
Threads damaged 3 A 3 Require repair or replacement.  
Threads stripped (threads 3 A 3 Require replacement. See note (7).  
missing) 3 3  
Wear exceeds manufacturer's 3 B 3 Require replacement.  
specifications 3 3

NOTE: (1) If greaseable, grease ball joint. If problem persists or  
joint is non-greaseable, require replacement.  
(2) Cracked grease boot will allow contaminants to enter the  
ball joint and will accelerate wear.  
(3) Lack of grease boot will allow contaminants to enter the  
ball joint and will accelerate wear.  
(4) Torn grease boot will allow contaminants to enter the ball  
joint and will accelerate wear.  
(5) If the greaseable ball joint still will not take grease  
after replacing the grease fitting, suggest replacement of  
ball joint.  
(6) Check for bent stud or damaged taper hole.  
(7) Check for damaged taper hole.

**BUSHINGS**

**BUSHINGS**

Condition 3 Code 3 Procedure  
Attaching hardware bent 3 B 3 Require repair or replacement of  
3 3 bent part if available; otherwise,  
3 3 replace bushing.  
Attaching hardware broken 3 A 3 Require replacement of broken part  
3 3 if available; otherwise, replace  
3 3 bushing.

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|                                                                                  |   |     |   |                                                                                                      |
|----------------------------------------------------------------------------------|---|-----|---|------------------------------------------------------------------------------------------------------|
| Attaching hardware corroded affecting structural integrity                       | 3 | A   | 3 | Require replacement of corroded part if available; otherwise, replace bushing.                       |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |   |     |   |                                                                                                      |
| Attaching hardware incorrect                                                     | 3 | A   | 3 | Require replacement of incorrect part if available; otherwise, replace bushing.                      |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |   |     |   |                                                                                                      |
| Attaching hardware loose                                                         | 3 | A   | 3 | Require repair or replacement of loose part if available; otherwise, replace bushing.                |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |   |     |   |                                                                                                      |
| Attaching hardware missing                                                       | 3 | C   | 3 | Require replacement of missing part if available; otherwise, replace bushing.                        |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |   |     |   |                                                                                                      |
| Attaching hardware threads damaged                                               | 3 | A   | 3 | Require repair or replacement of part with damaged threads if available; otherwise, replace bushing. |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |   |     |   |                                                                                                      |
| Attaching hardware threads stripped (threads missing)                            | 3 | A   | 3 | Require replacement of part with stripped threads if available; otherwise, replace bushing.          |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |   |     |   |                                                                                                      |
| Binding                                                                          | 3 | A   | 3 | Require repair or replacement.                                                                       |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |   |     |   |                                                                                                      |
| Deteriorated, affecting performance                                              | 3 | A   | 3 | Require repair or replacement.                                                                       |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |   |     |   |                                                                                                      |
| Distorted, affecting performance                                                 | 3 | A   | 3 | Require repair or replacement.                                                                       |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |   |     |   |                                                                                                      |
| Leaking (fluid-filled type)                                                      | 3 | A   | 3 | Require replacement.                                                                                 |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |   |     |   |                                                                                                      |
| Missing                                                                          | 3 | A   | 3 | Require replacement.                                                                                 |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |   |     |   |                                                                                                      |
| Noisy                                                                            | 3 | B,2 | 3 | Further inspection required. See note (1) and caution below.                                         |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |   |     |   |                                                                                                      |
| Rubber separating from internal metal sleeve on bonded bushing                   | 3 | A   | 3 | Require replacement.                                                                                 |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |   |     |   |                                                                                                      |
| Seized                                                                           | 3 | A   | 3 | Require replacement.                                                                                 |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |   |     |   |                                                                                                      |
| Shifted (out of position)                                                        | 3 | B   | 3 | Require repair or replacement.                                                                       |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |   |     |   |                                                                                                      |
| Split                                                                            | 3 | A   | 3 | Require replacement.                                                                                 |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |   |     |   |                                                                                                      |
| Surface cracking (weather-checked)                                               | 3 |     | 3 | No service suggested or required.                                                                    |

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NOTE: (1) If noise isolated to bushing, suggest repair or replacement.

CAUTION: Use only approved lubricant on rubber bushings. Petroleum-based lubricants may damage rubber bushings.

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

**CENTER LINKS**

**CENTER LINKS**

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

| Condition | 3 | Code | 3 | Procedure |
|-----------|---|------|---|-----------|
|-----------|---|------|---|-----------|

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

|                              |   |   |   |                                                                                      |
|------------------------------|---|---|---|--------------------------------------------------------------------------------------|
| Attaching hardware incorrect | 3 | A | 3 | Require replacement of incorrect part, if available; otherwise, replace center link. |
|------------------------------|---|---|---|--------------------------------------------------------------------------------------|

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

|                          |   |   |   |                                                                                            |
|--------------------------|---|---|---|--------------------------------------------------------------------------------------------|
| Attaching hardware loose | 3 | A | 3 | Require repair or replacement of loose part, if available; otherwise, replace center link. |
|--------------------------|---|---|---|--------------------------------------------------------------------------------------------|

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

|                            |   |   |   |                                                                                    |
|----------------------------|---|---|---|------------------------------------------------------------------------------------|
| Attaching hardware missing | 3 | C | 3 | Require replacement of missing part, if available; otherwise, replace center link. |
|----------------------------|---|---|---|------------------------------------------------------------------------------------|

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

|                                    |   |   |   |                                                                                                           |
|------------------------------------|---|---|---|-----------------------------------------------------------------------------------------------------------|
| Attaching hardware threads damaged | 3 | A | 3 | Require repair or replacement of part with damaged threads, if available; otherwise, replace center link. |
|------------------------------------|---|---|---|-----------------------------------------------------------------------------------------------------------|

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

|                                                       |   |   |   |                                                                                                  |
|-------------------------------------------------------|---|---|---|--------------------------------------------------------------------------------------------------|
| Attaching hardware threads stripped (threads missing) | 3 | A | 3 | Require replacement of part with stripped threads, if available; otherwise, replace center link. |
|-------------------------------------------------------|---|---|---|--------------------------------------------------------------------------------------------------|

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

|      |   |   |   |                      |
|------|---|---|---|----------------------|
| Bent | 3 | B | 3 | Require replacement. |
|------|---|---|---|----------------------|

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

|         |   |   |   |                                                  |
|---------|---|---|---|--------------------------------------------------|
| Binding | 3 | A | 3 | Further inspection required. See note (1) below. |
|---------|---|---|---|--------------------------------------------------|

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

|                     |   |     |   |                                    |
|---------------------|---|-----|---|------------------------------------|
| Grease boot cracked | 3 | B,2 | 3 | Suggest replacement. See note (2). |
|---------------------|---|-----|---|------------------------------------|

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

|                     |   |     |   |                                    |
|---------------------|---|-----|---|------------------------------------|
| Grease boot missing | 3 | B,2 | 3 | Suggest replacement. See note (3). |
|---------------------|---|-----|---|------------------------------------|

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

|                  |   |     |   |                                    |
|------------------|---|-----|---|------------------------------------|
| Grease boot torn | 3 | B,2 | 3 | Suggest replacement. See note (4). |
|------------------|---|-----|---|------------------------------------|

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

|                       |   |   |   |                                        |
|-----------------------|---|---|---|----------------------------------------|
| Grease fitting broken | 3 | A | 3 | Require replacement of grease fitting. |
|-----------------------|---|---|---|----------------------------------------|

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

|                        |   |   |   |                                        |
|------------------------|---|---|---|----------------------------------------|
| Grease fitting missing | 3 | C | 3 | Require replacement of grease fitting. |
|------------------------|---|---|---|----------------------------------------|

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

|                           |   |   |   |                               |
|---------------------------|---|---|---|-------------------------------|
| Grease fitting won't seal | 3 | A | 3 | Require replacement of grease |
|---------------------------|---|---|---|-------------------------------|

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3 3 fitting.

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

Grease seal missing 3 B,2 3 Suggest replacement. See note (5).

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

Grease seal torn 3 B,2 3 Suggest replacement. See note (6).

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

Looseness (perceptible 3 A,1 3 Suggest replacement. See note (7).

horizontal movement) 3 3

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

CAUTION: DO NOT use pliers or pry bar to check ball and socket

movement. Use only moderate hand pressure.

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

Looseness that is excessive 3 B 3 Require replacement. See notes (8)

3 3 and (9), caution below.

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

CAUTION: DO NOT use pliers or pry bar to check ball and socket

movement. Use only moderate hand pressure.

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

Seized 3 A 3 Require replacement.

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

Stud bent 3 B 3 Require replacement. See note (10)

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

Stud broken 3 A 3 Require replacement. See note (10)

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

Stud loose in taper hole 3 A 3 Require repair or replacement.

3 3 See note (10) below.

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

Taper hole elongated 3 A 3 Require replacement. See note (11)

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

Threads damaged 3 A 3 Require repair or replacement.

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

Threads stripped (threads 3 A 3 Require replacement. See note (10)

missing) 3 3

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

Wear exceeds manufacturer's 3 B 3 Require replacement.

specifications 3 3

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

NOTE: (1) If greaseable, grease joint. If problem persists or joint is non-greaseable, require replacement.

(2) Cracked grease boot will allow contaminants to enter the joint and will accelerate wear.

(3) Lack of grease boot will allow contaminants to enter the joint and will accelerate wear.

(4) Torn grease boot will allow contaminants to enter the joint and will accelerate wear.

(5) Lack of grease seal will allow contaminants to enter the joint and will accelerate wear.

(6) Torn grease seal will allow contaminants to enter the joint and will accelerate wear.

(7) If manufacturer's procedures for inspection exist, use those procedures; otherwise, use an approved inspection method such as the dry park check.

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- (8) Excessive looseness is defined as being significant enough to affect vehicle handling or structural integrity.
- (9) If manufacturer's procedures for inspection exist, use those procedures; otherwise, use an approved inspection method such as the dry park check.
- (10) Check for damaged taper hole.
- (11) Check for damaged stud.

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

**CONTROL ARM SHAFTS**

**CONTROL ARM SHAFTS**

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

| Condition                                             | 3 | Code | 3 | Procedure                                                                                           |
|-------------------------------------------------------|---|------|---|-----------------------------------------------------------------------------------------------------|
| Attaching hardware broken                             | 3 | A    | 3 | Require replacement of broken part, if available; otherwise, replace shaft.                         |
| Attaching hardware loose                              | 3 | A    | 3 | Require repair or replacement of loose part, if available; otherwise, replace shaft.                |
| Attaching hardware missing                            | 3 | C    | 3 | Require replacement of missing part, if available; otherwise, replace shaft.                        |
| Attaching hardware threads damaged                    | 3 | A    | 3 | Require repair or replacement of part with damaged threads, if available; otherwise, replace shaft. |
| Attaching hardware threads stripped (threads missing) | 3 | A    | 3 | Require replacement of part with stripped threads, if available; otherwise, replace shaft.          |
| Bent                                                  | 3 | B    | 3 | Require replacement.                                                                                |
| Shaft bushing surface undersized (worn)               | 3 | B    | 3 | Require replacement.                                                                                |
| Threads damaged                                       | 3 | A    | 3 | Require repair or replacement.                                                                      |
| Threads stripped (threads missing)                    | 3 | A    | 3 | Require replacement.                                                                                |

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

**CONTROL ARMS**

**CONTROL ARMS**

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

| Condition                 | 3 | Code | 3 | Procedure                                                                                 |
|---------------------------|---|------|---|-------------------------------------------------------------------------------------------|
| Attaching hardware bent   | 3 | B    | 3 | Require repair or replacement of bent part, if available; otherwise, replace control arm. |
| Attaching hardware broken | 3 | A    | 3 | Require replacement of broken part, if available; otherwise, replace control arm.         |

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AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA  
Attaching hardware corroded<sup>3</sup> A <sup>3</sup> Require replacement of corroded  
affecting structural <sup>3</sup> <sup>3</sup> part, if available; otherwise,  
integrity <sup>3</sup> <sup>3</sup> replace control arm.  
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA  
Attaching hardware <sup>3</sup> A <sup>3</sup> Require replacement of incorrect  
incorrect <sup>3</sup> <sup>3</sup> part, if available; otherwise,  
<sup>3</sup> <sup>3</sup> replace control arm.  
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA  
Attaching hardware loose <sup>3</sup> A <sup>3</sup> Require repair or replacement of  
<sup>3</sup> <sup>3</sup> loose part, if available;  
<sup>3</sup> <sup>3</sup> otherwise, replace control arm.  
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA  
Attaching hardware missing <sup>3</sup> C <sup>3</sup> Require replacement of missing  
<sup>3</sup> <sup>3</sup> part, if available; otherwise,  
<sup>3</sup> <sup>3</sup> replace control arm.  
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA  
Attaching hardware threads <sup>3</sup> A <sup>3</sup> Require repair or replacement of  
damaged <sup>3</sup> <sup>3</sup> part with damaged threads, if  
<sup>3</sup> <sup>3</sup> available; otherwise, replace  
<sup>3</sup> <sup>3</sup> control arm.  
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA  
Attaching hardware threads <sup>3</sup> A <sup>3</sup> Require replacement of part with  
stripped (threads missing)<sup>3</sup> <sup>3</sup> stripped threads, if available;  
<sup>3</sup> <sup>3</sup> otherwise, replace control arm.  
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA  
Bent <sup>3</sup> B <sup>3</sup> Require replacement.  
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA  
Bushing hole oversized <sup>3</sup> B <sup>3</sup> Require replacement.  
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA  
Ball joint hole oversized <sup>3</sup> B <sup>3</sup> Further inspection required.  
(loose interference or <sup>3</sup> <sup>3</sup> See note (1) below.  
press fit) <sup>3</sup> <sup>3</sup>  
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA  
Corroded, affecting <sup>3</sup> A <sup>3</sup> Require replacement.  
structural integrity <sup>3</sup> <sup>3</sup>  
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA  
Holes distorted <sup>3</sup> A <sup>3</sup> Require replacement.  
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA  
Threads damaged <sup>3</sup> A <sup>3</sup> Require repair or replacement.  
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA  
Threads stripped (threads <sup>3</sup> A <sup>3</sup> Require replacement.  
missing) <sup>3</sup> <sup>3</sup>  
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA  
NOTE: (1) If oversized ball joint is available, require replacement  
of ball joint. If oversized ball joint is not available,  
require replacement of control arm.  
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

DRAG LINKS

DRAG LINKS

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[illegible]

| Condition | 3 | Code | 3 | Procedure |
|-----------|---|------|---|-----------|
|-----------|---|------|---|-----------|

[illegible]

|                    |   |   |   |                                  |
|--------------------|---|---|---|----------------------------------|
| Attaching hardware | 3 | A | 3 | Require replacement of incorrect |
| incorrect          | 3 |   | 3 | part, if available; otherwise,   |
|                    | 3 |   | 3 | replace drag link.               |

[illegible]

|                          |   |   |   |                                  |
|--------------------------|---|---|---|----------------------------------|
| Attaching hardware loose | 3 | A | 3 | Require repair or replacement of |
|                          | 3 |   | 3 | loose part, if available;        |
|                          | 3 |   | 3 | otherwise, replace drag link.    |

[illegible]

|                            |   |   |   |                                |
|----------------------------|---|---|---|--------------------------------|
| Attaching hardware missing | 3 | C | 3 | Require replacement of missing |
|                            | 3 |   | 3 | part, if available; otherwise, |
|                            | 3 |   | 3 | replace drag link.             |

[illegible]

|                                       |   |   |   |                                  |
|---------------------------------------|---|---|---|----------------------------------|
| Attaching hardware threads to damaged | 3 | A | 3 | Require repair or replacement of |
|                                       | 3 |   | 3 | part with damaged threads, if    |
|                                       | 3 |   | 3 | available; otherwise, replace    |
|                                       | 3 |   | 3 | drag link.                       |

[illegible]

|                            |   |   |   |                                  |
|----------------------------|---|---|---|----------------------------------|
| Attaching hardware threads | 3 | A | 3 | Require replacement of part with |
| stripped (threads missing) | 3 |   | 3 | stripped threads, if available;  |
|                            | 3 |   | 3 | otherwise, replace drag link.    |

[illegible]

Bent                      3   B   3 Require replacement.

[illegible]

|         |   |   |   |                              |
|---------|---|---|---|------------------------------|
| Binding | 3 | A | 3 | Further inspection required. |
|         | 3 |   | 3 | See note (1) below.          |

[illegible]

Grease boot cracked                    <sup>3</sup> B,2 <sup>3</sup> Suggest replacement. See note (2).

[illegible]

Grease boot missing                    3   B,2   3 Suggest replacement. See note (3).

[illegible]

Grease boot torn                    <sup>3</sup> B,2 <sup>3</sup> Suggest replacement. See note (4).

[illegible]

|                       |   |   |   |                               |
|-----------------------|---|---|---|-------------------------------|
| Grease fitting broken | 3 | A | 3 | Require replacement of grease |
|                       | 3 |   | 3 | fitting.                      |

[illegible]

```
Grease fitting missing      3  C  3  Require replacement of grease
                             3  3  fitting.
```

[illegible]

```
Grease fitting won't seal 3 A 3 Require replacement of grease
                             3 3 fitting.
```

~~~~~

Grease seal missing 3 B,2 3 Suggest replacement. See note (5).

[illegible]

Grease seal torn ³ B.2 ³ Suggest replacement. See note (4).

[illegible]

Looseness (perceptible horizontal movement)	3	A,1	3	Suggest replacement. See note (6).
	3		3	

[illegible]

CAUTION: DO NOT use pliers or pry bar to check ball and socket

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movement. Use only moderate hand pressure.

Looseness that is excessive³ B ³ Require replacement. See notes (6)

³ and (7), caution below.

CAUTION: DO NOT use pliers or pry bar to check ball and socket

movement. Use only moderate hand pressure.

Seized ³ A ³ Require replacement.

Stud bent ³ B ³ Require replacement. See note (8).

Stud broken ³ A ³ Require replacement. See note (8).

Stud loose in taper hole ³ A ³ Require repair or replacement.

³ See note (8) below.

Taper hole elongated ³ A ³ Require replacement. See note (9).

Threads damaged ³ A ³ Require repair or replacement.

Threads stripped (threads ³ A ³ Require replacement. See note (8).

missing) ³ ³

Wear exceeds manufacturer's³ B ³ Require replacement.

specifications ³ ³

NOTE: (1) If greaseable, grease joint. If problem persists or joint is

non-greaseable, require replacement.

(2) Cracked grease boot will allow contaminants to enter the

joint and will accelerate wear.

(3) Lack of grease boot will allow contaminants to enter the

joint and will accelerate wear.

(4) Torn grease boot will allow contaminants to enter the joint

and will accelerate wear.

(5) Missing grease seal will allow contaminants to enter the

joint and will accelerate wear.

(6) If manufacturer's procedures for inspection exist, use those

procedures; otherwise, use an approved inspection method

such as the dry park check.

(7) Excessive looseness is defined as being significant enough

to affect vehicle handling or structural integrity.

(8) Check for damaged taper hole.

(9) Check for damaged stud.

ELECTRONIC RIDE CONTROL SHOCKS & STRUTS

NOTE: This section covers the electronic damping control portion of the electronic shock or strut. For dampening portion of shock or strut conditions and procedures, refer to the "Shock Absorbers, Strut Cartridges, and Strut Assemblies" section.

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ELECTRONIC RIDE CONTROL SHOCKS & STRUTS

AA			
Condition	3	Code	3 Procedure
AA			
Connector bent	3	A	3 Require repair or replacement.
AA			
Connector broken	3	A	3 Require repair or replacement.
AA			
Connector loose	3	A	3 Require repair or replacement.
AA			
Electronic valve control inoperative	3	B,2	3 Suggest replacement. See note (1).
AA			
Terminal bent	3	A	3 Require repair or replacement.
AA			
Terminal broken	3	A	3 Require repair or replacement.
AA			
Terminal corroded	3	A	3 Require repair or replacement.
AA			
Terminal loose	3	A	3 Require repair or replacement.
AA			
NOTE: (1) It is acceptable to replace with a non-electronically controlled unit, where available.			
AA			

IDLER ARMS

IDLER ARMS

AA			
Condition	3	Code	3 Procedure
AA			
Attaching hardware broken	3	A	3 Require replacement of broken
	3		3 part, if available; otherwise,
	3		3 replace idler arm.
AA			
Attaching hardware incorrect	3	A	3 Require replacement of incorrect
	3		3 part, if available; otherwise,
	3		3 replace idler arm.
AA			
Attaching hardware loose	3	A	3 Require repair or replacement of
	3		3 loose part, if available;
	3		3 otherwise, replace idler arm.
AA			
Attaching hardware missing	3	C	3 Require replacement of missing
	3		3 part, if available; otherwise,
	3		3 replace idler arm.
AA			
Attaching hardware threads damaged	3	A	3 Require repair or replacement of
	3		3 part with damaged threads, if
	3		3 available; otherwise, replace
	3		3 idler arm.

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AA

Attaching hardware threads ³ A ³ Require replacement of part with
stripped (threads missing)³ ³ stripped threads, if available;
³ ³ otherwise, replace idler arm.

AA

Binding ³ A ³ Further inspection required.
³ ³ See note (1) below.

AA

Grease boot cracked ³ B,2 ³ Suggest replacement. See note (2).

AA

Grease boot missing ³ B,2 ³ Suggest replacement. See note (3).

AA

Grease boot torn ³ B,2 ³ Suggest replacement. See note (4).

AA

Grease fitting broken ³ A ³ Require replacement of grease
³ ³ fitting.

AA

Grease fitting missing ³ C ³ Require replacement of grease
³ ³ fitting.

AA

Grease fitting won't seal ³ A ³ Require replacement of seal.

AA

Grease seal missing ³ B,2 ³ Suggest replacement. See note (5).

AA

Grease seal torn ³ B,2 ³ Suggest replacement. See note (4).

AA

Greaseable joint will not ³ B,2 ³ Suggest replacement of grease
take grease ³ ³ fitting. See note (6) below.

AA

Looseness at frame bracket ³ B ³ Require repair or replacement.
end ³ ³ See notes (7) and (8) below.

AA

Looseness at link end ³ A,1 ³ Suggest replacement. See note (7).
(perceptible horizontal ³ ³
movement) ³ ³

AA

CAUTION: DO NOT use pliers or pry bar to check ball and socket
movement. Use only moderate hand pressure.

AA

Looseness at link end that ³ B ³ Require replacement. See notes (7)
is excessive ³ ³ and (9) and caution below.

AA

CAUTION: DO NOT use pliers or pry bar to check ball and socket
movement. Use only moderate hand pressure.

AA

Mounted out of position ³ B ³ Require repositioning.
(center link not parallel)³ ³

AA

Nut on stud loose ³ A ³ Require repair or replacement.
³ ³ See note (10) below.

AA

Seized ³ A ³ Require replacement.

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```

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Stud bent                 3   B   3   Require replacement. See note (11)
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Stud broken               3   A   3   Require replacement. See note (11)
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Taper hole elongated     3   A   3   Require replacement. See note (12)
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Threads damaged          3   A   3   Require repair or replacement.
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Threads stripped (threads 3   A   3   Require replacement. See note (11)
missing)                  3       3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Wear exceeds manufacturer's 3   B   3   Require replacement.
specifications           3       3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

```

- NOTE: (1) If greaseable, grease joint. If problem persists or joint is non-greaseable, require replacement.
- (2) Cracked grease boot will allow contaminants to enter joint and will accelerate wear.
- (3) Lack of grease boot will allow contaminants to enter joint and will accelerate wear.
- (4) Torn grease boot will allow contaminants to enter joint and will accelerate wear.
- (5) Missing grease seal will allow contaminants to enter joint and will accelerate wear.
- (6) If greaseable joint will not take grease after replacing the grease fitting, suggest replacement of idler arm.
- (7) If manufacturer's procedures and specifications exist, use those procedures and specifications; otherwise, use an approved inspection method such as the dry park check.
- (8) Looseness is defined as movement that creates excessive toe change.
- (9) Excessive looseness is defined as significant enough to affect vehicle handling or structural integrity.
- (10) Check for bent stud or damaged taper hole.
- (11) Check for damaged taper hole.
- (12) Check for damaged stud.

```

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

```

KING PINS

You are not required to replace king pins in axle sets. However, when replacing a king pin due to wear exceeding manufacturer's specifications, you may suggest replacement of the other king pin on the axle if its measurement shows it is close to the end of its useful life.

KING PINS

```

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Condition                 3   Code 3   Procedure
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Bearing balls pitted     3   A   3   Require replacement.

```

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AA
Bearing balls worn 3 A 3 Require replacement.
AA
Bearing races pitted 3 A 3 Require replacement.
AA
Bearing races worn 3 A 3 Require replacement.
AA
Bearing rollers pitted 3 A 3 Require replacement.
AA
Bearing rollers worn 3 A 3 Require replacement.
AA
Bearing seal bent 3 B,2 3
AA~ Suggest replacement of seal or
Bearing seal missing 3 B,2 3 bearing.
AA~
Bearing seal torn 3 B,2 3
AA
Binding 3 A 3 Require repair or replacement of
 3 3 affected parts.
AA
End caps missing 3 C 3 Require replacement of missing
 3 3 part, if available; otherwise,
 3 3 replace king pin.
AA
End play exceeds 3 B 3 Require repair.
specifications 3 3
AA
Grease fitting broken 3 A 3
AA~
Grease fitting missing 3 C 3 Require replacement of grease
AA~ fitting.
Grease fitting won't seal 3 A 3
AA
Locating pins missing 3 C 3 Require replacement of missing
 3 3 part, if available; otherwise,
 3 3 replace king pin.
AA
Looseness exceeds 3 B 3 Require replacement of worn parts.
manufacturer's specs 3 3
AA
Seized 3 A 3 Require replacement.
AA
Threads damaged 3 A 3 Require repair or replacement.
AA
Threads stripped (threads 3 A 3 Require replacement.
missing) 3 3
AA
Will not take grease 3 B,2 3 Suggest replacement of grease
 3 3 fitting. See note (1) below.
AA

NOTE: (1) If king pin will not take grease after replacement of grease fitting, suggest replacement of king pin.

[illegible]

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Looseness (perceptible horizontal movement) 3 A,1 3 Suggest replacement. See note (7)

CAUTION: DO NOT use pliers or pry bar to check ball and socket movement. Use only moderate hand pressure.

Looseness that is excessive 3 B 3 Require replacement. See notes (7) and (8), caution below.

CAUTION: DO NOT use pliers or pry bar to check ball and socket movement. Use only moderate hand pressure.

Nut on stud loose 3 A 3 Require repair or replacement. See note (9) below.

Seized 3 A 3 Require replacement.

Splines damaged 3 A 3 Require repair or replacement.

Splines stripped (splines missing) 3 A 3 Require replacement.

Stud bent 3 B 3 Require replacement. See note (10)

Stud broken 3 A 3 Require replacement. See note (10)

Stud loose in taper hole 3 A 3 Require repair or replacement. See note (10) below.

Taper hole elongated 3 A 3 Require replacement. See note (11)

Threads damaged 3 A 3 Require repair or replacement.

Threads stripped (threads missing) 3 A 3 Require replacement. See note (10)

NOTE: (1) If greaseable, grease joint. If problem persists or joint is non-greaseable, require replacement.

(2) Cracked grease boot will allow contaminants to enter joint and will accelerate wear.

(3) Lack of grease boot will allow contaminants to enter joint and will accelerate wear.

(4) Torn grease boot will allow contaminants to enter joint and will accelerate wear.

(5) Lack of grease seal will allow contaminants to enter joint and will accelerate wear.

(6) Torn grease seal will allow contaminants to enter joint and will accelerate wear.

(7) If manufacturer's procedures for inspection exist, use those procedures; otherwise, use an approved inspection method such as the dry park check.

(8) Excessive looseness is defined as being significant enough

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to affect vehicle handling or structural integrity.

(9) Check for bent stud of damaged taper hole.

(10) Check for damaged taper hole.

(11) Check for damaged stud.

AA

POWER STEERING HOSES

POWER STEERING HOSES

AA

Condition	3	Code	3	Procedure
-----------	---	------	---	-----------

AA

Blistered	3	B	3	Require replacement.
-----------	---	---	---	----------------------

AA

Blocked	3	A	3	Require repair or replacement.
---------	---	---	---	--------------------------------

AA

Fitting threads damaged	3	A	3	Require repair or replacement.
-------------------------	---	---	---	--------------------------------

AA

Fitting threads stripped	3	A	3	Require replacement.
--------------------------	---	---	---	----------------------

(threads missing) 3 3

AA

Inner fabric (webbing) cut	3	A	3	Require replacement.
----------------------------	---	---	---	----------------------

AA

Leaking	3	A	3	Require repair or replacement.
---------	---	---	---	--------------------------------

AA

Missing	3	C	3	Require replacement.
---------	---	---	---	----------------------

AA

Outer covering is cracked	3	B	3	Require replacement.
---------------------------	---	---	---	----------------------

to the extent that the 3 3

inner fabric of hose is 3 3

visible 3 3

AA

Restricted	3	A	3	Require repair or replacement.
------------	---	---	---	--------------------------------

AA

POWER STEERING (HYDRAULIC) PUMPS

If diagnosis has determined that complete disassembly is necessary to determine the extent of the system failure, the suggestion may be made to rebuild or replace the power steering pump. Repair or replacement of the following components may be required if performed as part of a power steering pump overhaul or rebuild service to meet a minimum rebuild standard.

POWER STEERING (HYDRAULIC) PUMPS

AA

Condition	3	Code	3	Procedure
-----------	---	------	---	-----------

AA

Attaching hardware bent	3	B	3	Require repair or replacement of
	3		3	bent part.

AA

Attaching hardware broken	3	A	3	Require replacement of broken
---------------------------	---	---	---	-------------------------------

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3 3 part.

AA

Attaching hardware loose 3 A 3 Require repair or replacement of
3 3 loose part.

AA

Attaching hardware missing 3 C 3 Require replacement of missing
3 3 part.

AA

Attaching hardware threads 3 A 3 Require repair or replacement of
damaged 3 3 part with damaged threads.

AA

Attaching hardware threads 3 A 3 Require replacement of part with
stripped (threads missing) 3 3 stripped threads.

AA

Belt alignment incorrect 3 B 3 Further inspection required.
3 3 See note (1) below.

AA

Belt cracked 3 A,1 3 Suggest replacement.

AA

Belt frayed 3 A,1 3 Suggest replacement.

AA

Belt missing 3 C 3 Require replacement.

AA

Belt noisy 3 B,2 3 Further inspection required.
3 3 See note (2) below.

AA

Belt plies separated 3 A 3 Require replacement.

AA

Belt tension out of spec 3 B 3 Require adjustment or replacement.

AA

Belt worn beyond adjustment 3 B 3 Require replacement.
range 3 3

AA

Belt worn so it contacts 3 A 3 Require replacement.
bottom of pulley 3 3

AA

Binding 3 A 3 Require repair or replacement.

AA

Fluid at or beyond service 3 C,3 3 Suggest fluid change.
interval 3 3

AA

Fluid contaminated 3 B 3 Require flushing and refilling of
3 3 the system. See note (3) below.

AA

Fluid level incorrect 3 B 3 Require adjustment of fluid level.

AA

Inadequate assist 3 A 3 Further inspection required.
3 3 See note (4) below.

AA

Leaking 3 A 3 Require repair or replacement.

AA

Noise 3 B,2 3 Further inspection required.

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3 3 See note (5) below.

AA

Pulley bent 3 A 3 Require repair or replacement of
3 3 pulley.

AA

Pulley missing 3 C? 3 Require replacement of pulley.

AA

Remote reservoir leaking 3 A 3 Require replacement of reservoir.

AA

Reservoir cap broken 3 A 3 Require replacement of cap.

AA

Reservoir cap missing 3 C 3 Require replacement of cap.

AA

Seized 3 A 3 Require replacement.

AA

Threads damaged 3 A 3 Require repair or replacement.

AA

Threads stripped (threads 3 A 3 Require replacement.
missing) 3 3

AA

NOTE: (1) Determine cause of incorrect alignment and require repair.

(2) Determine cause of noise and suggest repair.

(3) Determine and correct source of contamination. OEM
specifications must be followed for fluid type.

(4) If pump is source of inadequate assist, require repair or
replacement.

(5) If noise is isolated to pump, suggest repair or replacement.

AA

RADIUS ARMS

RADIUS ARMS

AA

Condition 3 Code 3 Procedure

AA

Attaching hardware broken 3 A 3 Require replacement of broken
3 3 part.

AA

Attaching hardware 3 A 3 Require replacement of incorrect
incorrect 3 3 part.

AA

Attaching hardware loose 3 A 3 Require repair or replacement of
3 3 loose part.

AA

Attaching hardware missing 3 C 3 Require replacement of missing
3 3 part.

AA

Attaching hardware threads 3 A 3 Require repair or replacement of
damaged 3 3 part with damaged threads.

AA

Attaching hardware threads 3 A 3 Require replacement of part with
stripped (threads missing) 3 3 stripped threads.

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Article Text (p. 32)

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Grease fitting broken 3 A 3

AA~

Grease fitting missing 3 C 3 Require replacement grease

AA~ fitting.

Grease fitting won't seal 3 A 3

AA

Grease seal missing 3 B,2 3 Suggest replacement. See note (5).

AA

Grease seal torn 3 B,2 3 Suggest replacement. See note (6).

AA

Looseness (perceptible 3 A,1 3 Suggest replacement. See note (7).

horizontal movement) 3 3

AA

CAUTION: DO NOT use pliers or pry bar to check ball and socket
movement. Use only moderate hand pressure.

AA

Looseness that is excessive 3 B 3 Require replacement. See notes (7)

 3 3 and (8) and caution below.

AA

CAUTION: DO NOT use pliers or pry bar to check ball and socket
movement. Use only moderate hand pressure.

AA

Seized 3 A 3 Require replacement.

AA

Stud bent 3 B 3 Require replacement. See note (9).

AA

Stud broken 3 A 3 Require replacement. See note (9).

AA

Stud loose in taper hole 3 A 3 Require repair or replacement.

 3 3 See note (9).

AA

Taper hole elongated 3 A 3 Require replacement. See note (10)

AA

Threads damaged 3 A 3 Require repair or replacement.

AA

Threads stripped (threads 3 A 3 Require replacement. See note (9).

missing) 3 3

AA

Wear exceeds manufacturer's 3 B 3 Require replacement.

specifications 3 3

AA

NOTE: (1) If greaseable, grease joint. If problem persists or joint
is non-greaseable, require replacement.

(2) Cracked grease boot will allow contaminants to enter the
joint and will accelerate wear.

(3) Lack of grease boot will allow contaminants to enter the
joint and will accelerate wear.

(4) Torn grease boot will allow contaminants to enter the joint
and will accelerate wear.

(5) Lack of grease seal will allow contaminants to enter joint
and will accelerate wear.

(6) Torn grease seal will allow contaminants to enter joint and

[illegible]

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Attaching hardware corroded	3	A	3	Require replacement of corroded
affecting structural	3		3	part, if available; otherwise,
integrity	3		3	replace shock or strut.
AA				
Attaching hardware	3	A	3	Require replacement of incorrect
incorrect	3		3	part, if available; otherwise,
	3		3	replace shock or strut.
AA				
Attaching hardware loose	3	A	3	Require repair or replacement of
	3		3	loose part, if available;
	3		3	otherwise, replace shock or strut.
AA				
Attaching hardware missing	3	C	3	Require replacement of missing
	3		3	part, if available; otherwise,
	3		3	replace shock or strut.
AA				
Attaching hardware threads	3	A	3	Require repair or replacement of
damaged	3		3	part with damaged threads, if
	3		3	available; otherwise, replace
	3		3	shock or strut.
AA				
Attaching hardware threads	3	A	3	Require replacement of part with
stripped (threads missing)	3		3	stripped threads, if available;
	3		3	otherwise, replace shock or strut.
AA				
Binding	3	A	3	Require replacement.
AA				
Body dented	3	A	3	Further inspection required.
	3		3	See note (1) below.
AA				
Body punctured	3	A	3	Require replacement.
AA				
Brake hose bracket bent	3	B	3	Require repair or replacement.
AA				
Brake hose bracket missing	3	C	3	Require replacement.
AA				
Brake hose bracket threads	3	C	3	Require repair or replacement.
damaged	3		3	
AA				
Brake hose bracket threads	3	C	3	Require replacement.
stripped (threads missing)	3		3	
AA				
Compression bumper missing	3	C	3	Require replacement of compression
	3		3	bumper.
AA				
Compression bumper split	3	A,1	3	Suggest replacement of compression
	3		3	bumper.
AA				
Damping (none)	3	A	3	Require replacement.
AA				
Dust boot (bellows) split	3	B,2	3	Suggest replacement of boot.
	3		3	See note (2) below.

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AA

Dust boot (bellows) missing³ B,2³ Suggest replacement of boot.

³ See (3) note below.

AA

Dust boot (bellows) torn³ B,2³ Suggest replacement of boot.

³ See note (4) below.

AA

Dust shield broken³ B,2³ Suggest replacement. See note (4).

AA

Dust shield missing³ B,2³ Suggest replacement. See note (4).

AA

Gland nut (strut housing³ A³ Require replacement of nut and/or
cap) is not removable³ housing. See note (5) below.

using appropriate tool³

AA

Gland nut (strut housing³ A³ Require repair or replacement of
cap) threads damaged³ nut.

AA

Gland nut (strut housing³ A³ Require replacement of nut.

cap) threads stripped³

(threads missing)³

AA

Housing dented³ A³ Further inspection required.

³ See note (6) below.

AA

Housing punctured³ A³ Require replacement.

AA

Jounce bumper missing³ C³ Require replacement of jounce

³ bumper.

AA

Jounce bumper split³ 1?³ Suggest replacement of jounce

³ bumper.

AA

Leaking oil, enough for³ A³ Require replacement. See caution

fluid to be running down³ below.

the body³

AA

CAUTION: If the strut cartridge has been replaced previously, the oil
on the strut housing may be filler oil. The technician must
identify the source of the oil.

AA

Noise³ B,2³ Further inspection required.

³ See note (7) below.

AA

Piston rod bent³ A³ Require replacement.

AA

Piston rod broken³ A³ Require replacement.

AA

Piston rod has surface³ B,2³ Suggest replacement.

defect³

AA

Piston rod threads damaged³ A³ Require repair or replacement.

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AA

Piston rod threads stripped³ A ³ Require replacement.

(threads missing) ³ ³

AA

Seized ³ A ³ Require replacement.

AA

Shock missing ³ C ³ Require replacement.

AA

Strut housing bent ³ A ³ Require replacement.

AA

Strut housing cap (gland ³ A ³ Require replacement of nut and/or

nut) is not removable ³ ³ housing. See note (5) below.

using appropriate tool ³ ³

AA

Strut housing cap (gland ³ A ³ Require repair or replacement of

nut) threads damaged ³ ³ nut.

AA

Strut housing cap (gland ³ A ³ Require replacement of nut.

nut) threads stripped ³ ³

(threads missing) ³ ³

AA

Strut housing severely ³ A ³ Require replacement.

corroded, affecting ³ ³

structural integrity ³ ³

AA

Strut housing threads ³ A ³ Require repair or replacement.

damaged ³ ³

AA

Strut housing threads ³ A ³ Require replacement.

stripped (threads missing)³ ³

AA

Tire cupping ³ A ³ Further inspection required.

³ ³ See note (8) below

AA

NOTE: (1) Require replacement of units where dents restrict shock or strut piston rod movement. If dents don't restrict movement, no service is suggested or required. Especially critical on mono-tube shocks.

(2) This condition can lead to damage of the piston rod, which, in turn, causes premature piston rod seal wear.

(3) This condition can lead to damage of the piston rod, which causes piston rod seal wear.

(4) This condition can lead to damage of the piston rod, which, in turn, causes premature piston rod seal wear.

(5) Only required if replacing cartridge.

(6) Require replacement of units where dents restrict shock or strut piston rod movement. If dents don't restrict movement, no service is suggested or required. Especially critical on mono-tube shocks.

(7) If noise is isolated to shock or strut, suggest replacement.

(8) Although shocks or struts may have contributed to tire cupping, an inspection is needed of the entire suspension

[illegible]

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Condition	3	Code	3	Procedure
Attaching hardware bent	3	B	3	Require repair or replacement of bent part.
Attaching hardware broken	3	A	3	Require replacement of broken part.
Attaching hardware corroded affecting structural integrity	3	A	3	Require replacement of corroded part.
Attaching hardware incorrect	3	A	3	Require replacement of incorrect part.
Attaching hardware loose	3	A	3	Require repair or replacement of loose part.
Attaching hardware missing	3	C	3	Require replacement of missing part.
Attaching hardware threads damaged	3	A	3	Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing)	3	A	3	Require replacement of part with stripped threads.
Broken (all springs except secondary leave(s) on multi-leaf springs)	3	A	3	Require replacement.
Coil clash	3		3	Require ride height check. See note (1) below.
Coil spring insulator deteriorated	3	B,2	3	Suggest replacement of insulator.
Coil spring insulator missing	3	B,2	3	Suggest replacement of insulator.
Coil spring insulator split	3	B,2	3	Suggest replacement of insulator.
Coil spring plastic coating deteriorated - rust present	3	A	3	Refer to manufacturer's service requirements. See note (2) below.
Composite spring damaged	3	A	3	Further inspection required. See note (3) below.
Cracked (all springs except composite leaf and secondary leave(s) on	3	A	3	Require replacement.

Condition			3	Code	3	Procedure
Attaching hardware bent						
			3	B	3	Require repair or replacement of bent part.

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Attaching hardware broken	3	A	3	Require replacement of broken
	3		3	part.
AA				
Attaching hardware loose	3	A	3	Require repair or replacement of
	3		3	loose part.
AA				
Attaching hardware missing	3	C	3	Require replacement of missing
	3		3	part.
AA				
Attaching hardware threads	3	A	3	Require repair or replacement of
damaged	3		3	part with damaged threads.
AA				
Attaching hardware threads	3	A	3	Require replacement of part with
stripped (threads missing)	3		3	stripped threads.
AA				
Blocked	3	A	3	Require repair or replacement.
AA				
Fitting incorrect (such as	3	B	3	Require replacement.
compression fitting)	3		3	
AA				
Flare type incorrect	3	B	3	Required replacement.
AA				
Leaking	3	A	3	Require tightening or replacement.
AA				
Line type incorrect	3	B	3	Require replacement.
AA				
Restricted	3	A	3	Require replacement.
AA				
Routed incorrectly	3	B	3	Require routing correction.
AA				
Rust-pitted	3	A,1	3	Suggest replacement.
AA				
Rust pitted affecting	3	A	3	Require replacement.
structural integrity	3		3	
AA				

STEERING ARMS

STEERING ARMS

Condition	3	Code	3	Procedure
AA				
Attaching hardware bent	3	B	3	Require repair or replacement of
	3		3	bent part.
AA				
Attaching hardware broken	3	A	3	Require replacement of broken
	3		3	part.
AA				
Attaching hardware	3	A	3	Require replacement of incorrect
incorrect	3		3	part.
AA				
Attaching hardware loose	3	A	3	Require repair or replacement of

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3 3 loose part.

AA

Attaching hardware missing 3 C 3 Require replacement of missing
3 3 part.

AA

Attaching hardware threads 3 A 3 Require repair or replacement of
damaged 3 3 part with damaged threads.

AA

Attaching hardware threads 3 A 3 Require replacement of part with
stripped (threads missing) 3 3 stripped threads.

AA

Bent 3 B 3 Require replacement.

AA

Broken 3 A 3 Require replacement.

AA

Taper hole elongated 3 A 3 Require replacement. See note (1).

AA

Threads damaged 3 A 3 Require repair or replacement.

AA

Threads stripped (threads 3 A 3 Require replacement.
missing) 3 3

AA

NOTE: (1) Check for damaged stud.

AA

STEERING DAMPERS

The following procedures are only required if the vehicle was originally equipped from the factory with a steering damper. If the steering damper is an add-on unit, then the unit may be removed instead of repairing or replacing.

STEERING DAMPERS

AA

Condition 3 Code 3 Procedure

AA

Attaching hardware bent 3 B 3 Require repair or replacement of
3 3 bent part, if available;
3 3 otherwise, replace steering
3 3 damper.

AA

Attaching hardware broken 3 A 3 Require replacement of broken
3 3 part, if available; otherwise,
3 3 replace steering damper.

AA

Attaching hardware corroded 3 A 3 Require replacement of corroded
affecting structural 3 3 part, if available; otherwise,
integrity 3 3 replace steering damper.

AA

Attaching hardware 3 A 3 Require replacement of incorrect
incorrect 3 3 part, if available; otherwise,
3 3 replace steering damper.

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Article Text (p. 43)

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Piston rod broken 3 A 3 Require replacement.
Piston rod has surface 3 B,2 3 Suggest replacement.
defect 3 3
Piston rod threads stripped 3 A 3 Require replacement.
(threads missing) 3 3
Piston rod threads damaged 3 A 3 Require repair or replacement.
Seized 3 A 3 Require replacement.
NOTE: (1) Require replacement of units where dents restrict damper
piston rod movement. If dents don't restrict movement, no
service is suggested or required. Especially critical on
mono-tube dampers.
(2) This condition can lead to damage of the piston rod, which,
in turn, causes premature piston rod seal wear.
(3) If noise is isolated to damper, suggest replacement.

STEERING GEARS (EXCEPT RACK & PINION)

If diagnosis has determined that complete disassembly is
necessary to determine the extent of the system failure, the
suggestion may be made to rebuild or replace the power steering pump.
Repair or replacement of the following components may be required, if
performed as part of a power steering pump overhaul or rebuild service
to meet a minimum rebuild standard.

STEERING GEARS (EXCEPT RACK & PINION)

Condition 3 Code 3 Procedure
Attaching hardware broken 3 A 3 Require replacement of broken
part.
Attaching hardware loose 3 A 3 Require repair or replacement of
loose part.
Attaching hardware missing 3 C 3 Require replacement of missing
part.
Attaching hardware threads 3 A 3 Require repair or replacement of
damaged 3 3 part with damaged threads.
Attaching hardware threads 3 A 3 Require replacement of part with
stripped (threads missing) 3 3 stripped threads.
Binding 3 A 3 Require repair or replacement
Flex coupler binding 3 A 3 Require repair or replacement of

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Article Text (p. 44)

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3 3 coupler.

Flex coupler loose 3 A 3 Require repair or replacement of

3 3 coupler.

Flex coupler missing parts 3 A 3 Require repair or replacement of

3 3 coupler.

Flex coupler soft/spongy 3 A 3 Require replacement of coupler.

Flex coupler torn 3 A 3 Require replacement of coupler.

Fluid contaminated 3 B 3 Require flushing and refilling
3 of the system. See note (1) below.

Gasket leaking 3 A 3 Require repair or replacement of
3 3 gasket.

Housing leaking 3 A 3 Require replacement.

Hydraulic fittings leaking 3 A 3 Require repair or replacement of
3 3 fittings.

Inadequate power assist 3 A 3 Further inspection required.
3 3 See note (2) below.

Lash exceeds manufacturer's 3 B 3 Require repair or replacement.
specifications 3 3

Seal leaking 3 A 3 Require repair or replacement of
3 3 seal and/or mating part.

Splines damaged 3 A 3 Require repair or replacement of
3 3 splines.

Splines stripped 3 A 3 Require replacement of splines.

Steering coupler shield 3 B,2 3 Suggest replacement.
cracked 3 3

Steering coupler shield 3 C 3 Require replacement.
missing 3 3

Threads damaged 3 A 3 Require repair or replacement of
3 3 part with damaged threads.

Threads stripped (threads 3 A 3 Require replacement of part with
missing) 3 3 stripped threads.

U-joint binding 3 A 3 Require repair or replacement of
3 3 joint.

```

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Bellows boot cracked (not      3      B,2  3 Suggest replacement of bellows
through)                        3      3 boot.

```

[illegible]

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Lash exceeds manufacturer's³ B ³ Require repair or replacement.
specifications ³ ³

AAAAAA Seal leaking ³ A ³ Require repair or replacement.
AAAAAA

AAAAAA Splines damaged ³ A ³ Require repair or replacement.
AAAAAA

AAAAAA Splines stripped (splines ³ A ³ Require replacement.
missing) ³ ³

AAAAAA Steel line blocked ³ A ³ Require repair or replacement of
AAAAAA line.

AAAAAA Steel line leaking ³ A ³
AAAAAA

AAAAAA Steel line missing ³ C ³ Require replacement of line.
AAAAAA

AAAAAA Steel line restricted ³ A ³ Require repair or replacement of
³ ³ line.

AAAAAA Steering coupler shield ³ B,2 ³ Suggest replacement.
cracked ³ ³

AAAAAA Steering coupler shield ³ C ³ Require replacement.
missing ³ ³

AAAAAA Steering coupler shield ³ B,2 ³ Suggest replacement.
torn ³ ³

AAAAAA Threads damaged ³ A ³ Require repair or replacement of
³ ³ part with damaged threads.

AAAAAA Threads stripped (threads ³ A ³ Require replacement of part with
missing) ³ ³ stripped threads.

AAAAAA U-joint binding ³ A ³ Require repair or replacement of
³ ³ joint.

AAAAAA U-joint loose ³ A ³ Require repair or replacement of
³ ³ joint.

AAAAAA Unequal power assist ³ A ³ Require repair or replacement.
AAAAAA

NOTE: (1) Determine and correct source of contamination.
Follow OE specifications for fluid type.

(2) Indicates internal wear.

(3) If steering gear is source of inadequate assist, require
repair or replacement.

AAAAAA

STEERING KNUCKLES

STEERING KNUCKLES

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Condition			3	Code	3	Procedure
Attaching hardware bent			3	B	3	Require repair or replacement of bent part.
Attaching hardware broken			3	A	3	Require replacement of broken part.
Attaching hardware incorrect			3	A	3	Require replacement of incorrect part.
Attaching hardware loose			3	A	3	Require repair or replacement of loose part.
Attaching hardware missing			3	C	3	Require replacement of missing part.
Attaching hardware threads damaged			3	A	3	Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing)			3	A	3	Require replacement of part with stripped threads.
Bent			3	B	3	Require replacement.
Broken			3	A	3	Require replacement.
Pinch bolt incorrect			3	B	3	Require replacement with bolt that meets OE design.
Pinch bolt loose			3	B	3	Require repair.
Pinch bolt missing			3	B	3	Require replacement.
Pinch bolt tabs deformed (pinched together), .032" or more before clamping			3	B	3	Require replacement. See note (1) below.
Taper hole elongated			3	A	3	Require replacement. See note (2).
Threads damaged			3	A	3	Require repair or replacement.
Threads stripped (threads missing)			3	A	3	Require repair or replacement.
NOTE: (1) Steering knuckle deformation can cause pinch bolt breakage.						
(2) Check for damaged stud.						

STRIKE OUT BUMPERS

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STRIKE OUT BUMPERS

AA			
Condition	3	Code	3 Procedure
AA			
Attaching hardware broken	3	A	3 Require replacement of broken
	3		3 part.
AA			
Attaching hardware corroded	3	A	3 Require replacement of corroded
affecting structural	3		3 part.
integrity	3		3
AA			
Attaching hardware loose	3	A	3 Require repair or replacement of
	3		3 loose part.
AA			
Attaching hardware missing	3	C	3 Require replacement of missing
	3		3 part.
AA			
Attaching hardware threads	3	A	3 Require repair or replacement of
damaged	3		3 part with damaged threads.
AA			
Attaching hardware threads	3	A	3 Require replacement of part with
stripped (threads missing)	3		3 stripped threads.
AA			
Missing	3	C	3 Require replacement.
AA			
Split	3	A,1	3 Suggest replacement.
AA			

STRUT RODS

STRUT RODS

AA			
Condition	3	Code	3 Procedure
AA			
Adjusting nut seized	3	A	3 Require repair or replacement.
	3		3 See note (1) below.
AA			
Attaching hardware bent	3	B	3 Require repair or replacement of
	3		3 bent part, if available;
	3		3 otherwise, replace strut rod.
AA			
Attaching hardware broken	3	A	3 Require replacement of broken
	3		3 part, if available; otherwise,
	3		3 replace strut rod.
AA			
Attaching hardware	3	A	3 Require replacement of incorrect
incorrect	3		3 part, if available; otherwise,
	3		3 replace strut rod.
AA			
Attaching hardware loose	3	A	3 Require repair or replacement of
	3		3 loose part, if available;
	3		3 otherwise, replace strut rod.

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AA

Attaching hardware missing	3	C	3	Require replacement of missing
	3		3	part, if available; otherwise,
	3		3	replace strut rod.

AA

Attaching hardware threads	3	A	3	Require repair or replacement of
damaged	3		3	part with damaged threads, if
	3		3	available; otherwise, replace
	3		3	strut rod.

AA

Attaching hardware threads	3	A	3	Require replacement of part with
stripped (threads missing)	3		3	stripped threads, if available;
	3		3	otherwise, replace strut rod.

AA

Attaching (mating) hole	3	A	3	Require repair or replacement of
oversized	3		3	frame.

AA

Attaching point on frame	3	A	3	Require repair of frame.
corroded, affecting	3		3	
structural integrity	3		3	

AA

Bent	3	A	3	Require replacement.
------	---	---	---	----------------------

AA

Mating (attaching) hole	3	A	3	Require repair or replacement of
oversized	3		3	frame.

AA

Threads damaged	3	A	3	Require repair or replacement.
-----------------	---	---	---	--------------------------------

AA

Threads stripped (threads	3	A	3	Require replacement.
missing)	3		3	

AA

NOTE: (1) Only required if an alignment is being performed.

AA

STRUT UPPER BEARING PLATE ASSEMBLIES

NOTE: When the following guidelines indicate replacement of bearing, only the bearing should be replaced if it is available separately; otherwise, replace the bearing plate assembly.

STRUT UPPER BEARING PLATE ASSEMBLIES

AA

Condition	3	Code	3	Procedure
-----------	---	------	---	-----------

AA

Attaching hardware broken	3	A	3	Require replacement of broken
	3		3	part, if available; otherwise,
	3		3	replace bearing plate assembly.

AA

Attaching hardware loose	3	A	3	Require repair or replacement of
	3		3	loose part, if available;
	3		3	otherwise, replace bearing plate

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3 3 assembly.

AA

Attaching hardware missing 3 C 3 Require replacement of missing
3 3 part, if available; otherwise,
3 3 replace bearing plate assembly.

AA

Attaching hardware threads 3 A 3 Require repair or replacement of
damaged 3 3 part with damaged threads, if
3 3 available; otherwise, replace
3 3 bearing plate assembly.

AA

Attaching hardware threads 3 A 3 Require replacement of part with
stripped (threads missing) 3 3 stripped threads, if available;
3 3 otherwise, replace bearing plate
3 3 assembly.

AA

Bearing axial or radial 3 B 3 Require replacement of bearing.
movement exceeds vehicle 3 3
manufacturer's specs 3 3

AA

Bearing binding 3 A 3 Require replacement of bearing.

AA

Bearing missing 3 C 3 Require replacement of bearing.

AA

Bearing seized 3 A 3 Require replacement of bearing.

AA

Bent 3 B 3 Require replacement.

AA

Holes distorted 3 A 3 Require replacement.

AA

Missing 3 C 3 Require replacement.

AA

Severely corroded, 3 A 3 Require replacement.
affecting structural 3 3
integrity 3 3

AA

SWAY BAR LINKS

SWAY BAR LINKS

AA

Condition 3 Code 3 Procedure

AA

Attaching hardware 3 A 3 Require replacement of incorrect
incorrect 3 3 part, if available; otherwise,
3 3 replace link.

AA

Attaching hardware loose 3 A 3 Require repair or replacement of
3 3 loose part, if available;
3 3 otherwise, replace link.

AA

Attaching hardware missing 3 C 3 Require replacement of missing

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3 3 part, if available; otherwise,
3 3 replace link.

AA

Attaching hardware threads 3 A 3 Require repair or replacement of
damaged 3 3 part with damaged threads, if
3 3 available; otherwise, replace
3 3 link.

AA

Attaching hardware threads 3 A 3 Require replacement of part with
stripped (threads missing) 3 3 stripped threads, if available;
3 3 otherwise, replace link.

AA

Ball and socket has 3 A,1 3 Suggest replacement. See note (1).
looseness (perceptible 3 3
vertical movement) 3 3

AA

CAUTION: DO NOT use pliers or pry bar to check ball and socket
movement. Use only moderate hand pressure.

AA

Ball and socket has 3 B 3 Require replacement. See notes (1)
looseness that is 3 3 and (2) and caution.
excessive 3 3

AA

Bent 3 B 3 Require replacement.

AA

Broken 3 A 3 Require replacement.

AA

Corroded, affecting 3 A 3 Require replacement.
structural integrity 3 3

AA

Grease boot cracked 3 B,2 3 Suggest replacement. See note (3).

AA

Grease boot missing 3 B,2 3 Suggest replacement. See note (4).

AA

Grease boot torn 3 B,2 3 Suggest replacement. See note (5).

AA

Missing 3 C 3 Require replacement.

AA

Nut on stud loose 3 A 3 Require repair. See note (6).

AA

Stud bent 3 B 3 Require replacement. See note (7).

AA

Stud broken 3 A 3 Require replacement. See note (7).

AA

Threads damaged 3 A 3 Require repair or replacement.

AA

Threads stripped (threads 3 A 3 Require replacement. See note (7).
missing) 3 3

AA

NOTE: (1) If manufacturer's procedures for inspection exist, use those
procedures; otherwise, use an approved inspection method
such as the dry park check.

[illegible]

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TIE ROD ENDS (INNER & OUTER)

TIE ROD ENDS (INNER & OUTER)

Condition				3	Code	3	Procedure
Attaching hardware incorrect				3	A	3	Require replacement of incorrect part, if available; otherwise, replace tie rod end.
Attaching hardware loose				3	A	3	Require repair or replacement of loose part, if available; otherwise, replace tie rod end.
Attaching hardware missing				3	C	3	Require replacement of missing part, if available; otherwise, replace tie rod end.
Attaching hardware threads damaged				3	A	3	Require repair or replacement of part with damaged threads, if available; otherwise, replace tie rod end.
Attaching hardware threads stripped (threads missing)				3	A	3	Require replacement of part with stripped threads, if available; otherwise, replace tie rod end.
Adjusting sleeve bent				3	B	3	Require replacement of sleeve or tie rod end.
Adjusting sleeve clamps out of position				3	B	3	Require repair.
Adjusting sleeve corroded, affecting structural integrity				3	A	3	Require replacement of sleeve or tie rod end.
Adjusting sleeve missing				3	C	3	Require replacement of sleeve or tie rod end.
Adjusting sleeve seized				3	A	3	Require repair or replacement. See note (1) below.
Adjusting sleeve threads damaged				3	A	3	Require repair or replacement of sleeve or tie rod end.
Adjusting sleeve threads stripped (threads missing)				3	A	3	Require replacement of sleeve or tie rod end.
Binding				3	A	3	Further inspection required. See note (2) below.

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AA
Grease boot cracked 3 3 Suggest replacement. See note (3).
AA
Grease boot missing 3 3 Suggest replacement. See note (4).
AA
Grease boot torn 3 3 Suggest replacement. See note (5).
AA
Grease fitting broken 3 A 3 Require replacement of grease
3 3 fitting.
AA
Grease fitting missing 3 C 3 Require replacement of grease
3 3 fitting.
AA
Grease fitting won't seal 3 A 3 Require replacement of grease
3 3 fitting.
AA
Grease seal missing 3 B,2 3 Suggest replacement of seal.
3 3 See note (4) below.
AA
Grease seal torn 3 B,2 3 Suggest replacement of seal.
3 3 See note (5) below.
AA
Greaseable tie rod end 3 B,2 3 Suggest replacement of grease
will not take grease 3 3 fitting. See note (6) below.
AA
Looseness (perceptible 3 A,1 3 Suggest replacement. See note (7).
horizontal movement) 3 3
AA
CAUTION: DO NOT use pliers or pry bar to check ball and socket
movement. Use only moderate hand pressure.
AA
Looseness exceeds 3 B 3 Require replacement.
manufacturer's specs 3 3
AA
Looseness that is excessive 3 B 3 Require replacement. See notes (7)
3 3 and (8), caution.
AA
Nut on stud loose 3 A 3 Require repair or replacement of
3 3 nut. See note (9) below.
AA
Seized 3 A 3 Require replacement
AA
Stud bent 3 B 3 Require replacement. See note (10)
AA
Stud broken 3 A 3 Require replacement. See note (10)
AA
Threads damaged 3 A 3 Require repair or replacement.
AA
Threads stripped (threads 3 A 3 Require replacement. See note (10)
missing) 3 3
AA
NOTE: (1) Only required if toe needs to be adjusted.

[illegible]

TRAILING ARMS

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Condition			3	Code	3	Procedure
Attaching hardware broken			3	A	3	Require replacement of broken part, if available; otherwise, replace trailing arm.
Attaching hardware loose			3	A	3	Require repair or replacement of loose part, if available; otherwise, replace trailing arm.
Attaching hardware missing			3	C	3	Require replacement of missing part, if available; otherwise, replace trailing arm.
Attaching hardware threads damaged			3	A	3	Require repair or replacement of part with damaged threads, if available; otherwise, replace trailing arm.
Attaching hardware threads stripped (threads missing)			3	A	3	Require replacement of part with stripped threads, if available; otherwise, replace trailing arm.
Bent			3	B	3	Require replacement.
Bushing hole oversized			3	B	3	Require replacement.
Corroded, affecting structural integrity			3	A	3	Require replacement.
Holes distorted			3	A	3	Require replacement.
Threads damaged			3	A	3	Require repair or replacement.
Threads stripped (threads missing)			3	A	3	Require replacement.

WHEEL ALIGNMENT

WHEEL ALIGNMENT

Wheel alignment is defined as the measurement, analysis, and adjustment of steering and suspension angles to conform to OEM specifications. These angles usually include, but are not limited to: caster, camber, toe, and thrust angle. Where these angles are not adjustable and not in specification, component replacement or correction kits may be required. Errors in set-back and steering axis inclination (SAI) are often attributable to failed or damaged components and must be corrected prior to performing an alignment.

Failure to replace or correct suggested or required parts or

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service may prevent a proper alignment.

Before performing an alignment check, inspect and verify the following:

- * Tire pressure and size
- * Vehicle loading
- * Ride height
- * Steering and suspension parts

Only if the inspection reveals that all the above are within published specifications, should a wheel alignment check and an alignment, if needed, be performed.

CAUTION: Under no circumstances should a technician bend or heat any steering or suspension component, unless specified by the vehicle manufacturer, for example, Ford forged twin "I" beam axles. All measurements and suggestions must be noted on the inspection report.

WHEEL ALIGNMENT

Condition	3	Code	3	Procedure
Dog tracking, shown to be				
caused by faulty alignment	3	B,2	3	Suggest repair.
Lead, shown to be caused				
by faulty alignment	3	B	3	Require alignment.
Part has been changed that				
may affect alignment	3	B	3	Require alignment check.
Pull, shown to be caused				
by faulty alignment	3	B	3	Require alignment.
Steering wheel off-center				
	3	B,2	3	Suggest alignment.
Tire wear, shown to be				
caused by faulty alignment	3	B	3	Require alignment.
Wander, shown to be caused				
by faulty alignment	3	B	3	Require alignment.

WHEEL BEARINGS, RACES, & SEALS

NOTE: When replacing or repacking wheel bearings, grease seal replacement is required. You are not required to replace these components in axle sets. Determine the need to replace based upon the individual component conditions that follow.

WHEEL BEARINGS, RACES, & SEALS

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Condition			3	Code	3	Procedure
Rear axle seal on rear-wheel drive leaking			3	A	3	Require replacement of seal and inspection of axle, bearing, housing, and vent tube
Seal bent			3	A,1	3	Suggest replacement.
Seal leaking			3	A	3	Require replacement of seal and inspection of bearings.
Seal missing			3	C	3	Require replacement.
Seal torn			3	A	3	Require replacement.
Wheel bearing assembly feels rough when rotated			3	A	3	Require replacement of bearing assembly.
Wheel bearing balls are pitted			3	A	3	Require replacement of bearing assembly.
Wheel bearing balls are worn			3	A	3	Require replacement of bearing assembly.
Wheel bearing end-play exceeds vehicle manufacturer's specs			3	A	3	Require adjustment of bearing, if possible. If proper adjustment cannot be obtained, require repair or replacement of worn component.
Wheel bearing race is loose in the hub bore			3	A	3	Require replacement of hub assembly and wheel bearings.
Wheel bearing races are pitted			3	A	3	Require replacement of bearing assembly.
Wheel bearing races are worn			3	A	3	Require replacement of bearing assembly.
Wheel bearing rollers are pitted			3	A	3	Require replacement of bearing assembly.
Wheel bearing rollers are worn			3	A	3	Require replacement of bearing assembly.

WHEELS & TIRES

TIRES

WARNING: These guidelines do not apply to split rims.

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Some vehicle manufacturers restrict replacement of tires to specific brands, types, or sizes.

High pressure temporary compact spare tires should not be used with any other rims or wheels, nor should standard tires, snow tires, wheel covers, or trim rings be used with high pressure compact spare rims or wheels.

Attempting to mount a tire of one diameter on a wheel of a different diameter or flange type may result in serious injury or death.

Only specially trained persons should de-mount or mount tires. Explosions of tire and wheel assembly can result from improper mounting, possibly causing serious injury or death.

Consult the vehicle owner's manual or vehicle placard for correct size, speed rating, designation, and cold inflation pressure of the original tires. DO NOT exceed the maximum load or inflation capacity of the tire specified by the Tire and Rim Association

When replacing tires, it is suggested that the replacement tires match or exceed the OEM speed rating designation. If tires of different speed rating designations are mixed on the same vehicle, the tires may vary in handling characteristics. DO NOT mix different speed rating designations on the same axle.

DO NOT mix radials with non-radial tires on the same axle, as this may affect vehicle handling and stability. If radial tires and bias or bias-belted ply tires are mixed on the same vehicle, the radials must be on the rear. High-pressure temporary compact spare tires are exempt from this rule.

DO NOT mix size or type (all season, performance, mud and snow) of tires on the same axle.

TIRES

Condition			3	Code	3	Procedure
Air pressure incorrect						
	3	B	3			Require repair
Bead broken						
	3	A	3			Require replacement.
Bead leaking, caused by tire						
	3	A	3			Require repair or replacement.
Bead wire/cord exposed						
	3	A	3			Require replacement.
Cord or belt material exposed						
	3	A	3			Require replacement.
Cord ply separations						
	3	A	3			Require replacement.
Directional/asymmetrical tires						
mounted incorrectly	3	B	3			Require remounting and/or repositioning.
Irregular tread wear,						
affecting performance	3	A	3			Suggest replacement.
	3		3			See note (1) below.
Load ratings less than OEM						
	3	B	3			Require replacement.

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specifications	3	3	
AAAAA			
Mixed tire size designations	3	A	3
on same axle	3		3
			Require rotation or replacement.
AAAAA			
Mixed tread types (all season,	3	A	3
performance, mud and snow)	3		3
on same axle	3		3
			Require rotation or replacement.
AAAAA			
Number of punctures exceeds	3	B	3
manufacturer's limit	3		3
			Require replacement.
AAAAA			
Out of balance	3	B	3
	3		3
			Require rebalance of tire/wheel assembly.
AAAAA			
Ply separation	3	A	3
			Require replacement.
AAAAA			
Pull or lead, caused by tire	3	A	3
	3		3
			Require rotation or replacement.
AAAAA			
Radial and bias or bias-belted	3	B	3
ply tires on same axle	3		3
			Require rotation or replacement.
AAAAA			
Radials are on the front and	3	B	3
not on the rear	3		3
			Require rotation or replacement. See note (2).
AAAAA			
Run flat damage	3	A	3
			Require replacement.
AAAAA			
Shoulder cut	3	A	3
			Require replacement.
AAAAA			
Shoulder puncture	3	A	3
			Require replacement.
AAAAA			
Shoulder with plug	3	A	3
			Require replacement.
AAAAA			
Sidewall bulge	3	A	3
			Require replacement.
AAAAA			
Sidewall cut	3	A	3
			Require replacement.
AAAAA			
Sidewall indentation	3		3
			No service required/suggested.
AAAAA			
Sidewall puncture	3	A	3
			Require replacement.
AAAAA			
Sidewall with plug	3	A	3
			Require replacement.
AAAAA			
Speed rating designations	3	B	3
different on same axle	3		3
			Suggest rotation or replacement.
AAAAA			
Tire and wheel assembly has	3	B	3
excessive run-out	3		3
	3		3
			Require repair or replacement of appropriate part. See note (3) below.
AAAAA			
Tires with more than 1/4"	3	B	3
			Require replacement.

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diameter difference on a	3	3
four-wheel drive vehicle	3	3
Tread area puncture larger in 3 B 3 Require replacement.		
diameter than tire	3	3
manufacturer's specifications	3	3
Tread missing pieces 3 A 3 Require replacement.		
(chunking), exposing cord	3	3
Tread missing pieces 3 A 3 Suggest replacement.		
(chunking), not exposing cord	3	3
Tread separations 3 A 3 Require replacement.		
Tube in tubeless tire 3 C,3 3 Suggest removal of tube.		
	3	3 See note (4) below.
Weather-checking 3 3 No service required/suggested.		
Worn to tread wear indicators 3 B 3 Require replacement.		

NOTE: (1) Determine and correct cause of irregular tire wear.
(2) If radials and bias or bias-belted ply tires are on the same vehicle, the radials must be on the rear axle, except for high-pressure temporary spares.
(3) Excessive is defined as enough to contribute to performance problems. Match mounting may correct run-out. If not, require replacement of appropriate part. Refer to manufacturer's specifications.
(4) Most manufacturers do not recommend tubes in tubeless tires. Inspect tire and wheel assembly to determine the reason for a tube in tubeless tire. Recommendation for repair or replacement should be based upon condition of tires and/or wheel listed in these guidelines.

VALVE STEMS

VALVE STEMS		
Condition	3	Code 3 Procedure
Bent	3	A,1 3 Suggest replacement.
Broken	3	A 3 Require replacement.
Cut, but not leaking	3	A,1 3 Suggest replacement.
Deteriorated (cracking, dry rot)	3	A,1 3 Suggest replacement.
Leaking	3	A 3 Require repair/replacement.

Condition	Code	Procedure
Bent	A	Require replacement.
Broken	A	Require replacement.
		See note (1) below.
Loose	B	Require repair or replacement
		of affected component.
Lug nut installed backward	B	Require repair.
Lug nut mating type incorrect	B	Require replacement of nut.
Lug nut mating surface dished	A	Require replacement of nut.
Lug nut flats rounded	A	Require replacement of nut.
		See note (2) below.
Lug nut seized	A	Require replacement of nut
		and/or stud. See note (2) below.
Stud incorrect	B	Require replacement of stud.
Threads damaged	A	Require repair or replacement of
		component with damaged threads.

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Threads stripped (threads 3 A 3 Require replacement of
missing) 3 3 component with stripped threads.

NOTE: (1) Some manufacturers require replacement of all studs on that
wheel if two or more studs or nuts on the same wheel are
broken or missing.

(2) Only required if removing wheel.

WHEELS

WARNING: Mounting a regular tire on a high-pressure compact spare
wheel is not permitted. Attempting to mount a tire of one
diameter on a wheel of a different diameter or flange type
may result in serious injury or death. If the wheel
identification stamp is not legible, or cannot be found,
DO NOT use the wheel until the size and type have been
properly identified. Wheels of different diameter, offset,
or width cannot be mixed on the same axle. Bead seat tapers
cannot be interchanged.

WHEELS

Condition 3 Code 3 Procedure

Bead leaking, caused by 3 A 3 Require repair or replacement.
wheel rim flange 3 3 See caution below.

CAUTION: DO NOT attempt to correct a bent wheel rim.

Bent wheel hub mounting 3 A 3 Require replacement.
surface 3 3

Bent wheel rim, causing 3 B,2 3 Suggest replacement.
vibration 3 3 See caution above.

Broken 3 A 3 Require replacement.

Cast wheel porous, causing 3 A 3 Require repair or replacement.
a leak 3 3

Clip-on balance weight is 3 B,2 3 Suggest replacement.
incorrect type for wheel 3 3
rim flange 3 3

Corrosion, affecting 3 A 3 Require replacement.
structural integrity 3 3

Corrosion build-up on wheel 3 A 3 Require repair.
hub mounting surface 3 3

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END OF ARTICLE

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ARTICLE BEGINNING

GENERAL INFORMATION

Steering & Suspension Systems - (Including Wheels & Tires)

All Makes & Models

Updated: January, 1997

MAP UNIFORM INSPECTION GENERAL GUIDELINES

OVERVIEW OF MOTORIST ASSURANCE PROGRAM

The Motorist Assurance Program (MAP) is the consumer outreach effort of the Automotive Maintenance and Repair Association, Inc. (AMRA). Participation in the Motorist Assurance Program is drawn from retailers, suppliers, independent repair facilities, vehicle manufacturers and industry associations.

The Motorist Assurance Program was established as an industry-wide effort to address concerns raised by regulators, the media and consumers questioning our ethics and methods of doing business. The automotive repair industry had been bombarded by months of negative stories in the media and scrutiny from state and federal regulators who focused on how the need for repairs is determined. MAP was formed as an industry response to this issue.

Our mission is to strengthen the relationship between the consumer and the auto repair industry. We produce materials that give motorists the information and encouragement to take responsibility for their vehicles - through proper, manufacturer-recommended, maintenance. We encourage participating service and repair shops (including franchisees and dealers) to adopt a Pledge to their Customers and the Motorist Assurance Program developed Standards of Service. All participating service providers have agreed to subscribe to this Pledge and to adhere to the promulgated Standards of Service which demonstrates to their customers that they are serious about customer satisfaction.

These Standards of Service require that an inspection of the vehicle's (problem) system be made according to industry guidelines. After learning that neither the car manufacturers nor any other source had complete guidelines, leading industry organizations, along with other industry participants banded together to address this challenging task. During the past two and a half years, they successfully developed industry inspection guidelines for the following systems: Exhaust, Brakes, ABS, Steering and Suspension, Engine Maintenance and Performance, HVAC, and Electrical systems. Guidelines for Drive Train and Transmission are currently being promulgated. Revisions to the inspection guidelines for Exhaust, Brakes/ABS and Steering and Suspension Systems, which were issued two years ago, are now being published for implementation beginning spring 1997. Participating shops utilize these Uniform Inspection Guidelines as part of the inspection process and for communicating their findings to their customers.

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The Motorist Assurance Program continues to work cooperatively and proactively with government agencies and consumer groups toward solutions that both benefit the customer and are mutually acceptable to both regulators and industry. We maintain the belief that industry must retain control over how we conduct our business, and we must be viewed as part of the solution and not part of the problem. Meetings with state and other government officials concerned with auto repair and/or consumer protection are conducted. Feedback from these representatives are brought back to members, and the program adjusted as needed.

To assure auto repair customers recourse if they were not satisfied with a repair transaction, the Motorist Assurance Program offers arbitration through MAP/BBB-CARE in cooperation with the Council of Better Business Bureaus and individual participating Bureaus. MAP "piloted" in Indianapolis and Pittsburgh during spring, 1996 - and publicized "roll-outs" in New Jersey, Detroit (MI), Chicago (IL) and Richmond (VA) were conducted. To put some "teeth" in the program, and accreditation requirement for shops was initiated. The requirements are stringent and a self-policing method has been incorporated which includes the "mystery shopping" of outlets. In addition, a committee of service providers had been working diligently developing standards for newspaper, television and Internet advertising.

We welcome you to join us as we continue our outreach ... with your support, both the automotive repair industry and your customers will reap the benefits. Please visit MAP at our Internet site: www.hunter.com/map.htm or contact us at:

808 17th Street, NW Suite 200

Washington, D.C. 20006

Ph. (202) 466-7050 Fax (202) 223-9569

OVERVIEW OF SERVICE REQUIREMENTS & SUGGESTIONS

It is MAP policy that all exhaust, brake, ABS, steering and suspension, wheel alignment, tires and wheels, driveline, engine performance and maintenance and heating, ventilation and air conditioning services be offered and performed under the guidelines and procedures specified in these sections.

Before any service is performed on a vehicle, an inspection of the appropriate system must be performed. The results of this inspection must be explained to the customer and documented on an inspection form. The condition of the vehicle and its components will indicate what services/part replacements may be required or suggested. In addition, suggestions may be made to satisfy the needs expressed by the customer.

This section lists the various parts and conditions that indicate required or suggested service or part replacement. Although this list is extensive, it is not inclusive. In addition to this list, a technician may make a suggestion. This suggestion must be based on substantial and informed experience or the vehicle manufacturer's recommended service interval.

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Some conditions indicate that service or part replacement is required because the part in question is no longer providing the function for which it is intended, does not meet a vehicle manufacturer's design specification or is missing.

- * Example: An exhaust pipe has corroded severely and has a hole in it through which exhaust gases are leaking. Replacement of the exhaust pipe in this case is required due to functional failure.
- * Example: A brake rotor has been worn to the point where it measures less than the vehicle manufacturer's specifications. Replacement of the rotor is required because it does not meet design specifications.

Some conditions indicate that a service or part replacement is suggested because the part is close to the end of its useful life or to address a customer's need, convenience or request. If a customer's vehicle has one of these conditions, the procedure may only be to suggest service.

- * Example: An exhaust pipe is rusted, corroded or weak, but no leaks are present. In this case, the exhaust pipe has not failed. However, there is evidence that the pipe may need replacement in the near future. Replacement of the pipe may be suggested for the customer's convenience in avoiding a future problem.
- * Example: The customer desires improved ride and/or handling, but the vehicle's shocks or struts have not failed. In this case, replacement may be suggested to satisfy the customer's wishes. In this case, replacement of the shocks or struts may not be sold as a requirement.

A customer, of course, has the choice of whether or not a shop will service his or her vehicle. He or she may decide not to follow some of your suggestions. When a customer declines to authorize a service or repair indicated in the MAP Uniform Inspection Guidelines as "required," a MAP shop may refuse service on that system, if proceeding with the work could create or continue an unsafe or unsatisfactory condition.

The following reasons may be used for required and suggested services. These codes are shown in the "Code" column of the Uniform Inspection Guidelines that follow.

PART REPLACEMENT CODE IDENTIFICATION

NOTE: Refer to the following tables for definitions of the codes listed in the condition/procedure tables for the specific components that may need to be replaced.

A - PART NO LONGER PERFORMS INTENDED PURPOSE

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CAUTION: DO NOT use ride height altering or load compensating components, such as variable rate springs and coil over shocks, on vehicles with height or load sensing proportioning valve-equipped braking systems, unless these components are original equipment.

AIR RIDE SUSPENSION

NOTE: Depending on the air suspension design, there are some aftermarket products available to eliminate the air ride suspension on certain vehicles. If the system has been eliminated with one of these products, then no service is suggested or required.

AIR RIDE SUSPENSION - AIR SHOCKS & AIR STRUTS

NOTE: This section covers the air spring portion of the air shock or strut. For dampening portion of shock or strut conditions and procedures, refer to the "Shock Absorbers, Strut Cartridges, and Strut Assemblies" section.

AIR RIDE SUSPENSION - AIR SHOCKS & AIR STRUTS

AA			
Condition	3	Code	3 Procedure
AA			
Inner fabric of air bag damaged	3	A	3 Require replacement.
	3		3
AA			
Leaking	3	A	3 Require repair or replacement.
AA			
Outer covering of air bag is cracked to the extent that inner fabric of air bag is visible	3	A,1	3 Suggest replacement.
	3		3
	3		3
	3		3
AA			

AIR RIDE SUSPENSION - AIR SPRING VALVES

AIR RIDE SUSPENSION - AIR SPRING VALVES

AA			
Condition	3	Code	3 Procedure
AA			
Attaching hardware incorrect	3	A	3 Require replacement of incorrect part.
	3		3
AA			
Attaching hardware loose	3	A	3 Require repair or replacement of loose part.
	3		3
AA			
Attaching hardware missing	3	C	3 Require replacement of missing part.
	3		3
AA			

*** SUSPENSION UNIFORM INSPECTION GUIDELINES ***

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Attaching hardware threads damaged	3	A	3	Require repair or replacement of part with damaged threads.
AA				
Attaching hardware threads stripped (threads missing)	3	A	3	Require replacement of part with stripped threads.
AA				
Blocked	3	A	3	Require repair or replacement.
AA				
Connector bent	3	A	3	Require repair or replacement.
AA				
Connector broken	3	A	3	Require replacement.
AA				
Connector loose	3	A	3	Require repair or replacement.
AA				
Inoperative	3	A	3	Require repair or replacement.
AA				
Leaking	3	A	3	Require repair or replacement.
AA				
Restricted	3	A	3	Require repair or replacement.
AA				

AIR RIDE SUSPENSION - AIR SPRINGS

AIR RIDE SUSPENSION - AIR SPRINGS

Condition	3	Code	3	Procedure
AA				
Attaching hardware broken	3	A	3	Require replacement of broken part.
AA				
Attaching hardware incorrect	3	A	3	Require replacement of incorrect part.
AA				
Attaching hardware loose	3	A	3	Require repair or replacement of loose part.
AA				
Attaching hardware missing	3	C	3	Require replacement of missing part.
AA				
Attaching hardware threads damaged	3	A	3	Require repair or replacement of part with damaged threads.
AA				
Attaching hardware threads stripped (threads missing)	3	A	3	Require replacement of part with stripped threads.
AA				
Collar cracked	3	A	3	Require replacement.
AA				
End cap cracked	3	A	3	Require replacement.
AA				
Inner fabric of bag damaged	3	A	3	Require replacement.
AA				
Leaking	3	A	3	Require repair or replacement.

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AA

Outer covering of air bag 3 A,1 3 Suggest replacement.
is cracked to the extent 3 3
that inner fabric of air 3 3
bag is visible 3 3

AA

Piston cracked 3 A 3 Require replacement.

AA

AIR RIDE SUSPENSION - COMPRESSORS

AIR RIDE SUSPENSION - COMPRESSORS

AA

Condition 3 Code 3 Procedure

AA

Attaching hardware bent 3 B 3 Require repair or replacement of
bent part.

AA

Attaching hardware broken 3 A 3 Require replacement of broken
part.

AA

Attaching hardware loose 3 A 3 Require repair or replacement of
loose part.

AA

Attaching hardware missing 3 C 3 Require replacement of missing
part.

AA

Attaching hardware threads 3 A 3 Require repair or replacement of
damaged 3 3 part with damaged threads.

AA

Attaching hardware threads 3 A 3 Require replacement of part with
stripped (threads missing) 3 3 stripped threads.

AA

Connector bent 3 A 3 Require repair or replacement.

AA

Connector broken 3 A 3 Require replacement.

AA

Connector loose 3 A 3 Require repair or replacement.

AA

Does not build pressure 3 A 3 Further inspection required.
3 3 See note (1) below.

AA

Excessive run time 3 B 3 Further inspection required.
3 3 See note (2) below.

AA

Inoperative 3 A 3 Require replacement.

AA

Leaking 3 A 3 Require repair or replacement.

AA

Missing 3 C 3 Require replacement.

AA

NOTE: (1) If failure to build pressure is traced to the compressor,

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require replacement.

- (2) If excessive run time is traced to the compressor, require replacement.

AA

AIR RIDE SUSPENSION - HEIGHT SENSORS

AIR RIDE SUSPENSION - HEIGHT SENSORS

AA

Condition	3	Code	3	Procedure
-----------	---	------	---	-----------

AA

Attaching hardware bent	3	B	3	Require repair or replacement of bent part.
-------------------------	---	---	---	---

AA

Attaching hardware broken	3	A	3	Require replacement of broken part.
---------------------------	---	---	---	-------------------------------------

AA

Attaching hardware corroded affecting structural integrity	3	A	3	Require replacement of corroded part.
--	---	---	---	---------------------------------------

AA

Attaching hardware loose	3	A	3	Require repair or replacement of loose part.
--------------------------	---	---	---	--

AA

Attaching hardware missing	3	C	3	Require replacement of missing part.
----------------------------	---	---	---	--------------------------------------

AA

Attaching hardware threads damaged	3	A	3	Require repair or replacement of part with damaged threads.
------------------------------------	---	---	---	---

AA

Attaching hardware threads stripped (threads missing)	3		3	Require replacement of part with stripped threads.
---	---	--	---	--

AA

Dust boot missing	3	B,2	3	Suggest replacement. See note (1).
-------------------	---	-----	---	------------------------------------

AA

Dust boot split	3	B,2	3	Suggest replacement. See note (1).
-----------------	---	-----	---	------------------------------------

AA

Dust boot torn	3	B,2	3	Suggest replacement. See note (1).
----------------	---	-----	---	------------------------------------

AA

Housing cracked	3	A	3	Require replacement.
-----------------	---	---	---	----------------------

AA

Lead routing incorrect	3	B	3	Require re-routing according to vehicle manufacturer's specs.
------------------------	---	---	---	---

AA

Loose	3	B	3	Require adjustment to vehicle manufacturer's specifications.
-------	---	---	---	--

AA

Missing	3	C	3	Require replacement.
---------	---	---	---	----------------------

AA

Output signal incorrect	3	A	3	Require repair or replacement.
-------------------------	---	---	---	--------------------------------

AA

Wire lead damaged	3	A	3	Require repair or replacement.
-------------------	---	---	---	--------------------------------

[illegible]

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Condition	3	Code	3	Procedure
Broken	3	A	3	Require replacement.
Missing	3	C	3	Require replacement.
Output signal incorrect	3	A	3	Require replacement.

AIR RIDE SUSPENSION - TORSION SPRINGS (COUNTER BALANCING)

AIR RIDE SUSPENSION - TORSION SPRINGS (COUNTER BALANCING)				
Condition	3	Code	3	Procedure
Attaching hardware bent	3	B	3	Require repair or replacement of bent part.
Attaching hardware broken	3	A	3	Require replacement of broken part.
Attaching hardware incorrect	3	A	3	Require replacement of incorrect part.
Attaching hardware loose	3	A	3	Require repair or replacement of loose part.
Attaching hardware missing	3	C	3	Require replacement of missing part.
Attaching hardware threads damaged	3	A	3	Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing)	3	A	3	Require replacement of part with stripped threads.
Broken	3	A	3	Require replacement.
Missing	3	C	3	Require replacement.

AIR RIDE SUSPENSION - TUBING

AIR RIDE SUSPENSION - TUBING				
Condition	3	Code	3	Procedure
Attaching hardware incorrect	3	A	3	Require replacement of incorrect part.
Attaching hardware loose	3	A	3	Require repair or replacement of loose part.

*** SUSPENSION UNIFORM INSPECTION GUIDELINES ***

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AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Attaching hardware missing      3   C   3   Require replacement of missing
                                   3   3   part.
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Blocked                          3   A   3   Require repair or replacement.
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Fitting incorrect               3   B   3   Require replacement.
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Leaking                          3   A   3   Require repair or replacement.
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Line type incorrect             3   B   3   Require replacement.
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Missing                         3   C   3   Require replacement.
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Restricted                       3   A   3   Require repair or replacement.
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Routed incorrectly              3   B   3   Require routing correction.
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

```

AIR RIDE SUSPENSION - WARNING LAMPS

AIR RIDE SUSPENSION - WARNING LAMPS

```

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Condition                       3   Code 3   Procedure
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Bulb burned out                 3   A   3   Require replacement.
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Warning light does not come     3       3
on during bulb check           3       3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Warning light flashes           3       3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Warning light is intermittent   3       3 Further inspection required to
Warning light is intermittent   3       3 determine cause.
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Warning light stays on after    3       3
initial bulb check             3       3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

```

AIR RIDE SUSPENSION - WIRING HARNESSSES

AIR RIDE SUSPENSION - WIRING HARNESSSES

```

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Condition                       3   Code 3   Procedure
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Connector bent                  3   A   3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Connector broken                3   A   3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Connector loose                 3   A   3 Require repair or replacement.
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Damaged (cut, burned, or       3   A   3
chafed)                        3       3

```

*** SUSPENSION UNIFORM INSPECTION GUIDELINES ***

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AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA~
Excessive resistance      3   B   3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA~
Fuse blown                3   A   3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA~ Require replacement.
Fusible link blown       3   A   3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA~
Open                      3   A   3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA~ Require repair or replacement.
Poor ground              3   A   3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA~
Routed incorrectly       3   B   3 Require re-routing according to
                        3       3 vehicle manufacturer's specs.
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA~
Shorted                  3   A   3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA~
Terminal bent            3   A   3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA~
Terminal broken          3   A   3 Require repair or replacement.
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA~
Terminal corroded        3   A   3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA~
Terminal loose           3   A   3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA~

```

BALL JOINTS

Before requiring or suggesting ball joint replacement, the approved OEM procedure must be used to measure ball joint wear. The measurement(s) obtained, along with the vehicle manufacturer's specifications, must be noted on the inspection report. Some states require that these measurements also appear on the invoice.

NOTE: The term "perceptible movement," defined as any visible movement in any direction, has been the industry standard for determining the need for replacement of follower ball joints. Some vehicle manufacturers are now publishing specifications for follower ball joints that were previously diagnosed by the "perceptible movement" standard. Before requiring or suggesting any parts be replaced based on "perceptible movement," consult your repair manual to determine if OEM specifications exist.

You are not required to replace ball joints in axle sets. However, when replacing a ball joint due to wear exceeding manufacturer's specification, you may suggest replacement of the other ball joint if its measurement shows it is close to the end of its useful life, for preventive maintenance.

BALL JOINTS

```

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA~
Condition                3   Code   3           Procedure

```

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[illegible]

Condition	Code	Procedure
Attaching hardware bent	B	Require repair or replacement of bent part if available; otherwise, replace bushing.
Attaching hardware broken	A	Require replacement of broken part if available; otherwise, replace bushing.

*** SUSPENSION UNIFORM INSPECTION GUIDELINES ***

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Attaching hardware corroded affecting structural integrity	3 3 3	A	3 3 3	Require replacement of corroded part if available; otherwise, replace bushing.
AA				
Attaching hardware incorrect	3 3 3	A	3 3 3	Require replacement of incorrect part if available; otherwise, replace bushing.
AA				
Attaching hardware loose	3 3 3	A	3 3 3	Require repair or replacement of loose part if available; otherwise, replace bushing.
AA				
Attaching hardware missing	3 3 3	C	3 3 3	Require replacement of missing part if available; otherwise, replace bushing.
AA				
Attaching hardware threads damaged	3 3 3	A	3 3 3	Require repair or replacement of part with damaged threads if available; otherwise, replace bushing.
AA				
Attaching hardware threads stripped (threads missing)	3 3 3	A	3 3 3	Require replacement of part with stripped threads if available; otherwise, replace bushing.
AA				
Binding	3	A	3	Require repair or replacement.
AA				
Deteriorated, affecting performance	3 3	A	3 3	Require repair or replacement.
AA				
Distorted, affecting performance	3 3	A	3 3	Require repair or replacement.
AA				
Leaking (fluid-filled type)	3	A	3	Require replacement.
AA				
Missing	3	A	3	Require replacement.
AA				
Noisy	3 3	B,2	3 3	Further inspection required. See note (1) and caution below.
AA				
Rubber separating from internal metal sleeve on bonded bushing	3 3 3	A	3 3 3	Require replacement.
AA				
Seized	3	A	3	Require replacement.
AA				
Shifted (out of position)	3	B	3	Require repair or replacement.
AA				
Split	3	A	3	Require replacement.
AA				
Surface cracking (weather-checked)	3 3		3 3	No service suggested or required.

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AA

NOTE: (1) If noise isolated to bushing, suggest repair or replacement.

CAUTION: Use only approved lubricant on rubber bushings. Petroleum-based lubricants may damage rubber bushings.

AA

CENTER LINKS

CENTER LINKS

AA

Condition	3	Code	3	Procedure
-----------	---	------	---	-----------

AA

Attaching hardware incorrect	3	A	3	Require replacement of incorrect part, if available; otherwise, replace center link.
------------------------------	---	---	---	--

AA

Attaching hardware loose	3	A	3	Require repair or replacement of loose part, if available; otherwise, replace center link.
--------------------------	---	---	---	--

AA

Attaching hardware missing	3	C	3	Require replacement of missing part, if available; otherwise, replace center link.
----------------------------	---	---	---	--

AA

Attaching hardware threads damaged	3	A	3	Require repair or replacement of part with damaged threads, if available; otherwise, replace center link.
------------------------------------	---	---	---	---

AA

Attaching hardware threads stripped (threads missing)	3	A	3	Require replacement of part with stripped threads, if available; otherwise, replace center link.
---	---	---	---	--

AA

Bent	3	B	3	Require replacement.
------	---	---	---	----------------------

AA

Binding	3	A	3	Further inspection required. See note (1) below.
---------	---	---	---	--

AA

Grease boot cracked	3	B,2	3	Suggest replacement. See note (2).
---------------------	---	-----	---	------------------------------------

AA

Grease boot missing	3	B,2	3	Suggest replacement. See note (3).
---------------------	---	-----	---	------------------------------------

AA

Grease boot torn	3	B,2	3	Suggest replacement. See note (4).
------------------	---	-----	---	------------------------------------

AA

Grease fitting broken	3	A	3	Require replacement of grease fitting.
-----------------------	---	---	---	--

AA

Grease fitting missing	3	C	3	Require replacement of grease fitting.
------------------------	---	---	---	--

AA

Grease fitting won't seal	3	A	3	Require replacement of grease
---------------------------	---	---	---	-------------------------------

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3 3 fitting.

AA
Grease seal missing 3 B,2 3 Suggest replacement. See note (5).

AA
Grease seal torn 3 B,2 3 Suggest replacement. See note (6).

AA
Looseness (perceptible 3 A,1 3 Suggest replacement. See note (7).
horizontal movement) 3 3

AA
CAUTION: DO NOT use pliers or pry bar to check ball and socket
movement. Use only moderate hand pressure.

AA
Looseness that is excessive 3 B 3 Require replacement. See notes (8)
3 3 and (9), caution below.

AA
CAUTION: DO NOT use pliers or pry bar to check ball and socket
movement. Use only moderate hand pressure.

AA
Seized 3 A 3 Require replacement.

AA
Stud bent 3 B 3 Require replacement. See note (10)

AA
Stud broken 3 A 3 Require replacement. See note (10)

AA
Stud loose in taper hole 3 A 3 Require repair or replacement.
3 3 See note (10) below.

AA
Taper hole elongated 3 A 3 Require replacement. See note (11)

AA
Threads damaged 3 A 3 Require repair or replacement.

AA
Threads stripped (threads 3 A 3 Require replacement. See note (10)
missing) 3 3

AA
Wear exceeds manufacturer's 3 B 3 Require replacement.
specifications 3 3

AA

NOTE: (1) If greaseable, grease joint. If problem persists or joint is
non-greaseable, require replacement.

(2) Cracked grease boot will allow contaminants to enter the
joint and will accelerate wear.

(3) Lack of grease boot will allow contaminants to enter the
joint and will accelerate wear.

(4) Torn grease boot will allow contaminants to enter the joint
and will accelerate wear.

(5) Lack of grease seal will allow contaminants to enter the
joint and will accelerate wear.

(6) Torn grease seal will allow contaminants to enter the joint
and will accelerate wear.

(7) If manufacturer's procedures for inspection exist, use those
procedures; otherwise, use an approved inspection method
such as the dry park check.

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- (8) Excessive looseness is defined as being significant enough to affect vehicle handling or structural integrity.
- (9) If manufacturer's procedures for inspection exist, use those procedures; otherwise, use an approved inspection method such as the dry park check.
- (10) Check for damaged taper hole.
- (11) Check for damaged stud.

AA

CONTROL ARM SHAFTS

CONTROL ARM SHAFTS

AA

Condition	3	Code	3	Procedure
Attaching hardware broken	3	A	3	Require replacement of broken part, if available; otherwise, replace shaft.
Attaching hardware loose	3	A	3	Require repair or replacement of loose part, if available; otherwise, replace shaft.
Attaching hardware missing	3	C	3	Require replacement of missing part, if available; otherwise, replace shaft.
Attaching hardware threads damaged	3	A	3	Require repair or replacement of part with damaged threads, if available; otherwise, replace shaft.
Attaching hardware threads stripped (threads missing)	3	A	3	Require replacement of part with stripped threads, if available; otherwise, replace shaft.
Bent	3	B	3	Require replacement.
Shaft bushing surface undersized (worn)	3	B	3	Require replacement.
Threads damaged	3	A	3	Require repair or replacement.
Threads stripped (threads missing)	3	A	3	Require replacement.

AA

CONTROL ARMS

CONTROL ARMS

AA

Condition	3	Code	3	Procedure
Attaching hardware bent	3	B	3	Require repair or replacement of bent part, if available; otherwise, replace control arm.
Attaching hardware broken	3	A	3	Require replacement of broken part, if available; otherwise, replace control arm.

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AA

Attaching hardware corroded³ A ³ Require replacement of corroded
affecting structural ³ ³ part, if available; otherwise,
integrity ³ ³ replace control arm.

AA

Attaching hardware ³ A ³ Require replacement of incorrect
incorrect ³ ³ part, if available; otherwise,
³ ³ replace control arm.

AA

Attaching hardware loose ³ A ³ Require repair or replacement of
³ ³ loose part, if available;
³ ³ otherwise, replace control arm.

AA

Attaching hardware missing ³ C ³ Require replacement of missing
³ ³ part, if available; otherwise,
³ ³ replace control arm.

AA

Attaching hardware threads ³ A ³ Require repair or replacement of
damaged ³ ³ part with damaged threads, if
³ ³ available; otherwise, replace
³ ³ control arm.

AA

Attaching hardware threads ³ A ³ Require replacement of part with
stripped (threads missing)³ ³ stripped threads, if available;
³ ³ otherwise, replace control arm.

AA

Bent ³ B ³ Require replacement.

AA

Bushing hole oversized ³ B ³ Require replacement.

AA

Ball joint hole oversized ³ B ³ Further inspection required.
(loose interference or ³ ³ See note (1) below.
press fit) ³ ³

AA

Corroded, affecting ³ A ³ Require replacement.
structural integrity ³ ³

AA

Holes distorted ³ A ³ Require replacement.

AA

Threads damaged ³ A ³ Require repair or replacement.

AA

Threads stripped (threads ³ A ³ Require replacement.
missing) ³ ³

AA

NOTE: (1) If oversized ball joint is available, require replacement
of ball joint. If oversized ball joint is not available,
require replacement of control arm.

AA

DRAG LINKS

DRAG LINKS

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Condition			3	Code	3	Procedure
Attaching hardware incorrect			3	A	3	Require replacement of incorrect part, if available; otherwise, replace drag link.
Attaching hardware loose			3	A	3	Require repair or replacement of loose part, if available; otherwise, replace drag link.
Attaching hardware missing			3	C	3	Require replacement of missing part, if available; otherwise, replace drag link.
Attaching hardware threads damaged			3	A	3	Require repair or replacement of part with damaged threads, if available; otherwise, replace drag link.
Attaching hardware threads stripped (threads missing)			3	A	3	Require replacement of part with stripped threads, if available; otherwise, replace drag link.
Bent			3	B	3	Require replacement.
Binding			3	A	3	Further inspection required. See note (1) below.
Grease boot cracked			3	B,2	3	Suggest replacement. See note (2).
Grease boot missing			3	B,2	3	Suggest replacement. See note (3).
Grease boot torn			3	B,2	3	Suggest replacement. See note (4).
Grease fitting broken			3	A	3	Require replacement of grease fitting.
Grease fitting missing			3	C	3	Require replacement of grease fitting.
Grease fitting won't seal			3	A	3	Require replacement of grease fitting.
Grease seal missing			3	B,2	3	Suggest replacement. See note (5).
Grease seal torn			3	B,2	3	Suggest replacement. See note (4).
Looseness (perceptible horizontal movement)			3	A,1	3	Suggest replacement. See note (6).
CAUTION: DO NOT use pliers or pry bar to check ball and socket						

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movement. Use only moderate hand pressure.

Looseness that is excessive³ B ³ Require replacement. See notes (6)

³ and (7), caution below.

CAUTION: DO NOT use pliers or pry bar to check ball and socket

movement. Use only moderate hand pressure.

Seized ³ A ³ Require replacement.

Stud bent ³ B ³ Require replacement. See note (8).

Stud broken ³ A ³ Require replacement. See note (8).

Stud loose in taper hole ³ A ³ Require repair or replacement.

³ See note (8) below.

Taper hole elongated ³ A ³ Require replacement. See note (9).

Threads damaged ³ A ³ Require repair or replacement.

Threads stripped (threads ³ A ³ Require replacement. See note (8).

missing) ³ ³

Wear exceeds manufacturer's³ B ³ Require replacement.

specifications ³ ³

NOTE: (1) If greaseable, grease joint. If problem persists or joint is non-greaseable, require replacement.

(2) Cracked grease boot will allow contaminants to enter the joint and will accelerate wear.

(3) Lack of grease boot will allow contaminants to enter the joint and will accelerate wear.

(4) Torn grease boot will allow contaminants to enter the joint and will accelerate wear.

(5) Missing grease seal will allow contaminants to enter the joint and will accelerate wear.

(6) If manufacturer's procedures for inspection exist, use those procedures; otherwise, use an approved inspection method such as the dry park check.

(7) Excessive looseness is defined as being significant enough to affect vehicle handling or structural integrity.

(8) Check for damaged taper hole.

(9) Check for damaged stud.

ELECTRONIC RIDE CONTROL SHOCKS & STRUTS

NOTE: This section covers the electronic damping control portion of the electronic shock or strut. For dampening portion of shock or strut conditions and procedures, refer to the "Shock Absorbers, Strut Cartridges, and Strut Assemblies" section.

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ELECTRONIC RIDE CONTROL SHOCKS & STRUTS

AA			
Condition	3	Code	3 Procedure
AA			
Connector bent	3	A	3 Require repair or replacement.
AA			
Connector broken	3	A	3 Require repair or replacement.
AA			
Connector loose	3	A	3 Require repair or replacement.
AA			
Electronic valve control inoperative	3	B,2	3 Suggest replacement. See note (1).
AA			
Terminal bent	3	A	3 Require repair or replacement.
AA			
Terminal broken	3	A	3 Require repair or replacement.
AA			
Terminal corroded	3	A	3 Require repair or replacement.
AA			
Terminal loose	3	A	3 Require repair or replacement.
AA			
NOTE: (1) It is acceptable to replace with a non-electronically controlled unit, where available.			
AA			

IDLER ARMS

IDLER ARMS

AA			
Condition	3	Code	3 Procedure
AA			
Attaching hardware broken	3	A	3 Require replacement of broken
	3		3 part, if available; otherwise,
	3		3 replace idler arm.
AA			
Attaching hardware incorrect	3	A	3 Require replacement of incorrect
	3		3 part, if available; otherwise,
	3		3 replace idler arm.
AA			
Attaching hardware loose	3	A	3 Require repair or replacement of
	3		3 loose part, if available;
	3		3 otherwise, replace idler arm.
AA			
Attaching hardware missing	3	C	3 Require replacement of missing
	3		3 part, if available; otherwise,
	3		3 replace idler arm.
AA			
Attaching hardware threads damaged	3	A	3 Require repair or replacement of
	3		3 part with damaged threads, if
	3		3 available; otherwise, replace
	3		3 idler arm.

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AA

Attaching hardware threads ³ A ³ Require replacement of part with
stripped (threads missing)³ ³ stripped threads, if available;
³ ³ otherwise, replace idler arm.

AA

Binding ³ A ³ Further inspection required.
³ ³ See note (1) below.

AA

Grease boot cracked ³ B,2 ³ Suggest replacement. See note (2).

AA

Grease boot missing ³ B,2 ³ Suggest replacement. See note (3).

AA

Grease boot torn ³ B,2 ³ Suggest replacement. See note (4).

AA

Grease fitting broken ³ A ³ Require replacement of grease
³ ³ fitting.

AA

Grease fitting missing ³ C ³ Require replacement of grease
³ ³ fitting.

AA

Grease fitting won't seal ³ A ³ Require replacement of seal.

AA

Grease seal missing ³ B,2 ³ Suggest replacement. See note (5).

AA

Grease seal torn ³ B,2 ³ Suggest replacement. See note (4).

AA

Greaseable joint will not ³ B,2 ³ Suggest replacement of grease
take grease ³ ³ fitting. See note (6) below.

AA

Looseness at frame bracket ³ B ³ Require repair or replacement.
end ³ ³ See notes (7) and (8) below.

AA

Looseness at link end ³ A,1 ³ Suggest replacement. See note (7).
(perceptible horizontal ³ ³
movement) ³ ³

AA

CAUTION: DO NOT use pliers or pry bar to check ball and socket
movement. Use only moderate hand pressure.

AA

Looseness at link end that ³ B ³ Require replacement. See notes (7)
is excessive ³ ³ and (9) and caution below.

AA

CAUTION: DO NOT use pliers or pry bar to check ball and socket
movement. Use only moderate hand pressure.

AA

Mounted out of position ³ B ³ Require repositioning.
(center link not parallel)³ ³

AA

Nut on stud loose ³ A ³ Require repair or replacement.
³ ³ See note (10) below.

AA

Seized ³ A ³ Require replacement.

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```

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Stud bent          3   B   3   Require replacement. See note (11)
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Stud broken        3   A   3   Require replacement. See note (11)
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Taper hole elongated 3   A   3   Require replacement. See note (12)
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Threads damaged    3   A   3   Require repair or replacement.
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Threads stripped (threads 3   A   3   Require replacement. See note (11)
missing)          3       3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Wear exceeds manufacturer's 3   B   3   Require replacement.
specifications    3       3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

```

- NOTE: (1) If greaseable, grease joint. If problem persists or joint is non-greaseable, require replacement.
- (2) Cracked grease boot will allow contaminants to enter joint and will accelerate wear.
- (3) Lack of grease boot will allow contaminants to enter joint and will accelerate wear.
- (4) Torn grease boot will allow contaminants to enter joint and will accelerate wear.
- (5) Missing grease seal will allow contaminants to enter joint and will accelerate wear.
- (6) If greaseable joint will not take grease after replacing the grease fitting, suggest replacement of idler arm.
- (7) If manufacturer's procedures and specifications exist, use those procedures and specifications; otherwise, use an approved inspection method such as the dry park check.
- (8) Looseness is defined as movement that creates excessive toe change.
- (9) Excessive looseness is defined as significant enough to affect vehicle handling or structural integrity.
- (10) Check for bent stud or damaged taper hole.
- (11) Check for damaged taper hole.
- (12) Check for damaged stud.

```

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

```

KING PINS

You are not required to replace king pins in axle sets. However, when replacing a king pin due to wear exceeding manufacturer's specifications, you may suggest replacement of the other king pin on the axle if its measurement shows it is close to the end of its useful life.

KING PINS

```

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Condition          3   Code 3   Procedure
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Bearing balls pitted 3   A   3   Require replacement.

```

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AA
Bearing balls worn 3 A 3 Require replacement.
AA
Bearing races pitted 3 A 3 Require replacement.
AA
Bearing races worn 3 A 3 Require replacement.
AA
Bearing rollers pitted 3 A 3 Require replacement.
AA
Bearing rollers worn 3 A 3 Require replacement.
AA
Bearing seal bent 3 B,2 3
AA~ Suggest replacement of seal or
Bearing seal missing 3 B,2 3 bearing.
AA~
Bearing seal torn 3 B,2 3
AA
Binding 3 A 3 Require repair or replacement of
 3 3 affected parts.
AA
End caps missing 3 C 3 Require replacement of missing
 3 3 part, if available; otherwise,
 3 3 replace king pin.
AA
End play exceeds 3 B 3 Require repair.
specifications 3 3
AA
Grease fitting broken 3 A 3
AA~
Grease fitting missing 3 C 3 Require replacement of grease
AA~ fitting.
Grease fitting won't seal 3 A 3
AA
Locating pins missing 3 C 3 Require replacement of missing
 3 3 part, if available; otherwise,
 3 3 replace king pin.
AA
Looseness exceeds 3 B 3 Require replacement of worn parts.
manufacturer's specs 3 3
AA
Seized 3 A 3 Require replacement.
AA
Threads damaged 3 A 3 Require repair or replacement.
AA
Threads stripped (threads 3 A 3 Require replacement.
missing) 3 3
AA
Will not take grease 3 B,2 3 Suggest replacement of grease
 3 3 fitting. See note (1) below.
AA

NOTE: (1) If king pin will not take grease after replacement of grease fitting, suggest replacement of king pin.

[illegible]

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Looseness (perceptible horizontal movement) 3 A,1 3 Suggest replacement. See note (7)

CAUTION: DO NOT use pliers or pry bar to check ball and socket movement. Use only moderate hand pressure.

Looseness that is excessive 3 B 3 Require replacement. See notes (7) and (8), caution below.

CAUTION: DO NOT use pliers or pry bar to check ball and socket movement. Use only moderate hand pressure.

Nut on stud loose 3 A 3 Require repair or replacement. See note (9) below.

Seized 3 A 3 Require replacement.

Splines damaged 3 A 3 Require repair or replacement.

Splines stripped (splines missing) 3 A 3 Require replacement.

Stud bent 3 B 3 Require replacement. See note (10)

Stud broken 3 A 3 Require replacement. See note (10)

Stud loose in taper hole 3 A 3 Require repair or replacement. See note (10) below.

Taper hole elongated 3 A 3 Require replacement. See note (11)

Threads damaged 3 A 3 Require repair or replacement.

Threads stripped (threads missing) 3 A 3 Require replacement. See note (10)

NOTE: (1) If greaseable, grease joint. If problem persists or joint is non-greaseable, require replacement.

(2) Cracked grease boot will allow contaminants to enter joint and will accelerate wear.

(3) Lack of grease boot will allow contaminants to enter joint and will accelerate wear.

(4) Torn grease boot will allow contaminants to enter joint and will accelerate wear.

(5) Lack of grease seal will allow contaminants to enter joint and will accelerate wear.

(6) Torn grease seal will allow contaminants to enter joint and will accelerate wear.

(7) If manufacturer's procedures for inspection exist, use those procedures; otherwise, use an approved inspection method such as the dry park check.

(8) Excessive looseness is defined as being significant enough

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to affect vehicle handling or structural integrity.

(9) Check for bent stud of damaged taper hole.

(10) Check for damaged taper hole.

(11) Check for damaged stud.

AA

POWER STEERING HOSES

POWER STEERING HOSES

AA

Condition	3	Code	3	Procedure
-----------	---	------	---	-----------

AA

Blistered	3	B	3	Require replacement.
-----------	---	---	---	----------------------

AA

Blocked	3	A	3	Require repair or replacement.
---------	---	---	---	--------------------------------

AA

Fitting threads damaged	3	A	3	Require repair or replacement.
-------------------------	---	---	---	--------------------------------

AA

Fitting threads stripped	3	A	3	Require replacement.
--------------------------	---	---	---	----------------------

(threads missing)	3		3	
-------------------	---	--	---	--

AA

Inner fabric (webbing) cut	3	A	3	Require replacement.
----------------------------	---	---	---	----------------------

AA

Leaking	3	A	3	Require repair or replacement.
---------	---	---	---	--------------------------------

AA

Missing	3	C	3	Require replacement.
---------	---	---	---	----------------------

AA

Outer covering is cracked	3	B	3	Require replacement.
---------------------------	---	---	---	----------------------

to the extent that the	3		3	
------------------------	---	--	---	--

inner fabric of hose is	3		3	
-------------------------	---	--	---	--

visible	3		3	
---------	---	--	---	--

AA

Restricted	3	A	3	Require repair or replacement.
------------	---	---	---	--------------------------------

AA

POWER STEERING (HYDRAULIC) PUMPS

If diagnosis has determined that complete disassembly is necessary to determine the extent of the system failure, the suggestion may be made to rebuild or replace the power steering pump. Repair or replacement of the following components may be required if performed as part of a power steering pump overhaul or rebuild service to meet a minimum rebuild standard.

POWER STEERING (HYDRAULIC) PUMPS

AA

Condition	3	Code	3	Procedure
-----------	---	------	---	-----------

AA

Attaching hardware bent	3	B	3	Require repair or replacement of
	3		3	bent part.

AA

Attaching hardware broken	3	A	3	Require replacement of broken
---------------------------	---	---	---	-------------------------------

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3 3 part.

AA

Attaching hardware loose 3 A 3 Require repair or replacement of
3 3 loose part.

AA

Attaching hardware missing 3 C 3 Require replacement of missing
3 3 part.

AA

Attaching hardware threads 3 A 3 Require repair or replacement of
damaged 3 3 part with damaged threads.

AA

Attaching hardware threads 3 A 3 Require replacement of part with
stripped (threads missing) 3 3 stripped threads.

AA

Belt alignment incorrect 3 B 3 Further inspection required.
3 3 See note (1) below.

AA

Belt cracked 3 A,1 3 Suggest replacement.

AA

Belt frayed 3 A,1 3 Suggest replacement.

AA

Belt missing 3 C 3 Require replacement.

AA

Belt noisy 3 B,2 3 Further inspection required.
3 3 See note (2) below.

AA

Belt plies separated 3 A 3 Require replacement.

AA

Belt tension out of spec 3 B 3 Require adjustment or replacement.

AA

Belt worn beyond adjustment 3 B 3 Require replacement.
range 3 3

AA

Belt worn so it contacts 3 A 3 Require replacement.
bottom of pulley 3 3

AA

Binding 3 A 3 Require repair or replacement.

AA

Fluid at or beyond service 3 C,3 3 Suggest fluid change.
interval 3 3

AA

Fluid contaminated 3 B 3 Require flushing and refilling of
3 3 the system. See note (3) below.

AA

Fluid level incorrect 3 B 3 Require adjustment of fluid level.

AA

Inadequate assist 3 A 3 Further inspection required.
3 3 See note (4) below.

AA

Leaking 3 A 3 Require repair or replacement.

AA

Noise 3 B,2 3 Further inspection required.

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³ See note (5) below.

AA

Pulley bent	3	A	3	Require repair or replacement of
-------------	----------	---	----------	----------------------------------

3 pulley.

AA
Pulley missing 3 C? 3 Require replacement of pulley.

3 C? 3 Require replacement of pulley.

Remote reservoir leaking 3 A 3 Require replacement of reservoir.

3 A **3** Require replacement of reservoir.

Reservoir cap broken 3 A 3 Require replacement of cap.

3 A 3 Require replacement of cap.

Reservoir cap missing 3 C 3 Require replacement of cap.

3 C 3 Require replacement of cap.

Seized 3 A 3 Require replacement.

3 A **3** Require replacement.

Threads damaged 3 A 3 Require repair or replacement.

³ A ³ Require repair or replacement.

```

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Threads stripped (threads 3 A 3 Require replacement.

```

3 A 3 Require replacement.

[illegible]

NOTE: (1) Determine cause of incorrect alignment and require repair.

(2) Determine cause of noise and suggest repair.

(3) Determine and correct source of contamination. OEM specifications must be followed for fluid type.

(4) If pump is source of inadequate assist, require repair or replacement.

(5) If noise is isolated to pump, suggest repair or replacement.

[illegible]

RADIUS ARMS

RADIUS ARMS

[illegible]

Code	Procedure
1	1. The first step is to identify the problem and the goal of the study.
2	2. The second step is to design the study and select the participants.
3	3. The third step is to collect data and analyze the results.
4	4. The fourth step is to draw conclusions and make recommendations.
5	5. The fifth step is to write the report and present the findings.

Attaching hardware broken 3 A 3 Require replacement of broken

³ A ³ Require replacement of broken

3 part.

Attaching hardware 3 A 3 Require replacement of incorrect

³ A ³ Require replacement of incorrect

3 part.

Attaching hardware loose 3 A 3 Require repair or replacement of

3 A **3** Require repair or replacement of

3 3 loose part.

Attaching hardware missing ³ C ³ Require replacement of missing

3 C 3 Require replacement of missing

3 3 part.

Attaching hardware threads ³ A ³ Require repair or replacement of

3 A 3 Require repair or replacement of

3 3 part with damaged threads.

Attaching hardware threads ³ A ³ Require replacement of part with

3 A 3 Require replacement of part with

stripped (threads missing)³ ³ stripped threads.

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Grease fitting broken 3 A 3

AAA

Grease fitting missing 3 C 3 Require replacement grease

AAA fitting.

Grease fitting won't seal 3 A 3

AAA

Grease seal missing 3 B,2 3 Suggest replacement. See note (5).

AAA

Grease seal torn 3 B,2 3 Suggest replacement. See note (6).

AAA

Looseness (perceptible 3 A,1 3 Suggest replacement. See note (7).

horizontal movement) 3 3

AAA

CAUTION: DO NOT use pliers or pry bar to check ball and socket movement. Use only moderate hand pressure.

AAA

Looseness that is excessive 3 B 3 Require replacement. See notes (7)

 3 3 and (8) and caution below.

AAA

CAUTION: DO NOT use pliers or pry bar to check ball and socket movement. Use only moderate hand pressure.

AAA

Seized 3 A 3 Require replacement.

AAA

Stud bent 3 B 3 Require replacement. See note (9).

AAA

Stud broken 3 A 3 Require replacement. See note (9).

AAA

Stud loose in taper hole 3 A 3 Require repair or replacement.

 3 3 See note (9).

AAA

Taper hole elongated 3 A 3 Require replacement. See note (10)

AAA

Threads damaged 3 A 3 Require repair or replacement.

AAA

Threads stripped (threads 3 A 3 Require replacement. See note (9).

missing) 3 3

AAA

Wear exceeds manufacturer's 3 B 3 Require replacement.

specifications 3 3

AAA

NOTE: (1) If greaseable, grease joint. If problem persists or joint is non-greaseable, require replacement.

(2) Cracked grease boot will allow contaminants to enter the joint and will accelerate wear.

(3) Lack of grease boot will allow contaminants to enter the joint and will accelerate wear.

(4) Torn grease boot will allow contaminants to enter the joint and will accelerate wear.

(5) Lack of grease seal will allow contaminants to enter joint and will accelerate wear.

(6) Torn grease seal will allow contaminants to enter joint and

[illegible]

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Attaching hardware corroded	3	A	3	Require replacement of corroded
affecting structural	3		3	part, if available; otherwise,
integrity	3		3	replace shock or strut.
AA				
Attaching hardware	3	A	3	Require replacement of incorrect
incorrect	3		3	part, if available; otherwise,
	3		3	replace shock or strut.
AA				
Attaching hardware loose	3	A	3	Require repair or replacement of
	3		3	loose part, if available;
	3		3	otherwise, replace shock or strut.
AA				
Attaching hardware missing	3	C	3	Require replacement of missing
	3		3	part, if available; otherwise,
	3		3	replace shock or strut.
AA				
Attaching hardware threads	3	A	3	Require repair or replacement of
damaged	3		3	part with damaged threads, if
	3		3	available; otherwise, replace
	3		3	shock or strut.
AA				
Attaching hardware threads	3	A	3	Require replacement of part with
stripped (threads missing)	3		3	stripped threads, if available;
	3		3	otherwise, replace shock or strut.
AA				
Binding	3	A	3	Require replacement.
AA				
Body dented	3	A	3	Further inspection required.
	3		3	See note (1) below.
AA				
Body punctured	3	A	3	Require replacement.
AA				
Brake hose bracket bent	3	B	3	Require repair or replacement.
AA				
Brake hose bracket missing	3	C	3	Require replacement.
AA				
Brake hose bracket threads	3	C	3	Require repair or replacement.
damaged	3		3	
AA				
Brake hose bracket threads	3	C	3	Require replacement.
stripped (threads missing)	3		3	
AA				
Compression bumper missing	3	C	3	Require replacement of compression
	3		3	bumper.
AA				
Compression bumper split	3	A,1	3	Suggest replacement of compression
	3		3	bumper.
AA				
Damping (none)	3	A	3	Require replacement.
AA				
Dust boot (bellows) split	3	B,2	3	Suggest replacement of boot.
	3		3	See note (2) below.

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AA

Dust boot (bellows) missing³ B,2³ Suggest replacement of boot.

³ ³ See (3) note below.

AA

Dust boot (bellows) torn³ B,2³ Suggest replacement of boot.

³ ³ See note (4) below.

AA

Dust shield broken³ B,2³ Suggest replacement. See note (4).

AA

Dust shield missing³ B,2³ Suggest replacement. See note (4).

AA

Gland nut (strut housing³ A³ Require replacement of nut and/or
cap) is not removable³ ³ housing. See note (5) below.
using appropriate tool³ ³

AA

Gland nut (strut housing³ A³ Require repair or replacement of
cap) threads damaged³ ³ nut.

AA

Gland nut (strut housing³ A³ Require replacement of nut.

cap) threads stripped³ ³
(threads missing)³ ³

AA

Housing dented³ A³ Further inspection required.

³ ³ See note (6) below.

AA

Housing punctured³ A³ Require replacement.

AA

Jounce bumper missing³ C³ Require replacement of jounce
³ ³ bumper.

AA

Jounce bumper split³ 1?³ Suggest replacement of jounce
³ ³ bumper.

AA

Leaking oil, enough for³ A³ Require replacement. See caution
fluid to be running down³ ³ below.
the body³ ³

AA

CAUTION: If the strut cartridge has been replaced previously, the oil
on the strut housing may be filler oil. The technician must
identify the source of the oil.

AA

Noise³ B,2³ Further inspection required.

³ ³ See note (7) below.

AA

Piston rod bent³ A³ Require replacement.

AA

Piston rod broken³ A³ Require replacement.

AA

Piston rod has surface³ B,2³ Suggest replacement.
defect³ ³

AA

Piston rod threads damaged³ A³ Require repair or replacement.

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AA

Piston rod threads stripped³ A ³ Require replacement.
(threads missing) ³ ³

AA

Seized ³ A ³ Require replacement.

AA

Shock missing ³ C ³ Require replacement.

AA

Strut housing bent ³ A ³ Require replacement.

AA

Strut housing cap (gland ³ A ³ Require replacement of nut and/or
nut) is not removable ³ ³ housing. See note (5) below.
using appropriate tool ³ ³

AA

Strut housing cap (gland ³ A ³ Require repair or replacement of
nut) threads damaged ³ ³ nut.

AA

Strut housing cap (gland ³ A ³ Require replacement of nut.
nut) threads stripped ³ ³
(threads missing) ³ ³

AA

Strut housing severely ³ A ³ Require replacement.
corroded, affecting ³ ³
structural integrity ³ ³

AA

Strut housing threads ³ A ³ Require repair or replacement.
damaged ³ ³

AA

Strut housing threads ³ A ³ Require replacement.
stripped (threads missing)³ ³

AA

Tire cupping ³ A ³ Further inspection required.
³ ³ See note (8) below

AA

- NOTE: (1) Require replacement of units where dents restrict shock or strut piston rod movement. If dents don't restrict movement, no service is suggested or required. Especially critical on mono-tube shocks.
- (2) This condition can lead to damage of the piston rod, which, in turn, causes premature piston rod seal wear.
- (3) This condition can lead to damage of the piston rod, which causes piston rod seal wear.
- (4) This condition can lead to damage of the piston rod, which, in turn, causes premature piston rod seal wear.
- (5) Only required if replacing cartridge.
- (6) Require replacement of units where dents restrict shock or strut piston rod movement. If dents don't restrict movement, no service is suggested or required. Especially critical on mono-tube shocks.
- (7) If noise is isolated to shock or strut, suggest replacement.
- (8) Although shocks or struts may have contributed to tire cupping, an inspection is needed of the entire suspension

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system. If the shock or strut is found to be contributing to the tire cupping, require replacement.

[illegible]

SPINDLES

SPINDLES

[illegible]

Condition	3	Code	3	Procedure
-----------	---	------	---	-----------

[illegible]

Attaching hardware broken	3	A	3	Require replacement of broken part
---------------------------	---	---	---	------------------------------------

[illegible]

Attaching hardware loose	3	A	3	Require repair or replacement of
	3		3	loose part.

[illegible]

Attaching hardware missing 3 C 3 Require replacement of missing
3 3 part.

[illegible]

Attaching hardware threads to damaged	3	A	3	Require repair or replacement of part with damaged threads.
---------------------------------------	---	---	---	---

[illegible]

Attaching hardware threads ³ A ³ Require replacement of part with
stripped (threads missing)³ ³ stripped threads.

[illegible]

Bent 3 B 3 Require replacement.

[illegible]

Broken **3** A **3** Require replacement.

[illegible]

Race seat area undersized **3** B **3** Require replacement.

[illegible]

Scored **3** A **3** Require repair or replacement.

[illegible]

Threads damaged	3	A	3	Require repair or replacement.
-----------------	---	---	---	--------------------------------

[illegible]

```
Threads stripped (threads 3 A 3 Require replacement.
missing) 3 3
```

[illegible]

SPRINGS: COIL, LEAF, & TORSION BAR

When springs are replaced, it is suggested, but not required, that both springs on an axle be replaced to maintain equal height from side to side and to provide a balanced ride and proper handling.

When variable rate springs are installed in place of conventional coil springs, they must be installed in axle sets to ensure proper handling, uniform ride, and proper chassis height.

Erroneous height measurements may result from: improper tire inflation, non-standard tire or wheel size, and heavy load in vehicle or trunk.

SPRINGS: COIL, LEAF, & TORSION BAR

[illegible]

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Condition	3	Code	3	Procedure
Attaching hardware bent	3	B	3	Require repair or replacement of bent part.
Attaching hardware broken	3	A	3	Require replacement of broken part.
Attaching hardware corroded affecting structural integrity	3	A	3	Require replacement of corroded part.
Attaching hardware incorrect	3	A	3	Require replacement of incorrect part.
Attaching hardware loose	3	A	3	Require repair or replacement of loose part.
Attaching hardware missing	3	C	3	Require replacement of missing part.
Attaching hardware threads damaged	3	A	3	Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing)	3	A	3	Require replacement of part with stripped threads.
Broken (all springs except secondary leave(s) on multi-leaf springs)	3	A	3	Require replacement.
Coil clash	3		3	Require ride height check. See note (1) below.
Coil spring insulator deteriorated	3	B,2	3	Suggest replacement of insulator.
Coil spring insulator missing	3	B,2	3	Suggest replacement of insulator.
Coil spring insulator split	3	B,2	3	Suggest replacement of insulator.
Coil spring plastic coating deteriorated - rust present	3	A	3	Refer to manufacturer's service requirements. See note (2) below.
Composite spring damaged	3	A	3	Further inspection required. See note (3) below.
Cracked (all springs except composite leaf and secondary leave(s) on	3	A	3	Require replacement.

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Condition			Code	Procedure
Attaching hardware bent	3	B	3	Require repair or replacement of bent part.

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Attaching hardware broken	3	A	3	Require replacement of broken
	3		3	part.
AA				
Attaching hardware loose	3	A	3	Require repair or replacement of
	3		3	loose part.
AA				
Attaching hardware missing	3	C	3	Require replacement of missing
	3		3	part.
AA				
Attaching hardware threads	3	A	3	Require repair or replacement of
damaged	3		3	part with damaged threads.
AA				
Attaching hardware threads	3	A	3	Require replacement of part with
stripped (threads missing)	3		3	stripped threads.
AA				
Blocked	3	A	3	Require repair or replacement.
AA				
Fitting incorrect (such as	3	B	3	Require replacement.
compression fitting)	3		3	
AA				
Flare type incorrect	3	B	3	Required replacement.
AA				
Leaking	3	A	3	Require tightening or replacement.
AA				
Line type incorrect	3	B	3	Require replacement.
AA				
Restricted	3	A	3	Require replacement.
AA				
Routed incorrectly	3	B	3	Require routing correction.
AA				
Rust-pitted	3	A,1	3	Suggest replacement.
AA				
Rust pitted affecting	3	A	3	Require replacement.
structural integrity	3		3	
AA				

STEERING ARMS

STEERING ARMS

Condition	3	Code	3	Procedure
AA				
Attaching hardware bent	3	B	3	Require repair or replacement of
	3		3	bent part.
AA				
Attaching hardware broken	3	A	3	Require replacement of broken
	3		3	part.
AA				
Attaching hardware	3	A	3	Require replacement of incorrect
incorrect	3		3	part.
AA				
Attaching hardware loose	3	A	3	Require repair or replacement of

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3 3 loose part.

AA

Attaching hardware missing 3 C 3 Require replacement of missing
3 3 part.

AA

Attaching hardware threads 3 A 3 Require repair or replacement of
damaged 3 3 part with damaged threads.

AA

Attaching hardware threads 3 A 3 Require replacement of part with
stripped (threads missing) 3 3 stripped threads.

AA

Bent 3 B 3 Require replacement.

AA

Broken 3 A 3 Require replacement.

AA

Taper hole elongated 3 A 3 Require replacement. See note (1).

AA

Threads damaged 3 A 3 Require repair or replacement.

AA

Threads stripped (threads 3 A 3 Require replacement.
missing) 3 3

AA

NOTE: (1) Check for damaged stud.

AA

STEERING DAMPERS

The following procedures are only required if the vehicle was originally equipped from the factory with a steering damper. If the steering damper is an add-on unit, then the unit may be removed instead of repairing or replacing.

STEERING DAMPERS

AA

Condition 3 Code 3 Procedure

AA

Attaching hardware bent 3 B 3 Require repair or replacement of
3 3 bent part, if available;
3 3 otherwise, replace steering
3 3 damper.

AA

Attaching hardware broken 3 A 3 Require replacement of broken
3 3 part, if available; otherwise,
3 3 replace steering damper.

AA

Attaching hardware corroded 3 A 3 Require replacement of corroded
affecting structural 3 3 part, if available; otherwise,
integrity 3 3 replace steering damper.

AA

Attaching hardware 3 A 3 Require replacement of incorrect
incorrect 3 3 part, if available; otherwise,
3 3 replace steering damper.

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[illegible]

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Piston rod broken 3 A 3 Require replacement.
AA
Piston rod has surface 3 B,2 3 Suggest replacement.
defect 3 3
AA
Piston rod threads stripped3 A 3 Require replacement.
(threads missing) 3 3
AA
Piston rod threads damaged 3 A 3 Require repair or replacement.
AA
Seized 3 A 3 Require replacement.
AA
NOTE: (1) Require replacement of units where dents restrict damper
piston rod movement. If dents don't restrict movement, no
service is suggested or required. Especially critical on
mono-tube dampers.
(2) This condition can lead to damage of the piston rod, which,
in turn, causes premature piston rod seal wear.
(3) If noise is isolated to damper, suggest replacement.
AA

STEERING GEARS (EXCEPT RACK & PINION)

If diagnosis has determined that complete disassembly is
necessary to determine the extent of the system failure, the
suggestion may be made to rebuild or replace the power steering pump.
Repair or replacement of the following components may be required, if
performed as part of a power steering pump overhaul or rebuild service
to meet a minimum rebuild standard.

STEERING GEARS (EXCEPT RACK & PINION)

AA
Condition 3 Code 3 Procedure
AA
Attaching hardware broken 3 A 3 Require replacement of broken
 3 3 part.
AA
Attaching hardware loose 3 A 3 Require repair or replacement of
 3 3 loose part.
AA
Attaching hardware missing 3 C 3 Require replacement of missing
 3 3 part.
AA
Attaching hardware threads 3 A 3 Require repair or replacement of
damaged 3 3 part with damaged threads.
AA
Attaching hardware threads 3 A 3 Require replacement of part with
stripped (threads missing)3 3 stripped threads.
AA
Binding 3 A 3 Require repair or replacement
AA
Flex coupler binding 3 A 3 Require repair or replacement of

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3 3 coupler.

Flex coupler loose 3 A 3 Require repair or replacement of

3 3 coupler.

Flex coupler missing parts 3 A 3 Require repair or replacement of

3 3 coupler.

Flex coupler soft/spongy 3 A 3 Require replacement of coupler.

Flex coupler torn 3 A 3 Require replacement of coupler.

Fluid contaminated 3 B 3 Require flushing and refilling
3 of the system. See note (1) below.

Gasket leaking 3 A 3 Require repair or replacement of
3 3 gasket.

Housing leaking 3 A 3 Require replacement.

Hydraulic fittings leaking 3 A 3 Require repair or replacement of
3 3 fittings.

Inadequate power assist 3 A 3 Further inspection required.
3 3 See note (2) below.

Lash exceeds manufacturer's 3 B 3 Require repair or replacement.
specifications 3 3

Seal leaking 3 A 3 Require repair or replacement of
3 3 seal and/or mating part.

Splines damaged 3 A 3 Require repair or replacement of
3 3 splines.

Splines stripped 3 A 3 Require replacement of splines.

Steering coupler shield 3 B,2 3 Suggest replacement.
cracked 3 3

Steering coupler shield 3 C 3 Require replacement.
missing 3 3

Threads damaged 3 A 3 Require repair or replacement of
3 3 part with damaged threads.

Threads stripped (threads 3 A 3 Require replacement of part with
missing) 3 3 stripped threads.

U-joint binding 3 A 3 Require repair or replacement of
3 3 joint.

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U-joint loose	3	A	3	Require repair or replacement of
	3		3	joint.

Unequal power assist 3 A 3 Require repair or replacement.

[illegible]

NOTE: (1) Determine and correct source of contamination.

OEM specifications must be followed for fluid type.

(2) If steering gear is source of inadequate assist, require repair or replacement.

[illegible]

STEERING GEARS: RACK & PINION

If diagnosis has determined that complete disassembly is necessary to determine the extent of the system failure, the suggestion may be made to rebuild or replace the power steering pump. Repair or replacement of the following components may be required, if performed as part of a power steering pump overhaul or rebuild service to meet a minimum rebuild standard.

STEERING GEARS: RACK & PINION

[illegible]

Condition	3	Code	3	Procedure
-----------	---	------	---	-----------

[illegible]

Attaching hardware broken	3	A	3	Require replacement of broken
	3		3	part.

[illegible]

Attaching hardware loose	3	A	3	Require repair or replacement of loose part.
--------------------------	---	---	---	--

[illegible]

Attaching hardware missing 3 C 3 Require replacement of missing
3 3 part.

[illegible]

Attaching hardware threads damaged	3 3	A	3 3	Require repair or replacement of part with damaged threads.
---------------------------------------	--------	---	--------	--

[illegible]

Attaching hardware threads ³ A ³ Require replacement of part with
stripped (threads missing)³ ³ stripped threads.

[illegible]

Balance tube blocked	3	A	3	Require repair or replacement of
	3		3	balance tube.

[illegible]

Balance tube missing	3	C	3	Require replacement of balance
	3		3	tube.

[illegible]

Balance tube restricted	3	A	3	Require repair or replacement of
	3		3	balance tube.

[illegible]

Bellows boot clamp missing ³ C ³ Require replacement of clamp.

[illegible]

Bellows boot cracked (not through)	3 3	B,2 3	3 3	Suggest replacement of bellows boot.
------------------------------------	--------	----------	--------	--------------------------------------

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[illegible]

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Lash exceeds manufacturer's³ B ³ Require repair or replacement.
specifications ³ ³

AA

Seal leaking ³ A ³ Require repair or replacement.

AA

Splines damaged ³ A ³ Require repair or replacement.

AA

Splines stripped (splines ³ A ³ Require replacement.
missing) ³ ³

AA

Steel line blocked ³ A ³ Require repair or replacement of

AA line.

Steel line leaking ³ A ³

AA

Steel line missing ³ C ³ Require replacement of line.

AA

Steel line restricted ³ A ³ Require repair or replacement of
³ ³ line.

AA

Steering coupler shield ³ B,2 ³ Suggest replacement.
cracked ³ ³

AA

Steering coupler shield ³ C ³ Require replacement.
missing ³ ³

AA

Steering coupler shield ³ B,2 ³ Suggest replacement.
torn ³ ³

AA

Threads damaged ³ A ³ Require repair or replacement of
³ ³ part with damaged threads.

AA

Threads stripped (threads ³ A ³ Require replacement of part with
missing) ³ ³ stripped threads.

AA

U-joint binding ³ A ³ Require repair or replacement of
³ ³ joint.

AA

U-joint loose ³ A ³ Require repair or replacement of
³ ³ joint.

AA

Unequal power assist ³ A ³ Require repair or replacement.

AA

NOTE: (1) Determine and correct source of contamination.

Follow OE specifications for fluid type.

(2) Indicates internal wear.

(3) If steering gear is source of inadequate assist, require
repair or replacement.

AA

STEERING KNUCKLES

STEERING KNUCKLES

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Condition			3	Code	3	Procedure
Attaching hardware bent			3	B	3	Require repair or replacement of bent part.
Attaching hardware broken			3	A	3	Require replacement of broken part.
Attaching hardware incorrect			3	A	3	Require replacement of incorrect part.
Attaching hardware loose			3	A	3	Require repair or replacement of loose part.
Attaching hardware missing			3	C	3	Require replacement of missing part.
Attaching hardware threads damaged			3	A	3	Require repair or replacement of part with damaged threads.
Attaching hardware threads stripped (threads missing)			3	A	3	Require replacement of part with stripped threads.
Bent			3	B	3	Require replacement.
Broken			3	A	3	Require replacement.
Pinch bolt incorrect			3	B	3	Require replacement with bolt that meets OE design.
Pinch bolt loose			3	B	3	Require repair.
Pinch bolt missing			3	B	3	Require replacement.
Pinch bolt tabs deformed (pinched together), .032" or more before clamping			3	B	3	Require replacement. See note (1) below.
Taper hole elongated			3	A	3	Require replacement. See note (2).
Threads damaged			3	A	3	Require repair or replacement.
Threads stripped (threads missing)			3	A	3	Require repair or replacement.
NOTE: (1) Steering knuckle deformation can cause pinch bolt breakage.						
(2) Check for damaged stud.						

STRIKE OUT BUMPERS

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STRIKE OUT BUMPERS

AA			
Condition	3	Code	3 Procedure
AA			
Attaching hardware broken	3	A	3 Require replacement of broken
	3		3 part.
AA			
Attaching hardware corroded	3	A	3 Require replacement of corroded
affecting structural	3		3 part.
integrity	3		3
AA			
Attaching hardware loose	3	A	3 Require repair or replacement of
	3		3 loose part.
AA			
Attaching hardware missing	3	C	3 Require replacement of missing
	3		3 part.
AA			
Attaching hardware threads	3	A	3 Require repair or replacement of
damaged	3		3 part with damaged threads.
AA			
Attaching hardware threads	3	A	3 Require replacement of part with
stripped (threads missing)	3		3 stripped threads.
AA			
Missing	3	C	3 Require replacement.
AA			
Split	3	A,1	3 Suggest replacement.
AA			

STRUT RODS

STRUT RODS

AA			
Condition	3	Code	3 Procedure
AA			
Adjusting nut seized	3	A	3 Require repair or replacement.
	3		3 See note (1) below.
AA			
Attaching hardware bent	3	B	3 Require repair or replacement of
	3		3 bent part, if available;
	3		3 otherwise, replace strut rod.
AA			
Attaching hardware broken	3	A	3 Require replacement of broken
	3		3 part, if available; otherwise,
	3		3 replace strut rod.
AA			
Attaching hardware	3	A	3 Require replacement of incorrect
incorrect	3		3 part, if available; otherwise,
	3		3 replace strut rod.
AA			
Attaching hardware loose	3	A	3 Require repair or replacement of
	3		3 loose part, if available;
	3		3 otherwise, replace strut rod.

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AA

Attaching hardware missing	3	C	3	Require replacement of missing
	3		3	part, if available; otherwise,
	3		3	replace strut rod.

AA

Attaching hardware threads	3	A	3	Require repair or replacement of
damaged	3		3	part with damaged threads, if
	3		3	available; otherwise, replace
	3		3	strut rod.

AA

Attaching hardware threads	3	A	3	Require replacement of part with
stripped (threads missing)	3		3	stripped threads, if available;
	3		3	otherwise, replace strut rod.

AA

Attaching (mating) hole	3	A	3	Require repair or replacement of
oversized	3		3	frame.

AA

Attaching point on frame	3	A	3	Require repair of frame.
corroded, affecting	3		3	
structural integrity	3		3	

AA

Bent	3	A	3	Require replacement.
------	---	---	---	----------------------

AA

Mating (attaching) hole	3	A	3	Require repair or replacement of
oversized	3		3	frame.

AA

Threads damaged	3	A	3	Require repair or replacement.
-----------------	---	---	---	--------------------------------

AA

Threads stripped (threads	3	A	3	Require replacement.
missing)	3		3	

AA

NOTE: (1) Only required if an alignment is being performed.

AA

STRUT UPPER BEARING PLATE ASSEMBLIES

NOTE: When the following guidelines indicate replacement of bearing, only the bearing should be replaced if it is available separately; otherwise, replace the bearing plate assembly.

STRUT UPPER BEARING PLATE ASSEMBLIES

AA

Condition	3	Code	3	Procedure
-----------	---	------	---	-----------

AA

Attaching hardware broken	3	A	3	Require replacement of broken
	3		3	part, if available; otherwise,
	3		3	replace bearing plate assembly.

AA

Attaching hardware loose	3	A	3	Require repair or replacement of
	3		3	loose part, if available;
	3		3	otherwise, replace bearing plate

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3 3 assembly.

AA

Attaching hardware missing 3 C 3 Require replacement of missing
3 3 part, if available; otherwise,
3 3 replace bearing plate assembly.

AA

Attaching hardware threads 3 A 3 Require repair or replacement of
damaged 3 3 part with damaged threads, if
3 3 available; otherwise, replace
3 3 bearing plate assembly.

AA

Attaching hardware threads 3 A 3 Require replacement of part with
stripped (threads missing) 3 3 stripped threads, if available;
3 3 otherwise, replace bearing plate
3 3 assembly.

AA

Bearing axial or radial 3 B 3 Require replacement of bearing.
movement exceeds vehicle 3 3
manufacturer's specs 3 3

AA

Bearing binding 3 A 3 Require replacement of bearing.

AA

Bearing missing 3 C 3 Require replacement of bearing.

AA

Bearing seized 3 A 3 Require replacement of bearing.

AA

Bent 3 B 3 Require replacement.

AA

Holes distorted 3 A 3 Require replacement.

AA

Missing 3 C 3 Require replacement.

AA

Severely corroded, 3 A 3 Require replacement.
affecting structural 3 3
integrity 3 3

AA

SWAY BAR LINKS

SWAY BAR LINKS

AA

Condition 3 Code 3 Procedure

AA

Attaching hardware 3 A 3 Require replacement of incorrect
incorrect 3 3 part, if available; otherwise,
3 3 replace link.

AA

Attaching hardware loose 3 A 3 Require repair or replacement of
3 3 loose part, if available;
3 3 otherwise, replace link.

AA

Attaching hardware missing 3 C 3 Require replacement of missing

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3 3 part, if available; otherwise,
3 3 replace link.

AA

Attaching hardware threads 3 A 3 Require repair or replacement of
damaged 3 3 part with damaged threads, if
3 3 available; otherwise, replace
3 3 link.

AA

Attaching hardware threads 3 A 3 Require replacement of part with
stripped (threads missing) 3 3 stripped threads, if available;
3 3 otherwise, replace link.

AA

Ball and socket has 3 A,1 3 Suggest replacement. See note (1).
looseness (perceptible 3 3
vertical movement) 3 3

AA

CAUTION: DO NOT use pliers or pry bar to check ball and socket
movement. Use only moderate hand pressure.

AA

Ball and socket has 3 B 3 Require replacement. See notes (1)
looseness that is 3 3 and (2) and caution.
excessive 3 3

AA

Bent 3 B 3 Require replacement.

AA

Broken 3 A 3 Require replacement.

AA

Corroded, affecting 3 A 3 Require replacement.
structural integrity 3 3

AA

Grease boot cracked 3 B,2 3 Suggest replacement. See note (3).

AA

Grease boot missing 3 B,2 3 Suggest replacement. See note (4).

AA

Grease boot torn 3 B,2 3 Suggest replacement. See note (5).

AA

Missing 3 C 3 Require replacement.

AA

Nut on stud loose 3 A 3 Require repair. See note (6).

AA

Stud bent 3 B 3 Require replacement. See note (7).

AA

Stud broken 3 A 3 Require replacement. See note (7).

AA

Threads damaged 3 A 3 Require repair or replacement.

AA

Threads stripped (threads 3 A 3 Require replacement. See note (7).
missing) 3 3

AA

NOTE: (1) If manufacturer's procedures for inspection exist, use those
procedures; otherwise, use an approved inspection method
such as the dry park check.

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- (2) Excessive looseness is defined as being significant enough to affect vehicle handling or structural integrity.
- (3) Cracked grease boot will allow contaminants to enter the joint and will accelerate wear.
- (4) Lack of grease boot will allow contaminants to enter the joint and will accelerate wear.
- (5) Torn grease boot will allow contaminants to enter the joint and will accelerate wear.
- (6) Check for bent stud or damaged taper hole.
- (7) Check for damaged taper hole.

[illegible]

SWAY BARS

SWAY BARS

[illegible]

Condition	3	Code	3	Procedure
-----------	---	------	---	-----------

[illegible]

Attaching hardware broken	3	A	3	Require replacement of broken
	3		3	part, if available; otherwise,
	3		3	replace sway bar.

[illegible]

Attaching hardware corroded affecting structural integrity	3 3 3	A	3 3 3	Require replacement of corroded part, if available; otherwise, replace sway bar.
--	-------------	---	-------------	--

[illegible]

Attaching hardware loose	3	A	3	Require repair or replacement of
	3		3	loose part, if available;
	3		3	otherwise, replace sway bar.

[illegible]

Attaching hardware missing	3	C	3	Require replacement of missing
	3		3	part, if available; otherwise,
	3		3	replace sway bar.

[illegible]

Attaching hardware threads damaged	3 3 3 3	A	3 3 3 3	Require repair or replacement of part with damaged threads, if available; otherwise, replace sway bar.
---------------------------------------	------------------	---	------------------	---

[illegible]

Attaching hardware threads	3	A	3	Require replacement of part with
stripped (threads missing)	3		3	stripped threads, if available;
	3		3	otherwise, replace sway bar.

[illegible]

Bent **3** B **3** Require replacement.

[illegible]

Broken 3 A 3 Require replacement.

[illegible]

Threads damaged **3** A **3** Require repair or replacement.

[illegible]

```
Threads stripped (threads 3 A 3 Require replacement.
missing) 3 3
```

[illegible]

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TIE ROD ENDS (INNER & OUTER)

TIE ROD ENDS (INNER & OUTER)

AA			
Condition	3	Code	3 Procedure
AA			
Attaching hardware incorrect	3	A	3 Require replacement of incorrect part, if available; otherwise, replace tie rod end.
AA			
Attaching hardware loose	3	A	3 Require repair or replacement of loose part, if available; otherwise, replace tie rod end.
AA			
Attaching hardware missing	3	C	3 Require replacement of missing part, if available; otherwise, replace tie rod end.
AA			
Attaching hardware threads damaged	3	A	3 Require repair or replacement of part with damaged threads, if available; otherwise, replace tie rod end.
AA			
Attaching hardware threads stripped (threads missing)	3	A	3 Require replacement of part with stripped threads, if available; otherwise, replace tie rod end.
AA			
Adjusting sleeve bent	3	B	3 Require replacement of sleeve or tie rod end.
AA			
Adjusting sleeve clamps out of position	3	B	3 Require repair.
AA			
Adjusting sleeve corroded, affecting structural integrity	3	A	3 Require replacement of sleeve or tie rod end.
AA			
Adjusting sleeve missing	3	C	3 Require replacement of sleeve or tie rod end.
AA			
Adjusting sleeve seized	3	A	3 Require repair or replacement. See note (1) below.
AA			
Adjusting sleeve threads damaged	3	A	3 Require repair or replacement of sleeve or tie rod end.
AA			
Adjusting sleeve threads stripped (threads missing)	3	A	3 Require replacement of sleeve or tie rod end.
AA			
Binding	3	A	3 Further inspection required. See note (2) below.

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AA
Grease boot cracked 3 3 Suggest replacement. See note (3).
AA
Grease boot missing 3 3 Suggest replacement. See note (4).
AA
Grease boot torn 3 3 Suggest replacement. See note (5).
AA
Grease fitting broken 3 A 3 Require replacement of grease
3 3 fitting.
AA
Grease fitting missing 3 C 3 Require replacement of grease
3 3 fitting.
AA
Grease fitting won't seal 3 A 3 Require replacement of grease
3 3 fitting.
AA
Grease seal missing 3 B,2 3 Suggest replacement of seal.
3 3 See note (4) below.
AA
Grease seal torn 3 B,2 3 Suggest replacement of seal.
3 3 See note (5) below.
AA
Greaseable tie rod end 3 B,2 3 Suggest replacement of grease
will not take grease 3 3 fitting. See note (6) below.
AA
Looseness (perceptible 3 A,1 3 Suggest replacement. See note (7).
horizontal movement) 3 3
AA
CAUTION: DO NOT use pliers or pry bar to check ball and socket
movement. Use only moderate hand pressure.
AA
Looseness exceeds 3 B 3 Require replacement.
manufacturer's specs 3 3
AA
Looseness that is excessive 3 B 3 Require replacement. See notes (7)
3 3 and (8), caution.
AA
Nut on stud loose 3 A 3 Require repair or replacement of
3 3 nut. See note (9) below.
AA
Seized 3 A 3 Require replacement
AA
Stud bent 3 B 3 Require replacement. See note (10)
AA
Stud broken 3 A 3 Require replacement. See note (10)
AA
Threads damaged 3 A 3 Require repair or replacement.
AA
Threads stripped (threads 3 A 3 Require replacement. See note (10)
missing) 3 3
AA
NOTE: (1) Only required if toe needs to be adjusted.

[illegible]

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TRAILING ARMS

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AA		
Condition	3 Code 3	Procedure
AA		
Attaching hardware broken	3 A 3	Require replacement of broken
	3	part, if available; otherwise,
	3	replace trailing arm.
AA		
Attaching hardware loose	3 A 3	Require repair or replacement of
	3	loose part, if available;
	3	otherwise, replace trailing arm.
AA		
Attaching hardware missing	3 C 3	Require replacement of missing
	3	part, if available; otherwise,
	3	replace trailing arm.
AA		
Attaching hardware threads	3 A 3	Require repair or replacement of
damaged	3	part with damaged threads, if
	3	available; otherwise, replace
	3	trailing arm.
AA		
Attaching hardware threads	3 A 3	Require replacement of part with
stripped (threads missing)	3	stripped threads, if available;
	3	otherwise, replace trailing arm.
AA		
Bent	3 B 3	Require replacement.
AA		
Bushing hole oversized	3 B 3	Require replacement.
AA		
Corroded, affecting	3 A 3	Require replacement.
structural integrity	3	
AA		
Holes distorted	3 A 3	Require replacement.
AA		
Threads damaged	3 A 3	Require repair or replacement.
AA		
Threads stripped (threads	3 A 3	Require replacement.
missing)	3	
AA		

WHEEL ALIGNMENT

WHEEL ALIGNMENT

Wheel alignment is defined as the measurement, analysis, and adjustment of steering and suspension angles to conform to OEM specifications. These angles usually include, but are not limited to: caster, camber, toe, and thrust angle. Where these angles are not adjustable and not in specification, component replacement or correction kits may be required. Errors in set-back and steering axis inclination (SAI) are often attributable to failed or damaged components and must be corrected prior to performing an alignment.

Failure to replace or correct suggested or required parts or

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service may prevent a proper alignment.

Before performing an alignment check, inspect and verify the following:

- * Tire pressure and size
- * Vehicle loading
- * Ride height
- * Steering and suspension parts

Only if the inspection reveals that all the above are within published specifications, should a wheel alignment check and an alignment, if needed, be performed.

CAUTION: Under no circumstances should a technician bend or heat any steering or suspension component, unless specified by the vehicle manufacturer, for example, Ford forged twin "I" beam axles. All measurements and suggestions must be noted on the inspection report.

WHEEL ALIGNMENT

Condition	3	Code	3	Procedure
Dog tracking, shown to be				
caused by faulty alignment	3	B,2	3	Suggest repair.
Lead, shown to be caused				
by faulty alignment	3	B	3	Require alignment.
Part has been changed that				
may affect alignment	3	B	3	Require alignment check.
Pull, shown to be caused				
by faulty alignment	3	B	3	Require alignment.
Steering wheel off-center				
	3	B,2	3	Suggest alignment.
Tire wear, shown to be				
caused by faulty alignment	3	B	3	Require alignment.
Wander, shown to be caused				
by faulty alignment	3	B	3	Require alignment.

WHEEL BEARINGS, RACES, & SEALS

NOTE: When replacing or repacking wheel bearings, grease seal replacement is required. You are not required to replace these components in axle sets. Determine the need to replace based upon the individual component conditions that follow.

WHEEL BEARINGS, RACES, & SEALS

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Article Text (p. 60)

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AA		
Condition	3 Code 3	Procedure
AA		
Rear axle seal on rear-wheel drive leaking	3 A 3	Require replacement of seal and inspection of axle, bearing, housing, and vent tube
AA		
Seal bent	3 A,1 3	Suggest replacement.
AA		
Seal leaking	3 A 3	Require replacement of seal and inspection of bearings.
AA		
Seal missing	3 C 3	Require replacement.
AA		
Seal torn	3 A 3	Require replacement.
AA		
Wheel bearing assembly feels rough when rotated	3 A 3	Require replacement of bearing assembly.
AA		
Wheel bearing balls are pitted	3 A 3	Require replacement of bearing assembly.
AA		
Wheel bearing balls are worn	3 A 3	Require replacement of bearing assembly.
AA		
Wheel bearing end-play exceeds vehicle manufacturer's specs	3 A 3	Require adjustment of bearing, if possible. If proper adjustment cannot be obtained, require repair or replacement of worn component.
AA		
Wheel bearing race is loose in the hub bore	3 A 3	Require replacement of hub assembly and wheel bearings.
AA		
Wheel bearing races are pitted	3 A 3	Require replacement of bearing assembly.
AA		
Wheel bearing races are worn	3 A 3	Require replacement of bearing assembly.
AA		
Wheel bearing rollers are pitted	3 A 3	Require replacement of bearing assembly.
AA		
Wheel bearing rollers are worn	3 A 3	Require replacement of bearing assembly.
AA		

WHEELS & TIRES

TIRES

WARNING: These guidelines do not apply to split rims.

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Some vehicle manufacturers restrict replacement of tires to specific brands, types, or sizes.

High pressure temporary compact spare tires should not be used with any other rims or wheels, nor should standard tires, snow tires, wheel covers, or trim rings be used with high pressure compact spare rims or wheels.

Attempting to mount a tire of one diameter on a wheel of a different diameter or flange type may result in serious injury or death.

Only specially trained persons should de-mount or mount tires. Explosions of tire and wheel assembly can result from improper mounting, possibly causing serious injury or death.

Consult the vehicle owner's manual or vehicle placard for correct size, speed rating, designation, and cold inflation pressure of the original tires. DO NOT exceed the maximum load or inflation capacity of the tire specified by the Tire and Rim Association

When replacing tires, it is suggested that the replacement tires match or exceed the OEM speed rating designation. If tires of different speed rating designations are mixed on the same vehicle, the tires may vary in handling characteristics. DO NOT mix different speed rating designations on the same axle.

DO NOT mix radials with non-radial tires on the same axle, as this may affect vehicle handling and stability. If radial tires and bias or bias-belted ply tires are mixed on the same vehicle, the radials must be on the rear. High-pressure temporary compact spare tires are exempt from this rule.

DO NOT mix size or type (all season, performance, mud and snow) of tires on the same axle.

TIRES

Condition			3	Code	3	Procedure
Air pressure incorrect			3	B	3	Require repair
Bead broken			3	A	3	Require replacement.
Bead leaking, caused by tire			3	A	3	Require repair or replacement.
Bead wire/cord exposed			3	A	3	Require replacement.
Cord or belt material exposed			3	A	3	Require replacement.
Cord ply separations			3	A	3	Require replacement.
Directional/asymmetrical tires mounted incorrectly			3	B	3	Require remounting and/or repositioning.
Irregular tread wear, affecting performance			3	A	3	Suggest replacement.
			3		3	See note (1) below.
Load ratings less than OEM			3	B	3	Require replacement.

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specifications	3	3	
AA			
Mixed tire size designations	3	A	3
on same axle	3		3
			Require rotation or replacement.
AA			
Mixed tread types (all season,	3	A	3
performance, mud and snow)	3		3
on same axle	3		3
			Require rotation or replacement.
AA			
Number of punctures exceeds	3	B	3
manufacturer's limit	3		3
			Require replacement.
AA			
Out of balance	3	B	3
	3		3
			Require rebalance of tire/wheel assembly.
AA			
Ply separation	3	A	3
			Require replacement.
AA			
Pull or lead, caused by tire	3	A	3
	3		3
			Require rotation or replacement.
AA			
Radial and bias or bias-belted	3	B	3
ply tires on same axle	3		3
			Require rotation or replacement.
AA			
Radials are on the front and	3	B	3
not on the rear	3		3
			Require rotation or replacement. See note (2).
AA			
Run flat damage	3	A	3
			Require replacement.
AA			
Shoulder cut	3	A	3
			Require replacement.
AA			
Shoulder puncture	3	A	3
			Require replacement.
AA			
Shoulder with plug	3	A	3
			Require replacement.
AA			
Sidewall bulge	3	A	3
			Require replacement.
AA			
Sidewall cut	3	A	3
			Require replacement.
AA			
Sidewall indentation	3		3
			No service required/suggested.
AA			
Sidewall puncture	3	A	3
			Require replacement.
AA			
Sidewall with plug	3	A	3
			Require replacement.
AA			
Speed rating designations	3	B	3
different on same axle	3		3
			Suggest rotation or replacement.
AA			
Tire and wheel assembly has	3	B	3
excessive run-out	3		3
	3		3
			Require repair or replacement of appropriate part. See note (3) below.
AA			
Tires with more than 1/4"	3	B	3
			Require replacement.

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diameter difference on a	3	3
four-wheel drive vehicle	3	3
Tread area puncture larger in 3 B 3 Require replacement.		
diameter than tire	3	3
manufacturer's specifications	3	3
Tread missing pieces 3 A 3 Require replacement.		
(chunking), exposing cord	3	3
Tread missing pieces 3 A 3 Suggest replacement.		
(chunking), not exposing cord	3	3
Tread separations 3 A 3 Require replacement.		
Tube in tubeless tire 3 C,3 3 Suggest removal of tube.		
	3	3 See note (4) below.
Weather-checking 3 3 No service required/suggested.		
Worn to tread wear indicators 3 B 3 Require replacement.		

NOTE: (1) Determine and correct cause of irregular tire wear.
(2) If radials and bias or bias-belted ply tires are on the same vehicle, the radials must be on the rear axle, except for high-pressure temporary spares.
(3) Excessive is defined as enough to contribute to performance problems. Match mounting may correct run-out. If not, require replacement of appropriate part. Refer to manufacturer's specifications.
(4) Most manufacturers do not recommend tubes in tubeless tires. Inspect tire and wheel assembly to determine the reason for a tube in tubeless tire. Recommendation for repair or replacement should be based upon condition of tires and/or wheel listed in these guidelines.

VALVE STEMS

VALVE STEMS		
Condition	3	Code 3 Procedure
Bent	3	A,1 3 Suggest replacement.
Broken	3	A 3 Require replacement.
Cut, but not leaking	3	A,1 3 Suggest replacement.
Deteriorated (cracking, dry rot)	3	A,1 3 Suggest replacement.
Leaking	3	A 3 Require repair/replacement.

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AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Missing                      3   C   3   Require replacement.
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Threads damaged              3   A   3   Require repair/replacement.
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Threads stripped (threads missing) 3   A   3   Require replacement.
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Valve cap missing           3   C   3   Require replacement of cap.
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Weather-checking            3   A,1 3   Suggest replacement.
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Won't take air              3   A   3   Require repair/replacement.
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA

```

WHEEL ATTACHMENT HARDWARE

For conditions noted below, also check conditions of wheel stud holes.

CAUTION: Proper lug nut torque is essential. Follow manufacturer's torque specifications and tightening sequence. DO NOT lubricate threads unless specified by the vehicle manufacturer.

WHEEL ATTACHMENT HARDWARE

```

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Condition                    3   Code 3   Procedure
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Bent                          3   A   3   Require replacement.
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Broken                        3   A   3   Require replacement.
                              3       3   See note (1) below.
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Loose                         3   B   3   Require repair or replacement
                              3       3   of affected component.
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Lug nut installed backward   3   B   3   Require repair.
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Lug nut mating type incorrect 3   B   3   Require replacement of nut.
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Lug nut mating surface dished 3   A   3   Require replacement of nut.
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Lug nut flats rounded        3   A   3   Require replacement of nut.
                              3       3   See note (2) below.
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Lug nut seized               3   A   3   Require replacement of nut
                              3       3   and/or stud. See note (2) below.
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Stud incorrect              3   B   3   Require replacement of stud.
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
Threads damaged              3   A   3   Require repair or replacement of
                              3       3   component with damaged threads.

```

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Threads stripped (threads 3 A 3 Require replacement of
missing) 3 3 component with stripped threads.

NOTE: (1) Some manufacturers require replacement of all studs on that
wheel if two or more studs or nuts on the same wheel are
broken or missing.

(2) Only required if removing wheel.

WHEELS

WARNING: Mounting a regular tire on a high-pressure compact spare
wheel is not permitted. Attempting to mount a tire of one
diameter on a wheel of a different diameter or flange type
may result in serious injury or death. If the wheel
identification stamp is not legible, or cannot be found,
DO NOT use the wheel until the size and type have been
properly identified. Wheels of different diameter, offset,
or width cannot be mixed on the same axle. Bead seat tapers
cannot be interchanged.

WHEELS

Condition 3 Code 3 Procedure

Bead leaking, caused by 3 A 3 Require repair or replacement.
wheel rim flange 3 3 See caution below.

CAUTION: DO NOT attempt to correct a bent wheel rim.

Bent wheel hub mounting 3 A 3 Require replacement.
surface 3 3

Bent wheel rim, causing 3 B,2 3 Suggest replacement.
vibration 3 3 See caution above.

Broken 3 A 3 Require replacement.

Cast wheel porous, causing 3 A 3 Require repair or replacement.
a leak 3 3

Clip-on balance weight is 3 B,2 3 Suggest replacement.
incorrect type for wheel 3 3
rim flange 3 3

Corrosion, affecting 3 A 3 Require replacement.
structural integrity 3 3

Corrosion build-up on wheel 3 A 3 Require repair.
hub mounting surface 3 3

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Cracked 3 A 3 Require replacement.
Directional/asymmetrical 3 B 3 Require remounting and/or
wheels mounted incorrectly 3 3 repositioning.
Load capacity less than 3 B 3 Require replacement.
OEM specifications 3 3
Offset mismatched on same 3 B 3 Require replacement.
axle 3 3
Rivets leaking 3 A 3 Require replacement.
Run-out beyond OEM specs 3 B 3 Require replacement.
Stud holes elongated 3 A 3 Require replacement. See note (1)
Welded or brazed repair 3 B,2 3 Suggest replacement.
Welds leaking 3 A 3 Require replacement.
Wheel hub centering (pilot) 3 B 3 Require replacement.
hole incorrect 3 3
NOTE: (1) Inspect wheel attaching hardware for damage.

END OF ARTICLE

*** SYMPTOM CHECK LIST ***

Article Text

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ARTICLE BEGINNING

SYMPTOM CHECK LIST WORKSHEETS

*** PLEASE READ THIS FIRST ***

NOTE: This article is intended for general information purposes only. It does not apply specifically to one make or model.

PURPOSE

Why Use the Symptom Check List Worksheets?

One of the most difficult and critical lines of communication is between the service customer and the technician. The clearer the technician understands the customer's concerns, the more likely the problem will be "fixed right the first time".

The Symptom Check List Worksheets in this article are designed to improve this communication. When used consistently, they can be helpful in reducing shop comebacks, increasing technician productivity, and producing satisfied customers. They also provide other benefits:

- * Reduce "No Trouble Found" problems
- * Increase customer involvement
- * Customer perceive that "they really care and listen"
- * Save time during peak write-up periods
- * Reduce recontacting customers for additional information
- * Improve night drop information
- * Insure all the right questions are asked at write-up

Making the Worksheets a Part of Your Normal Routine

The following information contains ideas that may be helpful in forming habits that promote daily use of the Symptom Check Lists:

- * HAVE THE SERVICE ADVISER FILL OUT THE FORM(S) WITH THE CUSTOMER WHENEVER POSSIBLE.
- * Place them in your night drop for the customer to fill out, along with an instruction sheet to help them understand what to do.
- * Hand out the worksheets to customers while they wait in line during the peak morning rush and ask them to fill it out. It will save time for all concerned and improve the quality of information received from the customer.
- * Make sure it is attached to the hard copy when it goes to the technician.
- * Place a copy with the final repair papers and review it with the customer at delivery.
- * Put a new worksheet in the glovebox of all departing customers.
- * Require that you personally see a copy of all worksheets filled out for shop comebacks.

*** SYMPTOM CHECK LIST ***

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- * Hold a shop meeting to get employee buy-in and their ideas on how to make it effective in your shop.

There are many other ways to utilize the concept, but as with every other idea, successful implementation depends on employee involvement and buy-in.

SYMPTOM CHECK LIST WORKSHEETS

CONDENSED VERSION - ALL ON ONE PAGE

NOTE: Have the service adviser fill out this form with the customer whenever possible.

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DRIVEABILITY WORKSHEET (To Be Filled Out By Vehicle Owner)	
Name: _____ Date: _____ Make: _____ Model: _____ Year: _____ Engine: _____ Mileage: _____	
FAULT CHARACTERISTICS - SYMPTOMS - DESCRIPTION OF PROBLEM (Please Check All That Apply In All Categories)	
Starting Problems	☐ Will Not Crank ☐ Cranks, But Won't Start ☐ Starts, But Takes A Long Time
Engine Quits/ Running Problems	Quits: ☐ Right After Starting ☐ When Put Into Gear ☐ Right After Vehicle Comes To A Stop ☐ During Steady Speed Driving ☐ While Idling ☐ During Acceleration ☐ When Parking
Poor Idling Conditions	Idle Speed: ☐ Is Too Slow At All Times ☐ Is Too Slow With A/C On ☐ Is Too Fast ☐ Is Rough Or Uneven ☐ Fluctuates Up and Down
Poor Running Conditions	☐ Runs Rough ☐ Lacks Power ☐ Hesitates Or Stumbles On Acceleration ☐ Bucks and Jerks ☐ Engine Knocks, Pings, Rattles ☐ Backfires ☐ Poor Fuel Economy ☐ Misfires or Cuts Out ☐ Surges and/or Chuggles ☐ Dieseling or Run-On ☐ Engine Light Always On ☐ Engine Light On Sometimes ☐ Fuel, Gas, or Sulfur Smell
Auto. Transmission Problems	☐ Improper Shifting (early/late) ☐ Changes Gear Randomly On Its Own ☐ Vehicle Does Not Move When In Gear
Poor Handling	☐ Pulls To One Side ☐ Hard Steering ☐ Vehicle Shakes and/or Vibrates While Moving
Noise Problems	Explain: _____
Odor Problems	Explain: _____
Problem Frequency	☐ Always ☐ Often ☐ Occasionally
Usually Occurs	☐ Morning ☐ Afternoon ☐ Anytime
Engine Temp.	☐ Cold ☐ Warm ☐ Hot
Vehicle Speed	☐ Low ☐ Cruising ☐ High
Driving Conditions During Occurrence	☐ Short - Less Than 2 Miles ☐ 2-10 Miles ☐ Long - More Than 10 Miles ☐ Stop & Go ☐ While Turning ☐ While Braking ☐ At Gear Engagement ☐ With A/C Operating ☐ With Headlights On ☐ During Acceleration ☐ During Deceleration ☐ Mostly Downhill ☐ Mostly Uphill ☐ Mostly Level ☐ Mostly Curvy ☐ Rough Road
Driving Habits	☐ Drive Hard Before Engine Is Warmed ☐ Allow Engine To Warm ☐ Mostly City Driving ☐ Highway ☐ Park Vehicle Inside ☐ Outside Drive Per Day: ☐ Less Than 10 Miles ☐ 10-50 ☐ More Than 50 Fuel Octane: ☐ 87 ☐ 89 ☐ 91 ☐ More Than 91 Brand: _____ ☐ Gasohol ☐ Propane Conversion
Outside Weather	☐ Cold ☐ Warm ☐ Hot ☐ Wet/Rainy ☐ Fog ☐ Snow/Hail ☐ Dust/Dirt ☐ Dry ☐ Humid

Fig. 1: Entire Vehicle - Symptom Check List For Customer

FULL VERSION - ALL ON FOUR PAGES

*** SYMPTOM CHECK LIST ***

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NOTE: Have the service adviser fill out these forms with the customer whenever possible.

Dear Valued Customer:

Our goal is to fix your problem correctly and get you back on the road as soon as possible in the unlikely event you experience a problem with your vehicle. Help us identify the exact nature of the concern by taking a few moments to complete the appropriate section of this diagnostic worksheet. Thank you.

CUSTOMER NAME: _____

PHONE NO.: _____

REPAIR ORDER NO.: _____

DIAGNOSTIC WORKSHEET

DRIVEABILITY - ENGINE - AUTOMATIC TRANSMISSION

SYMPTOM (CHECK ALL THAT APPLY)
ENGINE

- ☐ "Service Engine Soon"/"Malfunction Indicator Light" on
- ☐ Hard start/no start (cranks OK)
- ☐ Won't crank
- ☐ Engine stalls
- ☐ Engine miss
- ☐ Miss while driving
- ☐ Hesitates, stumbles or sags
- ☐ Rough idle
- ☐ Idle is too high ☐ Idle is too low
- ☐ Poor power/performance
- ☐ Surge or chuggle, buck - jerk - skip
- ☐ Poor gas mileage ☐ Highway ☐ City
- ☐ Pings, detonates
- ☐ Suphur, rotten egg odor
- ☐ Backfires (popping noise) - underhood/tailpipe
- ☐ Exhaust smoke ☐ Increased oil consumption
- ☐ Runs on after key is turned off
- ☐ Speed fluctuates without moving accelerator
- ☐ Engine noise (explain): _____

_____ (whine, rattle, groan, clunk, etc.)

☐ Other: _____

TRANSMISSION

- ☐ Does not shift properly ☐ Hard shift
- ☐ Will not shift ☐ Up ☐ Down
- ☐ Will not shift into overdrive
- ☐ Engine starts in other than "P" or "N"
- ☐ Noise (describe): _____

_____ (whine, rattle, groan, clunk, buzz, etc.)

- ☐ Shifts into gear too early
- ☐ Overdrive doesn't work with speed control, but is otherwise OK
- ☐ Highway speed - shudder, surge, etc.
- ☐ Other: _____

EXPLAIN: _____

OPERATING CONDITIONS (CHECK ALL THAT APPLY)
HOW OFTEN DOES IT OCCUR? (Engine and/or Transmission)

- ☐ Always ☐ Few seconds ☐ Few minutes
- ☐ Few hours ☐ Few days ☐ Few weeks
- ☐ Few months ☐ Variable ☐ Only during event
- ☐ Every _____ to _____ miles ☐ Unknown
- ☐ Other (explain): _____
- ☐ Just started ☐ Getting better ☐ Getting worse
- ☐ Since new

WHEN DOES IT OCCUR? (Engine and/or Transmission)
When Engine Temperature is:

- ☐ Cold ☐ Warm ☐ Hot
- ☐ All the time ☐ Only during warmup

Weather Conditions:

- ☐ Very cold - below 0 degrees F ☐ Cold - 0 to 32 degrees F
- ☐ Cool - 32 to 60 degrees F ☐ Warm - 60 to 80 degrees F
- ☐ Hot - Above 80 degrees F ☐ Any environment
- ☐ Raining ☐ Dry ☐ Humid
- ☐ Snow/ice ☐ Wet roads ☐ Other (explain below)

Driving Conditions:

- ☐ Light throttle ☐ Medium throttle ☐ Hard throttle
- ☐ Starting ☐ At idle ☐ Decelerating
- ☐ Over bumps ☐ When shifting ☐ While turning
- ☐ Cruising steady at _____ MPH ☐ While braking
- ☐ Anytime ☐ Uphill ☐ Downhill
- ☐ Highway ☐ City/town ☐ Stop and go
- ☐ Between _____ MPH and _____ MPH
- ☐ Only with A/C or Defrost on

What Type of Fuel?

- ☐ Regular UL ☐ Mid range UL ☐ Premium Unleaded
- ☐ Gasohol ☐ Ethanol ☐ Methanol
- ☐ Diesel #1 ☐ Diesel #2 ☐ Various brands

What Brand? _____

When Gear Selector is in:

- ☐ Park/Neutral ☐ Reverse ☐ Overdrive
- ☐ Drive/3 ☐ Drive/2 ☐ Drive/1

Between Gears:

- ☐ Park to R or D ☐ Rev/Drive ☐ First/Second
- ☐ Second/Third ☐ Third/Overdrive

*** SYMPTOM CHECK LIST ***

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BRAKES - STEERING - SUSPENSION

SYMPTOM

- | | | |
|---|--|---------------------------------------|
| ☐ Vehicle pulls right - When _____ | ☐ Suspension bottoms out | ☐ Sits uneven |
| ☐ Vehicle pulls left - When _____ | ☐ Leans or sways in corners | ☐ "Dog" tracks |
| ☐ Steering wheel vibrates at _____ MPH | ☐ Brake light on | ☐ ABS light on |
| ☐ Excessive play in steering | ☐ Traction control light on | ☐ Soft ride |
| ☐ Erratic steering when braking | ☐ Uneven tire wear | |
| ☐ Poor steering wheel return after cornering | | |

Hard to steer

- ☐ Effort ☐ Wanders
☐ Steering wheel off center

Shimmy/vibration (check box below for location)

- | | | |
|--------------------------------|--------------------------------|--------------------------------------|
| ☐ Front | ☐ Rear | ☐ Don't know |
| ☐ Seat | ☐ Floor | ☐ Other _____ |

Brake pedal

- ☐ Noise ☐ Pulses ☐ Squeaks ☐ Hard ☐ Mushy ☐ Excessive travel

WHEN DOES IT OCCUR?

- | | | | | |
|--|--|---------------------------------------|---------------------------------------|---------------------------------------|
| ☐ Cold days | ☐ Hot days | ☐ Wet/rain | ☐ All the time | ☐ Intermittent |
| ☐ Parking maneuvers | ☐ At road speed | ☐ Accelerating | ☐ Decelerating | |

EXPLAIN: _____

SQUEAK - RATTLE - NOISE CONDITIONS

AREA OF NOISE

- | | | | | |
|--|----------------------------------|--------------------------------------|---------------------------------|-------------------------------------|
| ☐ Engine Compartment | ☐ Left | ☐ Right | ☐ Center | ☐ Don't know |
| ☐ Front Suspension | ☐ Left | ☐ Right | ☐ Center | ☐ Don't know |
| ☐ Rear Suspension | ☐ Left | ☐ Right | ☐ Center | ☐ Don't know |
| ☐ Passenger Compartment | ☐ Left | ☐ Right | ☐ Center | ☐ Don't know |
| ☐ Instrument Panel | ☐ Left | ☐ Right | ☐ Center | ☐ Don't know |
| ☐ Doors | ☐ Left | ☐ Right | ☐ Center | ☐ Don't know |
| ☐ Rear seat area | ☐ Console | ☐ Other _____ | | |

NOISE SOUNDS LIKE

- | | | | | | |
|----------------------------------|-------------------------------------|--------------------------------------|--------------------------------------|----------------------------------|--------------------------------|
| ☐ Knocks | ☐ Hard metal | ☐ Light metal | ☐ Roars | ☐ Ticking | ☐ Whine |
| ☐ Squeaks | ☐ Rattles | ☐ Scraping | ☐ Other _____ | | |

HOW OFTEN DOES IT OCCUR?

- ☐ Continuous ☐ Often ☐ Intermittent ☐ Just started ☐ Since new

WHEN DOES IT OCCUR?

- | | | | | | |
|--|---|--|--|---------------------------------------|---|
| ☐ All the time | ☐ Speed | ☐ RPM | ☐ Only moving | ☐ On turns | ☐ Braking |
| ☐ Hard throttle | ☐ Light throttle | ☐ Decelerate | ☐ Steady speed | ☐ Idle in gear | ☐ Idle out of gear |
| ☐ Hot days | ☐ Cold days | ☐ Humid or rainy | ☐ Temperature _____ | | |
| ☐ Heavy bumps | ☐ Light bumps | ☐ Smooth pavement | | | |

EXPLAIN: _____

CUSTOMER NAME:

PHONE NO.:

REPAIR ORDER NO:

SHOP USE ONLY:

VIN#:

MILES:

TECHNICIAN:

ADVISOR#:

50H15062

*** SYMPTOM CHECK LIST ***

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AIR CONDITIONING - HEATER - VENTILATION

SYSTEM OR AREA AFFECTED

- | | | | | | |
|--|--|------------------------------------|------------------------------------|-----------------------------------|-------------------------------------|
| ☐ Air conditioner | ☐ Heater | ☐ Defroster | ☐ Vent | ☐ Bi-Level | ☐ Fan/blower |
| ☐ Max A/C | ☐ Automatic Temperature Control | | ☐ Mix/blend | ☐ Economy | ☐ All |

SYMPTOM

- | | | | |
|--|--|---|--|
| ☐ Does not work | ☐ Blows wrong temperature air | ☐ No air comes out of vents | ☐ Rapid cycling |
| ☐ Noisy (explain) | ☐ Broken | ☐ Odor | ☐ Blows fuse |
| ☐ Leaks | ☐ Insufficient heat or cool | ☐ Air comes from wrong outlets | |
| | | ☐ Other (explain below) | |

WHEN DOES IT OCCUR?

- | | | | | |
|--|------------------------------|--|---------------------------------------|--|
| ☐ All the time | ☐ Hot | ☐ Cold | ☐ Intermittent | ☐ Right after startup |
| ☐ When change controls only | | ☐ Other (explain below) | | ☐ Fan blower speed High / Med / Low |

EXPLAIN: _____

ELECTRICAL - RADIO - TAPE/CD PLAYER

SYMPTOM - MUSIC SYSTEM

- | | | | | | |
|---|--------------------------------|-------------------------------------|--|--------------------------------------|---|
| ☐ Does not work | ☐ Noisy | ☐ Static | ☐ Won't load | ☐ Won't eject | ☐ Poor reception |
| ☐ Controls do not work | | ☐ Blows fuse | ☐ Other (explain below) | | |

SYSTEM AFFECTED

- | | | | | |
|--------------------------------------|------------------------------------|---|---|---|
| ☐ Radio only | ☐ AM | ☐ FM | ☐ FM stereo | ☐ Graphic equalizer |
| ☐ Tape player | ☐ CD player | ☐ Whole system | ☐ Steering wheel buttons | ☐ Phone |
| ☐ Speakers | ☐ Front | ☐ Rear | ☐ Left | ☐ Right |
| ☐ Antenna | ☐ Clock | ☐ Radio or player controls | | ☐ Rear seat controls |

ALL OTHER ELECTRICAL ITEMS OR ACCESSORIES

Please list the complaint accessory or item and check any applicable symptom(s) from the list that follows:

- | | | | | |
|-------|---|---------------------------------------|--|----------------------------------|
| _____ | ☐ Inoperable | ☐ Noisy | ☐ No control | ☐ Erratic |
| | ☐ Check light on or flashing | | ☐ Works improperly (explain below) | |
| | ☐ Blows fuse | ☐ Intermittent | ☐ Related system affected (explain below) | |
| _____ | ☐ Inoperable | ☐ Noisy | ☐ No control | ☐ Erratic |
| | ☐ Check light on or flashing | | ☐ Works improperly (explain below) | |
| | ☐ Blows fuse | ☐ Intermittent | ☐ Related system affected (explain below) | |

- | | | | | |
|-------|---|---------------------------------------|--|----------------------------------|
| _____ | ☐ Inoperable | ☐ Noisy | ☐ No control | ☐ Erratic |
| | ☐ Check light on or flashing | | ☐ Works improperly (explain below) | |
| | ☐ Blows fuse | ☐ Intermittent | ☐ Related system affected (explain below) | |

WHEN DOES IT OCCUR?

- | | | | |
|--|---|-------------------------------|---|
| ☐ All the time | ☐ Hot | ☐ Cold | ☐ Just after starting - malfunctions for a while |
| ☐ Intermittent | ☐ After runs for _____ minutes | | ☐ Rough roads or bumps only |
| ☐ Other (explain below) | | | |

EXPLAIN: _____

CUSTOMER NAME: _____

PHONE NO.: _____

REPAIR ORDER NO: _____

SHOP USE ONLY:

VIN#: _____

MILES: _____

TECHNICIAN: _____

ADVISOR#: _____

*** SYMPTOM CHECK LIST ***
Article Text (p. 7)
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WATER LEAK - WINDNOISE

WATER LEAK

Leak Occurs When?

- | | | | |
|--|--|--|--|
| ☐ Setting level | ☐ Any time it rains | ☐ While driving in the rain | ☐ Car wash only |
| ☐ Back lower than front (facing uphill) | | ☐ Front lower than back (facing downhill) | |

Location of Leak (where water appears):

- | | | | | | |
|---|------------------------------------|------------------------------------|---|-------------------------------------|--|
| ☐ LF Door | ☐ RF Door | ☐ LR Door | ☐ RR Door | ☐ Windshield | ☐ Rear window |
| ☐ LF window | ☐ RF window | ☐ LR window | ☐ RR window | ☐ Side door | ☐ Sunroof/T-Top |
| ☐ Under instrument panel | | | ☐ Rear door/rear hatch | | |

WINDNOISE:

Location:

- | | | | | | |
|---|------------------------------------|------------------------------------|---|-------------------------------------|--|
| ☐ LF Door | ☐ RF Door | ☐ LR Door | ☐ RR Door | ☐ Windshield | ☐ Rear window |
| ☐ LF window | ☐ RF window | ☐ LR window | ☐ RR window | ☐ Side door | ☐ Sunroof/T-Top |
| ☐ Under instrument panel | | | ☐ Rear door/rear hatch | | |

EXPLAIN: _____

MANUAL TRANSMISSION - CLUTCH

SYMPTOM - MANUAL GEAR SHIFT

- | | |
|--|--|
| ☐ Hard to shift | ☐ Doesn't shift |
| ☐ Grinds going into _____ gear | |
| ☐ Noisy when in _____ gear or neutral _____ | |
| ☐ Slips/pops out of gear | |
| ☐ Noise (describe): _____ | |

- | |
|--|
| ☐ Upshift light stays on |
| ☐ Upshift light doesn't light |

WHEN DOES IT OCCUR?

- | | |
|---------------------------------------|-------------------------------------|
| ☐ All the time | ☐ Light load |
| ☐ Heavy load | |

EXPLAIN: _____

SYMPTOM - CLUTCH

- | | |
|---|--|
| ☐ Hard to push | ☐ Fail to release |
| ☐ Noise when pressing pedal down (describe): _____ | |

- | | |
|--|---|
| ☐ Slips | ☐ Chattering (grabbing) |
| ☐ Odor present | ☐ Pedal stays on the floor |
| ☐ Squealing sound | |

WHEN DOES IT OCCUR?

When Engine Temperature is:

- | | |
|---------------------------------------|---------------------------------------|
| ☐ Cold | ☐ Hot |
| ☐ Accelerating | ☐ Decelerating |

COMMENTS:

CUSTOMER NAME:

PHONE NO.:

REPAIR ORDER NO:

SHOP USE ONLY:

VIN#:

MILES:

TECHNICIAN:

ADVISOR#:

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NOTE: Have the service adviser fill out these forms with the customer whenever possible.

DRIVEABILITY - ENGINE - AUTOMATIC TRANSMISSION	
SYMPTOM (CHECK ALL THAT APPLY) ENGINE	OPERATING CONDITIONS (CHECK ALL THAT APPLY) HOW OFTEN DOES IT OCCUR? (Engine &/or Transmission)
☐ "Service Engine Soon"/Malfunction Indicator Light" on ☐ Hard start/no start (cranks OK) ☐ Won't crank ☐ Engine stalls ☐ Engine miss ☐ Miss while driving ☐ Hesitates, stumbles or sags ☐ Rough idle ☐ Idle is too high ☐ Poor power/performance ☐ Surge or chuggle, buck - jerk - skip ☐ Poor gas mileage ☐ Ping, detonates ☐ Sulphur/rotten egg odor ☐ Backfires (popping noise) - underhood/tailpipe ☐ Exhaust smoke ☐ Runs on after key is turned off ☐ Speed fluctuates without moving accelerator ☐ Engine noise (explain): (whine, rattle, groan, clunk, etc.) ☐ Other:	☐ Always ☐ Few hours ☐ Few months ☐ Every _____ to _____ miles ☐ Other (explain): ☐ Just started ☐ Since new ☐ Few Seconds ☐ Few days ☐ Variable ☐ Only during event ☐ Unknown ☐ Getting better ☐ Getting worse WHEN DOES IT OCCUR? (Engine and/or Transmission) When Engine Temperature is: ☐ Cold ☐ All the time ☐ Warm ☐ Only during warmup ☐ Hot Weather Conditions: ☐ Very cold - below 0°F ☐ Cool - 32 to 60°F ☐ Hot - above 80°F ☐ Raining ☐ Snow/Ice ☐ Other (explain): ☐ Cold - 0 to 32°F ☐ Warm - 60 to 80°F ☐ Any environment ☐ Dry ☐ Wet roads Driving Conditions: ☐ Light throttle ☐ Starting ☐ Over bumps ☐ Cruising - steady at _____ MPH ☐ Anytime ☐ Highway ☐ Between _____ MPH and _____ MPH ☐ Only with A/C or Defrost on ☐ Medium throttle ☐ At idle ☐ When shifting ☐ Uphill ☐ City/town ☐ Hard throttle ☐ Decelerating ☐ While turning ☐ While braking ☐ Downhill ☐ Stop and go What Type of Fuel? ☐ Regular UL ☐ Gasohol ☐ Diesel #1 ☐ Midrange UL ☐ Ethanol ☐ Diesel #2 ☐ Premium UL ☐ Methanol ☐ Various brands What Brand? When Gear Selector is in: ☐ Park/Neutral ☐ Drive/3 ☐ Reverse ☐ Drive/2 ☐ Overdrive ☐ Drive/1 Between Gears: ☐ Park to R or D ☐ Second/Third ☐ Reverse/Drive ☐ Third/Overdrive ☐ First/Second
TRANSMISSION	
☐ Does not shift properly ☐ Will not shift ☐ Will not shift into overdrive ☐ Engine starts in other than "P" or "N" ☐ Noise (describe): (whine, rattle, groan, clunk, buzz, etc.) ☐ Shifts into next gear too early ☐ Overdrive doesn't work with speed control, but is otherwise OK ☐ Highway speed - shudder, surge, etc. ☐ Other:	
EXPLAIN:	
CUSTOMER NAME:	PHONE NO.:
SHOP USE ONLY:	REPAIR ORDER NO.:
VIN#:	TECHNICIAN:
MILES:	ADVISOR#:

Fig. 6: Engine Driveability & Automatic Transmission

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BRAKES - STEERING - SUSPENSION

SYMPTOM

- | | | |
|---|--|---------------------------------------|
| ☐ Vehicle pulls right - When _____ | ☐ Suspension bottoms out | ☐ Sits uneven |
| ☐ Vehicle pulls left - When _____ | ☐ Leans or sways in corners | ☐ "Dog" tracks |
| ☐ Steering wheel vibrates at _____ MPH | ☐ Brake light on | ☐ ABS light on |
| ☐ Excessive play in steering | ☐ Traction control light on | ☐ Soft ride |
| ☐ Erratic steering when braking | ☐ Uneven tire wear | |
| ☐ Poor steering wheel return after cornering | | |

Hard to steer

- ☐ Effort ☐ Wanders
☐ Steering wheel off center

Shimmy/vibration (check box below for location)

- | | | |
|--------------------------------|--------------------------------|--------------------------------------|
| ☐ Front | ☐ Rear | ☐ Don't know |
| ☐ Seat | ☐ Floor | ☐ Other _____ |

Brake pedal

- ☐ Noise ☐ Pulses ☐ Squeaks ☐ Hard ☐ Mushy ☐ Excessive travel

WHEN DOES IT OCCUR?

- | | | | | |
|--|--|---------------------------------------|---------------------------------------|---------------------------------------|
| ☐ Cold days | ☐ Hot days | ☐ Wet/rain | ☐ All the time | ☐ Intermittent |
| ☐ Parking maneuvers | ☐ At road speed | ☐ Accelerating | ☐ Decelerating | |

EXPLAIN: _____

CUSTOMER NAME:

PHONE NO.:

REPAIR ORDER NO:

SHOP USE ONLY:

VIN#:

MILES:

TECHNICIAN:

ADVISOR#:

Fig. 7: ^{50C15059} Brakes, Steering, & Suspension

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AIR CONDITIONING - HEATER - VENTILATION

SYSTEM OR AREA AFFECTED

- | | | | | | |
|--|--|------------------------------------|------------------------------------|-----------------------------------|-------------------------------------|
| ☐ Air conditioner | ☐ Heater | ☐ Defroster | ☐ Vent | ☐ Bi-Level | ☐ Fan/blower |
| ☐ Max A/C | ☐ Automatic Temperature Control | | ☐ Mix/blend | ☐ Economy | ☐ All |

SYMPTOM

- | | | | |
|--|---|---|--|
| ☐ Does not work | ☐ Blows wrong temperature air | ☐ No air comes out of vents | ☐ Rapid cycling |
| ☐ Noisy (explain) | ☐ Broken ☐ Odor | ☐ Air comes from wrong outlets | ☐ Blows fuse |
| ☐ Leaks | ☐ Insufficient heat or cool | ☐ Other (explain below) | |

WHEN DOES IT OCCUR?

- | | | | | |
|--|------------------------------|--|---------------------------------------|--|
| ☐ All the time | ☐ Hot | ☐ Cold | ☐ Intermittent | ☐ Right after startup |
| ☐ When change controls only | | ☐ Other (explain below) | | ☐ Fan blower speed High / Med / Low |

EXPLAIN: _____

CUSTOMER NAME:

PHONE NO.:

REPAIR ORDER NO:

SHOP USE ONLY:

VIN#:

MILES:

TECHNICIAN:

ADVISOR#:

Fig. 8: ^{50A15057}Air Conditioning, Heater & Ventilation

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ELECTRICAL - RADIO - TAPE/CD PLAYER

SYMPTOM - MUSIC SYSTEM

- | | | | | | |
|---|--------------------------------|-------------------------------------|--|--------------------------------------|---|
| ☐ Does not work | ☐ Noisy | ☐ Static | ☐ Won't load | ☐ Won't eject | ☐ Poor reception |
| ☐ Controls do not work | | ☐ Blows fuse | ☐ Other (explain below) | | |

SYSTEM AFFECTED

- | | | | | |
|--------------------------------------|------------------------------------|---|---|--|
| ☐ Radio only | ☐ AM | ☐ FM | ☐ FM stereo | ☐ Graphic equalizer |
| ☐ Tape player | ☐ CD player | ☐ Whole system | ☐ Steering wheel buttons | ☐ Phone |
| ☐ Speakers | ☐ Front | ☐ Rear | ☐ Left | ☐ Right |
| ☐ Antenna | ☐ Clock | ☐ Radio or player controls | ☐ Rear seat controls | |

ALL OTHER ELECTRICAL ITEMS OR ACCESSORIES

Please list the complaint accessory or item and check any applicable symptom(s) from the list that follows:

- | | | | | |
|-------|---|---------------------------------------|--|----------------------------------|
| _____ | ☐ Inoperable | ☐ Noisy | ☐ No control | ☐ Erratic |
| | ☐ Check light on or flashing | | ☐ Works improperly (explain below) | |
| | ☐ Blows fuse | ☐ Intermittent | ☐ Related system affected (explain below) | |
| _____ | ☐ Inoperable | ☐ Noisy | ☐ No control | ☐ Erratic |
| | ☐ Check light on or flashing | | ☐ Works improperly (explain below) | |
| | ☐ Blows fuse | ☐ Intermittent | ☐ Related system affected (explain below) | |
| _____ | ☐ Inoperable | ☐ Noisy | ☐ No control | ☐ Erratic |
| | ☐ Check light on or flashing | | ☐ Works improperly (explain below) | |
| | ☐ Blows fuse | ☐ Intermittent | ☐ Related system affected (explain below) | |

WHEN DOES IT OCCUR?

- | | | | |
|--|---|-------------------------------|---|
| ☐ All the time | ☐ Hot | ☐ Cold | ☐ Just after starting - malfunctions for a while |
| ☐ Intermittent | ☐ After runs for _____ minutes | | ☐ Rough roads or bumps only |
| ☐ Other (explain below) | | | |

EXPLAIN: _____

CUSTOMER NAME:

PHONE NO.:

REPAIR ORDER NO:

SHOP USE ONLY:

VIN#:

MILES:

TECHNICIAN:

ADVISOR#:

Fig. 9: ^{50B15058}Electrical, Radio & Tape/CD Player

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MANUAL TRANSMISSION - CLUTCH

SYMPTOM - MANUAL GEAR SHIFT

- ☐ Hard to shift ☐ Doesn't shift
☐ Grinds going into _____ gear
☐ Noisy when in _____ gear or neutral _____
☐ Slips/pops out of gear
☐ Noise (describe): _____

- ☐ Upshift light stays on
☐ Upshift light doesn't light

WHEN DOES IT OCCUR?

- ☐ All the time ☐ Light load
☐ Heavy load

EXPLAIN: _____

SYMPTOM - CLUTCH

- ☐ Hard to push ☐ Fail to release
☐ Noise when pressing pedal down (describe): _____

- ☐ Slips ☐ Chattering (grabbing)
☐ Odor present ☐ Pedal stays on the floor
☐ Squealing sound

WHEN DOES IT OCCUR?

When Engine Temperature is:

- ☐ Cold ☐ Hot
☐ Accelerating ☐ Decelerating

CUSTOMER NAME:

PHONE NO.:

REPAIR ORDER NO:

SHOP USE ONLY:

VIN#:

MILES:

TECHNICIAN:

ADVISOR#:

Fig. 10: ^{50.115056} Manual Transmission & Clutch

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SQUEAK - RATTLE - NOISE CONDITIONS

AREA OF NOISE

- | | | | | |
|--|----------------------------------|--------------------------------------|---------------------------------|-------------------------------------|
| ☐ Engine Compartment | ☐ Left | ☐ Right | ☐ Center | ☐ Don't know |
| ☐ Front Suspension | ☐ Left | ☐ Right | ☐ Center | ☐ Don't know |
| ☐ Rear Suspension | ☐ Left | ☐ Right | ☐ Center | ☐ Don't know |
| ☐ Passenger Compartment | ☐ Left | ☐ Right | ☐ Center | ☐ Don't know |
| ☐ Instrument Panel | ☐ Left | ☐ Right | ☐ Center | ☐ Don't know |
| ☐ Doors | ☐ Left | ☐ Right | ☐ Center | ☐ Don't know |
| ☐ Rear seat area | ☐ Console | ☐ Other _____ | | |

NOISE SOUNDS LIKE

- | | | | | | |
|----------------------------------|-------------------------------------|--------------------------------------|--------------------------------------|----------------------------------|--------------------------------|
| ☐ Knocks | ☐ Hard metal | ☐ Light metal | ☐ Roars | ☐ Ticking | ☐ Whine |
| ☐ Squeaks | ☐ Rattles | ☐ Scraping | ☐ Other _____ | | |

HOW OFTEN DOES IT OCCUR?

- | | | | | |
|-------------------------------------|--------------------------------|---------------------------------------|---------------------------------------|------------------------------------|
| ☐ Continuous | ☐ Often | ☐ Intermittent | ☐ Just started | ☐ Since new |
|-------------------------------------|--------------------------------|---------------------------------------|---------------------------------------|------------------------------------|

WHEN DOES IT OCCUR?

- | | | | | | |
|--|---|--|--|---------------------------------------|---|
| ☐ All the time | ☐ Speed | ☐ RPM | ☐ Only moving | ☐ On turns | ☐ Braking |
| ☐ Hard throttle | ☐ Light throttle | ☐ Decelerate | ☐ Steady speed | ☐ Idle in gear | ☐ Idle out of gear |
| ☐ Hot days | ☐ Cold days | ☐ Humid or rainy | ☐ Temperature _____ | | |
| ☐ Heavy bumps | ☐ Light bumps | ☐ Smooth pavement | | | |

EXPLAIN: _____

CUSTOMER NAME:

PHONE NO.:

REPAIR ORDER NO:

SHOP USE ONLY:

VIN#:

MILES:

TECHNICIAN:

ADVISOR#:

Fig. 11: ^{50F15060} Squeak, Rattle, & Noise Conditions

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WATER LEAK - WINDNOISE

WATER LEAK

Leak Occurs When?

- | | | | |
|--|--|--|--|
| ☐ Setting level | ☐ Any time it rains | ☐ While driving in the rain | ☐ Car wash only |
| ☐ Back lower than front (facing uphill) | | ☐ Front lower than back (facing downhill) | |

Location of Leak (where water appears):

- | | | | | | |
|---|------------------------------------|------------------------------------|---|-------------------------------------|--|
| ☐ LF Door | ☐ RF Door | ☐ LR Door | ☐ RR Door | ☐ Windshield | ☐ Rear window |
| ☐ LF window | ☐ RF window | ☐ LR window | ☐ RR window | ☐ Side door | ☐ Sunroof/T-Top |
| ☐ Under instrument panel | | | ☐ Rear door/rear hatch | | |

WINDNOISE:

Location:

- | | | | | | |
|---|------------------------------------|------------------------------------|---|-------------------------------------|--|
| ☐ LF Door | ☐ RF Door | ☐ LR Door | ☐ RR Door | ☐ Windshield | ☐ Rear window |
| ☐ LF window | ☐ RF window | ☐ LR window | ☐ RR window | ☐ Side door | ☐ Sunroof/T-Top |
| ☐ Under instrument panel | | | ☐ Rear door/rear hatch | | |

EXPLAIN: _____

CUSTOMER NAME:

PHONE NO.:

REPAIR ORDER NO:

SHOP USE ONLY:

VIN#:

MILES:

TECHNICIAN:

ADVISOR#:

50115055

Fig. 12: Water Leak & Wind Noise

END OF ARTICLE

2.22L 5-CYL

Article Text

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ARTICLE BEGINNING

1987 VOLKSWAGEN ENGINES
2.22L 5-Cylinder

Quantum, Quantum Syncro

* PLEASE READ THIS FIRST *

NOTE: For engine repair procedures not covered in this article,
see ENGINE OVERHAUL PROCEDURES - GENERAL INFORMATION article
in the GENERAL INFORMATION section.

ENGINE CODING

ENGINE IDENTIFICATION

Engine number is stamped on machined pad just below cylinder
head on left side of block. Letter prefix indicates engine type.

ENGINE IDENTIFICATION CODES TABLE

Application	Engine Code
-------------	-------------

2.22L 5-Cylinder

Quantum, Quantum Syncro	KX
-------------------------	----

ENGINE, MANIFOLDS & CYLINDER HEAD

ENGINE R & I

REMOVAL

1) Disconnect battery ground cable. Open heater control valve fully. Open cap on coolant expansion tank. Remove engine mounting bolt holding coolant pipe at bellhousing. Remove all coolant hoses. Remove ground strap from left engine mount. Remove upper radiator cover. Remove power steering pump with hoses attached. Tie pump aside.

2) Disconnect wiring from engine mounted components. Remove fuel injectors, cold start valve and control pressure regulator, leaving fuel lines attached. Plug injector sockets and cap injectors and cold start valve. Remove throttle rod. Remove front engine stop.

3) On Quantum (with A/T) belt pulley on crankshaft must be removed. Hold pulley in place with Locking Spanner (2084). Using Extension (2079), remove crankshaft bolt through grille opening. Remove 2 and loosen other 2 pulley bolts. Loosen pulley with light taps. Remove 2 remaining bolts and belt pulley, leaving drive sprocket in place on crankshaft.

4) Remove alternator adjusting and mounting bolts. Tie

2.22L 5-CYL

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alternator aside with wires attached. Remove alternator bracket from engine block. Loosen clamps and remove air duct. Disconnect all vacuum hoses leading to engine. Disconnect fuel feed and return lines. Disconnect breather hose from valve cover. Remove air filter cover.

5) If equipped with automatic transmission, remove coolant hoses at ATF cooler. Remove coolant hose flange from engine block. Remove cover for right engine mount. Loosen left and right engine mounts at frame. Detach ground strap from mounting bracket.

6) Remove all but one bolt holding engine to transmission. If A/C equipped, remove compressor drive belt. Disconnect wire from compressor clutch. Remove compressor mount bolts from engine. Hang compressor aside with hoses connected. Disconnect starter wires. Remove both front subframe bolts.

7) On all models, disconnect exhaust pipe from manifold and exhaust pipe support at transmission. Remove starter. Working through starter mounting hole, remove 3 bolts holding torque converter to flex plate (if equipped). Remove lower bolts which hold engine to transmission. Detach shift rod (or clutch cable) from transmission. Attach Support Bar (VW 785/1) under transmission.

8) Ensure all wiring, hoses, lines, cables and linkages are disconnected from engine. Attach lifting device to engine and lift engine slightly. On all models, adjust support bar to contact transmission. Remove last bolt holding engine to transmission.

9) Separate engine from transmission. On Quantum models, lift engine without allowing it to turn. On models with A/T, secure torque converter in transmission.

INSTALLATION

1) Reverse removal procedure to install engine. On all models, ensure starter wires will not touch engine block or exhaust system. When installing belt pulley on crankshaft, align dimple on pulley with nub on sprocket. Use Loctite 573 on both threads and contact surface of crankshaft bolt.

2) Adjust tension of power steering pump, alternator and A/C compressor belts. Refill cooling system. Adjust accelerator cable or throttle linkage rods. Tighten engine mounting bolts with engine running at idle speed. Ensure cooling fan cycles properly.

CYLINDER HEAD & MANIFOLDS R & I

REMOVAL

1) Disconnect battery ground strap. Drain cooling system. Disconnect coolant hoses from head. Disconnect all vacuum hoses from intake manifold. Disconnect all electrical and ignition wires at cylinder head and intake manifold.

2) Remove fuel injectors and cold start valve, leaving fuel lines attached. Cap injectors and cold start valve and plug injector sockets. Remove air duct from throttle housing. Remove throttle rods or cables from throttle valve housing.

3) Disconnect fuel supply and return lines at fuel

2.22L 5-CYL

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distributor. Remove airflow sensor and fuel distributor. Disconnect exhaust pipe from manifold. Remove upper radiator cover. Remove drive belts.

4) Remove power steering pump and position aside with hoses connected. Remove camshaft cover and timing belt cover. See Fig. 1. Loosen water pump bolts to relieve tension on timing belt. Remove timing belt. Remove water pump to replace "O" ring.

NOTE: Sealing "O" ring between water pump and cylinder block should be replaced whenever water pump bolts are loosened as leak may occur if old "O" ring is reused.

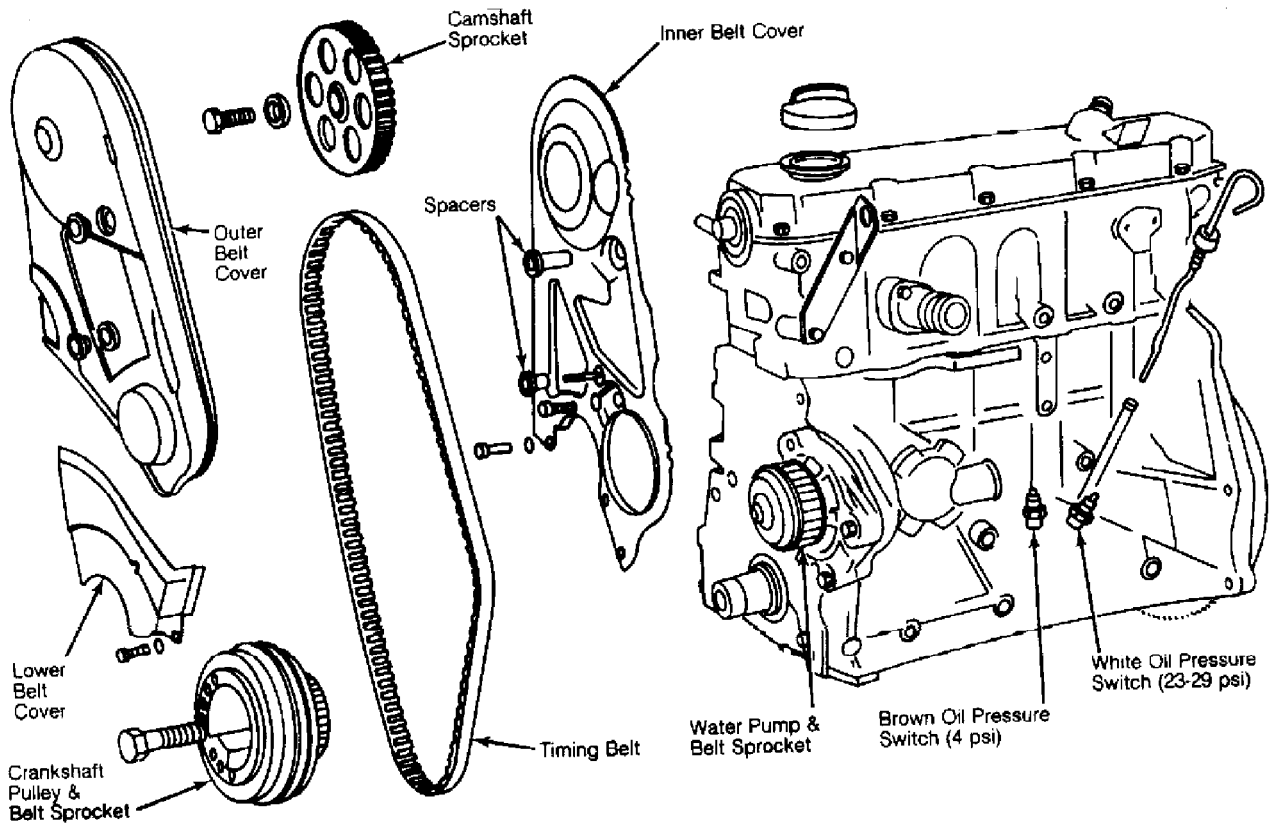


Fig. 1: Timing Belt, Sprockets & Covers

Always check sealing "O" ring when water pump is moved or loosened.

5) Loosen head bolts in reverse order of tightening sequence. See Fig. 2. Ensure all wiring, hoses and lines have been disconnected from cylinder head and intake manifold before lifting head from block. Remove cylinder head with intake manifold attached.

2.22L 5-CYL

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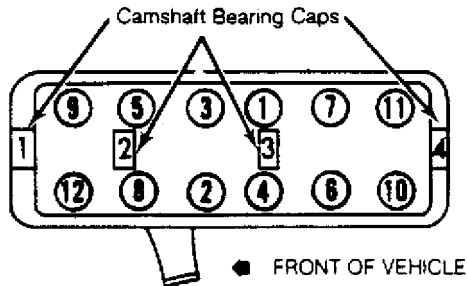


Fig. 2: Cylinder Head Tightening Sequence

CAUTION: If head bolt(s) require replacement, install new polygon bolts in complete sets only. Polygon head bolts do not require retorque procedure at 1000 mile service following repair.

INSTALLATION

1) Check cylinder head for warping with straightedge. Maximum warp allowable is .004" (.10 mm). Minimum thickness of head after machining, measured from head gasket surface to camshaft cover gasket surface, is 5.226" (132.75 mm).

2) Install head gasket dry with part number facing upward. Use locating pins to hold gasket in place. Before installing cylinder head, turn crankshaft until all pistons are about equal distance from TDC to prevent any open valves from hitting pistons. Position head correctly and install bolts No. 9 and 11 to align head. Remove locating pins and install remaining bolts.

3) Tighten cylinder head bolts in 3 stages. See Fig. 2. First step of head bolt tightening procedure is to 29 ft. lbs. (40 N.m). Second step is to 43 ft. lbs. (60 N.m). Third step is an additional 180 degrees in one movement (two 90 degree movements are acceptable).

4) Set engine to TDC of compression stroke on No. 1 cylinder. Turn camshaft until timing mark on sprocket is aligned with upper edge of camshaft cover gasket (or rear timing belt cover). See Fig. 3. Install water pump with NEW sealing "O" ring, leaving bolts loose enough to move pump body.

5) Install timing belt. Turn water pump body counterclockwise to increase belt tension. Tension is correct when belt can be twisted 90 degrees using finger pressure at point midway between camshaft sprocket and water pump sprocket. Recheck valve timing. Complete installation in reverse order of removal.

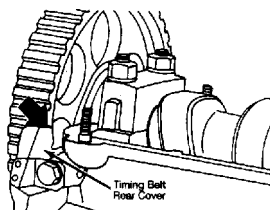


Fig. 3: Aligning Camshaft Sprocket

CAMSHAFT

2.22L 5-CYL

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TIMING BELT COVER R & I

REMOVAL & INSTALLATION

Remove upper radiator cover. Remove all drive belts from pulleys. Remove power steering pump with pressure hoses connected. Position pump aside. Remove timing belt cover. To install, reverse removal procedure.

TIMING BELT R & I

REMOVAL

1) Remove upper radiator cover. Remove drive belts. Remove power steering pump with pressure hoses connected. Position pump aside. Remove camshaft cover and outer timing belt covers. See Fig. 1.

2) Using crankshaft bolt, turn crankshaft clockwise to TDC of compression stroke on No. 1 cylinder. Align timing mark on back of camshaft sprocket with upper edge of gasket. See Fig. 3.

3) Loosen water pump adjusting bolts to relieve tension on timing belt. Remove timing belt. Remove water pump to check sealing "O" ring. Do not allow crankshaft or camshaft to move.

INSTALLATION & VALVE TIMING

1) Both camshaft lobes on No. 1 cylinder must point upward. Mark (notch or dot) on back of camshaft sprocket must be aligned with top of valve cover gasket or rear timing belt cover. Crankshaft must be at TDC for No. 1 cylinder. Flywheel TDC mark must be aligned with index point on transmission housing.

2) Install water pump with new sealing "O" ring. Install timing belt. Turn water pump body counterclockwise to increase belt tension. Tension is correct when belt can be twisted 90 degrees using finger pressure at point midway between camshaft sprocket and water pump sprocket. Recheck valve timing. Complete installation in reverse order of removal.

VALVE TIMING

See TIMING BELT INSTALLATION & VALVE TIMING.

CAMSHAFT R & I

REMOVAL

Remove timing belt. If necessary, mark camshaft bearing caps No. 1 to No. 4 (front to rear). Loosen nuts holding No. 2 and No. 4 caps in diagonal pattern. Remove No. 2 and No. 4 caps. Loosen nuts holding No. 1 and No. 3 caps in diagonal pattern. Remove No. 1 and No. 3 caps. Remove camshaft from head.

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INSTALLATION

1) Lubricate bearing surfaces in caps and camshaft journals. Install camshaft. Ensure oil spray jet is situated so that spray direction is at 90 degrees to camshaft. Install all bearing caps in original positions and correctly aligned.

2) Ensure caps are aligned correctly. See Fig. 4. Lightly tighten No. 2 and No. 4 caps in diagonal pattern. Tighten nuts on all 4 caps in diagonal pattern. Install remaining components. Set valve timing.

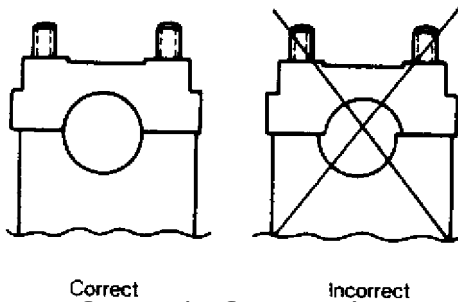


Fig. 4: Alignment of Camshaft Bearing Cap

CAMSHAFT OIL SEAL R & I

REMOVAL

1) Remove timing belt cover and camshaft cover. Position No. 1 piston on TDC. Loosen camshaft sprocket bolt while keeping camshaft from moving. Loosen water pump adjusting bolts to relieve tension on timing belt.

2) Remove timing belt. Remove water pump to check sealing ring. Remove camshaft sprocket and Woodruff key. Install sprocket bolt 3 turns into end of camshaft and secure with lock nut. Use Seal Extractor (2085) to remove camshaft oil seal.

3) Back inner portion of extractor 3 or 4 turns out from outer portion. Lock inner part with set screw on outer part. Lubricate threaded head of seal extractor and thread it into seal while pushing against end of extractor. Loosen set screw and turn inner part of extractor until seal comes out.

INSTALLATION

1) Lubricate seal lips and seal recess with oil. Use Seal Installer (10-203) to press seal into place until flush with chamfered edge of head.

2) Install water pump and timing belt. Adjust valve timing and belt tension. Install remaining parts in reverse of removal procedure.

CAMSHAFT INSPECTION

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END PLAY

Remove valve lifters. Check camshaft end play. If end play exceeds limit, check camshaft thrust flange and bearing cap for wear. Replace worn components.

CAUTION: Hydraulic valve lifters are always stored with contact face down. This applies to new lifters or to lifters removed for engine repairs. Lifters will take about 30 minutes to leak down after installation. DO NOT start engine during leak-down period as internal engine damage will occur.

OIL CLEARANCE

1) Remove camshaft and valve lifters. Keep lifters in order for reassembly. Place hydraulic lifters on clean surface with contact faces down. Remove sprocket and oil seal from camshaft. Clean bearing caps, bearing seats and camshaft journals.

2) Place camshaft on cylinder head. Ensure lobes do not touch valves or valve spring retainers. Place Plastigage on camshaft journals parallel to length of camshaft. Install bearing caps in correct position and tighten cap nuts. DO NOT rotate camshaft with Plastigage installed.

3) Remove bearing caps and read clearance. If wear limit is exceeded, repeat measurement with new camshaft installed. If wear limit is still exceeded with new camshaft, cylinder head must be replaced.

VALVES

VALVE ARRANGEMENT

E-I-E-I-I-E-I-E-I-E (Front-to-rear).

VALVE GUIDES R & I

INSPECTION

1) Clean valve guides. Attach dial indicator and Adapter (VW 387) to mounting surface of cylinder head. Insert new valve into valve guide. End of valve stem must be flush with end of valve guide.

2) Rock valve head back and forth against tip of dial indicator to measure clearance between stem and guide. If reading exceeds limits, replace guides and/or valves. See VALVES specifications at end of article.

REMOVAL

Use press and Valve Guide Drift (10-206) to remove and install guides. Press guides out from combustion chamber side of head.

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INSTALLATION

Coat new guides with oil. Press guides into head from camshaft side. Press guides in as far as possible. Do not use more than one ton of pressure after guide shoulder is seated as guide shoulder may break. Ream guide by hand to proper size.

VALVES & SEATS

CAUTION: NEVER rework exhaust valves on machine. Lap exhaust valves by hand only.

1) If intake valves are to be refaced, they must exceed minimum standards. Measure intake valve stem diameter. Measure exhaust valve stem diameter. Measure overall length of valves. See VALVES specifications at end of article.

2) One of 2 limits for cutting valve seats (dimension "y") is determined by measured distance "X" between stem end of closed stem and upper face of cylinder head (where camshaft cover gasket rests). See Fig. 5. Insert valve into guide and hold tightly against seat.

3) Measure distance "X". Subtract minimum dimension "X" from measured distance "X". Result is maximum cut allowed (dimension "y") for refacing valve seats. Minimum dimension "X" is 1.33" (33.8 mm) for intake valves and 1.34" (34.1 mm) for exhaust valves.

NOTE: If minimum dimension "X" is greater than measured distance "X", cylinder head must be replaced. If minimum dimension is not observed, hydraulic valve lifters may not function properly.

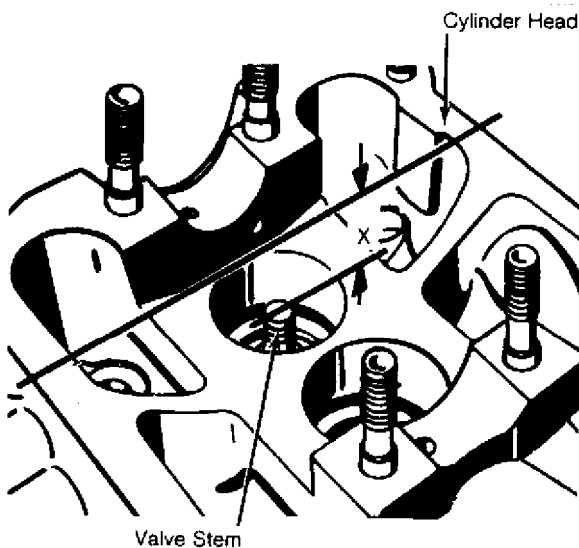


Fig. 5: Measuring Refacing Limit Of Valve Seats

4) On all models, second limit for maximum amount of material that may be removed from seat is determined by distance "D" from lower

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face of cylinder head to edge of 45 degrees valve seat angle. See Fig. 6. Maximum distance "D" for intake seats is .36" (9.2 mm). Maximum distance "D" for exhaust seats is .35" (9.0 mm).

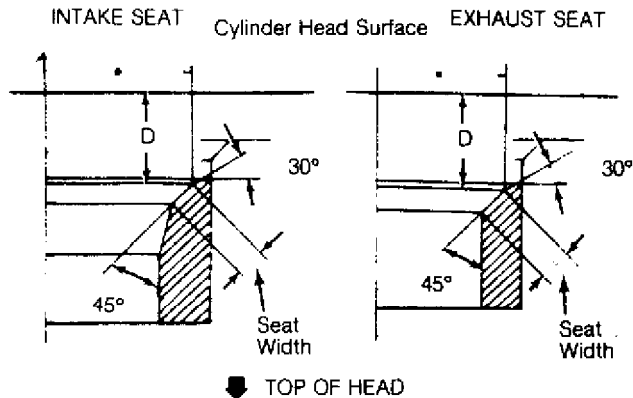


Fig. 6: Measuring Refacing Limits of Valve Seats

5) Do not reface exhaust valves on machine. Lap exhaust valves only by hand. Be sure to remove all traces of grinding compound from valves and guides after valves have been lapped into seats.

VALVE STEM OIL SEALS R & I

NOTE: Valve stem seals may be replaced with cylinder head installed on vehicle.

CAUTION: Hydraulic valve lifters are always stored with contact face down. This applies to new lifters or to lifters removed for engine repairs. Lifters will take about 30 minutes to leak down after installation. DO NOT start engine during leak-down period as internal engine damage will occur.

REMOVAL

1) Remove camshaft. Remove hydraulic lifters. Keep in order for reassembly. Remove spark plug of cylinder to be serviced. Turn crankshaft until piston is at BDC.

2) Install air hose and Adapter (VW 653/3) in spark plug hole and apply line pressure of at least 87 psi. Do not remove line pressure until valve spring components are reassembled.

CAUTION: Be aware that engine can rotate due to air pressure if piston is not at true BDC. Keep hands clear of belts and pulleys.

3) Use Spring Compressor (VW 541/1 or 2036). Compress valve spring and remove keepers, retainers and springs. Take out seals with Seal Remover Pliers (10-218).

INSTALLATION

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Slide protective plastic sleeve onto valve stem. Lubricate new seal and push into place with Seal Installer (10-204). Install remaining components in reverse order of removal. Ensure valve timing is correct.

HYDRAULIC VALVE LIFTERS

NOTE: Hydraulic valve lifters are not repairable or adjustable. Any worn, damaged or noisy lifter must be replaced as complete assembly. Some occasional valve/lifter noise is normal immediately after starting engine.

CHECKING

1) Run engine until radiator cooling fan has cycled at least once. Hold engine at steady 2500 RPM for 2 minutes. Allow engine speed to return to idle. If lifter is still noisy, replace it.

2) Remove camshaft cover. Turn engine by crankshaft bolt until both camshaft lobes of cylinder to be checked point upward. Push down on lifters with wooden stick. If lifter compresses more than .004" (.10 mm), it must be replaced.

3) If hydraulic valve lifters are removed for engine repairs, keep them in correct order for reassembly. Store lifters on clean surface with contact surface facing down. This is upside down compared to installed position.

CAUTION: Hydraulic valve lifters are always stored with contact face down. This applies to new lifters as well as to lifters removed for engine repairs. Lifters will take about 30 minutes to leak down after installation. DO NOT start engine during leak-down period as internal engine damage will occur.

PISTONS, PINS & RINGS

OIL PAN R & I

REMOVAL

Remove 2 front bolts of subframe. Drain engine oil. Remove dipstick. Remove flywheel dust cover. Remove rear pan bolts. Remove remaining pan bolts and lower pan from engine.

INSTALLATION

Clean all gasket mating surfaces. Make sure flange of oil pan is not distorted. Install oil pan with new gasket. Tighten pan bolts in criss-cross pattern. Replace dipstick and flywheel dust cover. Tighten subframe bolts.

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PISTON & ROD ASSEMBLY R & I

REMOVAL

1) Drain oil and coolant. Remove cylinder head and oil pan. Place piston to be removed at bottom of cylinder and cover with cloth to collect metal cuttings. Use ridge reamer to remove ridge or deposit from upper end of cylinder bore.

2) Before removing piston and rod from engine, mark rod and rod cap for cylinder identification. Remove rod cap and carefully push piston and rod out top of cylinder. Loosely install rod cap to rod for reassembly.

PISTON IDENTIFICATION

Piston recess is measured from face of piston, to bottom of dish in top of piston. The compression height of these pistons, is measured from face of piston to top of wrist pin opening. See PISTON IDENTIFICATION table.

INSTALLATION

1) Coat cylinder bore, piston and rings with engine oil. Ensure ring end gaps are spaced 120 degrees apart. Install ring compressor on piston, making sure position of rings does not change.

2) Install piston and rod in original bore. Arrow on piston head faces toward front of engine. Forged marks (lumps) on rod and cap must also face toward front of engine. Make sure connecting rod bolts do not damage bearing journals on crankshaft.

PISTON IDENTIFICATION TABLE

XX

Engine	Recess	Compression Height
--------	--------	--------------------

KX, JT	8.1 mm	22.2 mm
--------	--------	---------

XX

FITTING

1) Measure cylinder out-of-round. Limit for cylinder out-of-round is .0016" (.040 mm). Determine piston-to-cylinder clearance. Block must be bored and oversize pistons installed if clearance is excessive. See PISTONS, PINS, RINGS specifications at end of article.

NOTE: Cylinder bore dimensions should not be measured with engine mounted on stand as readings may be incorrect due to distortion of block.

2) Different oversizes of pistons are available, depending upon engine application. See PISTON & CYLINDER DIMENSIONS table for available pistons and correct bore dimensions.

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PISTON & CYLINDER DIMENSIONS TABLE

AA

Size	Piston Diameter	Cylinder Bore
------	-----------------	---------------

2.22L

Standard	 80.98 mm	 81.01 mm
1st O/S	 81.23 mm	 81.26 mm
2nd O/S	 81.48 mm	 81.51 mm

AA

FITTING RINGS

Measure piston ring end gap. Measure ring side clearance. Install compression rings on piston with "TOP" mark facing upward. Recessed edge on outside of center ring must face down toward piston pin. Oil scraper ring can be installed either way. Space ring end gaps 120 degrees apart.

PISTON PIN REPLACEMENT R & I

REMOVAL

Remove circlip from pin bore groove. Use Piston Pin Drift (VW 207C) to remove and install piston pin. If pin is too tight, warm pistons to about 140°F (60°C) and then install pin.

INSTALLATION

Assemble connecting rod to piston. Arrow on piston head and forged marks on connecting rod must face toward front of engine when assembly is installed. Use pin drift to install piston pin. Install circlip into pin bore groove.

CRANKSHAFT & ROD BEARINGS

MAIN BEARINGS

1) Main bearing caps are numbered one through 6 (front to rear). Never interchange bearing caps. Use Plastigage method for measuring bearing clearances. See CRANKSHAFT MAIN & CONNECTING ROD BEARINGS specifications at end of article.

2) When replacing bearings, install grooved bearing halves into cylinder block. Plain bearing halves are installed in main caps. Lubricate crankshaft journals and bearings prior to installation.

CONNECTING ROD BEARINGS

Use Plastigage method for measuring bearing clearances. Use feeler gauge to check connecting rod side clearance. See CRANKSHAFT MAIN & CONNECTING ROD BEARINGS specifications at end of article.

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CRANKSHAFT END PLAY

Use feeler gauge to check crankshaft end play. Insert feeler gauge between No. 4 main bearing (thrust bearing) and crankshaft journal thrust face. See CRANKSHAFT MAIN & CONNECTING ROD BEARINGS specifications at end of article.

FRONT CRANKSHAFT OIL SEAL R & I

REMOVAL

1) Remove lower grille. Remove timing belt cover. Loosen water pump to remove timing belt. Remove water pump to replace sealing "O" ring. Use Crankshaft Lock (2084) to hold crankshaft.

2) Remove crankshaft damper/pulley bolt with Spanner (2079). Remove pulley with belt drive sprocket. Using Seal Remover (2086), carefully pry seal from oil pump housing.

INSTALLATION

1) Lightly coat new seal lip and outer edge with oil. Using Seal Installer (2080) and Guide Sleeve (2080A), press in seal until seated. Install crankshaft damper with timing belt. Install water pump with new sealing ring. Mount crankshaft lock on crankshaft pulley.

2) Use Loctite 573 on crankshaft damper bolt and install. Use spanner and torque wrench to tighten crankshaft pulley bolt. Torque specification only applies if torque wrench handle and spanner are in a straight line.

3) Remove tools and adjust timing belt tension. Make sure valve timing is correct. Install remaining parts in reverse order of disassembly.

REAR CRANKSHAFT OIL SEAL R & I

REMOVAL

Index mark flywheel/drive plate to crankshaft before removal. Remove flywheel/drive plate. Note position of any shims used. Using Seal Remover (2086), carefully pry oil seal from seal flange.

INSTALLATION

1) Coat lips of new seal with oil. Position seal in place and start by hand. Using Seal Installer (2003/1), press seal in until seated. There must be sufficient clearance between drive plate (A/T models) and back of engine block. Bolt torque converter tightly to crankshaft without shim.

2) Measure inside of drive plate from top edge of lip to face of plate where torque converter attaches. Measure from top edge of lip to engine block on both sides of block. Subtract inside measurement

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from outside measurement. If result is in range of .68-.74" (17.2-18.8 mm), no shim is required between drive plate and end of crankshaft. If result is smaller than range, shim is required.

3) Remove bolts and coat with locking compound. Install flywheel/flex plate with correct shim (if required) and tighten bolts. Note that notch on outer washer of flex plate faces toward torque converter on models with A/T. Replace shoulder bolts with new bolts. Install remaining components.

ENGINE OILING

ENGINE OILING SYSTEM

Slipper gear-type pump is used. Oil pump is mounted at front of engine and driven by crankshaft. See Fig. 7. Oil is lifted from pan by oil suction tube, which extends from oil pump. Oil is then fed to internal engine moving parts. Lubrication is either by pressure feed or drainage method.

CRANKCASE CAPACITY

Crankcase capacity is either 3.7 qts. (3.5L) with filter replacement or 3.2 qts. (3.0L) if filter is not replaced.

OIL PRESSURE

Oil pressure is 29 psi (2.0 kg/cm²) at 2000 RPM. Measurement is to be made with fresh oil at temperature of 176°F (80°C).

OIL PRESSURE RELIEF VALVE

Oil pressure relief valve opens at 77-91 psi (5.3-6.3 kg/cm²).

OIL PRESSURE WARNING SYSTEM

1) Dynamic oil pressure warning system is used on this motor. Control unit with buzzer is mounted on relay panel adapter. Dual oil pressure switches are on side of block. See Fig. 1.

2) Contacts of both switches are open with engine off. If oil pressure drops below 4.0 psi (.3 kg/cm²) while engine is running, contacts of Brown oil pressure switch will open. Buzzer will sound and oil pressure symbol will appear on instrument panel.

3) If oil pressure drops below 23-29 psi (1.6-2.0 kg/cm²) with engine running at 2500 RPM, contacts of White oil pressure switch will open. Buzzer will sound and oil pressure symbol will appear on instrument panel.

OIL PUMP R & I

REMOVAL & DISASSEMBLY

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1) Remove all drive belts from crankshaft pulley. Remove power steering pump (with hoses connected) and position aside. Remove timing belt covers. Loosen crankshaft damper/pulley bolt.

2) Turn crankshaft to position No. 1 piston at TDC after compression stroke. Loosen water pump adjusting bolts. Turn water pump to relieve tension on timing belt.

3) Remove lower timing belt cover. Ensure crankshaft position has not changed. Remove damper/pulley from crankshaft with drive sprocket attached. Remove dipstick.

4) Drain engine oil and remove oil pan. Remove oil suction tube from oil pump. Remove oil pump. Remove end cover from pump housing. Lift out outer and inner pump gears. See Fig. 7.

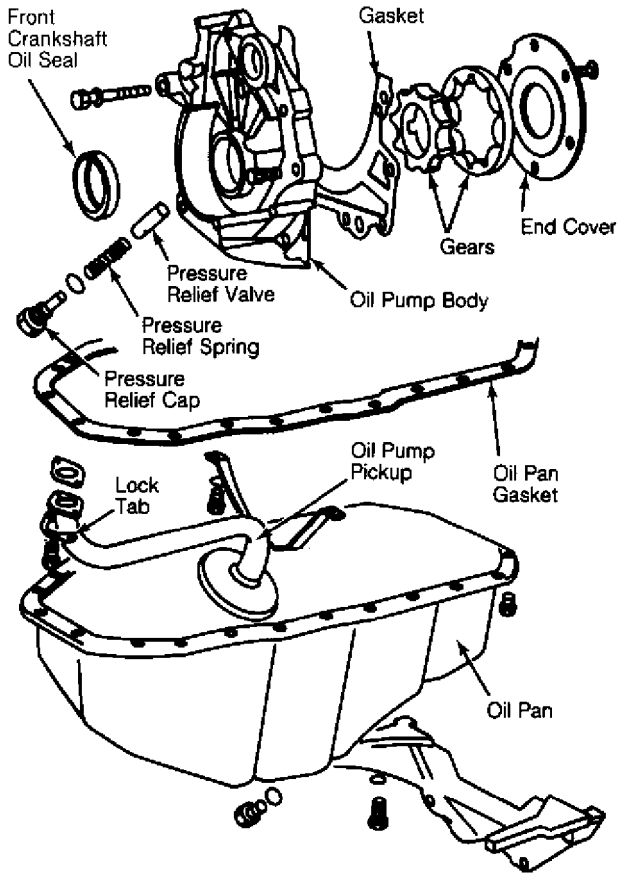


Fig. 7: Oil Pump, Pick-Up & Pan

INSPECTION & REASSEMBLY

Inspect end cover, housing and gears for wear or scoring. Replace end cover if scored. If pump gears require replacement, replace only in pairs. Install gears in pump housing with triangular mark facing end cover. Install end cover.

INSTALLATION

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Prime oil pump prior to installing. Install oil pump in reverse of removal procedure. Coat threads of crankshaft damper/pulley bolt with Loctite prior to installing. Adjust timing belt tension. Ensure valve timing is correct.

ENGINE COOLING

WATER PUMP R & I

REMOVAL

1) Drain cooling system. Remove timing belt covers. Turn crankshaft to TDC for No. 1 cylinder. Align timing marks on flywheel and camshaft gear with reference marks.

2) Loosen water pump to relieve tension on timing belt. Remove timing belt. Do not allow crankshaft or camshaft to move. Remove water pump.

NOTE: If remanufactured water pump is being used, check "O" ring size. Some pumps are resurfaced and require a 5 mm "O" ring. These pumps will have numeral "5" stamped in mounting flange.

INSTALLATION

Install water pump in reverse of removal procedure, using new "O" ring. Ensure valve timing is correct prior to installing remaining components.

NOTE: For further information on cooling systems, see ENGINE COOLING SYSTEMS article in this section.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS TABLE

AA

Application Ft. Lbs. (N.m)

Camshaft Bearing Cap Nuts 14 (20)

Camshaft Sprocket Bolt 58 (80)

Connecting Rod Cap Nuts 37 (50)

Crankshaft Damper/Pulley Bolt (1) (2) 258 (350)

Cylinder Head Bolts

Step 1 29 (40)

Step 2 43 (60)

Step 3 Plus 180 Degree (1/2 Turn)

Exhaust Manifold-to-Head Nuts 18 (25)

Flywheel-to-Crankshaft Bolts (1)

Without Shoulder 55 (75)

With Shoulder (3) 74 (100)

Intake Manifold Bolts 18 (25)

Main Bearing Cap Bolts 47 (65)

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Torque Converter-to-Drive Plate Bolts 22 (30)

- (1) - Use locking compound.
- (2) - Applies only when using Spanner (2079) and torque wrench. Torque wrench must be in-line with spanner handle.
- (3) - Always use new bolts.

AA

ENGINE SPECIFICATIONS

GENERAL ENGINE SPECIFICATIONS

GENERAL ENGINE SPECIFICATIONS TABLE

AA

Application	In. (mm)
-------------	----------

2.22L

Displacement	
Cu. In.	135.8
Liters	2.22
Fuel System	KE-Jetronic
HP @ RPM	110 @ 5500
Torque Ft. @ RPM	122 @ 2500
Compr. Ratio	8.5:1
Bore	3.19 (81.0)
Stroke	3.40 (86.4)

AA

VALVE SPECIFICATIONS

VALVE SPECIFICATIONS TABLE

AA

Application	In. (mm)
-------------	----------

2.22L

Intake (1)	
Head Diameter	1.496 (38.00)
Face Angle	45°
Seat Angle	(3) 45°
Seat Width	(4) .079 (2.00)
Stem Diameter	.314 (7.98)
Stem Clearance	.039 (1.0)
Valve Lift	...
Exhaust (2)	
Head Diameter	1.300 (33.00)
Face Angle	45°
Seat Angle	(3) 45°
Seat Width	(5) .094 (2.40)
Stem Diameter	.313 (7.95)
Stem Clearance	.051 (1.3)
Valve Lift	...

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- (1) - Overall length is 3.58" (90.9 mm).
- (2) - Overall length is 3.57" (90.8 mm).
- (3) - Correction angle is 30 degrees.
- (4) - Diameter limit is 1.47" (37.2 mm).
- (5) - Diameter limit is 1.28" (32.4 mm).

AA

PISTONS, PINS & RINGS SPECIFICATIONS

PISTONS, PINS & RINGS SPECIFICATIONS TABLE

AA

Application	In. (mm)
-------------	----------

2.22L

Pistons

Clearance	(1) .001-.003 (.03-.08)
-----------	-------------------------

Pins

Piston Fit	(2)
------------	-----

Rod Fit	Interference
---------	--------------

Rings

Ring No.	All
----------	-----

End Gap	(3) .010-.020 (.25-.50)
---------	-------------------------

Side Clearance	(4) .0008-.003 (.020-.080)
----------------	----------------------------

(1) - Wear limit is .003" (.08 mm)

(2) - Push fit at 140°F (60°C).

(3) - Wear limit is .04" (1.0 mm).

(4) - Wear limit is .004" (.10 mm).

AA

CRANKSHAFT MAIN & CONNECTING ROD BEARINGS SPECS

CRANKSHAFT MAIN & CONNECTING ROD BEARINGS SPECS TABLE

AA

Application	In. (mm)
-------------	----------

2.22L

Standard Size

Main Bearings

Journal Diameter.	(1) 2.2818-2.2826 (57.958-57.978)
-------------------	-----------------------------------

Clearance	(2) .0005-.0030 (.015-.076)
-----------	-----------------------------

Thrust Bearing	No. 4
----------------	-------

Crankshaft End Play	(3) .003-.007 (.07-.18)
---------------------	-------------------------

Connecting Rod Bearings

Journal Diameter.	(1) 1.880-1.880 (47.76-47.78)
-------------------	-------------------------------

Clearance	(4) .0006-.0024 (.015-.062)
-----------	-----------------------------

Side Play	.016 Max. (.41)
-----------	-----------------

1st U/Size

Main Bearings

Journal Diameter	2.2720-2.2728 (57.708-57.728)
------------------	-------------------------------

Connecting Rod Bearings

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Journal Diameter 1.870-1.871 (47.51-47.53)
2nd U/Size
Main Bearings
Journal Diameter 2.2621-2.2629 (57.458-57.478)
Connecting Rod Bearings
Journal Diameter 1.860-1.861 (47.26-47.28)
3rd U/Size
Main Bearings
Journal Diameter 2.2523-2.2531 (57.208-57.228)
Connecting Rod Bearings
Journal Diameter 1.850-1.852 (47.01-47.03)

(1) - Out-of-round limit is .001" (.03 mm).

(2) - Wear limit is .006" (.16 mm).

(3) - Wear limit is .010" (.25 mm).

(4) - Wear limit is .005" (.12 mm).

AA

CAMSHAFT SPECIFICATIONS

CAMSHAFT SPECIFICATIONS TABLE

AA

Application (1)	In. (mm)
-----------------	----------

Journal Diameter	
Clearance	004 (.10) Max.
Lobe Lift	

(1) - Maximum end play is .001" (.03 mm).

AA

END OF ARTICLE

A - ENGINE/VIN ID

Article Text

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ARTICLE BEGINNING

1983-88 ENGINE PERFORMANCE

Volkswagen VIN Code Identification

Quantum, Quantum Syncro, Quattro

MODEL IDENTIFICATION

WV2YB0255KH099717

① ② ③ ④ ⑤ ⑥ ⑦ ⑧ ⑨ ⑩ ⑪ ⑫ ⑬ ⑭ ⑮ ⑯ ⑰

1 Manufacturing Country

W • Germany

- 1 • USA
- 3 • Mexico
- 9 • Brazil

2-3 Manufacturer

VW • Volkswagen

4 Series

- A • 1983-90 2-Door Basic
- B • 1983-90 2-Door Custom
- C • 1983-90 2-Door Delux
- D • 1983-90 2-Door Sport
- E • 1983-88 4-Door Basic
- F • 1983-90 4-Door Custom
- G • 1983-90 4-Door Delux

5 Engine

- A • 4-Cyl. Gas, 80 & 100 HP
- B • 4-Cyl. Gas, 102 & 123 HP
- B • 5-Cyl. Gas, 110 & 115 HP
- C • 4-Cyl. Gas, 123 HP
- n/a • 4-Cyl. Diesel, 52 HP
- n/a • 4-Cyl. Turbo Diesel, 58 HP

6 Restraint System

- 0 • Active
- 9 • Passive

7-8 Model

- 32 • 1983-88 Quantum 2 Door & 4 Door
- 33 • 1983-88 Quantum SW & Quattro

9 VIN Check Digit

- 2 • Computer Selected Check Number

10 Vehicle Model Year

- D • 1983
- E • 1984
- F • 1985
- G • 1986
- H • 1987
- J • 1988
- K • 1989
- L • 1990

11 Assembly Plant

- A • Ingolstadt
- B • Brussel
- E • Emden
- G • Graz
- H • Hannover
- K • Osnabruk
- M • Mexico
- N • Neckarsulm
- P • Brazil
- S • Stuttgart
- V • Westmoreland, PA, USA
- W • Wolfsburg

12-17 Serial Number

- Sequential Production Number

Fig. 1: VIN Code Identification

VIN CODE ID EXPLANATION

Numbers preceding the explanations in the legend below refer to the sequence of characters as listed on VIN identification label in Fig. 1. The legend listed below will also be found in Fig. 1.

1 Manufacturing Country

A - ENGINE/VIN ID

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W * Germany
1 * USA
3 * Mexico
9 * Brazil

2-3 Manufacturer

VW * Volkswagen

4 Series

A * 1983-88 2-Door Basic
B * 1983-88 2-Door Custom
C * 1983-88 2-Door Delux
D * 1983-88 2-Door Sport
E * 1983-88 4-Door Basic
F * 1983-88 4-Door Custom
G * 1983-88 4-Door Delux

5 Engine

A * 4-Cyl. Gas, 80 & 100 HP
B * 4-Cyl. Gas, 102 & 123 HP
B * 5-Cyl. Gas, 110 & 115 HP
C * 4-Cyl. Gas, 123 HP
n/a * 4-Cyl. Diesel, 52 HP
n/a * 4-Cyl. Turbo Diesel, 58 HP

6 Restraint System

0 * Active
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7-8 Model

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A * Ingolstadt
B * Brussel
E * Emden
G * Graz
H * Hannover
K * Osnabruk
M * Mexico

A - ENGINE/VIN ID

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N * Neckarsulm
P * Brazil
S * Stuttgart
V * Westmoreland, PA, USA
W * Wolfsburg

12-17 Serial Number

* Sequential Production Number

END OF ARTICLE

- | | | |
|-------------------|----------------------|--|
| * Compressor | Quiet, No Leaks | Noisy - Check belts, oil level, seals, gaskets, reed valves. |
| * Condenser | Free of Obstructions | Blocked - Clean off.
Plugged - Flush or replace. |
| * Receiver-Drier | Dry & warm to touch | Frosty - Check for restriction, replace desiccant. |
| * Sight Glass | Clear or few bubbles | Bubbly, foamy or streaks - Check gauge readings. |
| * High Side Lines | Dry & warm to touch | Frosty or very hot - Check for restriction or overcharge. |
| * Low Side Lines | Dry & cool to touch | Frosty or warm - Check for restriction, low charge or bad valve. |
| * Expansion Valve | Dry | Frosty - Check for |

A/C SYSTEM GENERAL DIAGNOSTIC PROCEDURES

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- | | | | |
|---|------------|---------------------|---|
| * | STV | Dry & cool to touch | moisture or restriction.
Check sensing bulb.
Frosty or warm - Check
gauge readings for valve
malfunction. |
| * | Evaporator | Dry & cold to touch | Freezing or warm - Check
expansion valve, STV or
thermo switch. |

AA

Gauge Readings Gauge Readings are:

- | | | | |
|---|-----------------|--------------------|---|
| * | High Side Gauge | See Pressure Chart | Above or below normal -
See A/C Diagnosis. |
| * | Low Side Gauge | See Pressure Chart | Above or below normal -
See A/C Diagnosis. |

AA

AMBIENT TEMPERATURE/PRESSURE

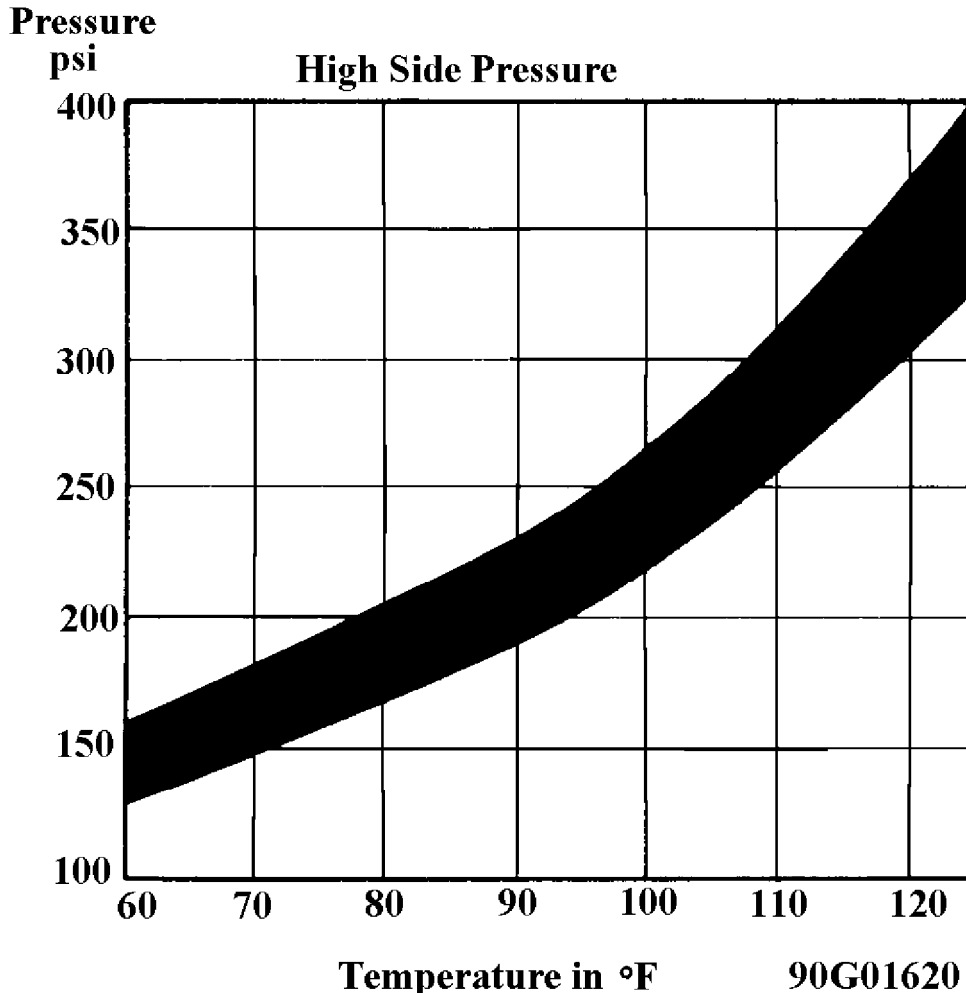


Fig. 1: Ambient Temperature/Pressure A/C Chart

A/C SYSTEM GENERAL DIAGNOSTIC PROCEDURES

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EVAPORATOR TEMPERATURE/PRESSURE

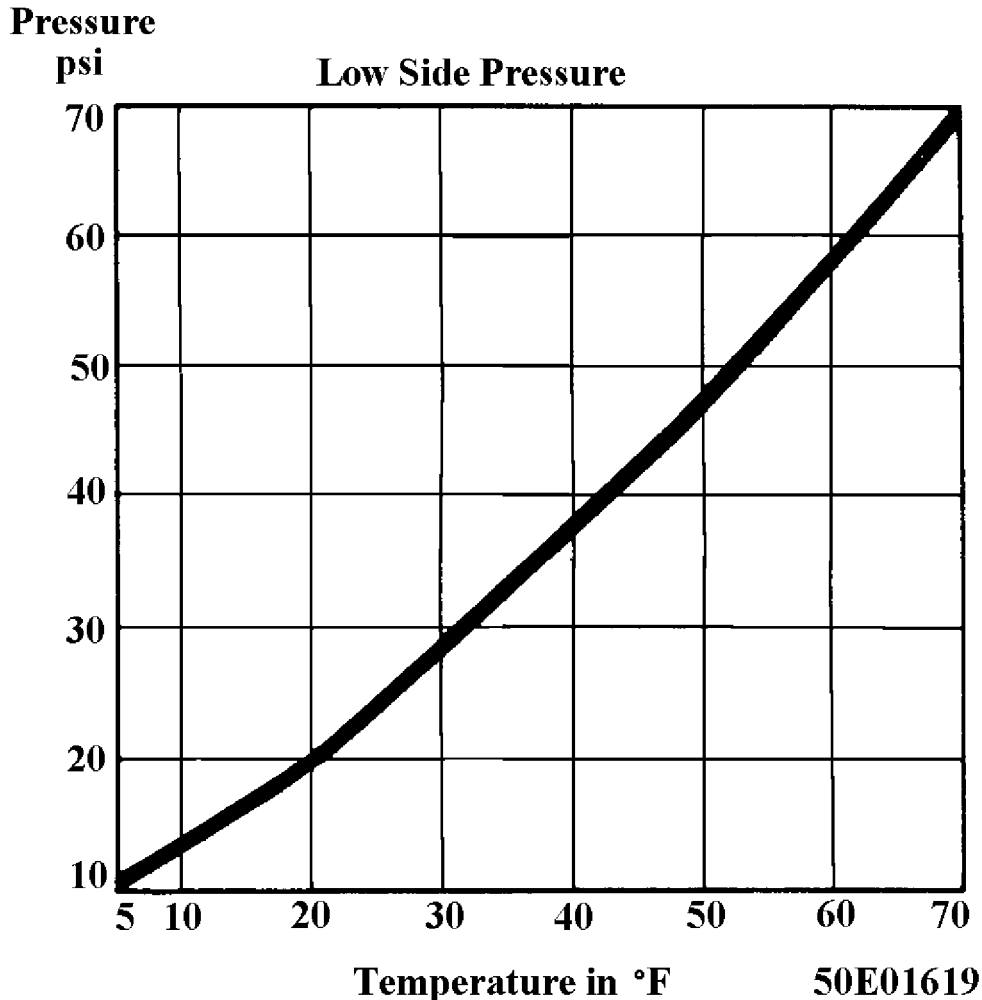


Fig. 2: Evaporator Temperature/Pressure A/C Chart

AIR CONDITIONING DIAGNOSIS WITH GAUGES FOR SYSTEMS WITH
INSUFFICIENT OR NO COOLING TABLE

AA

Low Side Gauge	High Side Gauge	Other Symptoms (1)	Diagnosis
----------------	-----------------	--------------------	-----------

AA

NORMAL	NORMAL	No or few bubbles in sight glass. High side gauge may go high. Low side gauge does not fluctuate with compressor on/off cycle.	Some Air and Moisture in System
NORMAL	NORMAL	Cools okay in morning but not during hot part of day. Bubbles in sight glass. Discharge air warm when low side gauge drops into vacuum.	Excessive Moisture in System
NORMAL	NORMAL	Thermostatic switch system only - compressor cycles off	Defective Thermostatic

A/C SYSTEM GENERAL DIAGNOSTIC PROCEDURES

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NORMAL to HIGH	NORMAL	and on too rapidly. Cycling clutch systems only - compressor doesn't turn on soon enough. Discharge air becomes warm as low side pressure rises.	Switch Misadjusted Thermostatic Switch or Defective Pressure Sensing Switch
LOW	LOW	Bubbles in sight glass. Outlet air slightly cool.	Low R-12 Charge
LOW	LOW	Sight glass clear. Outlet air very warm.	Excessively Low R-12 Charge
LOW	LOW	Outlet air slightly cool. Sweating or frost at expansion valve.	Expansion Valve Stuck Closed Screen Plugged or Sensing Bulb Malfunction
LOW	LOW	Outlet air slightly cool. High side line cool to touch. Sweating or frost on high side.	Restriction on High Side
LOW	HIGH	Evaporator outlet pipe cold. Low side goes into vacuum when blower is disconnected.	STV Stuck Open
HIGH	LOW	Evaporator outlet pipe warm. Outlet air warm.	STV Stuck Closed
HIGH	LOW	Noise from compressor.	Compressor Malfunction
HIGH	HIGH	Outlet air warm. Liquid line very hot. Bubbles in sight glass.	Compressor Malfunction or R-12 Overcharge
HIGH	HIGH	Outlet air slightly cool. Bubbles in sight glass.	Large Amount of Air and Moisture in System
HIGH	HIGH	Outlet air warm. Evaporator outlet sweating and frost.	Expansion Valve Stuck Open

(1) - If equipped with a low refrigerant charge protection system,
compressor operation may have stopped.

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END OF ARTICLE

A/C SYSTEM PRECAUTIONS

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ARTICLE BEGINNING

AIR CONDITIONING & HEAT
A/C System Precautions

*** PLEASE READ THIS FIRST ***

CAUTION: When discharging air conditioning system, use only approved refrigerant recovery/recycling equipment. Make every attempt to avoid discharging refrigerant into the atmosphere.

BEFORE OPENING THE SYSTEM

Before disconnecting any lines or fittings, the system must be completely discharged using approved refrigerant recovery/recycling equipment.

DISCHARGING A/C SYSTEM

NOTE: Recent findings by the EPA indicate that R-11, R-12 and R-113 are harmful to the Earth's protective Ozone layer. Make every attempt possible, to avoid discharging R-11, R-12 or R-113 into the atmosphere.

1) Remove service valve caps and install gauges. For high side gauge hose, Adapter (D81L-19703-A) must be used to connect to high side service valve.

2) Place open end of center hose in garage exhaust outlet or in a well ventilated area. Slightly open low side gauge valve and let refrigerant escape slowly without losing refrigerant oil.

3) When system is nearly discharged, using approved refrigerant recovery/recycling equipment, open high side gauge valve to release any pressure trapped in compressor. Close valves immediately after discharging to prevent entry of moisture.

DISCONNECTING LINES & FITTINGS

1) After system is discharged, using approved refrigerant recovery/recycling equipment, carefully clean entire area around coupling nut to prevent dirt entering system. Always use two wrenches to avoid twisting or distorting lines and fittings (hold fitting with one wrench while loosening coupling nut with second wrench).

2) Cap or plug all LINES and FITTINGS immediately to prevent entry of air and moisture into system. Do not remove these caps until connections are being made.

COMPONENT REPLACEMENT

When components are replaced, system oil level must be adjusted. Add refrigeration oil to replacement component. See

A/C SYSTEM PRECAUTIONS

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Compressor oil Check article, as well as, Component Oil Replacement Quantities" chart under "A/C SYSTEM SPECS" article in this section.

USING R-12 REFRIGERANT - SAFETY PRECAUTIONS

1) Always work in a well-ventilated, clean area. Refrigerant (R-12) is heavier than oxygen, and will displace oxygen in a confined area. Always wear eye protection when working around air conditioning systems and R-12. The system's high pressure can cause severe injury to eyes and skin if a hose were to burst. R-12 evaporates quickly when exposed to atmosphere, freezing anything it contacts.

2) Use care when handling refrigerant containers. DO NOT drop or strike containers or expose refrigerant containers to excessive heat. Containers must never be heated more than 125°F (52°C). Never expose R-12 directly to open flame.

CAUTION: When R-12 is exposed to an open flame, drawn into a running engine, or detected with a Halide (propane) leak tester, poisonous phosgene gas is formed. Keep work areas ventilated and avoid running engines near work area.

USING INDIVIDUAL R-12 CANS

Disposable refrigerant cans (referred to as one pound cans) have a flat type seal or a screw type seal, and proper can tap must be used for each type. Be sure sealing gasket on can tap is in good condition. A proper safety can tap will prevent refrigerant from flowing back into open can, as tap has a one-way flow control.

NOTE: Recent findings by the EPA indicate that refrigerant is harmful to the Earth's protective Ozone layer. When discharging refrigerant avoid allowing refrigerant to enter the atmosphere. Refrigerant recovery system should be used when discharging the system.

MULTI-CAN DISPENSING VALVES

A multi-can dispensing valve allows attachment of several cans of refrigerant, and is a good substitute when a bulk container is not available. Cans are installed onto each leg of multi-can dispensing valve in the same manner as the individual cans, and each leg has its own can tap.

CAN TAP INSTALLATION FLAT TYPE SEAL CANS

On cam-lock or one-piece can taps, first turn the handle outward to the fully open position. Securely engage locking lugs over the can flange, and lock them in place by turning cam lock or locking nut. Screw tap assembly into adapter so sealing gasket is fully seated against the can top. Turn tap inward to pierce the can and close the tap. DO NOT open tap until ready to purge the service hose or dispense

A/C SYSTEM PRECAUTIONS

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refrigerant into the system.

On 2-piece can taps, be certain tap handle is turned fully inward to the closed position. Check that locking base is turned to its outer limit. Securely engage locking lugs over the can flange. Turn entire tap assembly (without disturbing the closed setting) downward into the locking base to pierce the can. DO NOT open tap until ready to dispense into system.

SCREW TYPE SEAL CANS

Ensure can tap is fully closed. Screw refrigerant can into can tap fitting until tight. This will pierce the can. Connect tap to center hose on manifold gauge set. DO NOT open tap until ready to dispense R-12 into system.

WARNING: DO NOT open high side hand valve while air conditioning system is in operation. This high pressure could rupture can or fitting at safety can valve, resulting in damage and personal injury.

CONNECTING LINES & FITTINGS

A new "O" ring should be used in all instances when connecting lines and fittings (dip "O" ring in clean refrigeration oil and make certain it is not twisted during installation). Always use two wrenches to avoid twisting or distorting lines and fittings, tighten coupling nuts securely.

PLACING SYSTEM IN OPERATION

After component replacement and/or system servicing has been completed and all connections have been made, proceed as follows:

- 1) Evacuate the system using a vacuum pump.
- 2) Charge the system with new R-12 (refrigerant) according to each individual vehicle as outlined in the GENERAL SERVICING article. Also see Refrigerant Capacity in this Section.
- 3) Leak test the system, with particular attention to all new connections and components.
- 4) Make a performance test of the system. Never assume that a recharging has automatically corrected a problem.

COMPRESSOR REMOVAL INFORMATION - ISOLATION METHOD

On systems which have compressors equipped with stem-type service valves (Tecumseh), it is possible to isolate the compressor for removal.

Isolating

Turn both high and low pressure manual valves to extreme clockwise (front seat) position. Loosen cap on high pressure manual

A/C SYSTEM PRECAUTIONS

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valve connection to compressor and allow gas to escape until compressor is relieved of pressure.

COMPRESSOR REMOVAL INFORMATION - DISCHARGE METHOD

This procedure is to be used on vehicles which have compressor equipped with Schrader service valves. In these cases, the compressor cannot be isolated and the system must be discharged, using approved refrigerant recovery/recycling equipment, prior to compressor removal.

END OF ARTICLE

A/C-HEATER SYSTEM - MANUAL

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ARTICLE BEGINNING

1987 Manual A/C-Heater System
VOLKSWAGEN

Quantum

A/C SYSTEM SPECIFICATIONS

SPECIFICATIONS

XX

System Type	Cycling Clutch
Compressor Type	York 2-Cyl.
R-12 Capacity	38 oz.
System Oil Capacity	8.0 oz.
Shut-Off Pressure High	218 psi (15.3 kg/cm ²)
Shut-Off Pressure Low	29 psi (2.0 kg/cm ²)
A/C Belt Deflection (1)	9/16" (15 mm)

(1) - Deflection of belt is midway between A/C compressor pulley
and crankshaft pulley.

XX

DESCRIPTION

The Quantum integrated A/C-heater system is a cycling clutch type. The compressor is cycled off and on by a thermostatic switch to maintain a constant cooling rate. The condenser/radiator cooling fan operates whenever air conditioning is operating.

System components include an evaporator assembly, condenser, expansion valve, control panel, vacuum motor unit, vacuum switch, high and low pressure switches, radiator fan and heater core.

The control panel includes a control lever, a rotary fan switch, and 4 push button controls controlling airflow, air distribution, and heater and A/C operation. The fan switch controls 4 fan speeds.

OPERATION

Fan Switch

The rotary fan switch allows selection of 4 speeds. The fan works as soon as ignition is switched on. The fan can only be switched off when "OFF" button is pushed.

Air Distribution Buttons

The far right button, with a symbol for airflow on it, allows airflow from defroster and upper side vents. The button marked "HEAT" and button marked "BI-LEVEL" allow airflow from lower side, center and floor vents. The button marked "A/C" allows airflow from center and lower side vents. The "OFF" button stops all airflow.

A/C-HEATER SYSTEM - MANUAL

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Temperature Control Lever

To turn on heater, move lever to right of intersection of cooling and heating scales. To turn on A/C, move lever to left of intersection of scales.

Vents

When operating, warm air comes out of defroster, upper side, center and floor vents. Cool air comes out of lower side and center vents. Defroster, upper side and floor vents can be opened or closed by operating push buttons.

Defroster

To defrost, push far right control button. Move temperature lever to far right. Close center and lower side vents.

PRESSURE SWITCHES

These switches are connected in series and are mounted on receiver-drier. The low pressure switch opens if high side pressure drops below 29 psi. This protects compressor when there is an excessive loss of R-12. The high pressure switch opens when high side pressure exceeds 218 psi.

RADIATOR FAN

The radiator fan is a 2-speed unit. It is controlled by a thermostatic switch. When air conditioner is in operation, radiator fan runs continuously.

VACUUM & WIRING DIAGRAMS

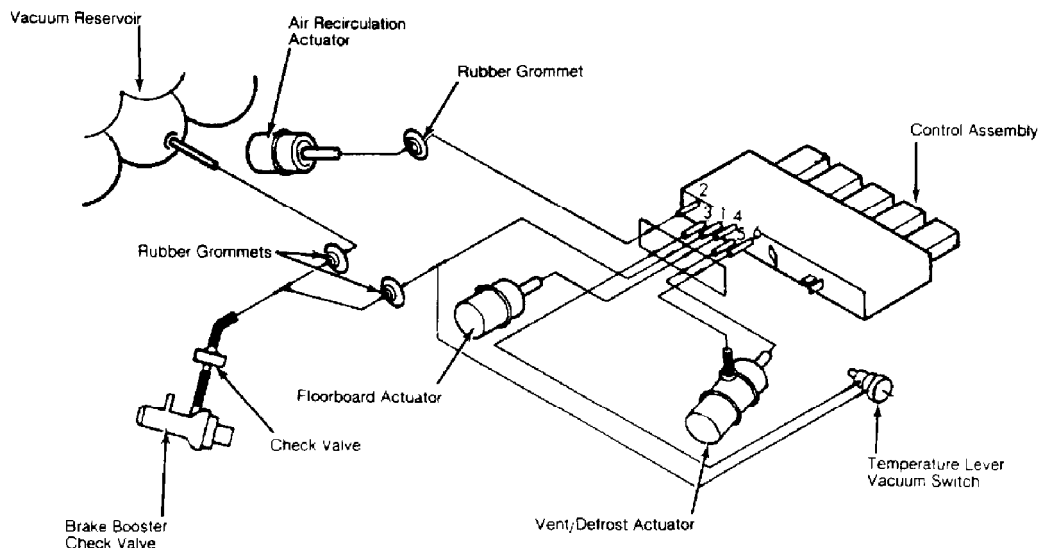


Fig. 1: Quantum Manual A/C-Heater System Vacuum Diagram

A/C-HEATER SYSTEM - MANUAL

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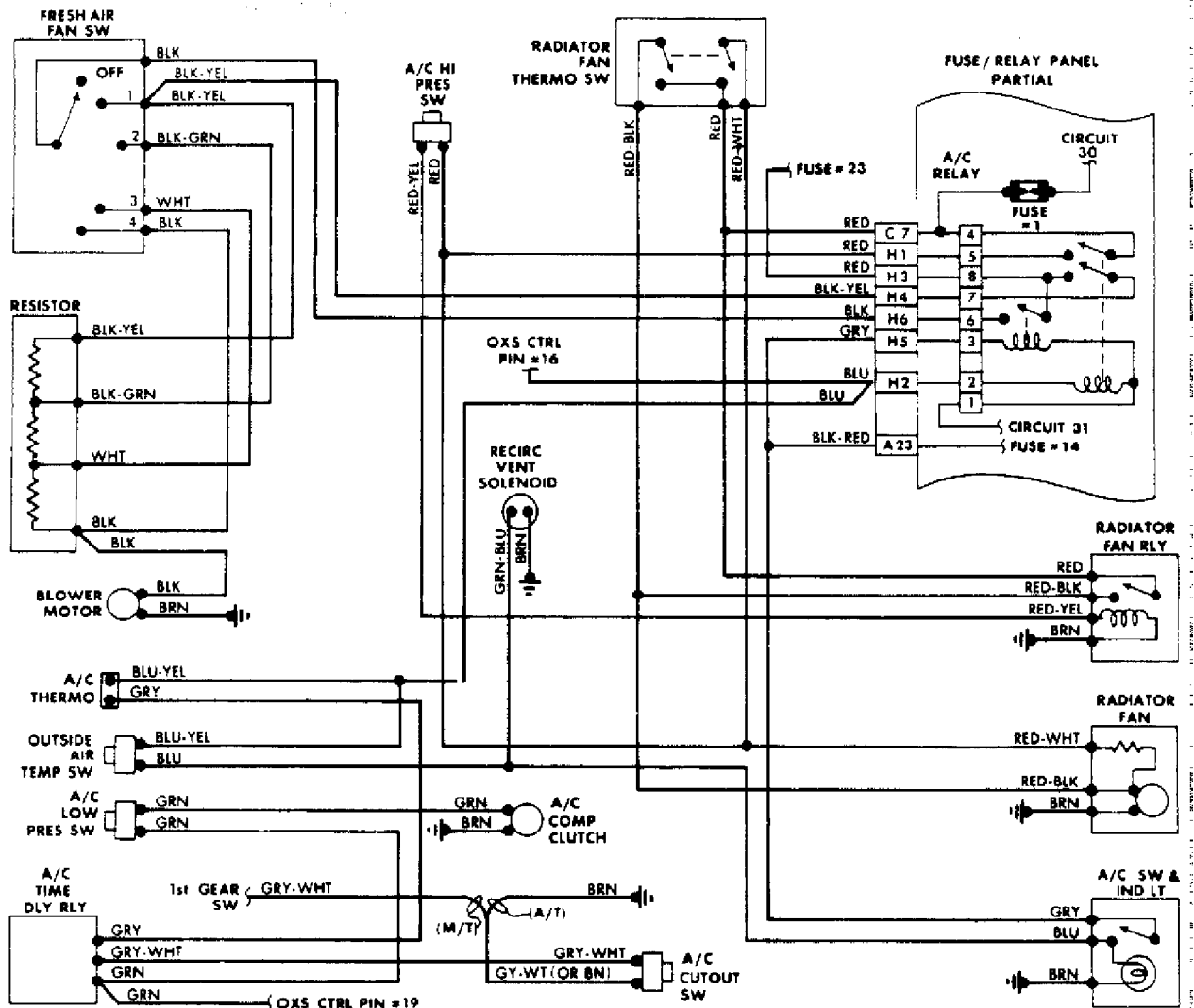


Fig. 2: Quantum Manual A/C-Heater System Wiring Diagram

END OF ARTICLE

ABBREVIATIONS

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ARTICLE BEGINNING

GENERAL INFORMATION

COMMONLY USED ABBREVIATION

"A" ABBREVIATION TABLE

"A" ABBREVIATION TABLE

ABBREVIATION	DEFINITION	
A	Amperes	3
A/C	Air Conditioning	3
A/T	Automatic Transmission/Transaxle	3
AAP	Auxiliary Accelerator Pump	3
AB	Air Bleed	3
ABCV	Air Bleed Control Valve	3
ABDC	After Bottom Dead Center	3
ABRS	Air Bag Restraint System	3
ABS	Anti-Lock Brake System	3
AC	Alternating Current	3
ACC	A/C Clutch Compressor	3
ACCS	A/C Cycling Switch	3
ACCUM	Accumulator	3
ACCY	Accessory	3
ACT	Air Charge Temperature Sensor	3
ACV	Thermactor Air Control Valve	3
ADJ	Adjust or Adjustable	3
ADV	Advance	3
AFS	Airflow Sensor	3
AI	Air Injection	3
AIR or A.I.R.	Air Injection Reactor	3
AIS	Air Injection System	3
ALCL	Assembly Line Communications Link	3
ALDL	Assembly Line Diagnostic Link	3
ARC	Automatic Ride Control	3
ASCD	Automatic Speed Control Device	3
ASCS	Air Suction Control Solenoid	3
ASD	Auto Shutdown	3
ASDM	Air Bag System Diagnostic Module	3
ASV	Air Suction Valve	3
ATC	Automatic Temperature Control	3
ATDC	After Top Dead Center	3
ATF	Automatic Transmission Fluid	3
ATS	Air Temperature Sensor	3
AXOD	Automatic Transaxle Overdrive	3
Abs.	Absolute	3
Accy.	Accessory	3
Alt.	Alternator or Altitude	3
Amp.	Ampere	3

Article Text (p. 2)

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"B" ABBREVIATION TABLE

[illegible]

"C" ABBREVIATION TABLE

[illegible]

ABBREVIATION	DEFINITION	
° C	Celsius (Degrees)	
C(3) I	Computer Controlled Coil Ignition	
C(4)	Computer Controlled Catalytic Converter	
CANP	Canister Purge solenoid	
CARB	California Air Resources Board	
CAT	Catalytic Converter	
CB	Circuit Breaker	

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"D" ABBREVIATION TABLE

ABBREVIATION	DEFINITION	
"D"	Drive	
DBC	Dual Bed Catalyst	
DC	Direct Current or Discharge	

ABBREVIATIONS

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³DDD	³Dual Diaphragm Distributor	3
³DERM	³Diagnostic Energy Reserve Module	3
³DFI	³Digital Fuel Injection	3
³DIC	³Driver Information Center	3
³DIS	³Direct Ignition System	3
³DIS	³Distributorless Ignition System	3
³DIST	³Distribution	3
³DISTR	³Distributor	3
³DK BLU	³Dark Blue	3
³DK GRN	³Dark Green	3
³DME	³Digital Motor Electronics (Motronic System)	3
³DOHC	³Double Overhead Cam	3
³DOT	³Department of Transportation	3
³DP	³Dashpot	3
³DRB-II	³Diagnostic Readout Box	3
³DVOM	³Digital Volt/Ohm Meter (see VOM)	3
³Def.	³Defogger or Defroster	3
³Def.	³Defrost	3
³Defog.	³Defogger	3
³Diag.	³Diagnostic	3
³Dist.	³Distributor or Distribution	3
³Dr.	³Door	3

AAUU

"E" ABBREVIATION TABLE

"E" ABBREVIATION TABLE

UAAA¿

³ABBREVIATION	³DEFINITION	3
AAA´		
³EAC	³Electric Assist Choke	3
³EACV	³Electric Air Control Valve	3
³EBCM	³Electronic Brake Control Module	3
³ECA	³Electronic Control Assembly	3
³ECAT	³Electronically Controlled Automatic Transaxle	3
³ECM	³Electronic Control Module	3
³ECT	³Engine Coolant Temperature Sensor	3
³ECU	³Electronic Control Unit or Engine Control Unit	3
³EDF	³Electric Drive Fan relay assembly	3
³EDIS	³Electronic Distributorless Ignition System	3
³EEC	³Electronic Engine Control	3
³EECS	³Evaporative Emission Control System	3
³EEPROM	³Electronically Erasable PROM	3
³EFE	³Early Fuel Evaporation	3
³EFI	³Electronic Fuel Injection	3
³EGO	³Exhaust Gas Oxygen sensor (see HEGO)	3
³EGR	³Exhaust Gas Recirculation system	3
³EGRC	³EGR Control solenoid or system	3
³EGRV	³EGR Vent solenoid or system	3
³EMR	³Emission Maintenance Reminder Module	3
³ESA	³Electronic Spark Advance	3
³ESC	³Electronic Spark Control	3

Article Text (p. 5)

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[illegible]

"F" ABBREVIATION TABLE

"F" ABBREVIATION TABLE

ABBREVIATION	DEFINITION
° F	Fahrenheit (Degrees)
F/B	Fuse Block
FBC	Feedback Carburetor
FI	Fuel Injector or Fuel Injection
FICD	Fast Idle Control Device
FIPL	Fuel Injector Pump Lever
FP	Fuel Pump
FPM	Fuel Pump Monitor
FPR-VSV	Fuel Pressure Regulator Vacuum Switching Valve
FWD	Front Wheel Drive
Fed.	Federal
Ft. Lbs.	Foot Pounds

"G" ABBREVIATION TABLE

"G" ABBREVIATION TABLE

ABBREVIATION	DEFINITION
g	grams
GND or GRND	Ground
GRN	Green
GRY	Gray
Ga.	Gauge
Gals.	gallons
Gov.	Governor

"H" ABBREVIATION TABLE

Article Text (p. 7)

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"J" ABBREVIATION TABLE

ÀÁÂÃÄÅÆÇÈÉÊËÌÍÎÏÐÑÒÓÔÕÖ×ØÙ

ÀÁÂÃÄÅÆÇÈÉÊËÌÍÎÏÐÑÒÓÔÕÖ×ØÙÚÛÜÝÞßàáâãäåæçèéêëìíîïðñòóôõö÷øùúûüýþÿ

Luggage: Luggage

"M" ABBREVIATION TABLE

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Sunday, March 19, 2000 01:01AM

[illegible]

"P" ABBREVIATION TABLE

ABBREVIATION DEFINITION		
3"p"	3Park	3
3P/C	3Printed Circuit	3
3P/N	3Park/Neutral	3
3P/S	3Power Steering	3
3PAV	3Pulse Air Valve	3
3PC-SOL	3Purge Control Solenoid	3
3PCM	3Powertrain Control Module	3
3PCS	3Purge Control Solenoid	3
3PCSDM	3Passenger Compartment Sensor/Diagnostic Module	3
3PCV	3Positive Crankcase Ventilation	3
3PFE	3Pressure Feedback EGR sensor or circuit	3
3PFI	3Port Fuel Injection (see MA SEFI)	3
3PGM-CARB	3Programmed Carburetor	3
3PGM-FI	3Programmed Fuel Injection	3
3PIP	3Profile Ignition Pickup	3
3PNK	3Pink	3
3PPL	3Purple	3
3PRNDL	3Park Reverse Neutral Drive Low	3
3PROM	3Programmable Read-Only Memory	3
3psi	3Pounds Per Square Inch	3
3PSPS	3Power Steering Pressure Switch	3
3PTC	3Positive Temperature Coefficient	3
3PTO	3Power Take-Off	3
3PWR GND	3Power Ground circuit	3
3Pkg.	3Package	3
3Press.	3Pressure	3
3Prog.	3Programmed or Programmable	3
3Pts.	3Pints	3
3Pwr.	3Power	3

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[illegible]

"T" ABBREVIATION TABLE

"T" ABBREVIATION TABLE

UAAA		
ABBREVIATION	DEFINITION	
AAA		
T.V.	Throttle Valve	
TAB	Thermactor Air By-Pass	
TAC	Thermostatic Air Cleaner	
TAD	Thermactor Air Diverter	
TAN	Tan	
TBI	Throttle Body Injection	
TCC	Torque Converter Clutch	
TCCS	Toyota Computer Control System	
TDC	Top Dead Center	
TDCL	Total Diagnostic Communication Link	
TFI	Thick Film Ignition system	
TGS	Top Gear Switch (cancels SIL in top gear)	
THERMAC	Thermostatic Air Cleaner	
THS	Transmission Hydraulic Switch	
TP/TPS	Throttle Position Sensor	
TPI	Tuned Port Injection	
TPS	Throttle Position Sensor/Switch	
TS	Temperature Sensor	
TSB	Technical Service Bulletin	
TTS	Transmission Temperature Switch	
TV	Thermovalve	
TWC	Three-Way Catalyst	
Temp.	Temperature	

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For Volkswagen Technical Site

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³Trans.                ³Transaxle/Transmission                                3
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"V" ABBREVIATION TABLE

[illegible]

"W" ABBREVIATION TABLE

[illegible]

END OF ARTICLE

Article Text

ARTICLE BEGINNING

COMMONLY USED ABBREVIATION

"A" ABBREVIATION TABLE

"A" ABBREVIATION TABLE

ABBREVIATION	DEFINITION
A	Amperes
A/C	Air Conditioning
A/T	Automatic Transmission/Transaxle
AAP	Auxiliary Accelerator Pump
AB	Air Bleed
ABCV	Air Bleed Control Valve
ABDC	After Bottom Dead Center
ABRS	Air Bag Restraint System
ABS	Anti-Lock Brake System
AC	Alternating Current
ACC	A/C Clutch Compressor
ACCS	A/C Cycling Switch
ACCUM	Accumulator
ACCY	Accessory
ACT	Air Charge Temperature Sensor
ACV	Thermactor Air Control Valve
ADJ	Adjust or Adjustable
ADV	Advance
AFS	Airflow Sensor
AI	Air Injection
AIR or A.I.R.	Air Injection Reactor
AIS	Air Injection System
ALCL	Assembly Line Communications Link
ALDL	Assembly Line Diagnostic Link
ARC	Automatic Ride Control
ASCS	Air Suction Control Solenoid
ASD	Auto Shutdown
ASDM	Air Bag System Diagnostic Module
ASV	Air Suction Valve
ATC	Automatic Temperature Control
ATDC	After Top Dead Center
ATF	Automatic Transmission Fluid
ATS	Air Temperature Sensor
AXOD	Automatic Transaxle Overdrive
Abs.	Absolute
Accy.	Accessory
Alt.	Alternator or Altitude
Amp.	Ampere
Assy.	Assembly

Article Text (p. 2)

For Volkswagen Technical Site

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"B" ABBREVIATION TABLE

"C" ABBREVIATION TABLE

3CBD	3Closed Bowl Distributor	3
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Article Text (p. 3)

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"D" ABBREVIATION TABLE

3 ABBREVIATION	3 DEFINITION	3
3 "D"	3 Drive	3
3 DBC	3 Dual Bed Catalyst	3
3 DC	3 Direct Current or Discharge	3
3 DDD	3 Dual Diaphragm Distributor	3

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For Volkswagen Technical Site

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"E" ABBREVIATION TABLE

[illegible]

ABBREVIATION	DEFINITION	
EAC	Electric Assist Choke	
EACV	Electric Air Control Valve	
EBCM	Electronic Brake Control Module	
ECA	Electronic Control Assembly	
ECAT	Electronically Controlled Automatic Transaxle	
ECM	Electronic Control Module	
ECT	Engine Coolant Temperature Sensor	
ECU	Electronic Control Unit or Engine Control Unit	
EDF	Electric Drive Fan relay assembly	
EDIS	Electronic Distributorless Ignition System	
EEC	Electronic Engine Control	
EECS	Evaporative Emission Control System	
EEPROM	Electronically Erasable PROM	
EFE	Early Fuel Evaporation	
EFI	Electronic Fuel Injection	
EGO	Exhaust Gas Oxygen sensor (see HEGO)	
EGR	Exhaust Gas Recirculation system	
EGRC	EGR Control solenoid or system	
EGRV	EGR Vent solenoid or system	
EMR	Emission Maintenance Reminder Module	
ESA	Electronic Spark Advance	
ESC	Electronic Spark Control	
EST	Electronic Spark Timing	

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Exo1 Exo3pt

"F" ABBREVIATION TABLE

[illegible]

"G" ABBREVIATION TABLE

[illegible]

"H" ABBREVIATION TABLE

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For Volkswagen Technical Site

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"I" ABBREVIATION TABLE

UAAA		
ABBREVIATION	DEFINITION	
AA		
I.D.	Inside Diameter	
IAC	Idle Air Control	
IACV	Idle Air Control Valve	
IC	Integrated Circuit	
ID	Identification	
IDM	Ignition Diagnostic Module	
IGN	Ignition system or circuit	
ILC	Idle Load Compensator	
In. Hg	Inches of Mercury	
INCH Lbs.	Inch Pounds	
INFL REST	Inflatable Restraint	
INJ	Injector or Injection	
IP	Instrument Panel	
IPC	Instrument Panel Cluster	
ISA	Idle Speed Actuator	
ISC	Idle Speed Control	
ISS	Idle Stop Solenoid	
ITS	Idle Tracking Switch	
IVSV	Idle Vacuum Switching Valve	
Ign.	Ignition	
In.	Inches	
Inj.	Injector	

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"J" ABBREVIATION TABLE

[illegible][illegible][illegible][illegible][illegible]

AAAAAAAAAAAAAAAAAAAAAA

"M" ABBREVIATION TABLE

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"N" ABBREVIATION TABLE

"O" ABBREVIATION TABLE

UAAA		
³ ABBREVIATION	³ DEFINITION	³
AAA		
³ O	³ Oxygen	³
³ O.D.	³ Outside Diameter	³

Article Text (p. 9)

For Volkswagen Technical Site

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"P" ABBREVIATION TABLE

[illegible]

"Q" ABBREVIATION TABLE

Article Text (p. 11)

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"T" ABBREVIATION TABLE

ABBREVIATION	DEFINITION
T.V.	Throttle Valve
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TAC	Thermostatic Air Cleaner
TAD	Thermactor Air Diverter
TAN	Tan
TBI	Throttle Body Injection
TCC	Torque Converter Clutch
TCCS	Toyota Computer Control System
TDC	Top Dead Center
TDCL	Total Diagnostic Communication Link
TFI	Thick Film Ignition system
TGS	Top Gear Switch (cancels SIL in top gear)
THERMAC	Thermostatic Air Cleaner
THS	Transmission Hydraulic Switch
TP/TPS	Throttle Position Sensor
TPI	Tuned Port Injection
TPS	Throttle Position Sensor/Switch
TS	Temperature Sensor
TSB	Technical Service Bulletin
TTS	Transmission Temperature Switch
TV	Thermovalve
TWC	Three-Way Catalyst
Temp.	Temperature
Trans.	Transaxle/Transmission

ALTERNATOR & REGULATOR - BOSCH

Article Text

1987 Volkswagen Quantum/Quantum Syncro

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ARTICLE BEGINNING

Alternators & Regulators
BOSCH WITH INTEGRAL REGULATORS

Volkswagen

DESCRIPTION

Bosch alternators are conventional 3-phase, self-rectifying type alternators. Bosch 55 through 75-amp alternators use 3 positive and 3 negative diodes connected to stator windings to rectify current. Bosch 80 and 90-amp alternators use 14 diodes.

All alternators use 3 exciter diodes connected to stator windings. These diodes turn off the alternator indicator light and supply power to the voltage regulator while the engine is running. Bosch regulators are transistorized solid state and integral with alternator.

TROUBLE SHOOTING

NOTE: See the TROUBLE SHOOTING - BASIC PROCEDURES article in the GENERAL TROUBLE SHOOTING section.

TESTING (ON-VEHICLE)

WIRING CONTINUITY TEST

1) Connect a voltmeter between alternator "B+" terminal and ground. Voltmeter should indicate battery voltage. If not, check wiring between alternator and battery.

2) Turn ignition on and check that alternator indicator light comes on. If light does not come on, check wiring between alternator and warning light, including indicator bulb.

ALTERNATOR & REGULATOR - BOSCH

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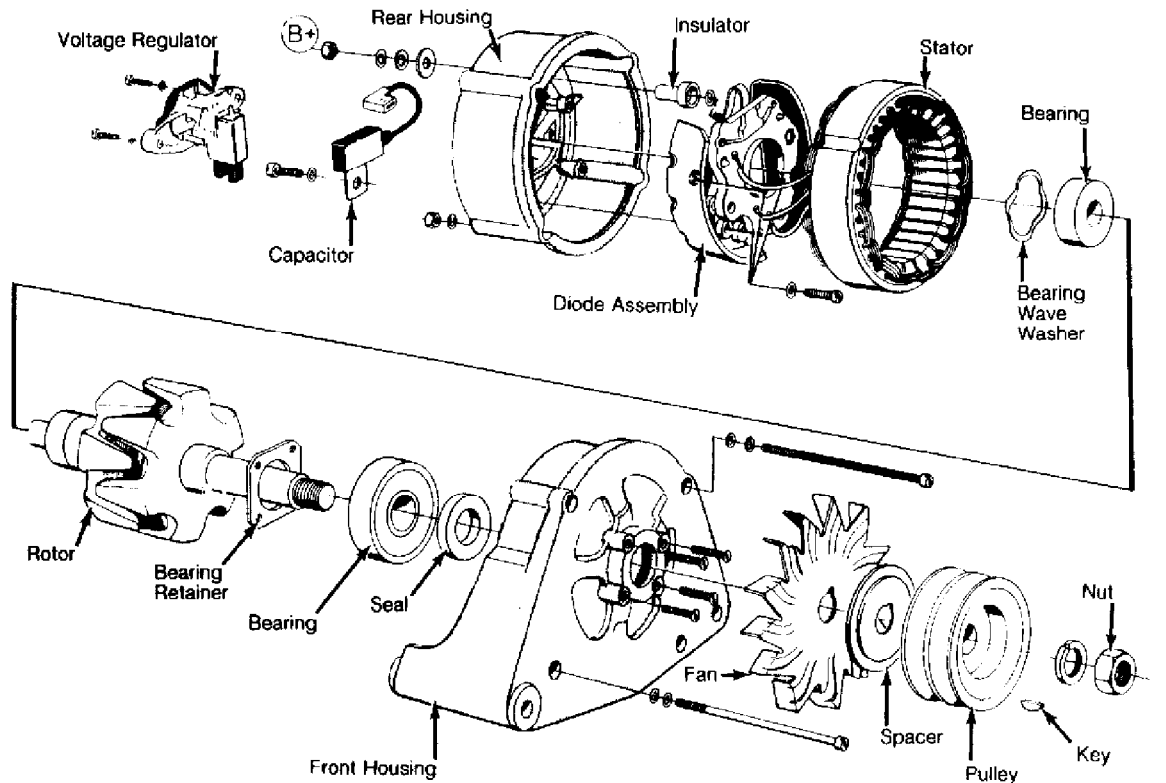


Fig. 1: Exploded View of Bosch 55-Ampere Alternator

OUTPUT TEST

1) Ensure connections at battery, alternator, and starter (most vehicles) are clean and tight. Ensure alternator, engine and body are properly grounded. Ensure alternator drive belt is tight and in good condition.

2) Connect ammeter following manufacturer's instructions. Connect voltmeter leads to battery terminals.

3) Start engine and run at 3000 RPM. Adjust carbon pile to obtain maximum alternator output. Do not allow voltage to go below 12.6 volts.

4) Alternator output should equal alternator rated output, minus 16-20 amps. If reading is 16-20 amps below alternator rating, replace regulator and retest. If output is still too low, repair or replace alternator.

REGULATOR CONTROL VOLTAGE TEST

1) Connect ammeter following manufacturer's instructions. Connect voltmeter leads to battery terminals. Start engine and run at 3000 RPM.

2) Run engine until voltage stops rising. Voltage should be 13.5-14.5 volts. If reading is incorrect, remove regulator and ensure brushes are longer than 7/32" (6 mm). Replace if necessary.

3) If brushes are okay and regulator fails to keep voltage within specified limits, replace regulator and retest. If voltage is

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still incorrect, repair or replace alternator.

OVERHAUL

DISASSEMBLY

1) Remove nut, lock washer, and pulley. Note position of spacer(s), then remove fan assembly and key. Scribe mark on front and rear housings. Remove voltage regulator and remove screws holding alternator together. Separate front and rear housings.

2) Disconnect capacitor from terminal. Remove nut, insulator(s), screws and washers. Remove stator assembly. See Figs. 1 and 3. Unsolder stator from diode assembly. Remove bearing wave washer or "O" ring from rear housing.

3) Support front housing and carefully press out rotor. Do not allow rotor to fall. Remove screws securing bearing retainer. Remove retainer, front bearing and seal. Remove rear bearing from slip ring end of rotor.

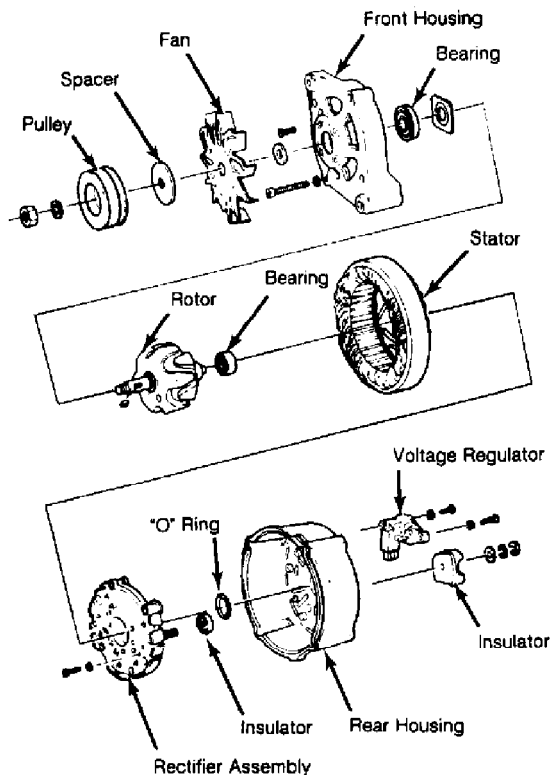


Fig. 2: 90-Ampere Alternator

TESTING & REPAIR

Diode Assembly

1) Place ohmmeter scale on x100 scale. Connect ohmmeter leads across "B+" terminal and 3 stator terminals one at a time. Reverse leads. Ohmmeter should indicate continuity in one direction only.

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2) Connect ohmmeter leads across negative plate and 3 stator terminals one at a time. See Fig. 3. Reverse leads. Ohmmeter should indicate continuity in one direction only.

3) Connect ohmmeter leads across "D+" terminal and 3 stator terminals one at a time. Reverse leads. Ohmmeter should indicate continuity in one direction only. If diodes are found to be defective, replace diode assembly.

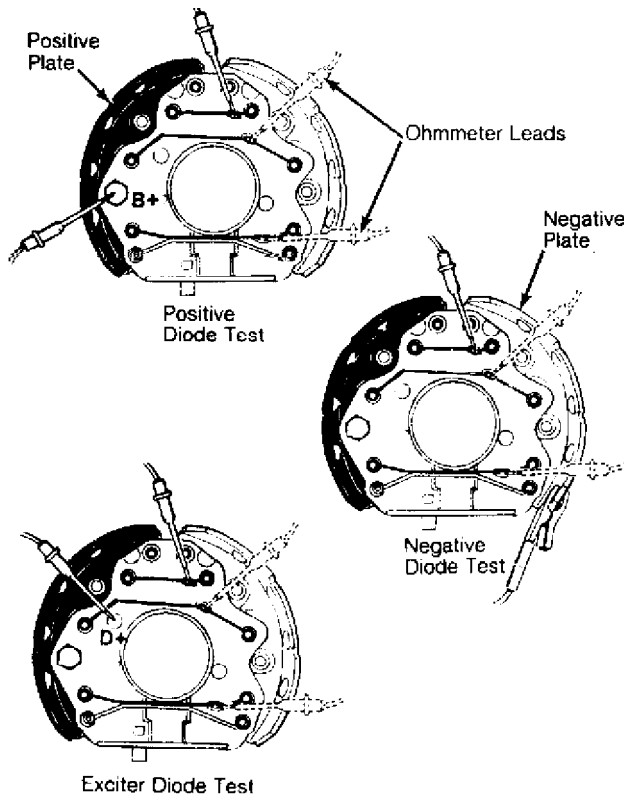


Fig. 3: Bosch Diode Assembly Test

Diode assembly for 55-amp alternator is shown. Others are similar.

Stator

1) Place ohmmeter on lowest scale. Connect ohmmeter across stator leads. Resistance between leads should be .14-.15 ohms for 55-amp alternator and .09-.10 ohms for 65 through 90-amp alternators. If resistance is incorrect, stator has open or shorted windings and must be replaced.

2) Place ohmmeter on X 1000 scale. Connect ohmmeter between stator core and stator lead. No continuity should exist. If continuity exists, stator is grounded and must be replaced.

Rotor

1) Place ohmmeter on lowest scale. Connect ohmmeter across slip rings. Resistance should be 3.4-3.75 ohms for 55-amp alternator and 2.8-3.1 ohms for 65 through 90-amp alternators.

2) If resistance is too low, rotor has short circuit and must be replaced. If resistance is infinity (no continuity), rotor has open

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circuit and must be replaced.

3) Place ohmmeter on x1000 scale. Connect ohmmeter between either slip ring and rotor core. No continuity should exist. If continuity exists, rotor is grounded and must be replaced.

4) Clean slip rings using fine sandpaper. Rings which are worn or pitted should be turned on lathe. Minimum ring diameter is 1 1/16" (26.8 mm). If slip rings are beyond repair, replace slip rings as outlined in steps 5) and 6).

5) Remove rear bearing from slip ring end of rotor. Unsolder wires from slip rings and bend up ends of rotor winding. Pull off slip rings. Ensure ends of rotor winding are not damaged.

6) Insert ends of rotor winding into slip ring and press new slip ring onto rotor. Slip ring end must be 9/64" (3.5 mm) from end of collar. Solder rotor winding to slip ring terminals. Turn rings on lathe and retest rotor. Maximum slip ring run-out is .0012" (.03 mm).

Bearings

Always replace bearings. If replacement front bearing is sealed on one side only, open side must face rotor. If replacement rear bearing is sealed on one side only, open side must face away from rotor.

Brushes

Ensure brushes are longer than 7/32" (6 mm). Replace if necessary. Unsolder brushes from voltage regulator. Solder new brushes. Do not allow solder to run into strands of brush leads. Brush must be free to slide in holder with normal spring tension of 10-14 ozs. (283-397 g).

REASSEMBLY

1) Install bearing, retainer, and screws in front housing. Press rotor onto housing. Press bearing on slip ring end of rotor. Solder stator to diode assembly. Exercise care when soldering near diodes due to possible heat damage.

2) Install insulators on stator assembly. Assemble stator assembly and rear housing. Install wave washer or "O" ring in rear housing. Align scribe marks and assemble front and rear housings.

3) Install key, fan assembly, and spacers. Install pulley, lock washer and nut. Tighten nut to 23-29 ft. lbs. (3-4 N.m). Ensure rotor spins freely. Install voltage regulator and capacitor.

ALTERNATOR APPLICATIONS

ALTERNATOR APPLICATION

AA

Model	Volts/Amps	(1) Bosch Part No.
-------	------------	-----------------------

Volkswagen		(2)
------------	-------	-----

(1) - Bosch alternator part numbers are preceded by the

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numbers 0 120.

- (2) - Alternator part numbers not available from manufacturer. Obtain part number from I.D. plate on the alternator.

AA

END OF ARTICLE

ALTERNATOR & REGULATOR - SEV MOTOROLA

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ARTICLE BEGINNING

ELECTRICAL
Alternators & Regulators - SEV Motorola

All Models

DESCRIPTION

SEV Motorola alternators are conventional 3-phase, self-rectifying type alternators. Three positive and 3 negative silicon diodes are used to rectify AC current.

BELT TENSION ADJUSTMENT

BELT TENSION SPECIFICATIONS

AA

Application (1) Deflection In. (mm)

Vanagon 3/8-9/16 (10-15)

All Others

New Belt 5/64 (2)

Used Belt 13/64 (5)

(1) - Deflection is with 22 lbs. (10 kg) pressure
applied midway on longest belt run.

AA

TROUBLE SHOOTING

NOTE: See TROUBLE SHOOTING - BASIC PROCEDURES article
in the GENERAL TROUBLE SHOOTING section.

TESTING (ON-VEHICLE)

1) Disconnect battery cables and install cut-out switch, variable resistor, ammeter and voltmeter. See Fig. 1. Connect ground cable and ensure cut-out switch is in closed position.

2) Start engine and run at 3000-4000 RPM. Adjust variable resistor to following amperage readings. Turn battery cut-out switch to "OFF" position. Set 65-amp alternators to 45 amps and 55-amp alternators to 25 amps. System is okay if voltmeter reads between 12.5-14.5 volts.

3) If system does not read correct voltage, substitute a good voltage regulator and repeat test. If correct voltage is still not present, alternator is defective.

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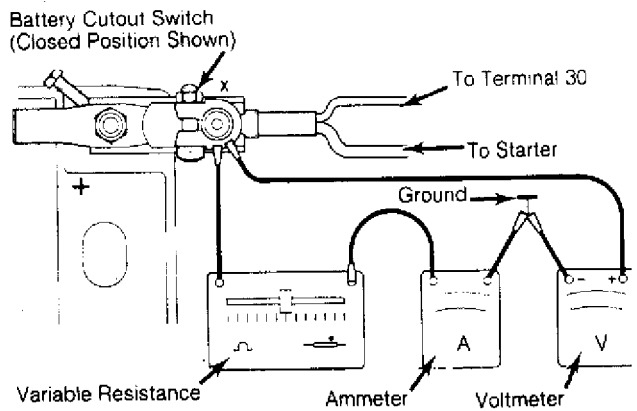


Fig. 1: Alternator Testing Set-Up
Courtesy of Volkswagen United States, Inc.

BENCH TESTING

STATOR

- 1) Check stator for short circuits. If one or more coils are burned, stator may be shorted.
- 2) Connect a self-powered low voltage test light between stator plates and stator terminal. If light illuminates, insulation between stator winding and stator plates is defective and stator should be replaced.

CAUTION: Use only specified test light. Do not use 110 or 220-volt test light on this or any other alternator test procedure.

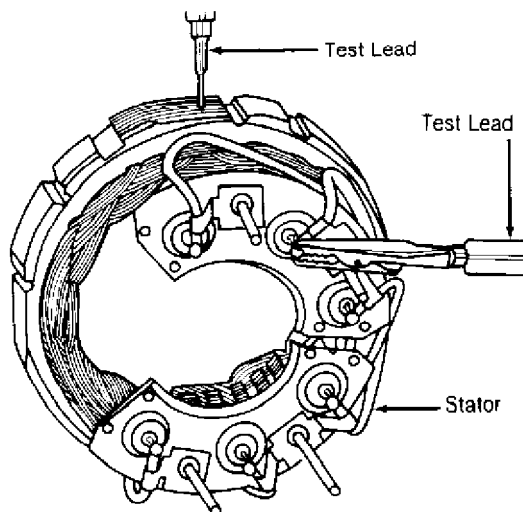


Fig. 2: Checking Stator for Shorts
Courtesy of Volkswagen United States, Inc.

DIODES

ALTERNATOR & REGULATOR - SEV MOTOROLA

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1) Check diodes with a diode tester for shorts or open circuits. If any diode is defective, entire diode assembly must be replaced.

2) If diode tester is not available, diode leads should be quickly and carefully unsoldered and tested with an ohmmeter. Diodes should show low resistance in flow direction and high resistance in reverse direction.

ROTOR

1) Ensure slip rings are not dirty or burned. Check winding for breakage or damaged isolation. Measure resistance between slip rings.

2) Normal resistance should be about 4.5 ohms. If winding is faulty, rotor must be replaced.

BRUSH HOLDER

1) Connect a self-powered low voltage test light between brushes. Test light should not illuminate. Connect test light between "DF" terminal and "+" brush. Test light should give steady light even if brush and/or terminal cable is moved.

2) Connect 12-volt test light between brush holder frame and "-" brush. Light should give steady light. If test results are not satisfactory or brush length is less than .51" (13 mm), replace brush holder. See Fig. 3.

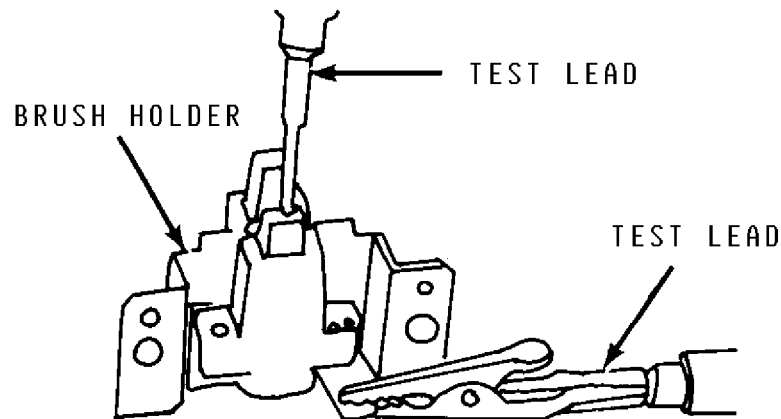


Fig. 3: Checking Brush Holder
Courtesy of Volkswagen United States, Inc.

NOTE: Brush length is measured between brush contact surface and holder, with brush resting against spring.

OVERHAUL

ALTERNATOR & REGULATOR - SEV MOTOROLA

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NOTE: Overhaul information is not provided. See Fig. 4 for overhaul reference.

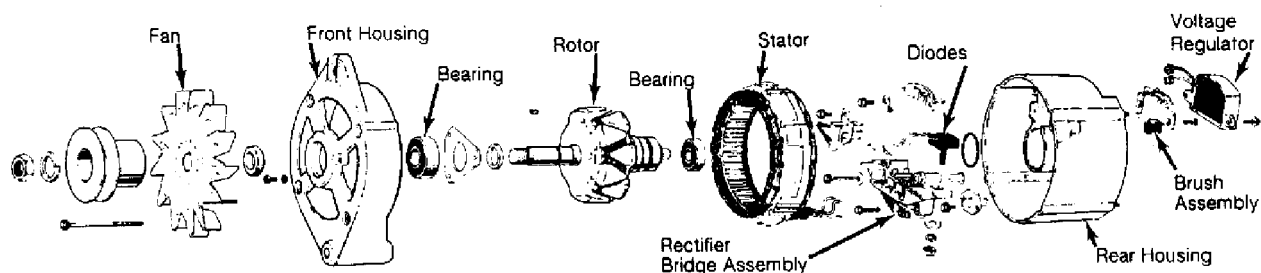


Fig. 4: Exploded View of SEV Motorola Alternator
Courtesy of Volkswagen United States, Inc.

END OF ARTICLE

ANTI-LOCK BRAKE SAFETY PRECAUTIONS

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ARTICLE BEGINNING

GENERAL INFORMATION

Anti-Lock Brake Safety Precautions

* PLEASE READ THIS FIRST *

This article is intended for general information purposes only. This information may not apply to all makes and models. If vehicle is equipped with Anti-Lock Brake System (ABS), refer to appropriate ANTI-LOCK BRAKE SYSTEM article in the BRAKES section for description, operation, depressurizing, testing, system bleeding, trouble shooting and servicing of specific system.

WARNING: Failure to depressurize ABS could lead to physical injury.

ANTI-LOCK BRAKE SAFETY PRECAUTIONS

WARNING: Failure to depressurize ABS could lead to physical injury.

- * NEVER open a bleeder valve or loosen a hydraulic line while ABS is pressurized.
- * NEVER disconnect or reconnect any electrical connectors while ignition is on. Damage to ABS control unit may result.
- * DO NOT attempt to bleed hydraulic system without first referring to the appropriate ANTI-LOCK BRAKE SYSTEM article in the BRAKES section.
- * Only use specially designed brake hoses/lines on ABS equipped vehicles.
- * DO NOT tap on speed sensor components (sensor, sensor rings). Sensor rings must be pressed into hubs, NOT hammered into hubs. Striking these components can cause demagnetization or a loss of polarization, affecting the accuracy of the speed signal returning to the ABS control unit.
- * DO NOT mix tire sizes. Increasing the width, as long as tires remain close to the original diameter, is acceptable. Rolling diameter must be identical for all 4 tires. Some manufacturers recommend tires of the same brand, style and type. Failure to follow this precaution may cause inaccurate wheel speed readings.
- * DO NOT contaminate speed sensor components with grease. Only use recommended coating, when system calls for an anti-corrosion coating.
- * When speed sensor components have been removed, ALWAYS check sensor-to-ring air gaps when applicable. These specifications can be found in each appropriate article.
- * ONLY use recommended brake fluids. DO NOT use silicone brake fluids in an ABS equipped vehicle.
- * When installing transmission devices (CB's, telephones, etc.) on ABS equipped vehicles, DO NOT locate the antenna near the ABS control unit (or any control unit).

ANTI-LOCK BRAKE SAFETY PRECAUTIONS

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- * Disconnect all on-board computers, when using electric welding equipment.
- * DO NOT expose the ABS control unit to prolonged periods of high heat (185 °F/85°C for 2 hours is generally considered a maximum limit).

END OF ARTICLE

AXLE SHAFTS - FRONT

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ARTICLE BEGINNING

1987 Drive Axles
VOLKSWAGEN FWD AXLE SHAFTS

DESCRIPTION

Axle shafts transfer power from transaxle to driving wheels. All axle shafts consist of a shaft and flexible Constant Velocity (CV) joint at each end. Inner CV joint is splined or bolted to transaxle. Outer CV joint is splined to hub assembly and secured by axle shaft nut.

The inner and outer CV joints are enclosed by a CV joint boot. The boot maintains lubrication in the joint and prevents contamination from entering the joint. Boots must be replaced when signs of leakage or cracks are present. The inner CV joint can be repaired without replacing assembly. The outer CV joint must be replaced as an assembly.

There are 3 different types of axle shaft CV joints. The Double Offset Joint (DOJ). The Birfield Joint (BJ) and the Tripod Joint (TJ) (sometimes referred to as tripot). The inner CV joint is bolted to differential case drive flanges.

TROUBLE SHOOTING

TROUBLE SHOOTING CHART

AA	
Condition	Possible Cause
Grease Leaks	CV boot torn or cracked
Clicking Noise	
on Cornering	Damaged outer CV
Clunk Noise	
on Acceleration	Damaged inner CV
Vibration or Shudder	
on Acceleration	Sticking, damaged or worn CV
	Misalignment or spring height
AA	

REMOVAL, DISASSEMBLY, REASSEMBLY & INSTALLATION

AXLE SHAFTS

CAUTION: Vehicle weight must not be allowed to rest on wheel bearings and hub, WITHOUT axle shaft installed and axle shaft nut tightened to specification.

Removal

1) Remove hub cap. Loosen axle shaft nut. Raise and support vehicle. Remove axle nut and wheel. Remove Allen bolts connecting inner CV joint to transmission case flange. See Fig. 1.

AXLE SHAFTS - FRONT

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2) Mark position of both ball joint flanges on control arms. Remove ball joint from control arm and pull pivot mounting outward while removing axle shaft. Press axle shaft out of hub with puller and guide past transaxle.

NOTE: Axle shafts should be disassembled **ONLY** to replace defective rubber boots. If boots are replaced, check all components for wear or damage and replace assembly if necessary.

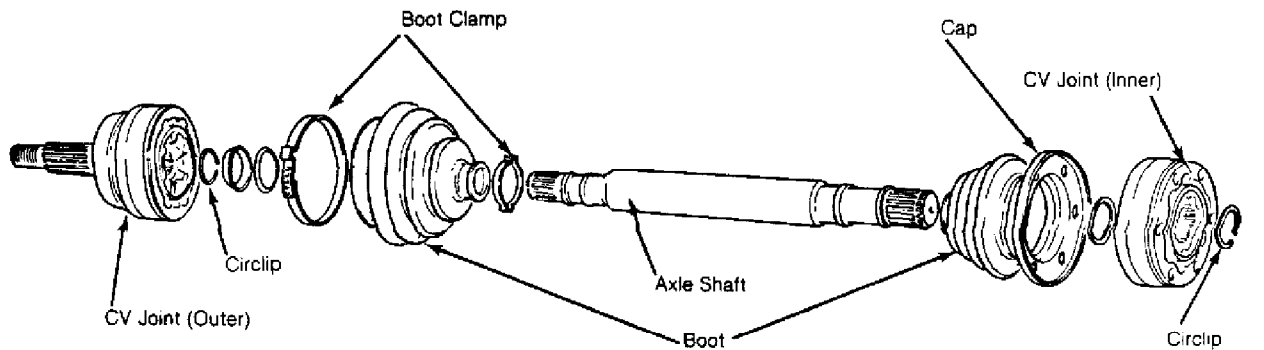


Fig. 1: Exploded View of Typical Volkswagen Axle Shaft Assembly

Disassembly

1) On inner CV joint, remove circlip from axle shaft and drive protective cap from CV joint. Place axle shaft in Holder (VW402) and press CV joint from shaft with Adapter (VW408a), supporting hub to prevent damage.

2) Pivot hub and cage assembly out of inner joint. Push out and remove balls. Align ball hub grooves with cage and remove hub. See Fig. 2.

NOTE: Inner CV joint and ball hub are matched sets. **DO NOT** interchange with outer joint. CV joint balls cannot be interchanged between CV joints.

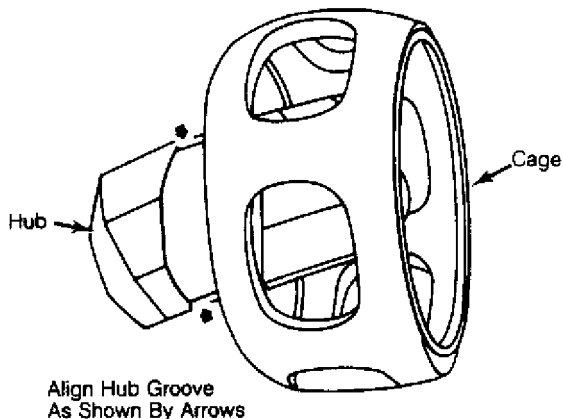


Fig. 2: Removing Volkswagen Inner CV Joint Ball Hub

3) Remove and discard inner boot clamp and boot. On outer CV

AXLE SHAFTS - FRONT

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joint, spread circlip inside ball hub and drive CV joint off axle shaft with brass drift by tapping on hub. Mark position of ball hub and outer joint. Tilt cage and remove each ball.

4) Align cage perpendicular to joint. Align 2 large openings of cage with raised portions of joint and remove cage and hub. Position one retainer of hub in large opening and remove hub by tilting outward. Remove and discard outer boot and clamp.

Reassembly

1) To reassemble CV joints, reverse disassembly procedure and note the following: lubricate joints with 3 ozs. of molybdenum disulphide grease. After inserting balls into inner CV joint hub and cage, insert hub and cage into joint in a perpendicular position.

2) Chamfer of ball hub splines must face larger diameter of joint. Rotate ball and cage into position and ensure CV joint wide ball groove and narrow hub groove are on same side of joint. See Fig. 3. Joint is correctly assembled if hub can move over shaft splines by hand.

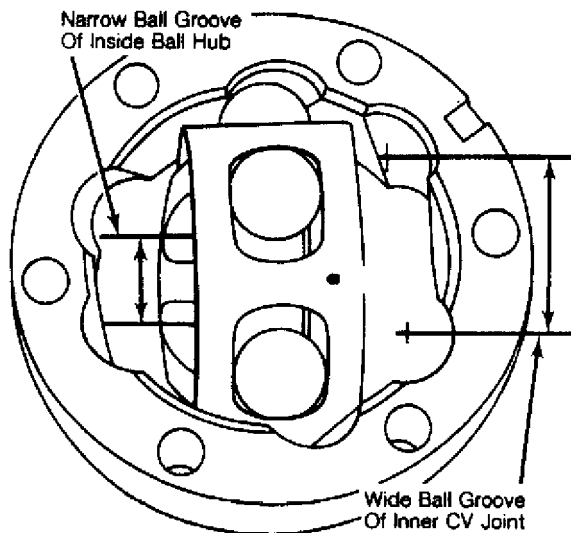


Fig. 3: Installing Volkswagen Ball Hub & Cage

3) Outer CV joint alignment marks must match after reassembly. Replace dust boots and clamps. Install CV joints onto axle shaft with inside ball hub chamfer facing shaft.

4) Outer CV joint must be assembled with dished washer concave side facing thrust washer and convex side of thrust washer facing CV joint. See Fig. 4.

5) Inner CV joint must be assembled with dished washer concave side facing CV joint when installed on shaft. Install boot clamps with open end facing opposite direction of normal rotation. Always use new circlips to retain CV joints on shafts.

AXLE SHAFTS - FRONT

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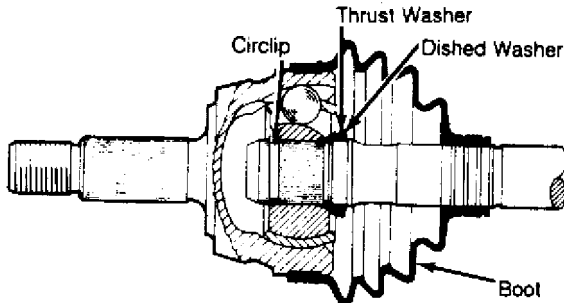


Fig. 4: Installation of Volkswagen Dished & Thrust Washers

Installation

1) To install, reverse removal procedure and note the following: install a new side retainer ring. Check seals at both ends of axle shaft and replace prior to installation if necessary. Lubricate transaxle seal lip with transaxle oil.

NOTE: Always install new cotter pin, washer and suspension nuts.

2) Install axle shaft into transaxle case. On all models with snap ring retained axle shafts, try to pull axle shaft out of differential by hand to ensure proper engagement of snap ring. Install axle shafts into wheel hub. Align suspension marks made at removal and tighten nuts. On Audi Coupe models, apply (D6) locking compound to splines.

3) Check camber setting and adjust if necessary. Stake axle shaft nut in place with a punch or install new cotter pin after tightening. Bleed brake system and replace transaxle fluid, if required.

TORQUE SPECIFICATIONS

TIGHTENING SPECIFICATIONS TABLE

AA

Application	Ft. Lbs. (N.m)
-------------	----------------

Volkswagen

Axle Shaft Nut	203 (280)
Ball Joint Nut	47 (64)
Brake Caliper Bolts	83 (115)
CV Joint Bolt	32 (43)
Stabilizer Bar Bolts	18 (21)

AA

END OF ARTICLE

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Drive Axles

CONDITION

CORRECTION

[illegible]

Wheel Bearing Problem	See HUB & BEARING ASSEMBLY in FWD AXLES SHAFTS article
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END OF ARTICLE

BOSCH CIS-E SYSTEM

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ARTICLE BEGINNING

1987 Computerized Engine Controls
BOSCH CIS-E (ELECTRONIC CONTROL) SYSTEM

Volkswagen: Fox, Golf, GTI, Jetta,
Quantum, Quantum Syncro, Scirocco

DESCRIPTION

Bosch CIS-E exhaust emission system uses CIS (Continuous Injection System) for fuel delivery and electronic controls for mixture adjustment.

Mechanical portion of CIS-E system consists of Mixture Control Unit (MCU), diaphragm pressure regulator, auxiliary air regulator, cold start valve, fuel injectors, fuel pump and filter. The MCU is comprised of the airflow sensor and fuel distributor.

Electronic controls consist of airflow sensor position indicator (potentiometer), differential pressure regulator, thermo time switch, coolant temperature sensor, Electronic Control Unit (ECU), Transistor Controlled Ignition (TCI), knock sensor, knock sensor control unit, throttle valve microswitch, altitude (barometric) sensor, lambda control and oxygen sensor.

If partial system failure occurs, the ECU will switch to a back-up or "limp-home" mode to allow vehicle operation until system can be repaired.

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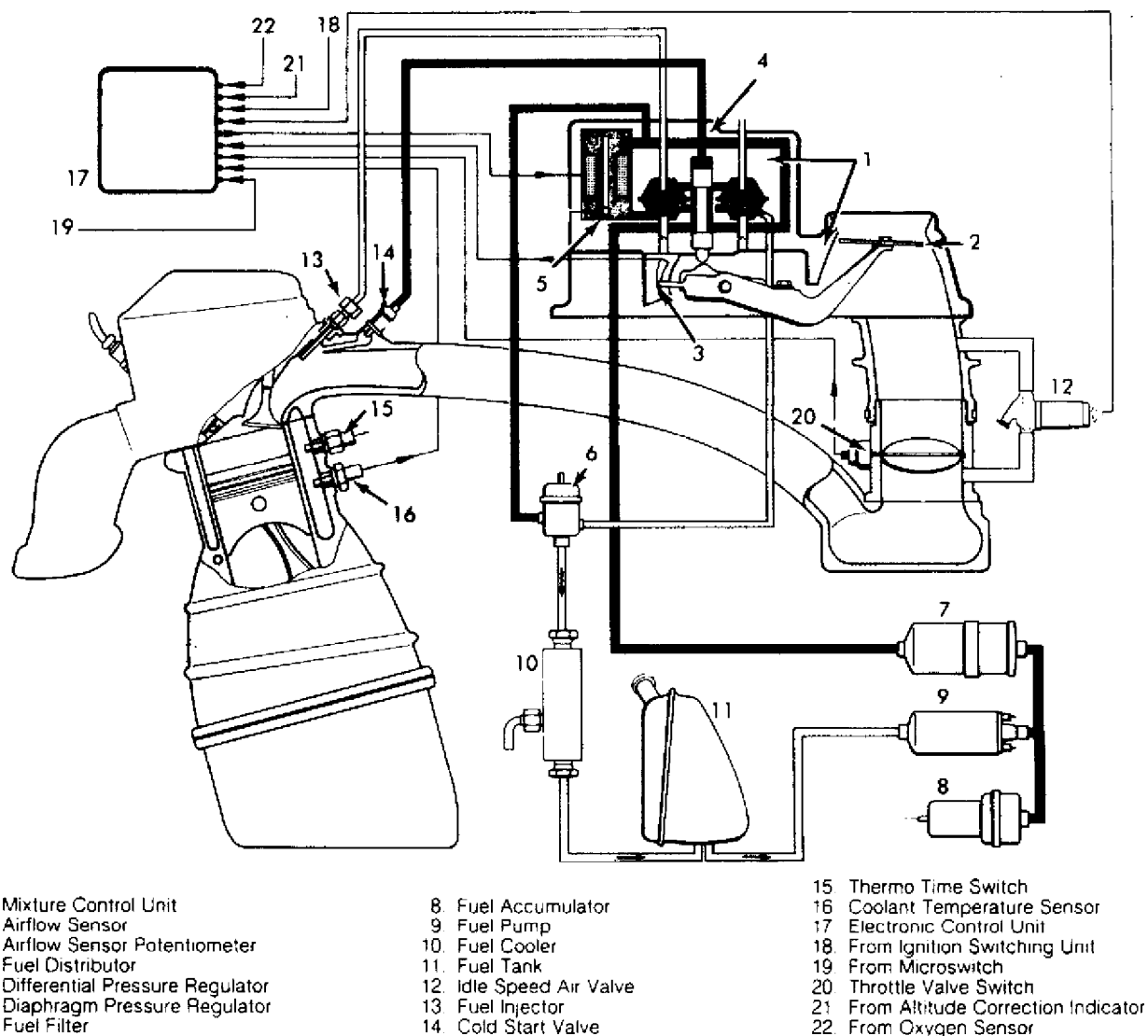


Fig. 1: Bosch CIS-E Component Diagram

OPERATION

FUEL SUPPLY

CIS-E FUEL PUMP LOCATIONS

XX

Make/Model	Location
Volkswagen	
Fox, Golf, GTI	
Jetta, Scirocco	(1) Rear/Underneath
Quantum	In Fuel Tank

(1) - These models have 2 fuel pumps. Transfer pump is mounted inside fuel tank with fuel gauge sender.

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XX

Fuel Pump & Relay

The fuel pump assembly, is equipped with a pressure damper at the suction end. Mounting location varies with model and manufacturer. Fuel pump is activated during start-up and when engine is running. Fuel pump relay switches off fuel pump in absence of signal from ignition control unit and provides voltage for oxygen sensor heating element.

Mixture Control Unit (MCU)

Fuel is metered and delivered to individual cylinders dependent on air intake quantity which is metered by airflow sensor. MCU consists of fuel distributor with differential pressure regulator and airflow sensor with potentiometer (sensor position indicator).

Airflow Sensor

Rest position of airflow sensor plate is angled in relation to air inlet venturi. Airflow sensor potentiometer is attached to the side of the MCU and connected to the air sensor plate actuating lever. It generates a voltage signal based on the position of the airflow sensor plate. The ECU uses this signal to adjust cold acceleration enrichment.

Fuel Distributor

The fuel distributor controls the flow of fuel to the injectors. A control plunger, operated by the airflow sensor regulates the control pressure differential between the injector supply (upper chamber) and the lower chamber (fuel return). This differential in pressure controls the amount of fuel flow to the injectors. The electrically controlled, differential pressure regulator also controls fuel flow from the lower chamber.

Differential Pressure Regulator

Differential pressure regulator is mounted on side of fuel distributor. An electrically operated plate valve combined with fixed outlet orifice, governs pressure in lower chamber. See Fig. 2. Pressure change in lower chamber causes movement of diaphragm and controls fuel volume flow to injectors.

Actuating signal comes from ECU and can range from 60 to 120 mA, depending upon engine operating conditions. With engine running, system pressure at fuel inlet is 75-82 psi (5.3-5.8 kg/cm²).

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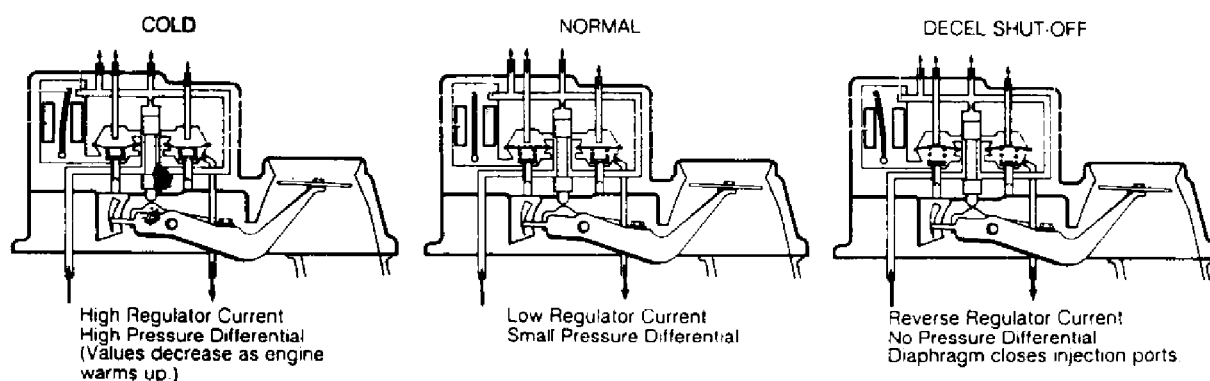


Fig. 2: Effect Of Differential Pressure Regulator Plate Position On Fuel Distributor

Electronic Control Unit (ECU)

ECU of Volkswagen models is found behind plenum panel on driver's side of vehicle. Ambient temperature around ECU must not exceed 180°F (85°C).

With ignition switched on, ECU is connected to battery voltage. To prevent voltage fluctuations when vehicle components are switched on, ECU is provided with voltage stabilizer circuit. Operating voltage is 8 volts.

ECU unit utilizes various input signals to control fuel delivery and control exhaust emissions. Output signals are sent to differential pressure regulator and to idle speed control valve.

Cranking Enrichment

During engine cranking, a signal from the starter relay is sent to the ECU to enrich the fuel mixture. The amount of enrichment or activation of the cold start valve is controlled by a coolant temperature sensor. When the enrichment amount is determined by the ECU it remains constant during that cranking cycle. A thermo timer controls enrichment cycle time after starting.

Warm-Up Enrichment

Fuel enrichment during warm-up is controlled by the differential pressure regulator. When cold, the signal from the coolant temperature sensor allows more current to be supplied to the pressure regulator. This will provide greater fuel enrichment.

Maximum Engine Speed Limiter

ECU senses engine speed based on impulses from terminal "TD" of ignition switching unit. Maximum engine speed is controlled by adjusting current supply to the differential pressure regulator from ECU. Lower chamber pressure in the fuel distributor is increased to limit fuel flow to the injectors. When maximum engine speed is reached a signal from the ECU will interrupt the fuel pump relay signal and shut off the fuel pump.

Altitude Correction

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Injection control is influenced by altitude. With ignition switched on or with engine running, altitude sensor will receive constant voltage signal of approximately 8 volts from ECU. As altitude increases (air pressure decreases), the signal from the ECU reduces current to the differential pressure regulator. This leans out the fuel mixture.

Lambda Control

Lambda control is integrated in ECU and sensor input signals. After input signals are amplified, output signal adjust differential pressure regulator.

Control range of differential pressure regulator current is 0-16 mA. Regulator pressure change at 8 mA or above.

Lambda control is non-operational under these conditions: oxygen sensor not ready for operation or defective, during deceleration shut-off, under full load conditions, during acceleration enrichment, when starting engine at coolant temperatures below 60°F (15°C) or until coolant temperature reaches 105°F (40°C).

Oxygen Sensor

Oxygen sensor is mounted in exhaust pipe in front of catalytic converter. Oxygen sensor measures oxygen content in exhaust gas. Heating element, energized through terminal No. 87 of fuel pump relay, is used to ensure constant operating temperature of oxygen sensor. When operating temperature range, which starts at 572°F (300°C), is reached, oxygen sensor sends voltage signal to ECU. A rich mixture will send a signal in excess of .5 volt while a lean mixture will give signal of less than .5 volt.

Throttle Valve Microswitch

Throttle valve microswitch is activated by ECU with constant voltage signal of 8 volts. During deceleration, circuit to ECU is closed by microswitch.

Time period of deceleration shut-off depends upon engine coolant temperature. Injection of fuel will restart at 900 RPM if engine is at operating temperature. If coolant temperature is lower than operating temperature, injection of fuel will begin at higher speed than 900 RPM.

Throttle valve microswitch opens before throttle valve. This allows deceleration shut-off to be interrupted before throttle valve opens, preventing cut-in hesitation.

Deceleration input signals received by ECU result in change of current direction to differential pressure regulator coils. Plate valve opens and causes pressure in lower chamber to increase. Increased fuel pressure, combined with spring tension, forces diaphragm to cover injector ports in fuel distributor. This interrupts fuel supply to injectors.

IGNITION & IDLE CONTROL

Knock Sensor

The knock sensor is mounted at the front of the cylinder

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block. A 3 wire connector transmits signals to the knock sensor control unit and to the TCI. The sensor mounting bolt torque influences sensor function. See REMOVAL & INSTALLATION section of this article. The knock sensors signal will advance or retard ignition timing to control combustion chamber pre-ignition.

Knock Sensor Control Unit

The knock sensor control unit receives signals from the knock sensor and also a vacuum signal from the inlet manifold. It transmits signals to the TCI control unit to adjust ignition timing.

Electronic Idle Speed Control

Idle speed ECU is integrated in CIS-E ECU but is functionally separate from CIS-E. Idle speed air valve, located in throttle valve by-pass hose, receives signals from idle speed ECU.

The idle speed control system also is influenced by the airflow sensor voltage signal. The control unit measures the airflow rate. In combination with engine speed, the position of the airflow sensor potentiometer and the coolant temperature, the idle speed air valve controls the idle speed.

When ignition is switched on, idle speed ECU is energized. Electronic control system generates a frequency of 100 Hz.

Idle Speed Air Control Valve

With ignition switched off, idle speed air control valve is opened to maximum by a set of return springs. This is the same position as that of "limp-home" engine operation. With ignition on and engine off, idle speed air control valve is activated. This provides a valve opening which is determined by coolant temperature.

ECU supplies specific voltage to air control valve which determines correct opening for setting engine speed. A/C operation will also send a signal to the ECU which will modify the signal to the air control valve. Engine speed is controlled by temperature from 1000 RPM at 0°F (-20°C) to low of 720 RPM at 68°F (20°C).

Idle Speed Boost Valves

Idle speed boost valves are used on 4-cylinder Volkswagen models. Vehicles without A/C use only one valve, called Idle Speed Boost Valve No. I. Vehicles with A/C also use second valve, called Idle Speed Boost Valve No. II.

With ignition on, constant voltage is supplied to idle speed boost valve No. I. If engine speed drops below 700 RPM, idle speed boost control (on relay board) completes ground circuit for boost valve No. I. Above 1050 RPM, control unit shuts off ground circuit to boost valve No. I.

Idle speed boost valve No. II is always grounded. When A/C is turned on, voltage is supplied to boost valve No. II.

TESTING

COLD START ENRICHMENT

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Thermo Time Switch

1) Check thermo time switch at connector on cold start valve when engine coolant temperature is less than 86°F (30°C). Disconnect and ground high tension lead at distributor cap end.

2) Disconnect connector from cold start valve. Connect test light across 2 terminals of cold start connector. Crank starter motor for 10 seconds. Test light must light up for 1-8 seconds, depending upon temperature. Thermo time switch cut-off temperature rating is stamped on switch.

Cold Start Valve

1) Check cold start valve with engine coolant temperature below 86°F (30°C). Disconnect and ground high tension lead at distributor cap end. Remove cold start valve from intake manifold with wiring and fuel line connected. Point tip into safe container.

2) Crank starter for 10 seconds. Valve should emit cone-shaped spray for time allowed by thermo time switch. Dry off tip and check for leaks. Acceptable leakage rate of cold start valve is one drip per minute or less.

Auxiliary Air Valve

1) Engine coolant must be below 86°F (30°C) for cold condition testing. Ignition must have been off so element in regulator has not been warmed up. Disconnect wiring connector from air regulator. Start cold engine and let it idle. Measure voltage across connector terminals. Voltage must be 11.5 volts.

2) Pinch either regulator hose. If idle does not decrease, replace auxiliary regulator. Attach wiring to regulator. Allow engine to idle for a minimum of 5 minutes. Pinch either regulator hose. If idle speed changes replace auxiliary air valve.

FUEL DELIVERY & SYSTEM PRESSURES

CAUTION: When working on fuel system, always follow these precautions on cleanliness:

- * Thoroughly clean all unions and area near connections before disconnecting.
- * Place removed parts on a clean surface and cover over. Use paper or plastic sheet. Use only lint-free cloths.
- * Components which have been opened or disassembled must be covered or sealed carefully if repair cannot be carried out immediately.
- * Only install clean components.
- * Only unpack replacement parts immediately before they are installed.
- * Do not use parts which have been stored loose (for instance, in toolboxes).
- * When fuel system is open, do not work with compressed air if this can be avoided or move car unless absolutely necessary.

WARNING: Fire hazard. Do not smoke or have anything in area that can ignite fuel.

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System Pressure (Golf & Jetta)

1) Connect pressure gauge (VW 1318) between line from fuel distributor of cold start valve and test port connection on lower chamber of fuel distributor, using adapter fittings (VW 1318/5). Test port is sealed by threaded plug. Bridge fuel pump relay with jumper switch (US 4480/3).

2) Disconnect wiring from differential pressure regulator. Open valve on pressure gauge (points at cold start valve line when open) and activate fuel pump. System pressure must be 68-78 psi (4.7-5.4 kg/cm²). If pressure reading is low and fuel pump delivery quantity is good, replace pressure regulator.

3) If pressure reading is high, disconnect fuel tank return line from diaphragm pressure regulator. Repeat test. If reading is correct, check for plugged return line. If reading is incorrect with line open, replace diaphragm pressure regulator.

4) If pressure is not within specification and pressure regulator valve has been replaced adjust system pressure at fuel distributor. Refer to SYSTEM PRESSURE in ADJUSTMENTS section of this article.

System Pressure (Quantum & Quantum Syncro)

1) Using new sealing washers and line adapter (VW 1318/5), connect pressure gauge (VW 1318) between fuel cold start valve and lower chamber connection of fuel distributor. Gauge lever positions: A - open, B - closed. See Fig. 3.

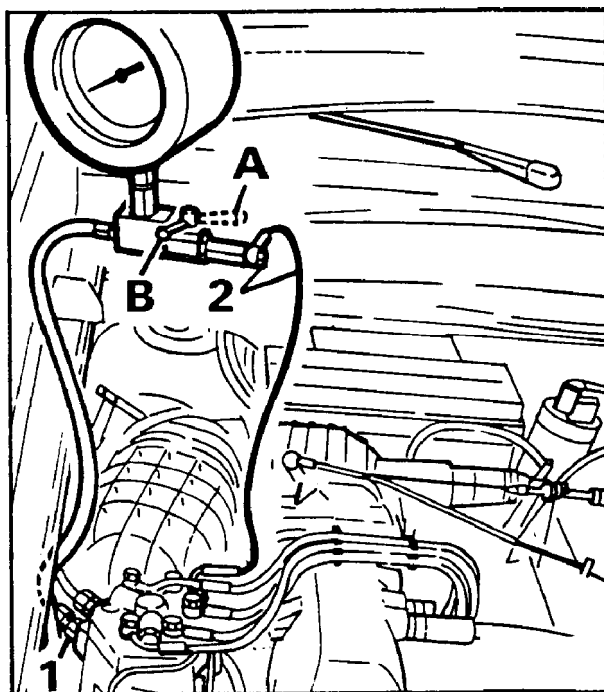


Fig. 3: Checking Fuel System Pressure
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2) Switch OFF (US 4480/3) remote control. Remove fuel pump relay and jump socket with (US 4480/3) remote control. Remove harness connector from differential pressure regulator. Open valve on pressure gauge (VW 1318). Turn ON remote control (US 4480/3). System pressure reading should be 75-82 psi (5.2-5.7 kg/cm²).

3) If pressure reading is low, check fuel pump delivery quantity. If okay, replace fuel pressure regulator.

4) If pressure is above specifications, disconnect fuel tank return line from fuel pressure regulator and repeat test. System pressure must be 75-82 psi (5.2-5.7 kg/cm²). If pressure is okay, check for plugged fuel return line. If pressure is not within specifications, replace fuel pressure regulator.

NOTE: System pressure is NOT adjustable on Quantum/Quantum Synchro models.

Differential (Control) Pressure

1) Close valve on pressure gauge. Activate fuel pump with jumper switch. Leave differential pressure regulator disconnected. Differential pressure reading should be 2.9-7.0 psi (.2-.5 kg/cm²) less than system pressure. If pressure is incorrect, disconnect lower chamber return line and measure volume.

2) Close open port to diaphragm pressure regulator. Activate fuel pump with jumper switch. Fuel volume should be .14-.16 qts. (.13-.15L) for period of one minute. If volume is correct, replace differential pressure regulator. If volume is incorrect, replace fuel distributor.

3) Close valve on pressure gauge. Install Test Harness (1315A/1) between differential pressure regulator and vehicle harness. Set multimeter to DCA 200 mA scale. Connect multimeter to test harness. Disconnect wiring to coolant temperature sensor. Connect 15, 000-ohm side of Test Resistor (VW 1490) to sensor wiring.

4) Turn on ignition and fuel pump. Differential pressure should be 10-17.5 psi (.7-1.2 kg/cm²) less than system pressure. Differential pressure regulator current should be 50-80 mA. If pressure is incorrect and current is correct, replace differential pressure regulator.

5) If both pressure and current readings are incorrect, remove test harness from differential pressure regulator. Check resistance of differential pressure regulator, which should be 17.5-21.5k ohms. If reading is incorrect, replace differential pressure regulator.

6) If reading is correct, check ground from temperature sensor to cold start valve. If ground is good, check power supply fuse. If fuse is okay, check terminals on ECU connector. If connector is okay, replace ECU.

Residual Pressure & Internal Leak Testing

1) Open valve on pressure gauge. Operate fuel pump for 30 seconds. Pressure can drop to a minimum of 38 psi (2.7 kg/cm²) after 10 minutes. If pressure drops below specification, inspect fuel pump check valve and all fuel fittings for leakage.

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NOTE: Pressure and leak testing does not include checking cold start valve.

2) If there are no leaks, check sensor plate clearance. If plate clearance is correct, replace diaphragm pressure regulator and repeat leak test. If pressure drop is not within specification, replace fuel distributor "O" rings.

Transfer Pump Delivery Volume

1) Check voltage supply to pumps. Connect Jumper Switch (US 4480/3) in place of fuel pump relay, on relay panel. Remove fuel filler cap. Disconnect and plug off Black fuel line from sending unit.

2) Connect hose to sender port and place opposite end in measuring container. Turn on fuel pumps. Minimum transfer pump delivery volume should be .42 qts. (.4L) in 10 seconds. Reconnect fuel line to sender.

Main Pump Delivery Volume

1) Check transfer pump (if equipped) and fuel filter. Disconnect fuel return line and place open end in measuring container. Switch on fuel pump with jumper switch. Check fuel pump delivery volume for 30 second period. Delivery rates are given with voltage reading at pump as volume will change with different voltages.

2) Minimum delivery volume for Volkswagen Quantum models is .71 qts. (.68L) for 30 seconds with reading of 11.4 volts at fuel pump. Minimum delivery volume for Volkswagen models using 52 mm fuel pump is .62 qts. (.59L) for 30 seconds with reading of 11.4 volts at fuel pump. Voltage is measured with engine off and fuel pump activated by jumper switch.

Injector Quantity Comparison

1) Remove fuel pump relay, from relay panel, and install Jumper Switch (US 4480/3) in off position in place of relay. Attach Fuel Quantity Analyzer (US 4480) to bumper and secure in place. Remove injectors from cylinder head with fuel lines attached. Check and replace fuel injector "O" rings as necessary.

2) Check tightness of injector insert (2-piece inserts). If inserts are loose, remove and clean threads. Use sealing compound when installing upper insert. Replace sealing washer that goes against cylinder head below lower portion of insert. Lubricate injector "O" rings with gasoline and install injectors, with fuel lines connected, into fuel quantity analyzer tubes.

3) Ensure lines are not kinked or bent. Loosen fittings to align fuel lines and retighten. Remove rubber boot from airflow sensor housing above sensor plate. Turn and lift setting screw and adjusting slide of Sensor Plate Adjustable Holder (VW 1348/1) into upper position. This simulates full throttle operation. See Fig. 4.

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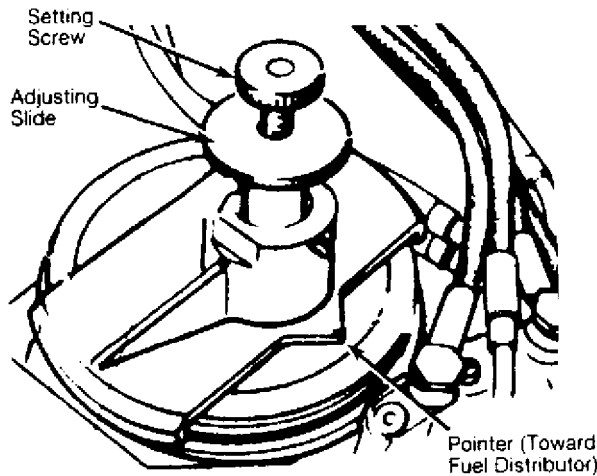


Fig. 4: Sensor Plate Adjustable Holder (VW 1348/1)
Pointer must face toward center of fuel distributor.

4) Place sensor plate adjustable holder on airflow sensor housing with holder centered over plate. Pointer on edge of holder base must point toward center of fuel distributor. Push adjusting slide of holder down onto stop.

5) Turn adjusting screw clockwise until magnetic end touches sensor plate retaining bolt. Activate fuel pump with jumper switch. Turn adjusting screw of holder counterclockwise until any one injector starts to deliver fuel. Turn off jumper switch and empty fuel quantity analyzer into fuel tank.

6) Idle injection quantity is measured first. Lifting adjusting slide of holder to first stop simulates idle position of sensor plate. Activate fuel pump with jumper switch until fuel level reaches 20 ml on scale of any tube for quantity comparison.

7) Check that all injectors have identical spray patterns that are even and cone-shaped. If not, raise sensor plate up quickly to full lift position and release. Repeat idle quantity test. Compare amounts of fuel delivered by all injectors with analyzer held level. Maximum difference in delivery quantity between injectors is 3.0 ml of fuel.

8) If fuel delivery quantity differs between high and low levels by more than 3.0 ml, interchange injectors and repeat test. If difference of delivery quantity changes with injectors, replace injectors. If difference of delivery quantity does not change with movement of injectors, either fuel lines are pinched or fuel distributor is defective.

9) Measure full throttle injection quantity. Empty analyzer into fuel tank and reinstall injectors in analyzer. Lift adjusting slide of holder to last stop to simulate full throttle position of sensor plate. Activate fuel pump with jumper switch until fuel level reaches 80 ml on scale of any tube of analyzer.

10) Check that all injectors have identical spray patterns that are even and cone-shaped. If not, raise sensor plate up quickly to full lift position and release. Repeat full throttle quantity test. Compare amounts of fuel delivered by all injectors with analyzer held level. Maximum difference in delivery quantity between injectors is 8.

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0 ml of fuel.

11) If fuel delivery quantity differs between high and low levels by more than 8.0 ml, interchange injectors and repeat test. If difference of delivery quantity changes with injectors, replace injectors. If difference of delivery quantity does not change with movement of injectors, either fuel lines are pinched or fuel distributor is defective.

12) Check fuel injectors for leakage immediately after delivery quantity test is complete. Set sensor plate in rest position. Activate fuel pump with jumper switch for 2 minutes. Injectors should not drip. Replace injectors that do drip.

ELECTRICAL COMPONENTS

System Testing

Following VOLTAGE CHECKS and RESISTANCE CHECKS charts show procedure for checking CIS-E system components from ECU connector. ECU connector terminal numbers are called out in testing procedures. Ignition MUST be off whenever ECU connector is disconnected or reconnected. Use care to avoid any terminal damage when testing, removing or attaching connectors.

Always check all connections used in test procedure. If readings are incorrect, disconnect terminals and determine if wiring or components are at fault. High tension lead should be disconnected at ignition distributor end and connected to ground. Use Digital Multimeter (US 1119).

THERMO-TIME SWITCH - OPERATIONAL TIME

XX

Temperature	Seconds
-------------	---------

-40F (-20C)	5-11
14F (-10C)	4-9
32F (0C)	3-7.5
50F (10C)	2-6.5
68F (20C)	1-4
86F (30C)	0-2
104F (40C)	0

XX

FOX CIS-E INJECTION - RESISTANCE CHECKS (1)

XX

Ohmmeter Between Terminals	No. 2 & No. 15
Components Checked	Ground Connection
Specifications	Reading of zero ohms

Ohmmeter Between Terminals	No. 9 & No. 15
Components Checked	Ground Connection
Specifications	Reading of zero ohms

Ohmmeter Between Terminals	No. 7 & No. 8
Components Checked	02 Sensor Shield

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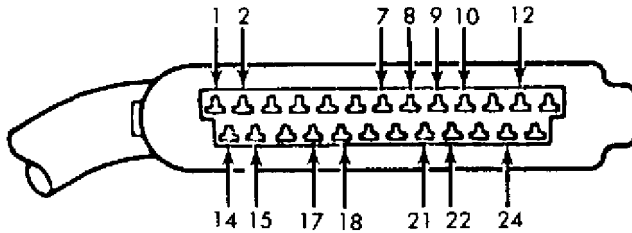
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Terminal Pin No. 1 = 12 Volts (+) From Ignition Switch
Terminal Pin No. 2 = Ground (-) Connection at Intake Manifold

Fig. 5: Fox - ECU Connector

VOLKSWAGEN - (16 VALVE) INJECTION VOLTAGE CHECKS (1)

AA

Voltmeter Between Terminals No. 1 & 2
Test Conditions Ignition on
Specifications Battery voltage

Voltmeter Between Terminals No. 2 & 3
Test Conditions Ignition on
Specifications Battery voltage

Voltmeter Between Terminals No. 2 & 4
Test Conditions Ignition on
Specifications Battery voltage

Voltmeter Between Terminals No. 2 & 5
Test Conditions Ignition on, operate full throttle
switch to full on position.
Specifications Battery voltage

Voltmeter Between Terminals No. 2 & 13
Test Conditions Ignition on. Throttle at idle
position, ensure idle switch is on.
Specifications Battery Voltage

Voltmeter Between Terminals No. 2 & 24
Test Conditions Operate Starter
Specifications Minimum 8 Volts

Voltmeter Between Terminals No. 2 & 25
Test Conditions Use LED Tester (US 1115),
operate starter.
Specifications LED must flicker. Test Hall signal
from ignition control unit.

Voltmeter Between Terminals (2) No. 2 & 6
Test Conditions With ignition on, switch on A/C.
Specifications Battery voltage

Voltmeter Between Terminals (2) No. 2 & 16
Test Conditions With ignition on, switch on A/C.

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Specifications Battery voltage

Voltmeter Between Terminals (2) No. 2 & 19

Test Conditions With ignition on, switch on A/C.

Specifications Battery voltage

- (1) - TESTING CONDITIONS: Disconnect CIS-E ECU connector with ignition off. Remove high tension lead from ignition distributor coil and connect to ground. Set multimeter to 20-volt DC scale.

- (2) - Vehicles With A/C.

AA

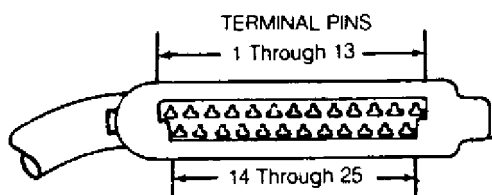


Fig. 6: ECU Connector - Terminal PIN Numbering

VOLKSWAGEN - (16 VALVE), INJECTION RESISTANCE CHECKS (1)

AA

Ohmmeter Between Terminals No. 2 & 7

Components Checked

Specifications Continuity

Ohmmeter Between Terminals No. 2 & (2) 9

Components Checked

Specifications Continuity

Ohmmeter Between Terminals No. 2 & 15

Components Checked

Specifications Continuity

Ohmmeter Between Terminals No. 2 & 20

Components Checked

Specifications Continuity

Ohmmeter Between Terminals No. 2 & 8

Components Checked Disconnect O2 sensor,
ground Green wire

Specifications Continuity

Ohmmeter Between Terminals No. 2 & 8

Components Checked Reconnect O2 sensor

Specifications Infinity ohms

Ohmmeter Between Terminals No. 10 & 12

Components Checked

Specifications 17.5-21.5 ohms

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Ohmmeter Between Terminals No. 14 & 17
Components Checked
Specifications Less than 1K ohms

Ohmmeter Between Terminals No. 17 & 18
Components Checked
Specifications Greater than 4K ohms

Ohmmeter Between Terminals No. 2 & 21
Components Checked (Temperature Sensor)
Specifications See Temp. Sensor Testing

(1) - TESTING CONDITIONS: Disconnect CIS-E ECU connector with
ignition off. Set multimeter ohm scale.

(2) - Connect to terminal No. 22 on Jetta GLI (16 Valve).

AA

GOLF GTI & JETTA GLI - INJECTION SYSTEM VOLTAGE CHECKS (1)

AA

Voltmeter Between Terminals No. 1 & No. 2
Components Checked Voltage Supply To ECU
Specifications Battery voltage with ignition on. If
not, check fuse 18. If fuse good, check open
ground circuit between intake manifold and ECU.

Voltmeter Between Terminals No. 1 & No. 2
Components Checked Voltage Supply From Starter
Specifications Minimum of 8 volts with starter
cranking. If not, check wiring to 15 and
"X" terminals reversed on relay board. See
wiring diagram.

Voltmeter Between Terminals No. 2 & No. 3/No.2 & No. 4
Components Checked Idle Stabilizer Control Valve & Wiring
Specifications Battery voltage with ignition on. If not,
check middle (voltage supply) wire of connector
for control valve. If center wire good, wire 3 or
4 to control valve is open. If wiring is good,
control valve is defective and should be replaced.

Voltmeter Between Terminals No. 2 & No. 5
Components Checked Full Throttle Switch & Wiring
Specifications Battery voltage with ignition on and
full throttle switch actuated. If not, check
middle (voltage supply) wire of connector for
throttle switch. If center wire good, wire 5
to full throttle switch is open. If wiring is
good, full throttle switch is defective (due
to no continuity) and should be replace.

Voltmeter Between Terminals No. 2 & No. 13
Components Checked Idle Switch & Wire 13

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Specifications Battery voltage with ignition on and idle switch activated by throttle lever. If not, wire 13 to idle switch is open. If wire good, idle switch is incorrectly adjusted or bade.

Voltmeter Between Terminals No. 2 & No. 6
Components Checked A/C Voltage Signal
Specifications Battery voltage with ignition and A/C on. If not, check A/C fuse. If good, check wiring bridge between wires 6 and 16. Check wires 16 and 19 to A/C.

Voltmeter Between Terminals No. 2 & No. 16
Components Checked A/C Voltage Signal
Specifications Battery voltage with ignition and A/C on. If not, check A/C fuse. If good, check wiring bridge between wires 6 and 16. Check wires 16 and 19 to A/C.

Voltmeter Between Terminals No. 2 & No. 19
Components Checked A/C Voltage Signal
Specifications Battery voltage with ignition and A/C on. If not, check A/C fuse. If good, check wiring bridge between wires 6 and 16. Check wires 16 and 19 to A/C.

Voltmeter Between Terminals No. 2 & No. 24
Components Checked Wiring Between Starter & ECU
Specifications Minimum 8 volts with starter cranking. If not, check wire 24 for open. If wire is good, starter solenoid switch is defective and should be replaced.

Voltmeter Between Terminals No. 2 & No. 25
Components Checked Hall RPM Signal & Ignition ECU
Specifications Voltage display must fluctuate with starter cranking. If not, check wire 25 to ignition ECU for open. If wire 25 good, check wiring between ignition distributor and ignition ECU. If wiring is good, Hall sensor is defective and should be replaced. If wiring and Hall sensor are good, ignition ECU is defective and should be replaced.

(1) - TESTING CONDITIONS: Disconnect and ground high tension lead at ignition distributor end. Unplug ECU connector with ignition off. Set multimeter to 20-volt DC scale.

AA

GOLF GTI & JETTA GLI - INJECTION SYSTEM RESISTANCE CHECKS (1)

AA

Ohmmeter Between Terminals No. 2 & No. 15
Components Checked Ground Cable Bridge
Specifications Reading of zero ohms

Ohmmeter Between Terminals No. 2 & No. 9
Components Checked M/T Models Only

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Specifications Reading of zero ohms

Ohmmeter Between Terminals No. 2 & No. 22

Components Checked A/T Models Only

Specifications Reading of zero ohms

Ohmmeter Between Terminals No. 7 & No. 2

Components Checked 02 Sensor Wire Shield

Specifications Reading of infinity ohms

Ohmmeter Between Terminals No. 2 & No. 8

Components Checked 02 Sensor & Wiring

Specifications Reading of zero ohms with Green 02
lead disconnected and grounded. If
not, Green wire has open.

Ohmmeter Between Terminals No. 2 & No. 8

Components Checked 02 Sensor & Wiring

Specifications Reading of infinity ohms with Green
02 lead connected to harness. If not,
02 is defective and should be replaced.

Ohmmeter Between Terminals No. 10 & No. 12

Components Checked Differential Pressure Reg. & Wiring

Specifications Reading of 17-22 ohms. If not, check
wire 10 or 12 for open. If wires are
good, differential pressure regulator
is defective and should be replaced.

Ohmmeter Between Terminals No. 14 & No. 17

Components Checked Potentiometer & Wiring (2)

Specifications Reading of less than 1000 ohms with
airflow sensor plate in rest position. If not,
check wires 14, 17 and 18 for open. If wires
are good, adjust or replace potentiometer.

Ohmmeter Between Terminals No. 17 & No. 18

Components Checked Potentiometer & Wiring (2)

Specifications Reading of more than 4000 ohms with airflow
sensor plate lifted away from rest position.
If not, check wires 14, 17, and 18 for open. If
wires are good, adjust or replace potentiometer.

Ohmmeter Between Terminals No. 2 & No. 21

Components Checked Temperature Sensor & Wiring

Specifications Reading of 6k ohms at 32°F (0°C). Reading of
2.5K ohms at 68°F (20°C). Reading of 300 ohms at
176°F (80°C). If readings are incorrect, check
ground line (wire 21) between intake manifold and
ECU. If wiring is good, temperature sensor is
defective and should be replaced.

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(1) - TESTING CONDITIONS: Disconnect and ground high tension lead at ignition distributor end. Unplug ECU connector with ignition off. Set multimeter to 20k ohm scale. Prevent ohmmeter damage by checking ONLY terminals listed.

(2) - Potentiometer terminals No. 1, 2 and 3 are connected respectively to terminals No. 18, 17 and 14 on ECU connector.

XX

QUANTUM 5-CYLINDER RESISTANCE CHECKS (1)

XX

Ohmmeter Between Terminals No. 2 & No. 22
Components Checked Ground Bridge
Specifications Reading of zero ohms. If not, check
for open in bridge across terminals.

Ohmmeter Between Terminals No. 2 & No. 15
Components Checked Ground Bridge
Specifications Reading of zero ohms. If not, check
for open in bridge across terminals.

Ohmmeter Between Terminals No. 7 & No. 8
Components Checked 02 Sensor Wire
Specifications Reading of infinity ohms. If not, check
for open circuit in 02 sensor lead.

Ohmmeter Between Terminals No. 2 & No. 8
Components Checked 02 Sensor Wiring
Specifications Reading of zero ohms with Green 02 sensor
lead unplugged and grounded. If not, check
for open in circuit in Green 02 sensor lead.

Ohmmeter Between Terminals No. 10 & No. 12
Components Checked Differential Pressure Reg. & Wiring
Specifications Reading of 17.5-21.5 ohms. If not, check for
open in circuit between regulator and ECU. If wiring
is good, replace differential pressure regulator.

Ohmmeter Between Terminals No. 14 & No. 17
Components Checked Potentiometer & Wiring
Specifications Reading below 12 k/ohms with airflow sensor
plate in rest position and altitude sensor
unplugged. If not, check wiring to terminals
No. 14 and 17 for opens. If wiring is good,
adjust or replace airflow sensor plate
potentiometer.

Ohmmeter Between Terminals No. 17 & No. 18
Components Checked Potentiometer & Wiring
Specifications Reading above 35 k/ohms with airflow sensor
plate in rest position and altitude sensor
unplugged. If not, check wiring to terminals
No. 14 and 17 for opens. If wiring is good,

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adjust or replace airflow sensor plate
potentiometer.

Ohmmeter Between Terminals No. 18 & No. 14
Components Checked Altitude Sensor
Specifications Reading of 21-26 k/ohms with potentiometer
unplugged. If not, check for open circuit in
wiring. If wiring is good, replace altitude
sensor.

Ohmmeter Between Terminals No. 11 & No. 14
Components Checked Altitude Sensor
Specifications Reading of 200-38,000 ohms with potentiometer
unplugged. If not, check for open circuit in
wiring. If wiring is good, replace altitude
sensor.

Ohmmeter Between Terminals No. 21 & No. 2
Components Checked Temperature Sensor
Specifications Reading of 2.5 k/ohms at 68°F (20°C).
Resistance reading should be higher at lower
temperatures and lower at higher temperatures.
If not, check for open circuit in wiring. If
wiring is good, replace temperature sensor.

Ohmmeter Between Terminals No. 1 & No. 5
Components Checked Full Throttle Switch
Specifications Reading of zero ohms with switch in full
throttle position. Reading of infinity with full
throttle switch in closed position. If not, check
wiring for open circuit. If wiring is good, adjust
or replace full throttle switch.

Ohmmeter Between Terminals No. 1 & No. 13
Components Checked Idle Switch
Specifications Reading of zero ohms with switch in idle
position. Reading of infinity with switch in any
open throttle position. If not, check wiring for
open circuit. If wiring is good, adjust or replace
idle switch.

(1) - TESTING CONDITIONS: Disconnect and ground high tension lead
at ignition distributor end. Unplug ECU connector with
ignition off. Set multimeter to 20-k/ohm scale. Prevent
ohmmeter damage by checking ONLY terminals listed.

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Fuel Pump Relay - 4-Cylinder Models

NOTE: No testing procedure was available from manufacturer for
5-cylinder Volkswagen models.

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1) Remove fuel pump relay from relay board. Turn ignition on. Using multimeter, measure voltage at following relay board sockets: between terminal No. 2 and ground, between terminals No. 2 and 1 and between terminals No. 4 and 1. Reading should be battery voltage or slightly less.

2) If reading is low or zero, check wiring. Refer to appropriate WIRING DIAGRAM in this article to check circuits. Measure voltage between relay board sockets No. 5 and 1. Battery voltage should be present. If reading is correct, ground middle wire of ignition distributor connector.

3) Voltage reading should drop for short time. If reading does drop, replace relay. Reading should be battery voltage or slightly less.

4) If reading is low or zero, check wiring. Refer to appropriate WIRING DIAGRAM in this article to check circuits. Measure voltage between relay board sockets No. 5 and 1. Battery voltage should be present. If reading is correct, ground middle wire of ignition distributor connector.

5) Voltage reading should drop for short time. If reading does drop, replace fuel pump relay and check Hall sender. If reading does not drop, check Hall ignition ECU.

Cold Start Enrichment

Connect test harness between differential pressure regulator and vehicle harness. See Fig. 7. Connect multimeter to test harness. Disconnect wiring from coolant temperature sensor. Turn ignition on. Differential pressure regulator current should be 80-110 mA. If not, replace ECU.

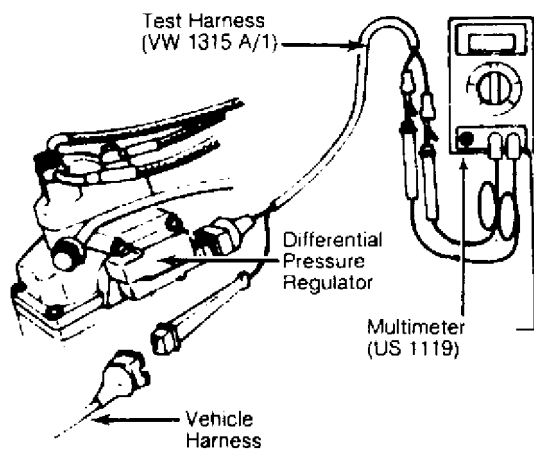


Fig. 7: Connecting Multimeter to Differential Pressure Regulator

Cold Acceleration Enrichment

1) Connect test harness between differential pressure regulator and vehicle harness. Connect multimeter to test harness. Disconnect wiring from coolant temperature sensor. Remove intake air boot.

2) Turn ignition on and lift sensor plate quickly to full open position. Differential pressure regulator current should increase to more than 110 mA, and drop back to 80-110 mA range. If not, check

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potentiometer and wiring to ECU. If potentiometer and wiring are good, replace ECU.

After Start Enrichment

1) Connect test harness between differential pressure regulator and vehicle harness. Connect multimeter to test harness. Disconnect wiring from coolant temperature sensor. Ground high tension lead (terminal No. 4) from ignition distributor.

2) Crank starter for 3 seconds. Return key to "ON" position. Differential pressure regulator current reading should increase to more than 120 mA for 20-50 seconds, and return to 80-110 mA range.

3) If not, check starter signal to terminal No. 24 of ECU connector. Check signal from relay board to starter motor (terminal No. 15a on starter). On 5-cylinder models, check voltage between ECU terminals No. 2 and 21. See VOLTAGE CHECKS and RESISTANCE CHECKS CHARTS in this article for appropriate testing procedure. If all wiring is okay, replace ECU.

Starting Enrichment - 5-Cylinder Models

1) Connect test harness between differential pressure regulator and vehicle harness. Connect multimeter to test harness. Disconnect wiring from coolant temperature sensor. Plug jumper end of Test Resistor (VW 1490) into harness connector of temperature sensor. Activate starter for 3 seconds.

2) Current reading should be more than 70 mA for first 1.5 seconds of starter operation. If not, check for open circuit between terminal No. 24 on ECU connector and terminal No. 15a on starter. If starter circuit is okay, check between terminals No. 2 and 21 on ECU connector. If wiring is okay, replace ECU.

Full Throttle Enrichment

1) Connect test harness between differential pressure regulator and vehicle harness. Connect multimeter to test harness. Disconnect wiring from coolant temperature sensor. Plug jumper end of test resistor into harness connector of temperature sensor. Unplug oxygen sensor. Turn ignition on.

2) Activate full throttle switch. Current reading should increase 3 mA when switch is activated. If not, check full throttle switch. See ADJUSTMENTS in this article.

3) If switch is functioning and adjusted correctly, check for open circuit between terminals No. 5 and 2 on ECU connector and terminals on full throttle switch. If wiring is good, replace ECU.

Deceleration Fuel Shut-Off Check

1) Engine oil temperature must be at minimum of 120°F (50°C). Reconnect wiring to temperature sensor. Start engine and run it at 2000 RPM briefly. Release throttle.

2) Differential pressure regulator current reading should briefly be negative (-30 to -60 mA) and return to positive when engine reaches approximately 1300 RPM. If not, check for open idle switch signal at ECU connector terminals No. 2 and 13. If switch is good, replace ECU.

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Altitude Sensor

- 1) Disconnect distributor high tension lead from distributor and connect to ground. Remove glove compartment and disconnect main connector from MCU. Disconnect connector terminal from potentiometer.
- 2) Measure resistance between connector pins No. 14 and 18 of the main connector. Resistance should be 2.1-2.6K ohms.
- 3) Measure resistance between connector pins No. 11 and 14. Resistance should be 200-3.6K ohms.
- 4) If resistance is not to specification check wiring continuity. If wires have continuity replace altitude sensor.

Idle Speed Stabilizer Valve

- 1) Connect Tester (VW 1367) using Cable Adapter (US 1112). Connect ohmmeter between terminal No. 1 of test connector and terminal No. 15 of main ECU connector. With stabilizer valve disconnected there should be continuity between these terminals.
- 2) Connect ohmmeter to terminal No. 2 of the test connection and terminal No. 3 of the central connector. With stabilizer valve disconnected there should be continuity between these terminals. Check and repair any open circuits using wiring diagrams for reference.
- 3) With stabilizer valve disconnected, connect voltmeter between terminal No. 2 of the idle stabilizer valve connector and ground. With ignition on, battery voltage should be present. See Fig. 8.
- 4) With ignition off, check for continuity between terminal No. 3 of the of the idle stabilizer valve connector and terminal No. 3 of the main ECU connector. Check for continuity between stabilizer connector terminal No. 1 and ECU connector No. 4.
- 5) Correct any open circuits and reconnect idle stabilizer valve connector. Connect ohmmeter between terminals No. 3 and 4 of the main ECU connector. Resistance specification is 24-30 ohms. Replace idle stabilizer valve if not within specification.

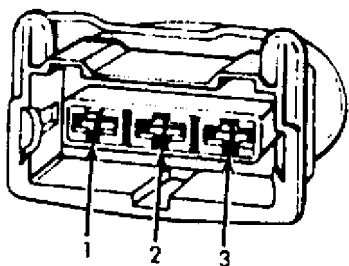


Fig. 8: Terminal Pins Idle Stabilizer Valve Connector ID

Oxygen Sensor

- 1) Before testing oxygen sensor, ensure the following conditions are met: engine oil temperature is at 176°F (80°C) minimum, radiator fan must cycle at least once, pressure gauges NOT connected, exhaust system free of leaks, oxygen sensor control working correctly, oxygen sensor heating element functional, all electrical units turned off (radiator fan and A/C must be off during test), and engine speed at 3000 RPM for 2 minutes.

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2) Connect test harness between differential pressure regulator and vehicle harness. Connect multimeter to test harness. Run engine at idle. After 2 minutes running time, oxygen sensor will be operational.

3) Check current reading at 3000 RPM. If reading fluctuates, oxygen sensor is good. If reading does not fluctuate at 3000 RPM, replace oxygen sensor.

Idle Speed Boost Valves

1) To test boost valve No. I, engine oil temperature must be at 176°F (80°C) minimum. If equipped, A/C system must be off. Run engine at idle speed. Turn on all electrical units except A/C system. Turn in idle speed adjusting screw to lower idle. At 750 RPM, boost valve No. I should open and idle speed will increase.

2) Pinch shut outlet air hose after "T" connector. Engine speed should drop. Leaving air hose pinched shut, raise engine idle speed to 870-930 RPM. Open air hose. Idle speed should increase. When 1050 RPM is reached, boost valve No. I should close and engine speed should drop to 870-930 RPM.

3) To check boost valve No. II (A/C equipped only), ensure A/C is off. Run engine at idle speed and pinch outlet air hose shut. Engine speed should not change. When A/C is switched on with air hose pinched shut, idle speed should drop.

Idle Speed Stabilization System

1) Engine oil temperature must be at 176°F (80°C) minimum. Ignition timing point is 4-8 degrees BTDC. A/C must be off. Connect Dwell Meter (VW 1367) using Adapter Cable (US 1112). Set "%" button on dwell meter and check duty cycle.

2) Reading should be 26-30% with oxygen sensor connected. Idle speed should be 800-900 RPM. If not, adjust duty cycle.

3) If reading shows 33% or 40%, ensure A/C is switched off. If A/C is off, check idle throttle switch function. Check for open circuit between idle switch and ECU connector.

4) If reading is fluctuating between 20-25%, check for open circuit in RPM signal from ignition ECU. If reading is steady 25%, and idle speed is high. Check for air leaks in throttle body. If no leaks are found, check for open circuit between ECU and idle stabilizer control valve. If circuit is correct, replace idle stabilization valve.

5) Turn A/C on. Idle speed should increase by 100 RPM. If not, check for open circuit between A/C switch on dash and terminals No. 6 and 16 on ECU connector. Check for RPM increase of 100 RPM when A/C compressor cycles off.

6) If idle speed goes over 1000 RPM when A/C compressor switches off, check compressor signal wire to ECU. Wire should go to ECU connector terminal No. 19. Ensure it is connected to the correct terminal and not terminal No. 16. Check wiring diagram and correct.

Knock Sensor

1) With ignition off, disconnect knock sensor from control unit. Measure resistance between terminals No. 13 and 14. Type I

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sensor should have 300K ohms resistance. A Type II sensor should measure infinity. Reconnect sensor to control unit.

2) Connect LED Test Light (US 1115) to single lead (Brown) connector and to battery (+) voltage. LED must light.

CAUTION: Do not use a standard test light to test knock sensor. Higher voltage type light may damage control unit.

3) With engine running, LED should go out (may glow slightly). Increase engine RPM one time to 3000 RPM. If LED lights again connect a jumper wire between outside terminals of knock sensor connector and momentarily (3 seconds) ground (-) center terminal.

4) The LED light will blink on and off in a pattern. Blinking twice at intervals indicates a fault in the knock sensor (sensor defective, wiring, mounting torque) or defective control unit.

5) If the LED light blinks three times in intervals it indicates a break in the vacuum hose to the control unit or the control unit vacuum sensor is defective.

Knock Sensor Control Unit

1) Ensure ignition coil and TCI unit are okay. Remove connector from knock sensor and turn ignition on. Check for battery voltage between connector pins No. 3 and 5.

2) Measure battery voltage between terminals No. 6 and 3. Open throttle valve, voltage should drop to zero volts. If voltage does not drop to zero check throttle idle switch.

3) Measure voltage between terminals No. 8 and 3 while opening throttle. Battery voltage should be present at full throttle. If battery voltage is not present check full throttle switch.

4) Remove harness connector from TCI (Hall sender) at distributor. Turn ignition on and measure voltage between outer terminals of connector. Voltage should be 5 volts minimum. Turn ignition off.

5) With ignition on, check voltage between terminals No. 1 (-) and 15 (+) of ignition coil. Touch center terminal of connector from TCI to ground. Voltage should increase briefly to 2 volts minimum. If it does not, replace knock sensor control unit.

Throttle Valve Switch

See ADJUSTMENTS in this article for checking and adjusting procedure for idle and full throttle valve switches.

NOTE: CIS-E fuel injection maintains constant fuel pressure throughout system. Relieve pressure before opening system. DO NOT allow fuel to leak on engine or electrical parts. DO NOT allow any open flame near fuel system being serviced.

REMOVAL & INSTALLATION

FUEL DISTRIBUTOR

Removal

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1) Disconnect battery and remove air cleaner. Disconnect all fuel and injector lines from fuel distributor. Plug fuel supply and return lines. Catch any fuel spillage with rag.

2) Disconnect wiring from differential pressure regulator. Remove screws holding fuel distributor to airflow sensor housing. Remove fuel distributor by turning back and forth while lifting up.

Installation

1) Lightly lubricate new sealing "O" ring and mount on fuel distributor. Install fuel distributor. Ensure "O" ring is not damaged or air leaks will result. Connect all fuel lines except those to fuel injectors. Check sensor plate adjusting lever and fuel distributor control piston for smooth operation.

2) Remove fuel pump relay and bridge fuel pump circuit. Use Jumper Switch (US 4480/3) in place of fuel pump relay. When pressure has built up, turn off fuel pump. Move sensor plate from rest position to end of travel.

3) Uniform resistance should be felt during entire movement. No resistance should be felt on quick return to rest position. Connect injector lines. Install fuel pump relay. Start engine and check complete fuel system for leaks.

FUEL INJECTORS

Removal

Remove injectors from inserts in head with fuel lines attached. Using 13 mm hex head socket, remove inserts from head. Use 2 wrenches to remove injectors from lines.

Installation

To install, reverse removal procedures. Use 2 wrenches when tightening injector lines to injectors. Always use new "O" rings and lubricate them to ease installation. On Volkswagen models with 2-piece inserts, replace insert sealing washer (against head) and use sealing compound on upper insert threaded portion.

THROTTLE VALVE HOUSING (TVH)

Removal

1) Disconnect accelerator cable from linkage. Disconnect return spring on throttle valve housing. On vehicles with cruise control, remove connecting rod on throttle valve housing. Pull off vacuum hoses for ignition advance and fuel evaporation system purge line. Remove nuts holding throttle valve housing to airflow sensor housing.

2) Disconnect throttle valve switch. Remove 2 nuts holding throttle valve housing to metallic front vibration mounts. Disconnect fuel return hose from diaphragm pressure regulator. Lift sensor housing upward and remove throttle valve housing. Remove gasket between intake manifold and throttle valve housing.

Installation

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To install, reverse removal procedure. Use new gasket. Adjust accelerator linkage and idle speed.

AIRFLOW SENSOR PLATE

Removal

Remove air filter and unscrew stop bracket. Heat fastening bolt for airflow sensor plate with hot air blower to loosen locking compound. Remove bolt carefully to ensure threads are not damaged. Use a 6 mm tap to clean out threads for airflow sensor plate fastening bolt.

Installation

Insert airflow sensor plate (identified by 5 punch marks) in upward direction. Lightly tighten self-locking screw. Check that sensor plate is centered and rest position is correct. See ADJUSTMENTS in this article. To complete installation, reverse removal procedure.

AIRFLOW SENSOR POTENTIOMETER

Removal & Installation

Remove diaphragm pressure regulator. Remove insulating compound to uncover screws holding potentiometer to housing. Remove potentiometer. Do not touch or damage slide contact and conductor. To install, reverse removal procedure. Adjust potentiometer. See ADJUSTMENTS in this article.

KNOCK SENSOR

Removal & Installation

1) The knock sensor is attached at the front of the engine block. There are 2 types of sensors. The Type I sensor has its cable connection molded off center from the side of the sensor. No washers are used on fastening bolt. Tighten to 7-9 ft. lbs. (10-12 N.m).

2) The Type II sensor has its connector cable molding centered on the side of the connector. It is tight end to 11-18 ft. lbs. (15-25 N.m) without washers.

ADJUSTMENTS

AIRFLOW SENSOR PLATE

1) Check basic adjustment of sensor plate lever. With fuel distributor removed from airflow sensor housing, measure distance between roller on sensor plate lever and contact points of fuel distributor on top of airflow sensor housing.

NOTE: Always check sensor plate lever adjustment if fuel distributor or airflow sensor has been replaced.

2) Use a depth gauge or vernier caliper for measuring distance. See Fig. 9. Distance should be .74-.75" (18.9-19.1 mm). If

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distance is out of specified range, correct it with adjustment of mixture screw.

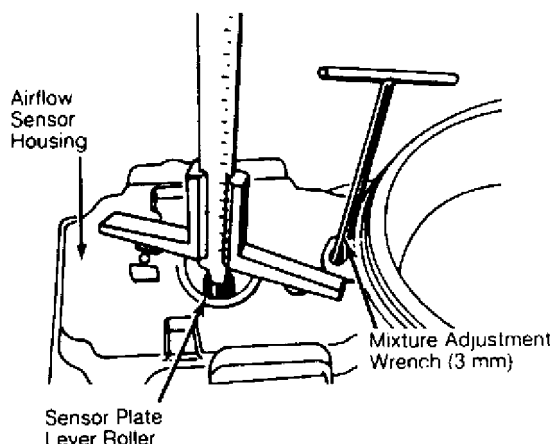


Fig. 9: Adjusting Sensor Plate Lever

Centering Sensor Plate & Lever

1) Check sensor plate for centered position in airflow sensor housing. If plate binds on housing or is off-center, remove 6 mm bolt holding plate to lever. Coat bolt with locking compound and install finger tight.

2) Use Centering Gauge (US 1109) or .004" (.10 mm) feeler gauges to set plate equidistant from sensor housing. If plate cannot be centered, remove airflow sensor housing to center sensor lever.

3) Turn housing upside-down and remove bolt clamping counterweight to sensor lever. Coat bolt with locking compound and install finger tight. Center sensor plate lever in housing and tighten clamping bolt. Complete centering of plate.

Sensor Plate Rest Position

Upper edge of sensor plate must be below lower edge of sensor cone .070-.080" (1.80-2.10 mm). See Fig. 10. If rest position is incorrect, raise sensor plate. Open or close wire clip to change position of sensor plate. DO NOT bend leaf spring.

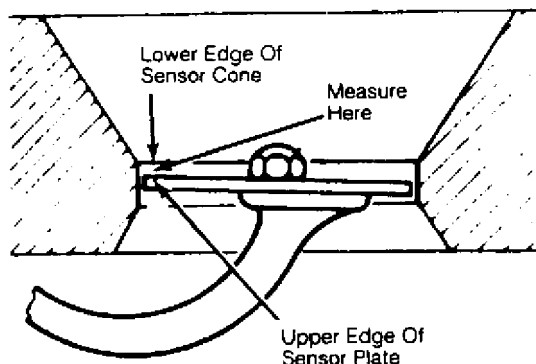


Fig. 10: Sensor Plate Rest Position

Sensor Plate Free Play

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1) Free play is between control piston and adjusting lever. Differential pressure regulator must have 4-16 mA current. Position of sensor plate lever must be correct. Measure free play on side of sensor cone closest to fuel distributor. See Fig. 11.

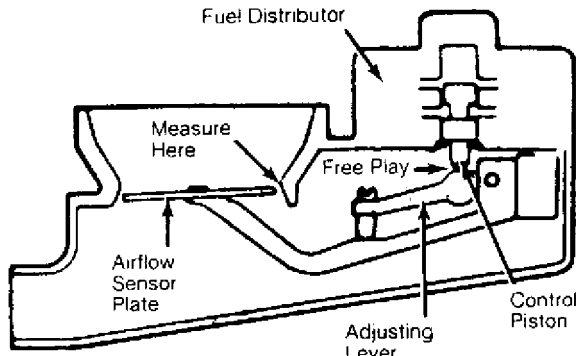


Fig. 11: Sensor Plate Free Play

2) Crank starter motor or use Jumper Switch (US 4480/3) for 10 seconds to develop fuel pressure. Lift sensor plate slightly until resistance is felt. Minimum clearance is any noticeable free play. Maximum clearance is .078" (2 mm) up to sensor cone.

3) If free play clearance is incorrect, remove fuel distributor. Check basic adjustment of sensor plate lever. Install fuel distributor and repeat free play clearance check. If still incorrect, adjust sensor plate clearance with control piston stop screw.

Sensor Plate Clearance Adjustment

1) Remove fuel distributor from airflow sensor housing. Turn distributor upside-down to access stop screw for control piston. This will adjust free play travel range of sensor plate lever.

2) Turning screw clockwise will increase clearance by keeping control piston higher in fuel distributor during operation. Turning screw counterclockwise will decrease clearance by allowing control piston to extend further out of fuel distributor during operation.

3) Adjusting stop screw 1/4 turn (90 degrees) will make .05" (1.3 mm) difference at sensor plate. Idle speed and CO (current reading) must be checked.

AIRFLOW SENSOR POTENTIOMETER

1) Check sensor plate rest position and adjust if necessary. Edge of plate closest to fuel distributor must be .069-.079" (1.75-2.05 mm) below lower edge of sensor housing venturi cone. Disconnect wiring from potentiometer. Connect Test Harness (VW 1501) to potentiometer, leaving vehicle harness plug disconnected.

2) Using Digital Multimeter (US 1119), measure resistance of potentiometer at terminals of test harness. Harness terminal No. 1 corresponds to potentiometer terminal No. 18; terminal No. 2 corresponds to potentiometer terminal No. 17; terminal No. 3 corresponds to potentiometer terminal No. 14.

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3) Reading should be greater than 4000 ohms with meter between harness terminals No. 1 and 2. Reading should be less than 1000 ohms with meter between terminals No. 2 and 3. Reading should increase evenly up to 4000 ohms as sensor plate is lifted smoothly. If readings are not correct, replace potentiometer.

4) Using Sensor Plate Adjustable Holder (VW 1348/1), lift sensor plate to lower edge (fuel distributor side) of airflow sensor housing. Install potentiometer. Partially tighten screws so that adjustment is possible. Connect multimeter between test harness terminal No. 2 and ground.

5) Set multimeter on 20 DCV scale and turn on ignition. Reading should be .2-.3 volts. If not, move potentiometer until reading is correct. Tighten mounting screws. To check adjustment, lift sensor plate to stop. Reading should be 7 volts. If correct, secure mounting screws with Loctite.

THROTTLE VALVE HOUSING

NOTE: Stop screw is set by manufacturer and should not be moved.

If basic factory setting has been changed, turn throttle stop screw counterclockwise until there is a gap between stop and screw. Turn screw in until it just touches stop. Turn screw 1/2 turn (180 degrees) further. Check and adjust idle speed and CO.

Idle Switch - Volkswagen GLI/GTI

1) Connect Test Harness (VW 1501) between vehicle harness and throttle switch lead. Turn ignition on. Connect voltmeter between terminal No. 1 of test harness and ground. If battery voltage is NOT present, check voltage supply between terminal No. 2 of test harness and ground.

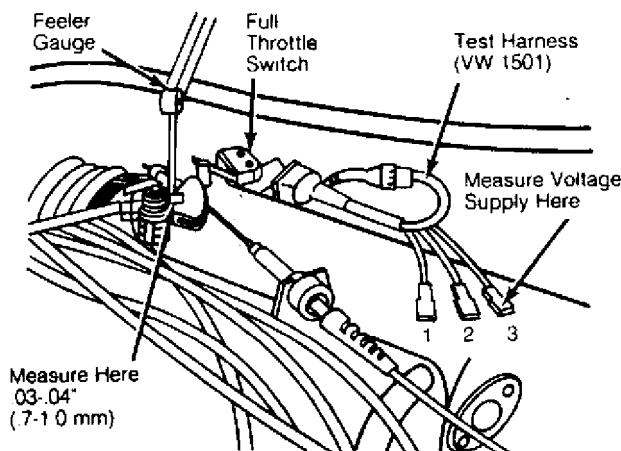


Fig. 12: Checking Throttle Idle Switch Adjustment

2) If battery voltage is NOT present, check and repair wiring. See VOLKSWAGEN GLI or GTI CIS-E WIRING DIAGRAM for wiring color and terminal numbers. Recheck voltage between terminal No. 1 and ground if wiring is repaired. If battery voltage is present, open and

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slowly close throttle valve.

3) Check switch-on point of idle switch, using feeler gauge between throttle lever and idle stop. Switch-on point gap should be .006-.002" (.15-.05 mm) before idle stop. If switch-on point is incorrect, loosen and adjust idle switch position. Idle switch is on underside of throttle valve housing, opposite idle stop.

Idle Switch - (Except Fox)

1) To check and adjust idle switch, loosen upper left bolt on throttle valve housing. Attach Protractor Pointer (3084) under bolt. Attach Protractor (3084) on primary throttle valve shaft, removing shaft nut if necessary. See Fig. 13.

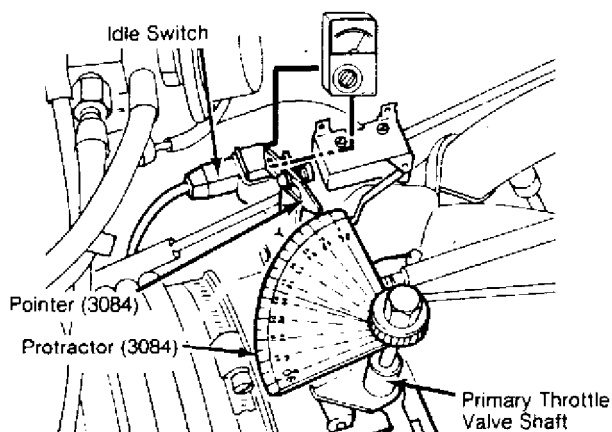


Fig. 13: Checking Throttle Valve Idle Switch Adjustment

2) Disconnect wiring to switch. Connect ohmmeter between terminals of switch. Set protractor so pointer is on "0" degrees. Open throttle to 20 degrees and close it slowly. Switch must have continuity from one degree to 2.5 degrees when opening.

3) If reading is incorrect, remove throttle valve housing. Loosen idle switch mounting screws and adjust switch position. See Fig. 14. Switch must close (continuity) before throttle control reaches idle stop position.

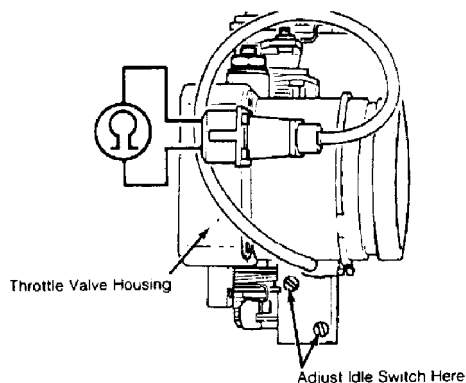


Fig. 14: Idle Switch Adjustment

Full Throttle Switch

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1) Attach protractor pointer to upper left bolt on throttle valve housing. Attach protractor to secondary throttle valve shaft. Remove shaft nut if necessary. Disconnect throttle switch wiring. Connect ohmmeter between switch terminals. See Fig. 15.

2) Set secondary throttle plate in full open position and move protractor until pointer is on "0" degrees. Allow secondary throttle valve to close about 30 degrees and reopen to full throttle position.

3) Ohmmeter must read zero ohms at 8-12 degrees before full throttle. Loosen mounting screws and adjust switch. Reading must be zero ohms (continuity) at full throttle position.

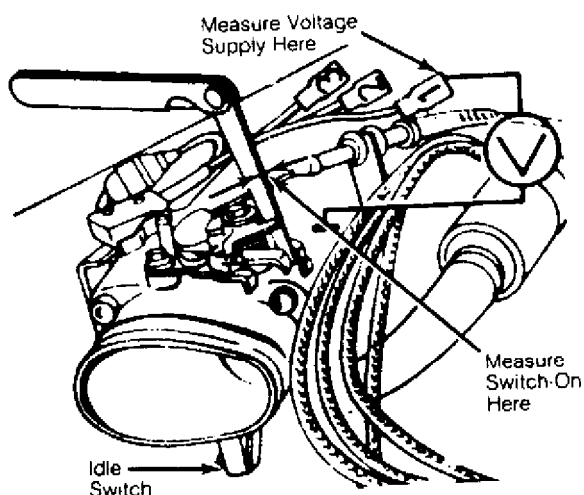


Fig. 15: Adjusting Full Throttle Switch

System Pressure

1) Check and note existing pressure. Remove pressure regulating valve from fuel distributor. See Fig. 16.

2) Adjust pressure by changing shims in shim stack. Add shims to raise system pressure. Remove shims to lower system pressure.

3) A shim change of .020" (.5 mm) will change system pressure approximately 4.2 psi. (.3 kg/cm²). Ensure any replacement shims are identical in diameter to existing shims.

WIRING DIAGRAMS

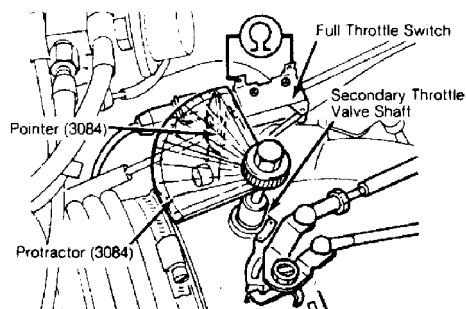


Fig. 16: Adjusting System Pressure

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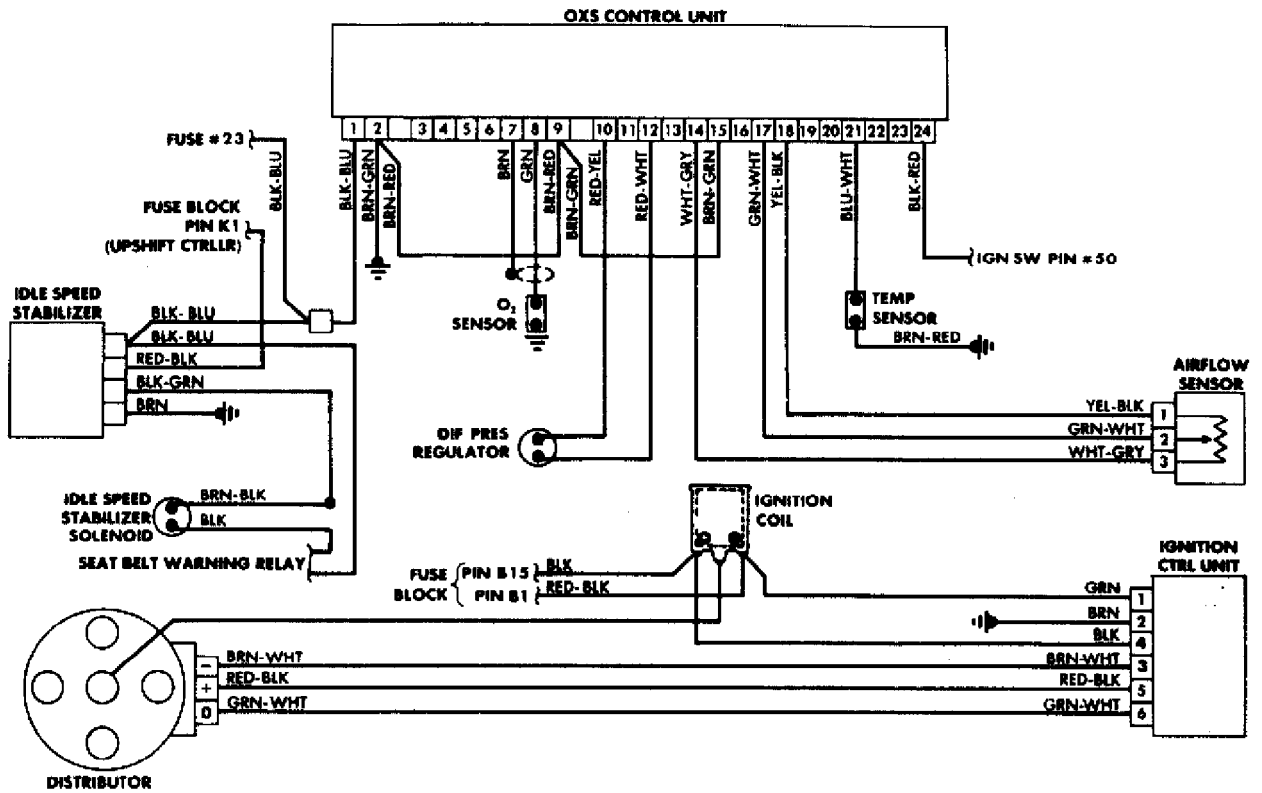


Fig. 17: Fox CIS-E Wiring Diagram

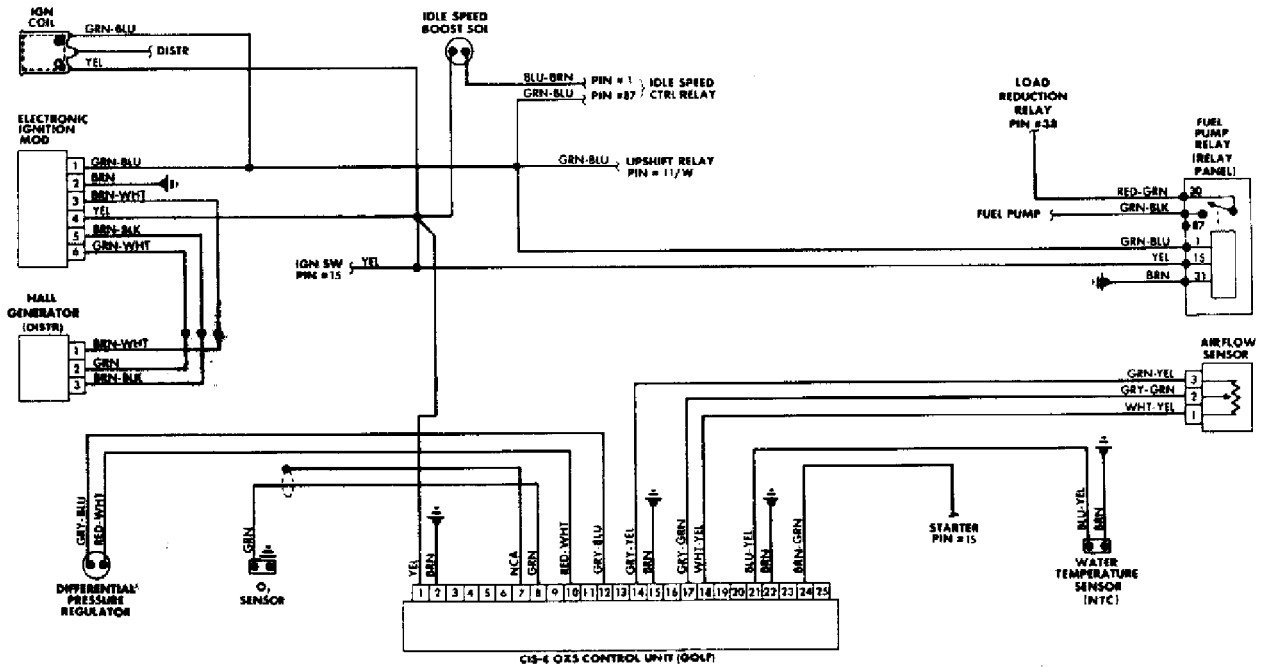


Fig. 18: Golf CIS-E Wiring Diagram

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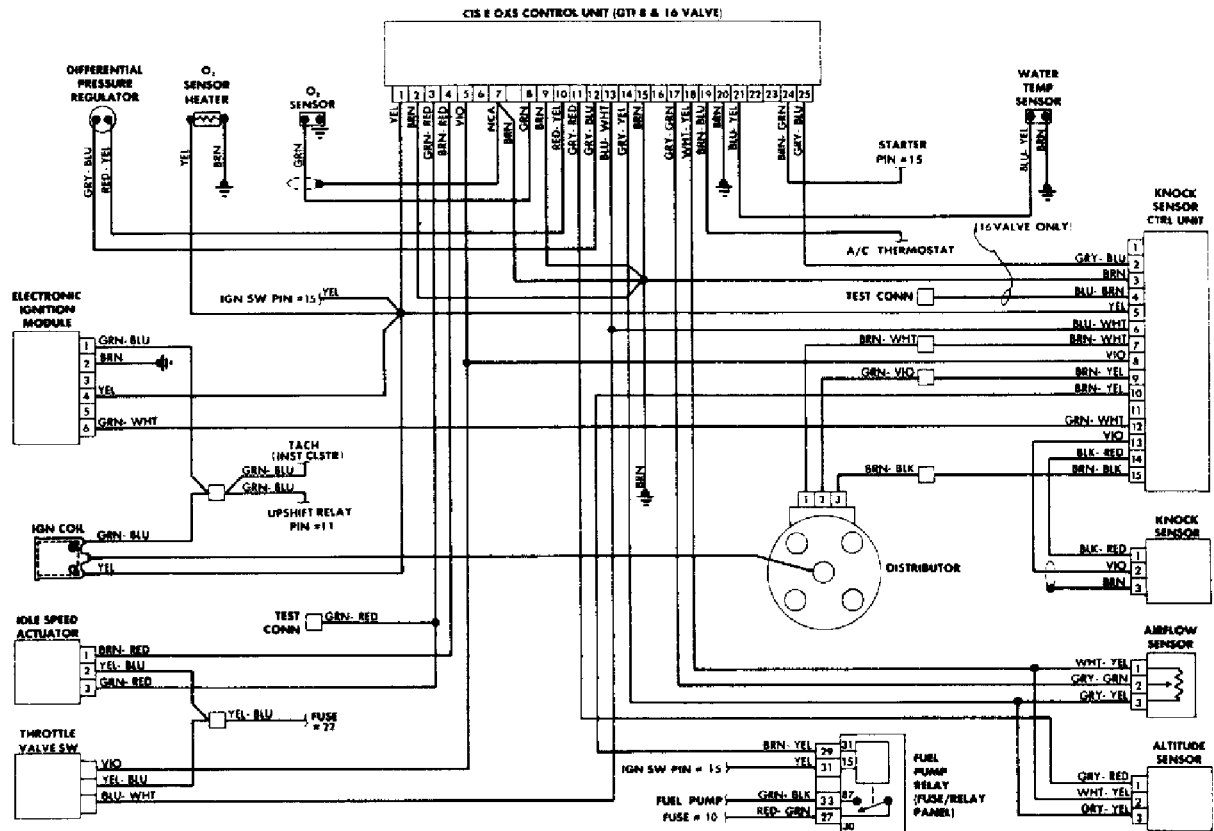


Fig. 19: Volkswagen GTI CIS-E Wiring Diagram

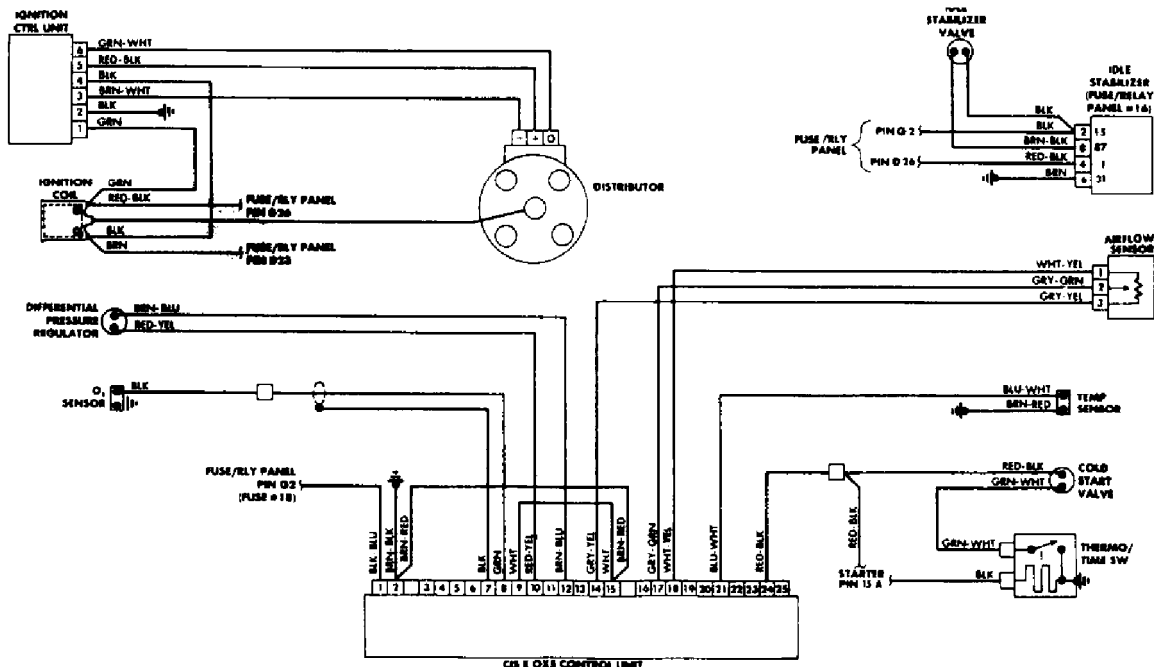


Fig. 20: Jetta & Jetta GLI (8-Valve) CIS-E Wiring Diagram

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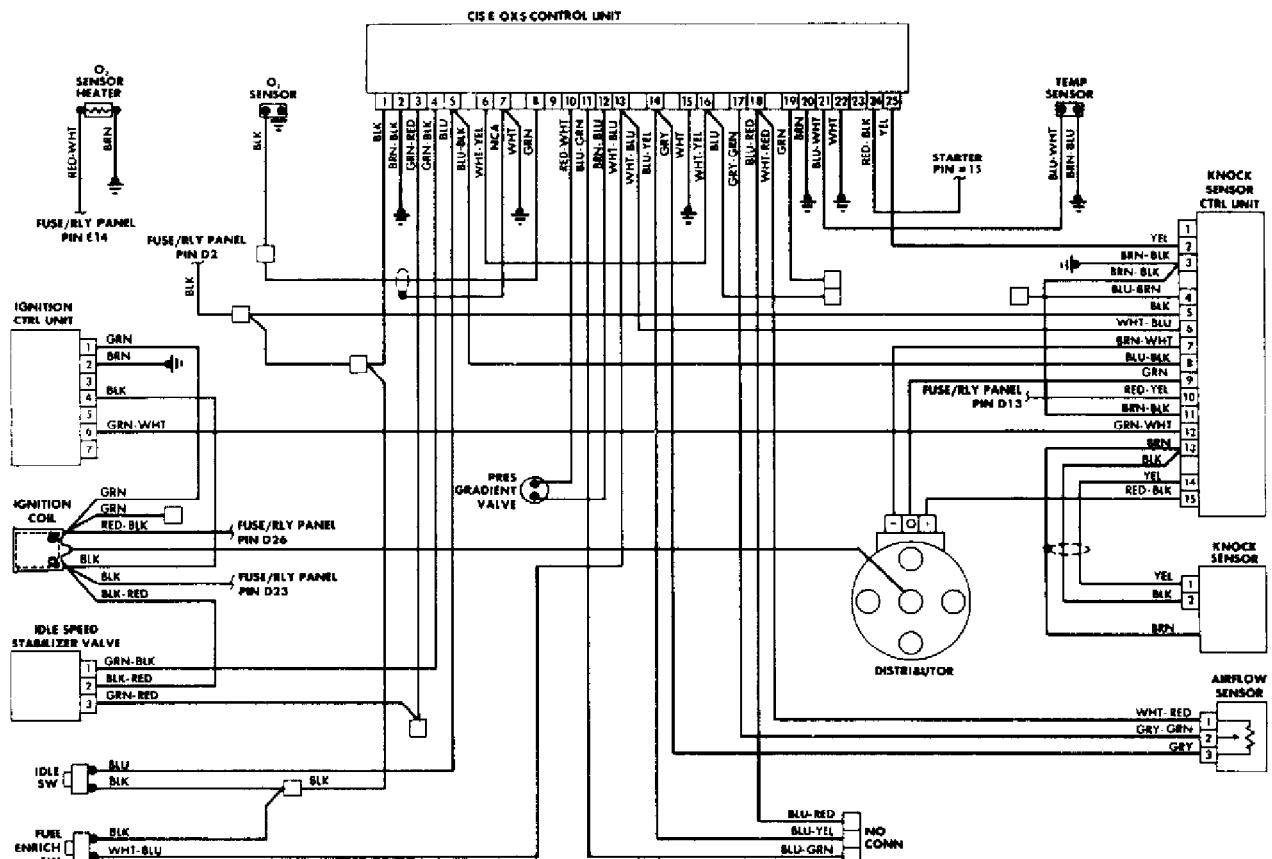


Fig. 21: Jetta GLI (16-Valve) CIS-E Wiring Diagram

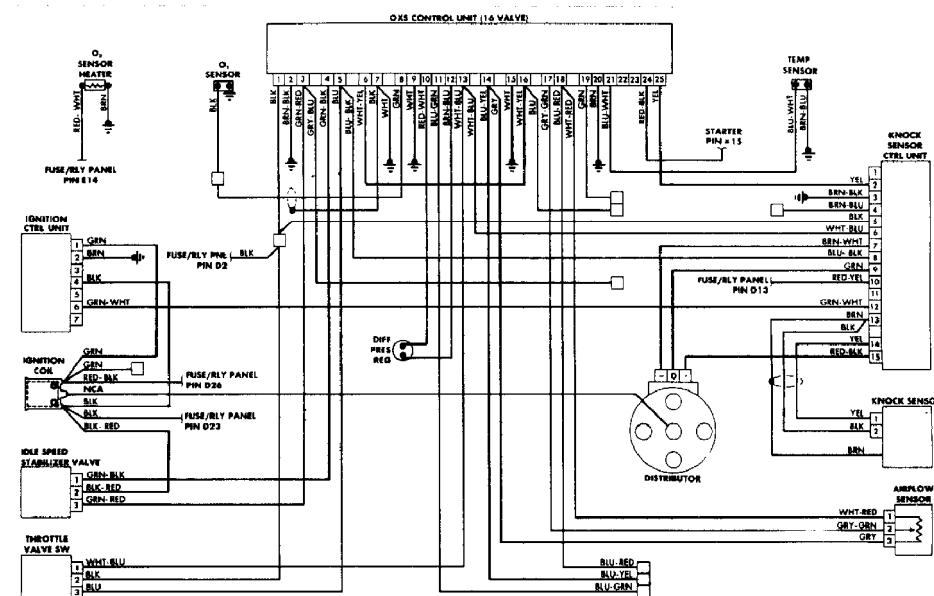


Fig. 22: Scirocco (16-Valve) CIS-E Wiring Diagram

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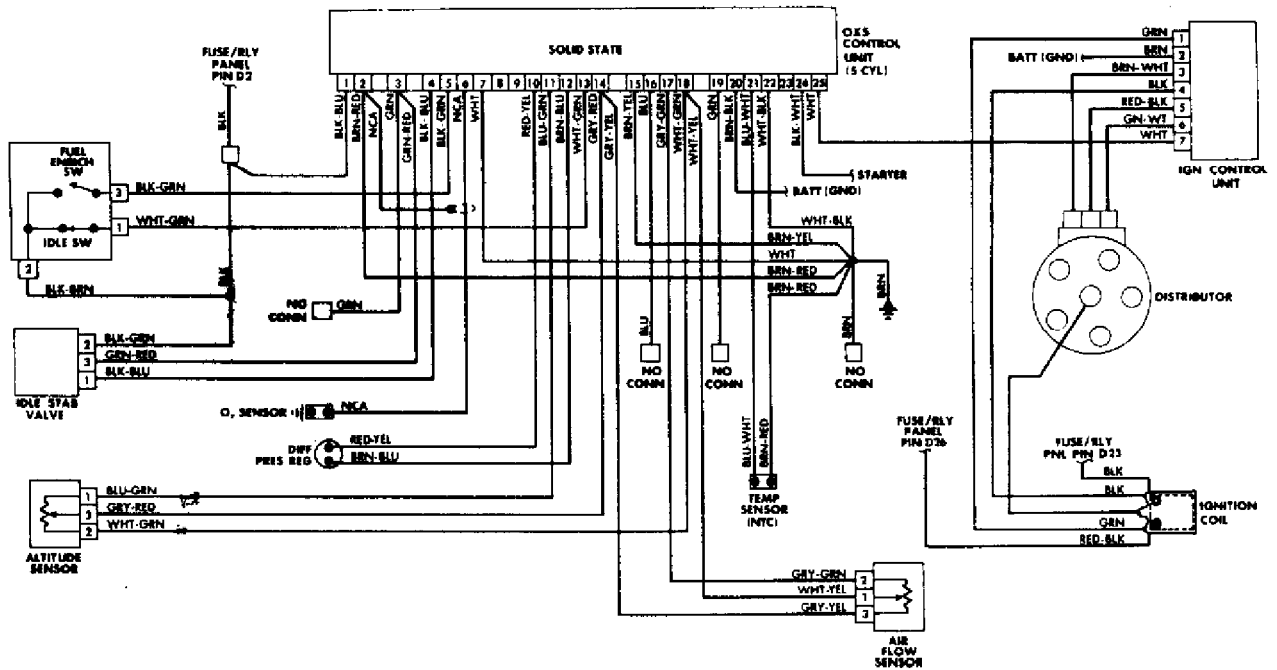


Fig. 23: Quantum & Quantum Syncro CIS-E Wiring Diagram

END OF ARTICLE

BRAKE SYSTEM

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ARTICLE BEGINNING

1987 Brakes
VOLKSWAGEN

Cabriolet, Fox, Golf, GTI, Jetta, Jetta GLI,
Quantum, Quantum Syncro, Scirocco, Vanagon, Vanagon Syncro

NOTE: Information on Scirocco is not available from manufacturer.

DESCRIPTION

GTI and Jetta GLI have 4-wheel disc brake systems. All other models have front disc brakes and self-adjusting rear drum brakes. All models are equipped with cable-actuated parking brake, which applies rear brakes.

All models use pressure regulator between front and rear brake circuits to avoid rear wheel lock-up during hard braking. Pressure regulator on Fox Coupe, and Vanagon models is nonadjustable proportioning type which is controlled by changes in operating angle of regulator.

On all other models, adjustable pressure regulators are used. Adjustable regulators vary braking pressures in direct proportion to tension placed upon operating spring. Operating spring is attached to control lever on regulator and bracket on axle. If vehicle weight transfer increases distance between lever and axle, tension on spring increases and regulator applies higher pressures to rear brakes. On Quantum Synchron, a height sensing proportioning valve is used.

BRAKE PRESSURE REGULATOR ADJUSTMENT

NOTE: Adjustable pressure regulators are mounted on body and operated by spring connected to rear axle. Nonadjustable pressure regulators, which are proportioning valves, have no spring connection to axle.

VANAGON & VANAGON SYNCRO

1) Raise vehicle and support securely. Attach Pressure Gauges (US 1016) to left front brake caliper and right rear wheel cylinder. Bleed pressure gauge and hoses through valve on gauges.

2) Pump brakes several times. Remove pressure regulator from studs, leaving brake lines connected. Press on brake pedal until reading on both gauges is 725 psi (50 bar).

3) Maintain pressure on pedal while tilting regulator forward. Stop tilting regulator at point where straight line between 2 mounting studs on body forms 30 degree angle with straight line between 2 mounting holes on regulator. Be careful not to kink brake lines when tilting regulator.

4) Increase pressure on brake pedal until reading on front

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ALL OTHERS

Fox				
Coupe & Sedan				
1st Reading		725 (50)		537-609 (37-42)
2nd Reading		1450 (100)		725-958 (50-66)
Wagon				
1st Reading		725 (50)		392-479 (27-33)
2nd Reading		1450 (100)		754-841 (52-58)
GLI/GTI				
1st Reading		725 (50)		450-479 (31-33)
2nd Reading		1450 (100)		754-783 (52-54)
Golf				
1st Reading		725 (50)		507-565 (35-39)
2nd Reading		1450 (100)		812-870 (56-60)
Jetta				
1st Reading		725 (50)		551-609 (38-42)
2nd Reading		1450 (100)		855-914 (59-63)
Jetta (16-Valve				

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Push rod is nonadjustable.

STOPLIGHT SWITCH ADJUSTMENT

NOTE: Stoplight switches mounted on master cylinder are nonadjustable.

Adjustable stoplight switch is located above brake pedal. Loosen lock nut. Turn switch until distance between brake pedal arm and first thread on switch body is .20-.24" (5-6 mm). Tighten lock nut. See Fig. 1.

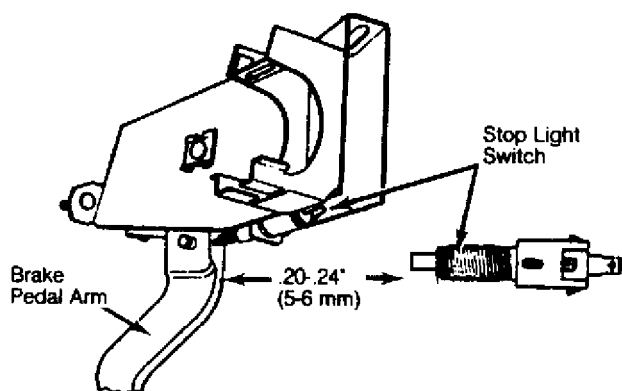


Fig. 1: Stoplight Switch Adjustment
Courtesy of Volkswagen United States, Inc.

PARKING BRAKE ADJUSTMENT

NOTE: Check rear brake adjustment before adjusting parking brake.

VANAGON & VANAGON SYNCRO

1) Raise vehicle and support securely. Release parking brake. Tighten self-locking adjusting nut until there is no play at brake components. Pull on cable housings to check for play. Apply and release parking brake several times.

2) Check adjustment by pulling parking brake handle up 2-4 notches. Rear wheels should be too tight to turn by hand. Release parking brake. Rear wheels should rotate freely.

REAR DISC MODELS

Raise vehicle and support securely. Release parking brake lever. Apply brake pedal once. Loosen lock nuts. Tighten each adjusting nut until lever on respective caliper lifts off stop. Measure gap between stop and lever. See Fig. 2. Do not move lever off stop more than .039" (1 mm). Tighten lock nuts.

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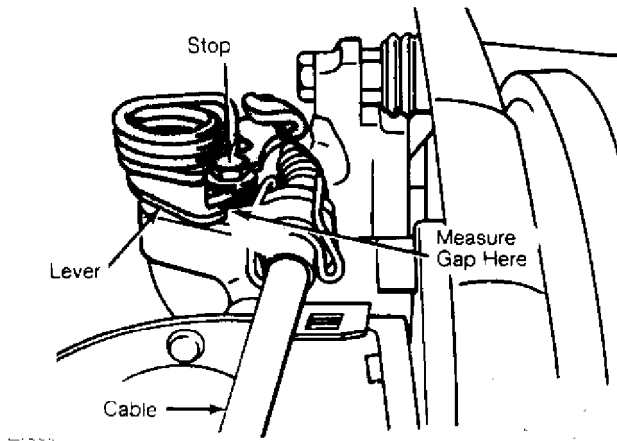


Fig. 2: Rear Disc Parking Brake Adjustment
Courtesy of Volkswagen United States, Inc.

ALL OTHERS

Raise vehicle and support securely. Apply brake pedal once firmly. Pull parking brake handle up 2 notches. Loosen locking nuts. Tighten each adjusting nut until respective rear wheel is locked. Release parking brake. Ensure rear wheels rotate freely. Tighten lock nuts.

WHEEL BEARINGS ADJUSTMENT

NOTE: FWD front wheel bearings and rear wheel bearings on Vanagon series, also called hub or axle bearings, are sealed units with one piece outer race. Bearings are nonadjustable.

REAR WHEEL BEARINGS (FWD MODELS)

To seat bearings, tighten adjusting nut snugly while turning drum or rotor to avoid binding of rollers. Back off and retighten nut until thrust washer can just be moved with screwdriver. Install locking cap and new cotter key. Install dust cap.

FRONT WHEEL BEARINGS (VANAGON & VANAGON SYNCRO)

To seat bearings, tighten adjusting nut snugly while turning rotor. Back off and retighten nut slowly while checking tension on thrust washer. Wheel bearings are correctly adjusted when thrust washer can just be moved with screwdriver under finger pressure. After adjustment, peen flange of NEW hub nut into spindle axle shaft recess.

FRONT PADS R & I

REMOVAL (QUANTUM & VANAGON SYNCRO)

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Raise and support vehicle. Remove front wheels. Remove 2 self-locking bolts from hold guide pins. Discard hold guide pins. Remove caliper. Remove front pads. See Fig. 3.

INSTALLATION

To install, reverse removal procedure. Install new hold guide pins. Wear limit of pads is .28" (7.0 mm), including backing plate.

REMOVAL (ALL OTHERS)

Raise vehicle and support securely. Remove front wheels. Remove mounting bolts. Push caliper housing upward and swing out from bottom. Siphon small amount of brake fluid from reservoir. Remove pads and retaining springs from carrier. Replace pads that exceed wear limit. Wear limit of pads is .28" (7.0 mm), including backing plate. See Fig. 4.

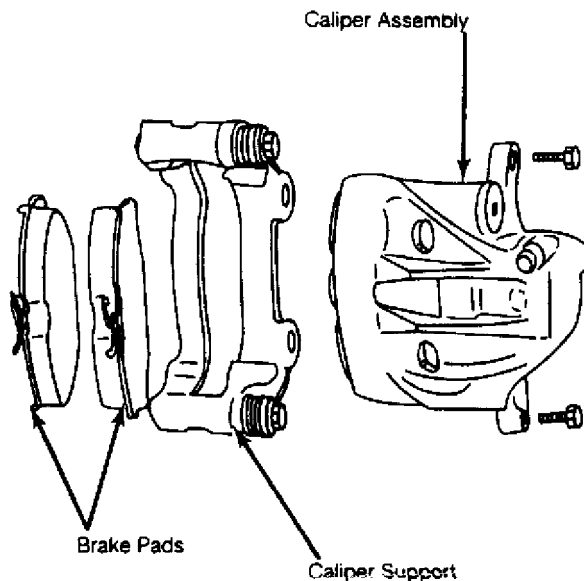


Fig. 3: Exploded View of Front Caliper Assembly (Quantum & Vanagon Syncro)
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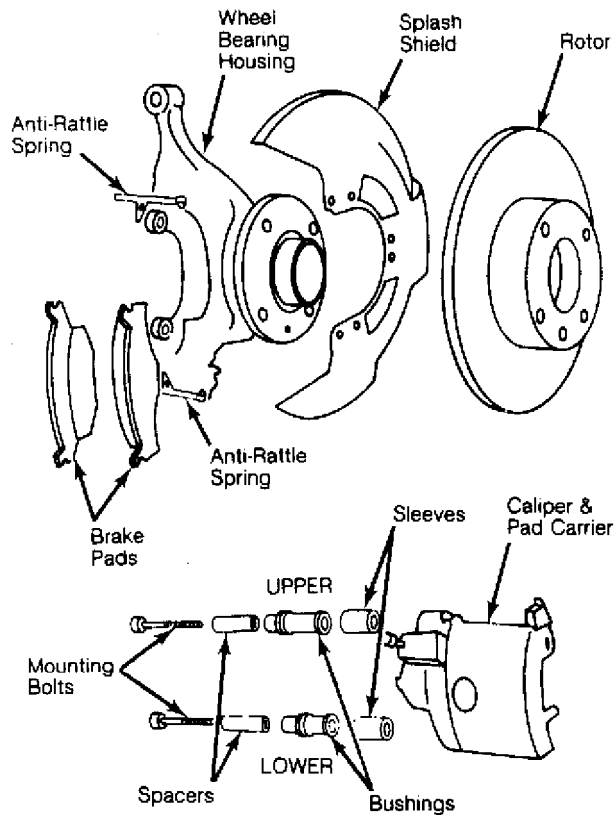


Fig. 4: Exploded View of Front Disc Brake Assembly (All Others)
Courtesy of Volkswagen United States, Inc.

INSTALLATION

1) Seat piston fully into cylinder bore by hand or using Piston Compressor (US 1023/4). Attach retaining springs to pad carrier. Install inner pad first and then install outer pad in carrier.

2) Install caliper housing into pad carrier. DO NOT force caliper any further than necessary to start Allen head mounting bolts. Excessive force could distort springs, which would cause noises during braking. Tighten mounting bolts to 30 ft. lbs. (40 N.m) on Fox, 18 ft. lbs. (25 N.m) on all other models.

FRONT & REAR CALIPER R & I

REMOVAL

Raise vehicle and support securely. Remove wheels. Disconnect brake line from caliper and plug openings. Bend back locking tabs (if equipped) on mounting bolts. Remove caliper mounting bolts. Remove caliper assembly from wheel bearing housing.

INSTALLATION

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To install, reverse removal procedure. Use new lock plates and mounting bolts. Bleed hydraulic brake system.

FRONT & REAR ROTOR R & I

REMOVAL (VANAGON & VANAGON SYNCRO)

Raise vehicle and support securely. Remove wheels. Remove caliper, leaving hose connected. Suspend caliper from frame with wire. Remove grease cap. Loosen peen nut. Remove thrust washer and outer wheel bearing. Pull hub and rotor from spindle.

REMOVAL (FWD MODELS)

Raise and support vehicle. Remove wheels. Remove caliper and suspend from frame with wire. Remove countersunk screw that holds rotor to hub. Pull rotor off hub.

INSTALLATION (ALL MODELS)

To install, reverse removal procedure. On Vanagon and Vanagon Syncro, adjust wheel bearings. See WHEEL BEARINGS ADJUSTMENT in this article.

REAR BRAKE PADS R & I

REMOVAL

Raise vehicle and support securely. Remove rear wheels. Disconnect parking brake cable from caliper. Using 2 wrenches, hold guide pin with open end wrench while removing upper self-locking mounting bolt. Swing caliper down on lower mounting bolt. Remove brake pads from carrier.

INSPECTION

New pads should be .472" (12 mm) thick without including thickness of backing plate. Wear limit is .276" (7 mm), including backing plate.

INSTALLATION

1) Place brake pads in carrier. Using Allen wrench, push piston into caliper while turning it clockwise. Depth of piston in bore of caliper determines clearance of outer pad to rotor.

2) Swing caliper into position and measure clearance between outer pad and rotor. When clearance is .039" (1.0 mm), brake adjustment is correct. Install NEW self-locking upper mounting bolt. Tighten bolt to 18 ft. lbs. (25 N.m). Reconnect parking brake cable and check parking brake adjustment.

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REAR DRUM R & I

CAUTION: ALWAYS loosen or tighten castellated axle nuts with wheels on ground.

REMOVAL (VANAGON & VANAGON SYNCRO)

Remove dust cap and cotter pin. Loosen castellated nut. Raise and support vehicle securely. Remove wheels. Release parking brake at equalizer, and back off adjuster. Remove drum retaining screws. Attach Drum Puller (OTC 827-B) and remove drum. Ensure drum can rotate freely during removal.

INSTALLATION

To install, reverse removal procedure. Drum retaining screws must be tight. Tighten castellated axle nut to 253 ft. lbs. (350 N.m). Adjust parking brake and depress brake pedal several times to set self-adjusting mechanism.

REMOVAL (FWD MODELS)

Raise and support vehicle. Remove wheels. Using screwdriver inserted through wheel bolt hole, push adjusting wedge up against stop. Remove grease cap, cotter pin, nut lock and nut. Remove thrust washer and outer bearing. Remove drum with inner bearing and grease seal.

INSTALLATION

To install, reverse removal procedure. Adjust wheel bearings. See WHEEL BEARINGS ADJUSTMENTS in this article. Apply brake pedal firmly several times to set self-adjusting mechanism.

BRAKE SHOES R & I

REMOVAL (VANAGON & VANAGON SYNCRO)

1) After removing drum, remove retainer clips, hold-down springs and anchor pins. Disconnect parking brake cable from lever on brake shoe. Disconnect lower return and adjuster springs. Pull brake shoes out of lower support. See Fig. 5.

2) Disconnect both upper return springs. Remove both brake shoes from backing plate together with adjuster lever. Ensure both pistons remain in wheel cylinder. Separate brake shoes from adjusting lever. Remove parking brake lever from rear brake shoe.

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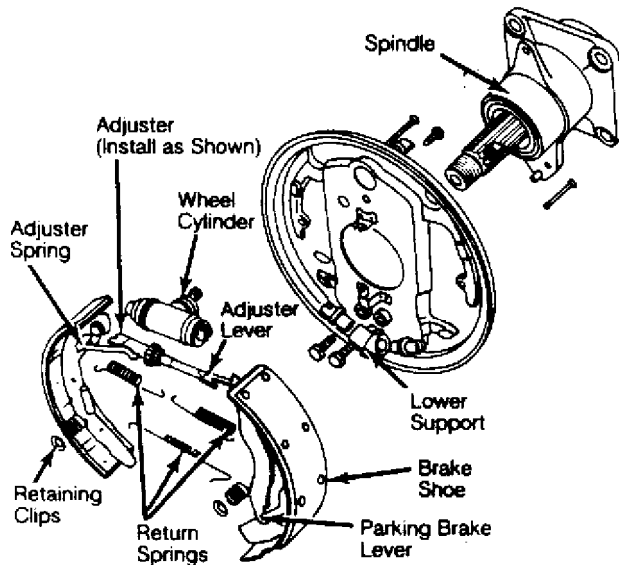


Fig. 5: Exploded View of Rear Brake Assembly (Vanagon & Vanagon Syncro)

Courtesy of Volkswagen United States, Inc.

INSTALLATION

1) To install, reverse removal procedure. Adjust brake shoes so that distance from lining surface on leading shoe to lining surface on trailing shoe is 9.87" (250.7 mm).

2) Adjust parking brake at equalizer. There should be no free play between parking brake lever on brake shoe and adjusting rod. Install brake drum. Depress brake pedal several times to set self-adjusting mechanism.

REMOVAL (FWD MODELS)

1) After removing drum, remove retainer clips, hold-down springs and anchor pins. Remove lower return spring. Disconnect parking brake cable from lever. See Fig. 6.

2) Disconnect adjusting wedge spring and upper return spring. Remove brake shoes together with push rod and tensioning spring. Place push rod and shoes in vise. Remove tension spring. Separate shoes from push rod.

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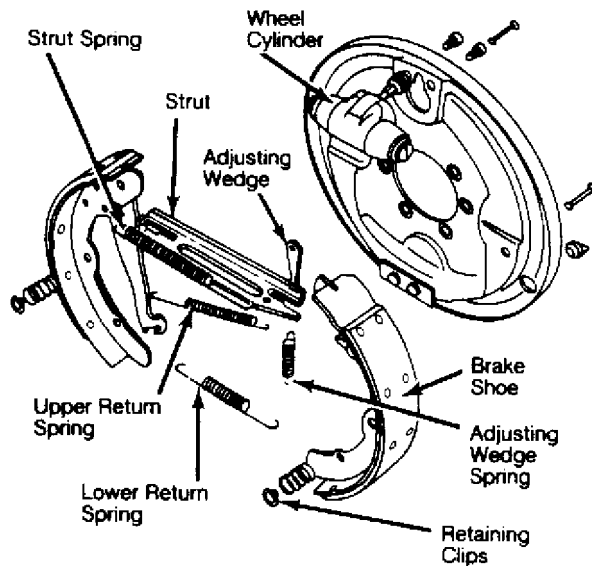


Fig. 6: Exploded View of Rear Brake Assembly (All Others)
Courtesy of Volkswagen United States, Inc.

INSTALLATION

To install, reverse removal procedure. Ensure that lug on adjusting wedge faces backing plate. Adjust wheel bearings. See WHEEL BEARINGS ADJUSTMENT in this article. Apply brake firmly to set self-adjusting mechanism.

MASTER CYLINDER R & I

REMOVAL (VANAGON & VANAGON SYNCRO)

1) Remove instrument panel. Drain or siphon fluid from master cylinder reservoir. Disconnect brake lines and wiring at master cylinder. Disconnect vacuum lines at power assist servo. Remove pedal and bracket assembly.

2) Disconnect brake push rod from brake pedal. Remove power assist servo and master cylinder assembly together from pedal bracket. Remove master cylinder from power assist servo.

INSTALLATION

To install, reverse removal procedure. Install new "O" ring between master cylinder and power assist servo. Adjust brake push rod length. See MASTER CYLINDER PUSH ROD ADJUSTMENT in this article. Bleed hydraulic system.

REMOVAL (ALL OTHERS)

1) Drain or siphon fluid from reservoir. Raise and support vehicle. Remove cover plate (if equipped). Disconnect brake lines and

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wiring at master cylinder.

2) On models without power assist servo, disconnect brake push rod at brake pedal. On models equipped with power assist servo, remove master cylinder from servo. Be careful to keep any spacers used on attaching bolts for proper installation.

INSTALLATION

To install, reverse removal procedure. Always use new "O" ring between master cylinder and power assist servo. Bleed hydraulic system.

POWER ASSIST SERVO FUNCTION TEST, R & I

FUNCTION TEST

1) With engine off, pump pedal to exhaust vacuum. Hold pressure on pedal when it is as high as it will go. Start engine. Pedal should sink slightly and then hold firmly.

2) If pedal does not react correctly, test vacuum check valve. Vacuum check valve is located in vacuum supply hose, which connects servo to intake manifold.

3) If air is forced into servo end of hose, good check valve should open and allow air to pass. If air is forced into manifold or pump end of hose, good check valve should seat and not allow air to pass. Replace defective check valve.

4) Repeat function test for servo. If pedal still does not react properly, check for defects or leaks in vacuum or hydraulic systems. If vacuum and hydraulic systems are good, power assist servo is defective and must be replaced.

REMOVAL (VANAGON & VANAGON SYNCRO)

Remove instrument panel. Separate power assist servo from master cylinder as previously described.

INSTALLATION

To install, reverse removal procedure. Before attaching brake push rod to brake pedal, check and adjust push rod length. See MASTER CYLINDER PUSH ROD in ADJUSTMENTS section of this article. Complete installation and bleed hydraulic system.

REMOVAL (ALL OTHERS)

1) Remove master cylinder from power assist servo as previously described. Disconnect brake push rod from brake pedal.

2) Disconnect vacuum hose from servo. Remove mounting nuts at firewall. Remove servo from vehicle.

INSTALLATION

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To install, reverse removal procedure. Always replace damping ring, washer, filter and "O" ring. Slots in damping washer and filter must be offset 180 degrees.

FRONT CALIPER OVERHAUL

DISASSEMBLY

Place caliper in soft-jawed vise. Insert wooden block in caliper. Blow compressed air into brake hose opening to force piston out of bore. Remove dust seal. Remove piston seal without damaging bore.

CLEANING & INSPECTION

Clean all parts in brake fluid. Check piston and caliper bore for wear or damage. Replace as necessary. Use all parts supplied in repair kit.

REASSEMBLY

1) Install piston seal in bore. Slide dust seal onto piston. Lubricate piston and cylinder bore with brake paste. Insert piston into bore. Place inner lip of dust seal into groove of caliper bore.

2) Press piston in as far as it will go with Piston Compressor (US 1023/4). When piston is fully seated, fit outer lip of dust seal into groove on piston.

REAR CALIPER OVERHAUL

DISASSEMBLY

Clamp caliper housing in soft-jawed vise. Use Allen wrench to remove piston from bore, turning it counterclockwise. Pry piston seal out of caliper housing bore, using care to avoid scratching surface of bore.

CLEANING & INSPECTION

Clean all parts in brake fluid. Black staining from piston seal wear may show on caliper bore walls and piston. This staining is normal. Check piston and caliper bore for wear or corrosion damage. Replace as necessary. Replace all parts included in repair kit.

REASSEMBLY

1) Lightly coat piston and seals with brake paste before refitting. Install piston seal in groove of caliper bore. Fit outer lip of dust cap onto piston. Inner lip of dust cap must be fitted into groove in caliper housing bore. See Fig. 7.

2) Press piston down into bore while turning in clockwise direction. Get piston as far as possible into bore. Outer lip of dust

BRAKE SYSTEM

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cap must slip into groove on piston. Check and adjust pad clearance and parking brake after installation and bleeding is completed.

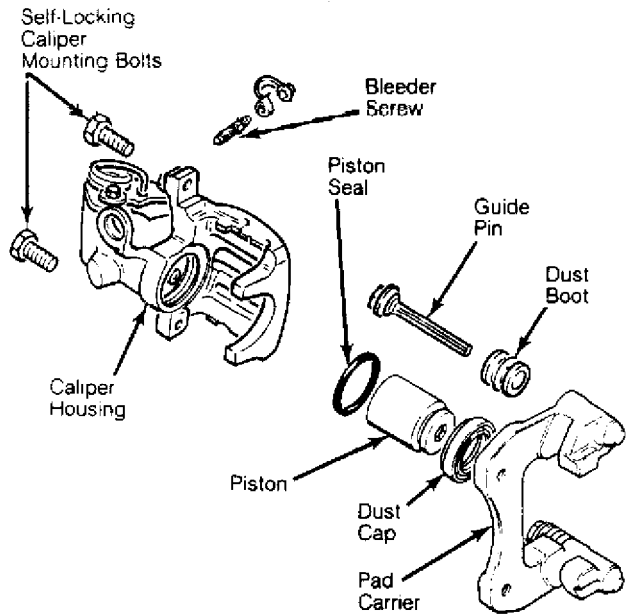


Fig. 7: Exploded View Of Rear Caliper
Courtesy of Volkswagen United States, Inc.

MASTER CYLINDER OVERHAUL

NOTE: Master cylinder used on GLI and GTI models is not to be rebuilt. Complete unit must be replaced if found to be defective.

DISASSEMBLY

1) Power assisted master cylinders differ in external design and primary piston configuration from unassisted versions. Disassembly procedure is identical for all versions. Remove dust boot (if equipped). Remove pressure valves and stoplight switches. See Fig. 8.

2) Move primary piston assembly slightly into bore in order to remove piston stop screw. Hold down piston assemblies against spring tension to remove circlip and washer from end of cylinder. Cover end of cylinder with rag to catch any internal parts or brake fluid that might pop out after circlip is removed.

3) Tap open end of cylinder to remove secondary piston assembly. Note location of primary and secondary return springs and piston cups for reassembly procedure. Also note difference in size and shape between components from primary and secondary circuits. Remove all external hardware from cylinder.

BRAKE SYSTEM

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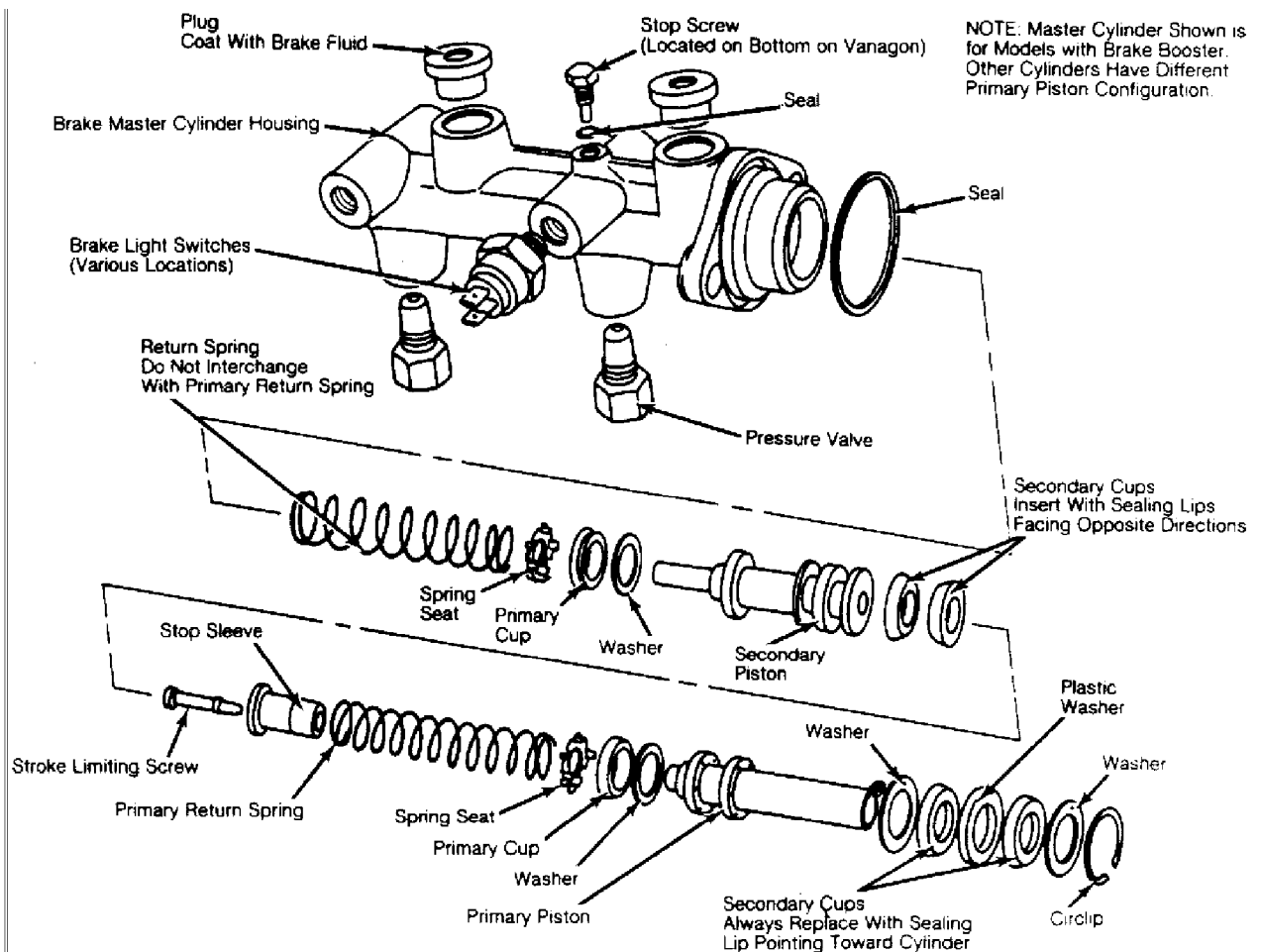


Fig. 8: Exploded View Of Power Assist Master Cylinder
Courtesy of Volkswagen United States, Inc.

CLEANING & INSPECTION

Clean all parts with brake fluid or denatured alcohol. Check cylinder bore and pistons for wear. Replace complete assembly if hard parts are damaged. Replace all soft parts during overhaul. ALWAYS use all parts included in repair kit.

REASSEMBLY

To assemble, reverse disassembly procedure. Coat primary piston shaft with lubricant supplied in repair kit. Coat pistons and cups with brake paste. DO NOT interchange return springs or piston cups between primary and secondary circuits. Secondary piston may have to be moved slightly to install stop screw.

POWER SERVO, REGULATING & PROPORTIONING VALVES OVERHAUL

POWER ASSIST SERVO, PRESSURE REGULATING VALVE & PROPORTIONING VALVE OVERHAUL

BRAKE SYSTEM

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Power assist servo units are supplied by both ATE and FAG. Servo units are interchangeable. Servo units supplied by either manufacturer may be installed with master cylinders supplied by the other. Vehicle manufacturer states that these servos, if defective, must be replaced as complete assemblies. DO NOT disassemble power assist servo as parts are not available.

TORQUE SPECIFICATIONS

TIGHTENING SPECIFICATIONS TABLE

Application Ft. Lbs. (N.m)

Backing Plate-to-Flange Bolt	44 (60)
Caliper Mounting Bolts (1)	
Fox	30 (41)
Quantum & Quantum Syncro	18 (25)
Vanagon & Vanagon Syncro	26 (35)
All Others	
Front	18 (25)
Rear	26 (35)
Pad Carrier Mounting Bolt	
Quantum & Quantum Syncro	52 (70)
Vanagon & Vanagon Syncro	115 (156)
All Others	48 (65)
Rear Axle Nut	
Vanagon	253 (350)
Rear Brake Shoe Support Bolt	
Vanagon	48 (65)

(1) - Always replace all self-locking bolts.

DISC SPECIFICATIONS

DISC BRAKE ROTOR SPECIFICATIONS TABLE

Application In. (mm)

Front	
Vanagon	
Disc Diameter	10.16 (258)
Lateral Runout	.004 (.1)
Parallelism	
Original Thickness	.591 (15.0)
Minimum Refinish Thickness	.512 (13.0)
Discard Thickness	.511 (12.9)
All Others	
Solid	
Disc Diameter	

BRAKE SYSTEM

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Lateral Runout	.002 (.06)
Parallelism	
Original Thickness	.472 (12.0)
Minimum Refinish Thickness	
Fox	.413 (10.5)
All Others	.394 (10.0)
Discard Thickness	.393 (9.99)

Vented

Disc Diameter	10.08 (256)
Lateral Runout	.002 (.06)
Parallelism	.0009 (.02)
Original Thickness	.787 (20.0)
Minimum Refinish Thickness	.708 (18.0)
Discard Thickness	.707 (17.9)

Rear

GLI/GTI Quantum Synchro

Disc Diameter	
Lateral Runout	.002 (.06)
Parallelism	
Original Thickness	.394 (10.0)
Minimum Refinish Thickness	.335 (8.5)
Discard Thickness	.315 (8.0)

AA

DRUM SPECIFICATIONS

DRUM BRAKE SPECIFICATIONS TABLE

AA

Application	In. (mm)
-------------	----------

Quantum

Drum Diameter	7.87 (200.0)
Drum Width	
Maximum Drum Refinish Diameter	7.89 (200.5)
Wheel Cylinder Diameter	
Master Cylinder Diameter	

Vanagon

Drum Diameter	9.92 (252)
Drum Width	
Maximum Drum Refinish Diameter	9.96 (253)
Wheel Cylinder Diameter	
Master Cylinder Diameter	

All Others

Drum Diameter	7.08 (180)
Drum Width	
Maximum Drum Refinish Diameter	7.11 (180.5)
Wheel Cylinder Diameter	
Master Cylinder Diameter	

BRAKE SYSTEM

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(1) - Use oversize linings after turning drum .020"
(.50 mm) or more.

AA

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CLUTCH

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ARTICLE BEGINNING

1987 Clutches

VOLKSWAGEN FOX & QUANTUM

DESCRIPTION

The clutch is a single dry disc type, using a diaphragm type pressure plate and a prelubricated clutch release bearing. The clutch is cable actuated.

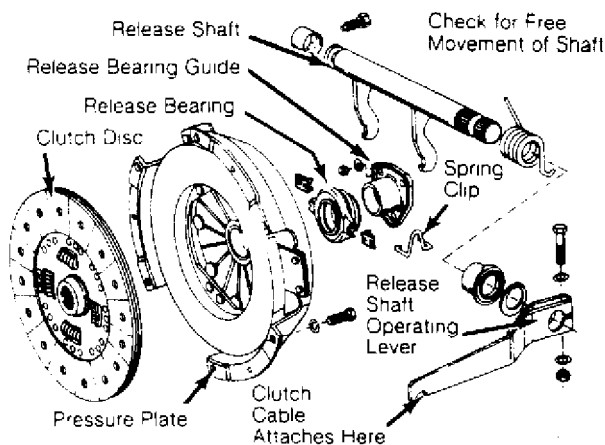


Fig. 1: Exploded View of Clutch Assembly
Courtesy of Volkswagen United States, Inc.

REMOVAL & INSTALLATION

CLUTCH ASSEMBLY

Removal

1) Disconnect battery ground. Remove upper engine-to-transaxle bolts. Detach speedometer cable. Unhook clutch cable. Disconnect exhaust pipe at manifold. Remove engine support bolts. Remove front muffler and exhaust pipe.

2) Remove drive shafts at transaxle. Disconnect back-up light wiring. Remove cover plate bolts. Remove starter bolt. Remove shift rod coupling bolt. Pry off shift rod coupling ball. Pull off shift rod coupling from shift rod.

3) Position transmission lift under transaxle and lift up slightly. Loosen bolt "A" and remove bolt "B" from rear transaxle mount. Remove rubber mount. See Fig. 2. Remove 3 front transaxle support bolts. Remove lower engine-to-transaxle bolts.

4) Pry transaxle away from engine. Remove transaxle by lowering transaxle support 2071 or US 618 with US 618/1. Lock flywheel to prevent rotation and index mark pressure plate and flywheel. Loosen pressure plate bolts 1/4 turn at a time, working in a diagonal pattern. Slide pressure plate off dowels on flywheel.

CLUTCH

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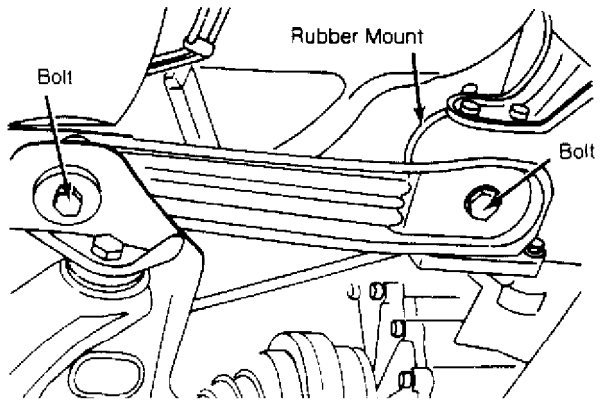


Fig. 2: Transaxle Support Assembly
Courtesy of Volkswagen United States, Inc.

Installation

1) Using a clutch alignment tool, fit pressure plate with clutch. Make sure alignment marks are observed. Loosely attach assembly with 6 bolts.

2) Tighten pressure plate bolts in a criss-cross pattern about 2 turns at a time. Position transaxle to engine. Make sure mainshaft splines are clean and lubricated lightly with molybdenum disulphide grease.

3) Reverse removal procedure to install remaining components. Make sure all engine-to-transaxle mounts are aligned and free of tension before tightening bolts and nuts.

CLUTCH RELEASE BEARING

Removal

With transaxle removed, remove retaining clips and springs from release bearing. Slide bearing off bearing guide.

Installation

To install, lubricate metal guide sleeve with molybdenum disulphide paste. Coat pivoting points between bearing and operating shaft with multipurpose grease. Position bearing to shaft and install retaining clips and springs.

NOTE: Bearing is pre-lubricated. DO NOT wash in solvent.

CLUTCH CABLE

Removal

Loosen cable adjusting nuts and free clutch cable housing from support bracket. Separate cable from clutch operating lever (mounted on side of clutch housing). Disconnect cable at pedal and force cable and housing into passenger compartment and remove.

Installation

To install new cable, reverse removal procedure and adjust pedal free play.

CLUTCH

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NOTE: If new clutch cable has been installed, make sure to recheck clutch pedal free play after 300 miles.

ADJUSTMENT

CLUTCH PEDAL FREE PLAY

Clutch pedal free play (measured at pedal pad) should be 9/16" (15 mm). Adjust free play at support bracket on transmission case by adjusting cable housing length with lock nuts on cable housing.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS TABLE

Application		Ft. Lbs. (N.m)
Clutch Assembly-to-Flywheel Bolts		18 (24)
Drive Shaft-to-Transmission Bolts		
8 mm Bolts		33 (45)
10 mm Bolts		59 (80)
Transmission-to-Engine Bolts		40 (54)

END OF ARTICLE

COMPUTER RELEARN PROCEDURES

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ARTICLE BEGINNING

GENERAL INFORMATION

Computer Relearn Procedures

All Models

* PLEASE READ THIS FIRST *

The following general procedures are to be used if driveability problems are encountered after power loss or battery has been disconnected. These procedures may provide an aid in eliminating these problems.

To reduce the possibility of complaints, after any service which requires battery power to be disconnected, vehicle should be road tested.

COMPUTER RELEARN PROCEDURES

Vehicles equipped with engine or transmission computers may require a relearn procedure after vehicle battery is disconnected. Many vehicle computers memorize and store vehicle operation patterns for optimum driveability and performance. When vehicle battery is disconnected, this memory is lost. The computer will use default data until new data from each key start is stored. As computer memorizes vehicle operation for each new key start, driveability is restored. Vehicle computers may memorize vehicles operation patterns for 40 of more key starts.

Customers often complain of driveability problems during relearn stage because vehicle acts differently then before being serviced. Depending on type and make of vehicle and how it is equipped, the following complaints (driveability problems) may exist:

- * Harsh Or Poor Shift Quality
- * Rough Or Unstable Idle
- * Hesitation Or Stumble
- * Rich Or Lean Running
- * Poor Fuel Mileage

These symptoms and complaints should disappear after a number of drive cycles have been memorized. To reduce the possibility of complaints, after any service which requires battery power to be disconnected, vehicle should be road tested. If a specific relearn procedure is not available, the following procedure may be used:

Automatic Transmission

- * Set parking brake, start engine in "P" or "N" position. Warm-up vehicle to normal operating temperature or until cooling fan cycles.
- * Allow vehicle to idle for one minute in "N" position. Select

COMPUTER RELEARN PROCEDURES

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"D" and allow engine to idle for one minute.

- * Accelerate at normal throttle position (20-50%) until vehicle shifts into top gear.
- * Cruise at light to medium throttle.
- * Decelerate to a stop, allowing vehicle to downshift, and use brakes normally.
- * Process may be repeated as necessary.

Manual Transmission

- * Place transmission in Neutral position.
- * Ensure emergency brake has been set and all accessories are turned off.
- * Start engine and bring to normal operating temperature.
- * Allow vehicle to idle in Neutral for one minute.
- * Initial relearn is complete: process will be completed during normal driving.

Some manufacturers identify a specific relearn procedure which will help establish suitable driveability during relearn stage. These procedures are especially important if vehicle is equipped with and electronically controlled automatic transmission or transaxle. Always complete procedure before returning vehicle to customer.

END OF ARTICLE

Article Text

ARTICLE BEGINNING

Volkswagon Cooling System Specifications

ENGINE COOLANT SPECIFICATIONS

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UAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 APPLICATION3PRESSURE3 COOLANT 3 THERMOSTAT OPEN 3 COOLING FAN 3
3
3 CAP PSI 3 CAPACITYAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3
3 3 3 3 0F(0C) 3 0F(0C) 30F(0C) 30F(0C) 3

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END OF ARTICLE

DEFOGGER - REAR WINDOW

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ARTICLE BEGINNING

1987 Accessories & Safety Equipment
ALL MANUFACTURERS DEFOGGERS - REAR WINDOW

All Import Car Models

DESCRIPTION

Rear window defogger systems use a heating wire grid bonded to the inside of rear window. Window heat is regulated by a control switch and a relay/timer. An indicator lamp should light to show system is operating. Power to the control switch is through a fuse in the fuse block.

OPERATION

Defogger operates when the ignition is on and control switch is moved to "ON" position. When the switch is turned to the "ON" position, current flows through the wire and evaporates the water from the window. The timer relay will keep power to the grid for a few minutes or until the ignition is turned off.

TROUBLE SHOOTING

DEFOGGER DOES NOT WORK

Blown fuse or poor contact. Defogger switch defective. Poor connections. Broken wire. Relay defective.

INDICATOR LIGHT DOES NOT WORK

Bulb burned out. Open wire or poor connection.

TESTING

SYSTEM TESTING

1) Check that all in-line fuses or circuit breakers are operational. Turn ignition and control switches to "ON" position. Check rear window glass temperature after a few minutes. Glass should feel warm to the touch.

2) If glass is not warm, use a test light or voltmeter to check for battery voltage at grid feed wire. If voltage is not correct, check wiring harness, control switch and timer/relay.

FILAMENT TESTING

1) To locate breaks in grid wire filaments, attach a voltmeter to middle portion of each filament. Attach other meter

DEFOGGER - REAR WINDOW

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probe to vertical section of window grid.

2) If a grid is broken, meter will register zero volts or battery voltage, depending on if grid is broken between or outside test leads. If wire is unbroken, meter will register about one half of battery voltage. To locate break, move probe along wire until the meter needle moves abruptly.

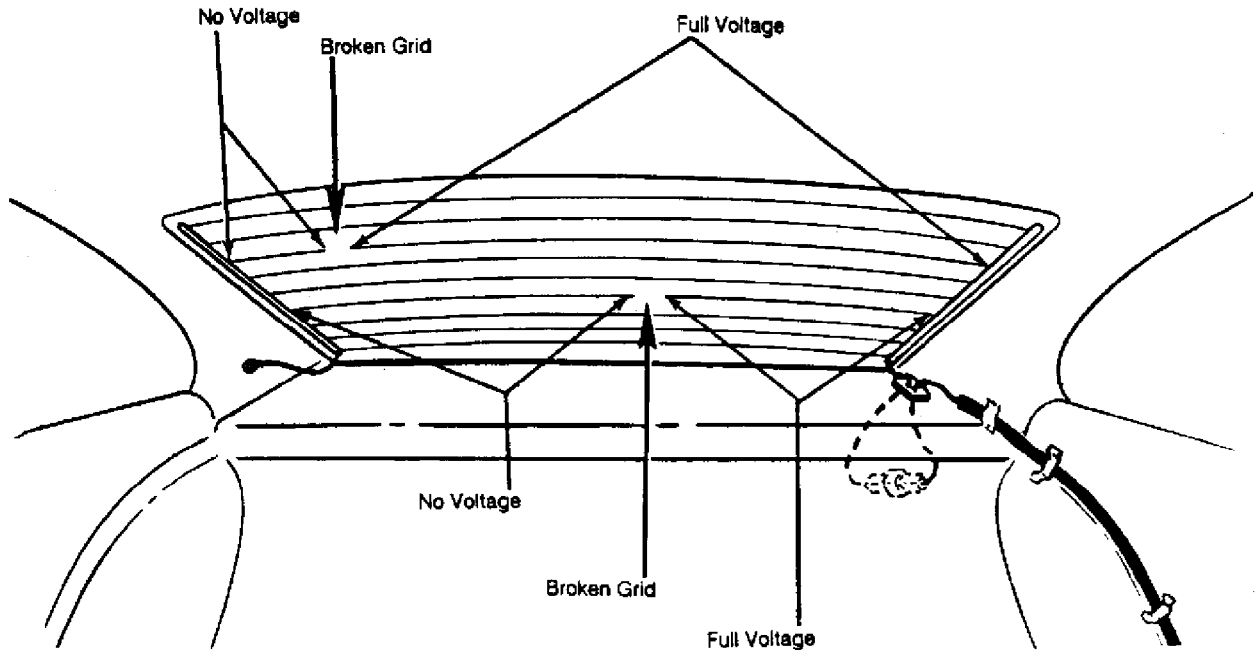


Fig. 1: Voltage Test for Broken Grid Filaments

END OF ARTICLE

DRIVE AXLE - GEAR TOOTH CONTACT PATTERNS

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ARTICLE BEGINNING

1983-93 DRIVE AXLES
Gear Tooth Contact Patterns

All Models

INSPECTION

PRELIMINARY INSPECTION

Wipe lubricant from internal parts. Rotate gears and inspect for wear or damage. Mount dial indicator to housing, and check backlash at several points around ring gear. Backlash must be within specifications at all points. If no defects are found, check gear tooth contact pattern.

GEAR TOOTH CONTACT PATTERN

NOTE: Drive pattern should be well centered on ring gear teeth. Coast pattern should be centered, but may be slightly toward toe of ring gear teeth.

1) Paint ring gear teeth with marking compound. Wrap cloth or rope around drive pinion flange to act as brake. Rotate ring gear until clear tooth contact pattern is obtained.

2) Contact pattern will indicate whether correct pinion bearing mounting shim has been installed and if drive gear backlash has been set properly. Backlash between drive gear and pinion must be maintained within specified limits, until correct tooth pattern is obtained.

DRIVE AXLE - GEAR TOOTH CONTACT PATTERNS

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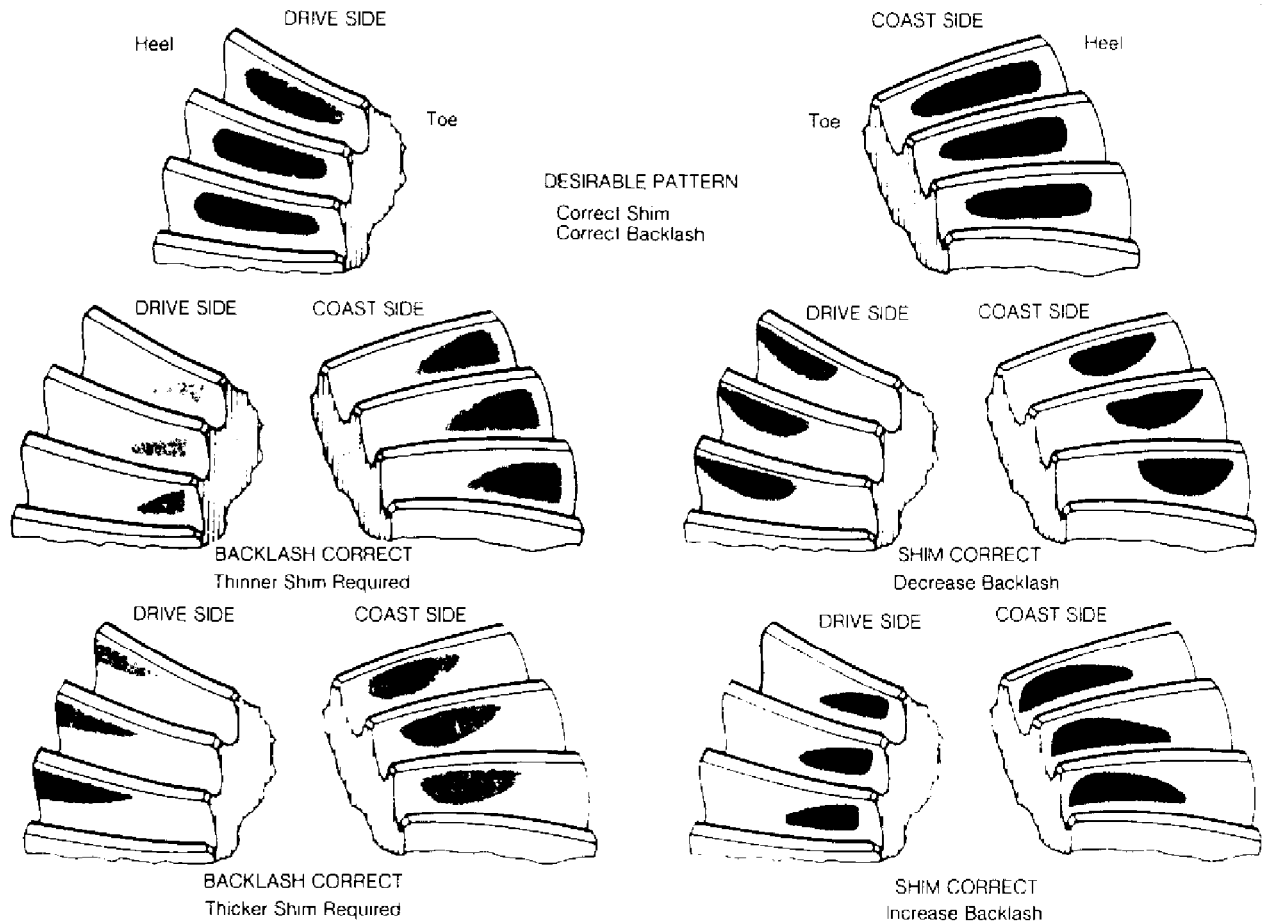


Fig. 1: Drive Axle Gear Tooth Patterns

ADJUSTMENTS

GEAR BACKLASH & PINION SHIM CHANGES

NOTE: Backlash is adjusted by either moving shims from one side of differential case to the other or by turning adjusting nuts on which side bearing races ride. Changing of pinion shims alters the distance from face of pinion of centerline of ring gear.

1) With no change in backlash, moving pinion further from ring gear moves drive pattern toward heel and top of tooth, and moves coast pattern toward toe and top of tooth.

2) With no change in backlash, moving pinion closer to ring gear moves drive pattern toward toe and bottom of tooth, and moves coast pattern toward heel and bottom of tooth.

3) With no change in pinion shim thickness, an increase in backlash moves ring gear further from pinion. Drive pattern moves toward heel and top of tooth, and coast pattern moves toward heel and top of tooth.

DRIVE AXLE - GEAR TOOTH CONTACT PATTERNS

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4) With no change in pinion shim thickness, decrease in backlash moves ring gear closer to pinion gear. Drive pattern moves toward toe and bottom of tooth, and coast pattern moves toward toe and bottom of tooth.

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DRIVE AXLE - REAR

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ARTICLE BEGINNING

1987 Drive Axle
VOLKSWAGEN QUANTUM SYNCRO

*** PLEASE READ THIS FIRST ***

NOTE: Complete information is not available from manufacturer.

DESCRIPTION

The rear axle is part of the full time 4WD system. Unlike most 4WD vehicles, this system does not use a transfer gearbox. The complete system consists of 3 differentials: front, central and rear. The front and central differential are incorporated with the 5-speed transmission. The central and rear differential can be locked at any speed for varying road conditions.

The rear differential has a hypoid type ring and pinion gear. The drive pinion gear is supported by roller bearings and preload is maintained by a collapsible spacer between the bearings. A locking device is incorporated and consists of a shift shaft, shift fork operating sleeve and gear.

OPERATION

Power is transmitted via the transmission to the central differential, through a drive shaft, to the rear axle final drive. Power is also transmitted through the pinion shaft to the front axle differential.

When traction between road surface and tires is low, differential locks for both central and rear axle differentials can be engaged to improve traction. The differential locks can be engaged either when the vehicle is stationary or while driving. There are 2 warning lamps on the console that indicate when the differentials are locked.

VACUUM SYSTEM

Central and rear differential locks are operated by a vacuum system. Center differential can be locked independently of rear differential. Rear differential can only be locked if center differential is locked. When differential locks are engaged, warning lights on console light up.

When operating knob is pulled to first position, vacuum is supplied to engagement side of center vacuum unit. When operating knob is pulled to second position, vacuum is supplied to engagement side of center and rear vacuum units.

When vacuum switch is pushed in, vacuum is transferred to the opposite side of vacuum units and differential locks are disengaged. See Fig. 1.

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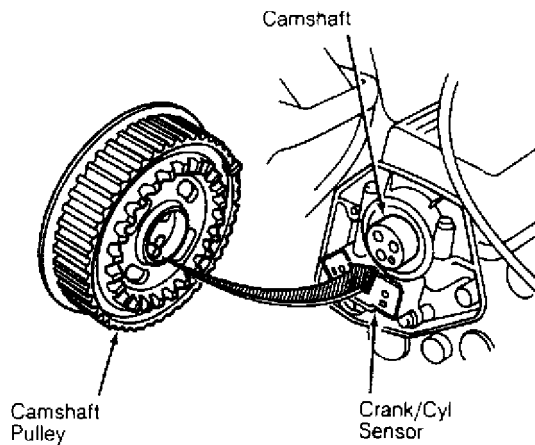


Fig. 1: Vacuum Control System
Courtesy of Audi of America, Inc.

AXLE RATIO & IDENTIFICATION

The rear axle identification code is stamped under the front nose section of the drive axle. Quantum Syncro rear final drive has identification letters AAG. Quantum Syncro final drive is 4.11:1.

ADJUSTMENTS

CENTER DIFFERENTIAL LOCK

Disengage lock. Plastic bracket on servo must be pulled in. Check that cable is located correctly at all mounting points. Pull outer cable to rear and install clip in front groove on outer cable. See Fig. 2.

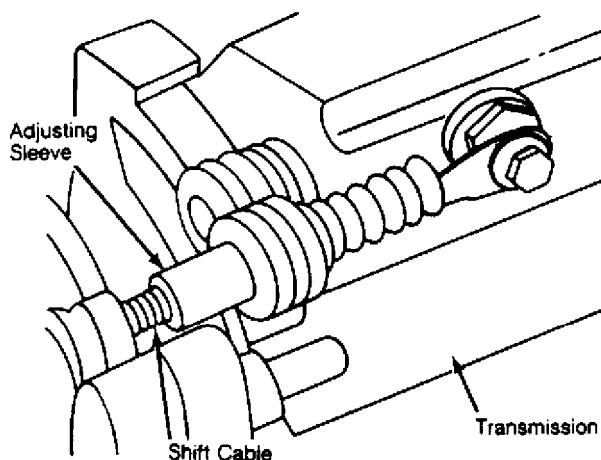


Fig. 2: Center Differential Lock

NOTE: Differential lock can only be engaged with sufficient vacuum. If necessary, run engine and check lock operation.

DRIVE AXLE - REAR

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REAR DIFFERENTIAL LOCK

Disengage lock. Clevis pin on servo must be pressed out. Loosen clamping bolt for lever on operating shaft. Turn operating shaft clockwise to stop and pull servo clevis out. In this position, tighten clamping bolt for lever. See Fig. 3.

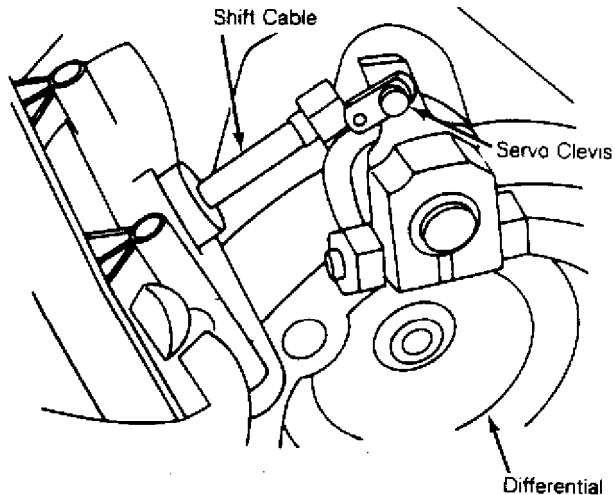


Fig. 3: Rear Differential Lock

DRIVE SHAFT

NOTE: When removing drive shaft always replace CV joint seals.

1) Loosen center support bearing bolts. Remove adjustment washers and reinstall bolts. Check drive shaft alignment with a straightedge approximately 47" (1194 mm) long. Be sure edge is perfectly straight. Cut recess .593" (15.08 mm) deep and 7.875" (200.03 mm) long in area of center support bearing.

2) Raise drive shaft by tightening bolts until both halves are exactly in line. Distance from center of "U" joint to support bracket must be equal. Measure dimensions from support bracket to support arm and select appropriate adjustment washers and install.

3) Align drive shaft from side to side by moving center bearing. Stretch a piece of string between front and rear CV joint outside diameters. Move center bearing until drive shaft runs parallel to string. String must not rest against center support bearing..

REMOVAL & INSTALLATION

NOTE: If repairs to rear final drive are necessary, other than those described in this article, complete unit must be replaced as an assembly.

DRIVE SHAFT

DRIVE AXLE - REAR

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Removal

Detach drive shaft from transmission output flange and support end of shaft. Disconnect drive shaft from rear final drive flange. If necessary, engage differential lock and block wheel. Tie up shaft end. Detach center bearing from body and remove drive shaft.

Installation

To install, reverse removal procedure. Always replace CV joint seals. Align drive shaft after installation.

AXLE SHAFTS

NOTE: Axle shafts are diagonally interchangeable. Left rear is identical with right front and right rear is identical with left front.

Removal

1) Loosen wheel bolts (remove and install axle nut only with wheels on ground). Remove axle nut. Raise vehicle and remove wheel. Remove right brake backing plate.

2) Detach axle shaft from final drive flange and lay out of way. Remove ball joint clamp bolt. Detach brake hose from bracket. Pry ball joint out of hub. Move strut toward outside.

3) Press stub axle from hub. Check that there is sufficient clearance between inner CV joint and final drive housing. Remove axle assembly. See Fig. 4.

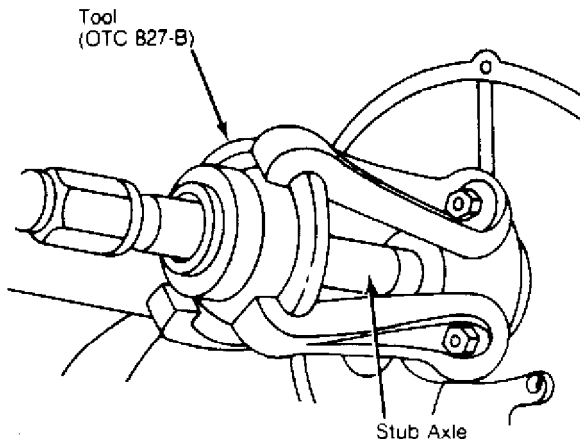


Fig. 4: Pressing Out Stub Axle

NOTE: Remove stub axle with mechanical or hydraulic puller only. Never heat up stub axle, as this will severely damage assembly.

Installation

To install, reverse removal procedure. Replace gasket on inner CV joint. Ensure axle splines are free of grease and oil. Apply

DRIVE AXLE - REAR

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a bead of locking compound about .203" (5.16 mm) wide around splines. Install axle shaft.

DRIVE AXLE

Removal

1) Remove rear drive shaft, lock rear differential and block wheel. Disconnect axle shafts. Remove clevis pin lock at differential lock lever.

2) Remove lock pin (only possible with differential lock in off position). Remove drive axle mounting bolts. Slightly raise drive axle with jack. Push forward, then carefully lower unit.

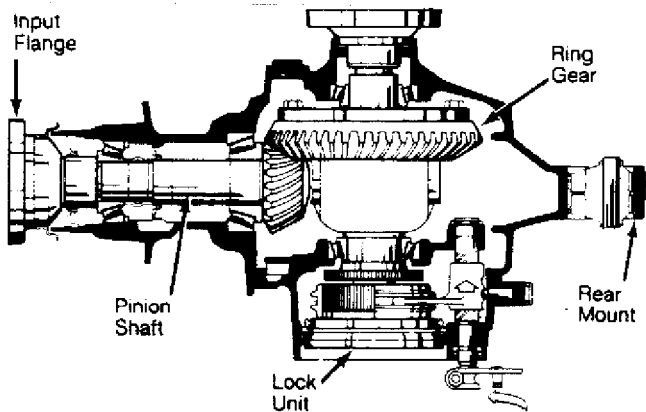


Fig. 5: Sectional View of Drive Axle
Courtesy of Audi of America, Inc.

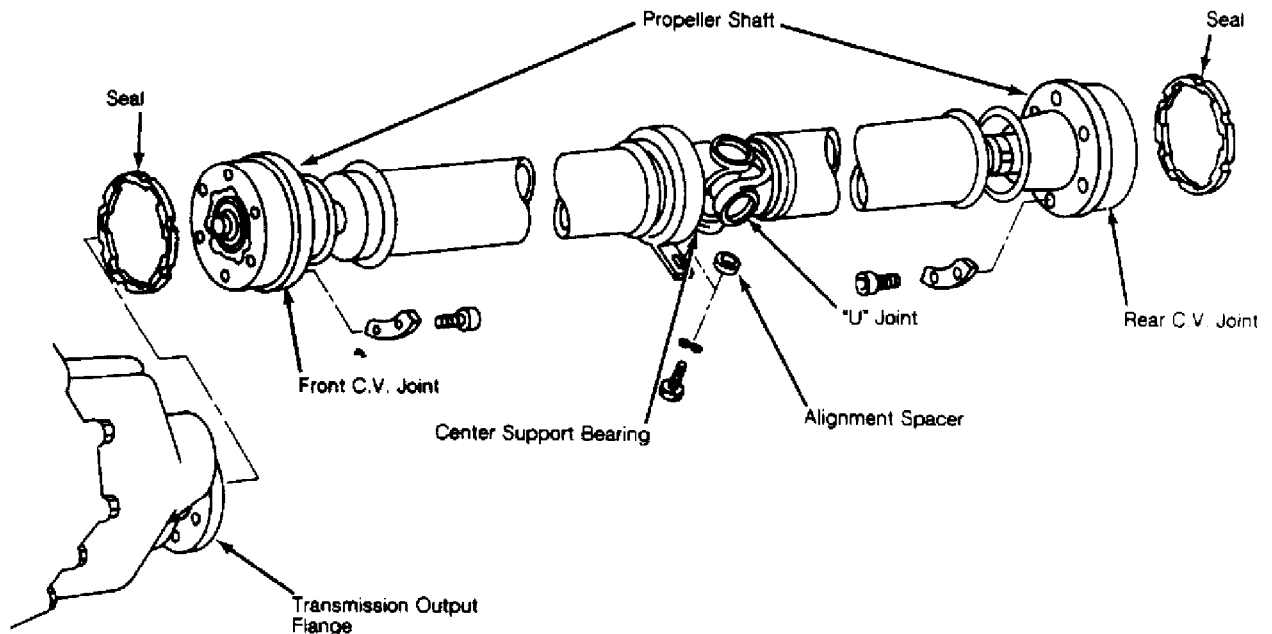


Fig. 6: Exploded View of Drive Shaft

Installation

DRIVE AXLE - REAR

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To install, reverse removal procedure. Ensure final drive mounts are not under tension. Readjust differential lock cable.

FINAL DRIVE FLANGE OIL SEAL

Removal (Right Side)

Disconnect axle shaft. While holding flange with drift, remove drive flange bolt. Place oil drip tray in position. Pull drive flange out and remove oil seal.

Installation

To install, drive in oil seal completely. Be careful not to damage seal. Fill space between sealing lips with multipurpose grease.

Removal (Left Side)

Drain oil from drive axle. Remove axle shaft and push upward out of way. Remove left drive axle mount. Lower drive axle until flange is accessible. Remove drive flange bolt while holding flange with 2 bolts. DO NOT lose adjustment shim between flange shaft and drive axle. Using a seal puller, remove oil seal.

Installation

1) Install threaded shaft of Seal Installer (3066). Place oil seal on seal installer and tighten to stop. Remove seal installer. Fill oil seal and sealing lips with multipurpose grease. See Fig. 7.

2) Attach adjustment shim (with grease) on flange shaft and install. Tighten drive flange bolt to 25 ft. lbs. (34 N.m). Install left final drive mount and tighten nut to 32 ft. lbs. (45 N.m). Check drive axle oil level and top off as necessary.

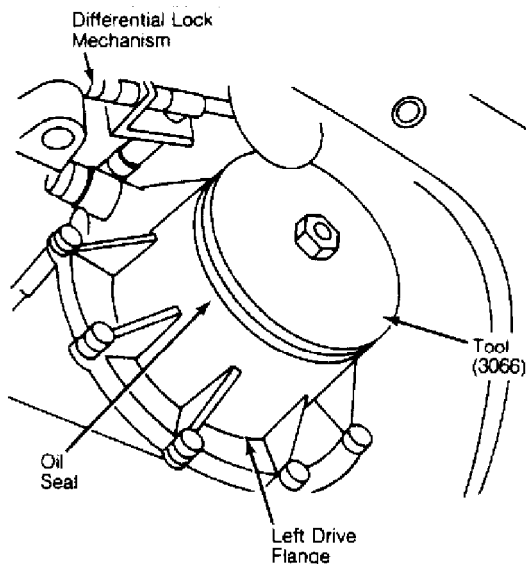


Fig. 7: Installing Left Flange Seal

PINION SHAFT SEAL

DRIVE AXLE - REAR

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Removal

Disconnect rear drive shaft at drive axle. Mark position of pinion nut on pinion. Always use same pinion nut if possible. Using Flange Holder (3028), remove pinion nut. Using Puller (VW 391), remove pinion flange. Using Seal Puller (VW 691), remove oil seal.

Installation

1) Fill oil seal with multipurpose grease between sealing lips and install to stop. Install pinion flange. Clean grease and oil from threads of pinion nut and pinion shaft.

2) Coat threads of pinion nut with thin coat of locking compound. Tighten pinion nut exactly to previously marked position. Lock collar of pinion nut. Connect drive shaft and tighten to 32 ft. lbs. (45 N.m). See Fig. 8.

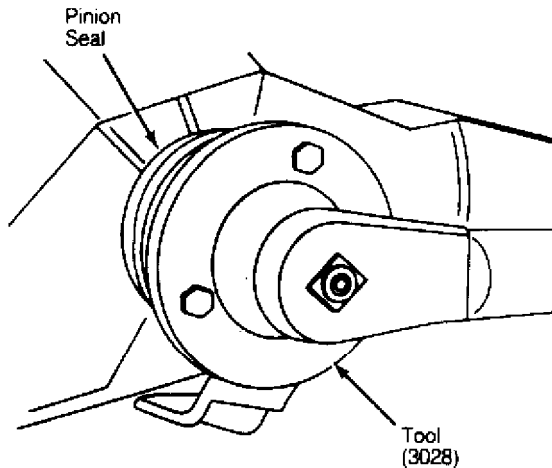


Fig. 8: Replacing Drive Axle Pinion Seal

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS TABLE

Application Ft. Lbs. (N.m)

Axle Shaft Bolt	58 (80)
Axle Nut	203 (280)
Ball Joint Clamp Nut	47 (65)
Center Support Bearing Bolt	14 (20)
Drive Shaft-to-Transmission	
Output Flange Bolt	40 (55)
Drive Shaft to Drive Axle Bolt	32 (45)
Rear Axle To Subframe Bolt	32 (45)
Wheel Bolt	80 (110)

END OF ARTICLE

ELECTRICAL COMPONENT LOCATOR

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ARTICLE BEGINNING

1987 Volkswagen

QUANTUM & QUANTUM SYNCRO

ELECTRICAL COMPONENTS

QUANTUM & QUANTUM SYNCRO COMPONENT LOCATOR CHART

AA

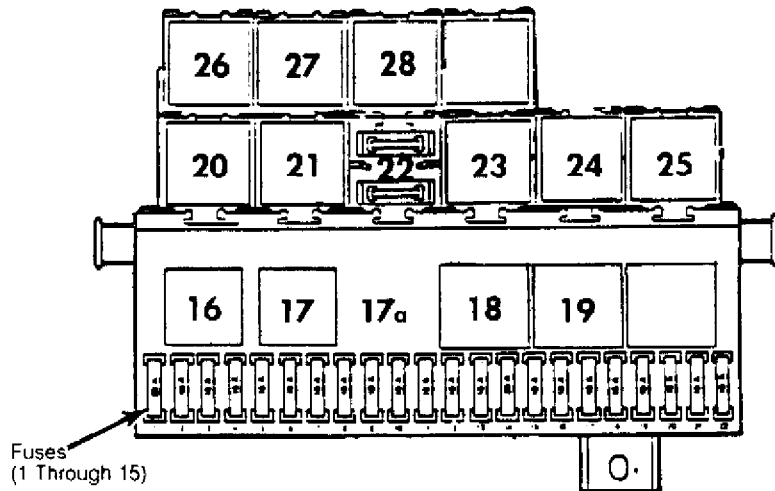
BUZZERS, RELAYS & TIMERS

AA

Component

Component Location

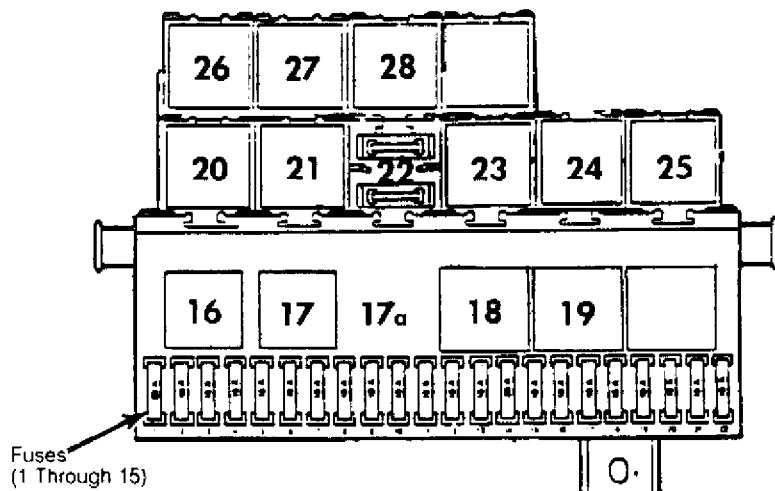
AA



- 16. Not Used
- 17. Load Reduction Relay
- 17a. Fuel Pump Relay Adapter
- 18. Intermittent Wiper Relay
- 19. Turn Signal/Hazard Flasher
- 20. Fuel Pump Relay
- 21. Rear Wiper Relay
- 22. A/C Relay
- 23. Upshift Indicator Control Relay
- 24. Horn Relay
- 25. Seat Belt Warning Buzzer
- 26. Oxygen Sensor Power Relay
- 27. Cold Start Valve Relay
- 28. Fuse Panel (Not Used)
- 29. Power Window Relay

A/C Relay

On fuse/relay panel.



- 16. Not Used
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- 17a. Fuel Pump Relay Adapter
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- 19. Turn Signal/Hazard Flasher
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- 28. Fuse Panel (Not Used)
- 29. Power Window Relay

Fuel Pump Relay

On fuse/relay panel.

ELECTRICAL COMPONENT LOCATOR

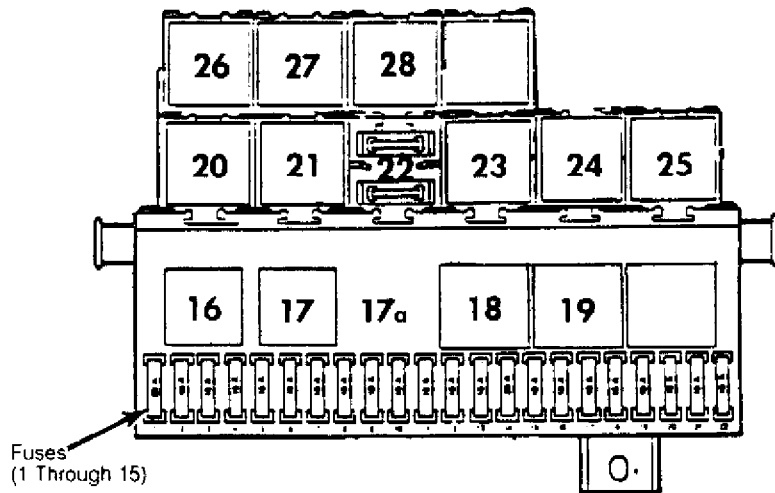
Article Text (p. 2)

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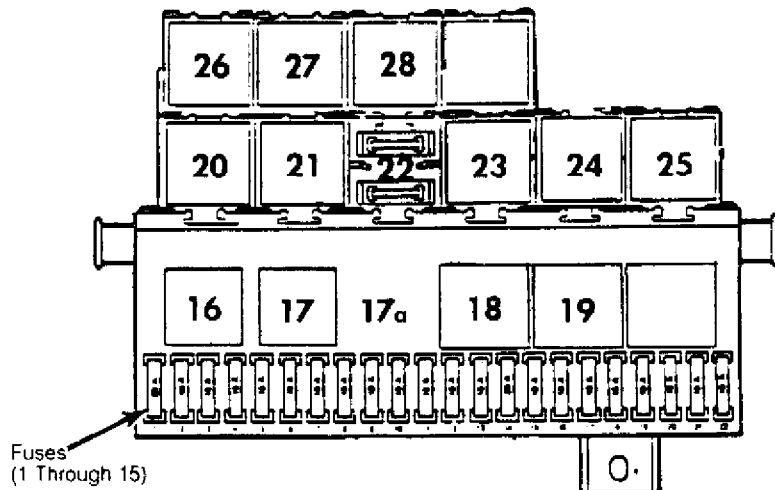
For Volkswagen Technical Site

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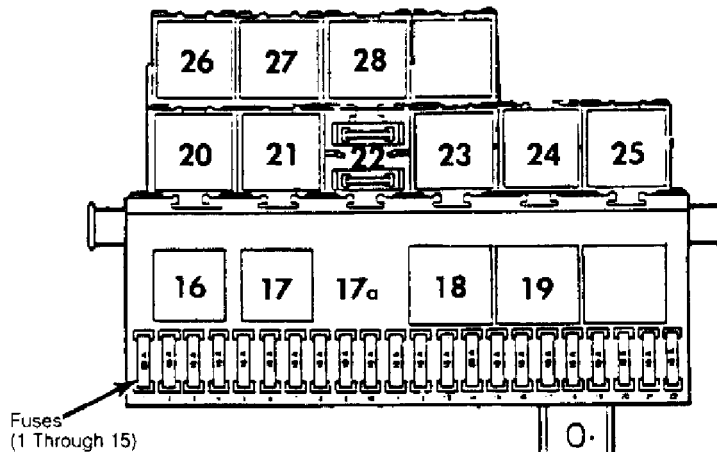
Sunday, March 19, 2000 01:44AM



- 16. Not Used
- 17. Load Reduction Relay
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- 26. Oxygen Sensor Power Relay
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ELECTRICAL COMPONENT LOCATOR

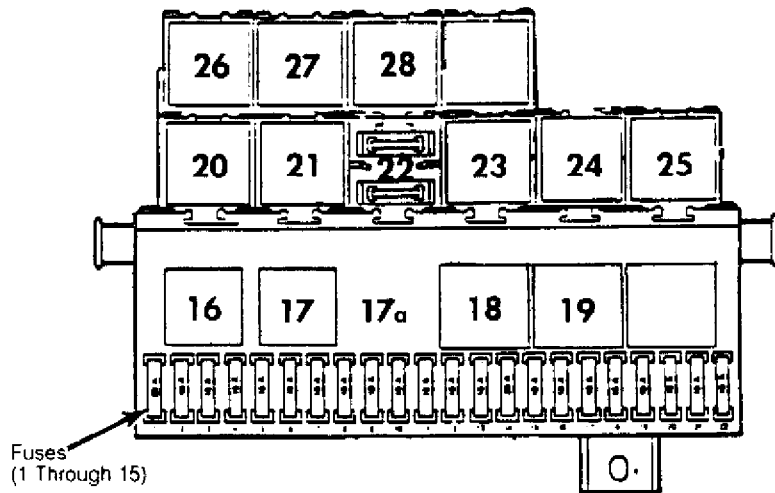
Article Text (p. 3)

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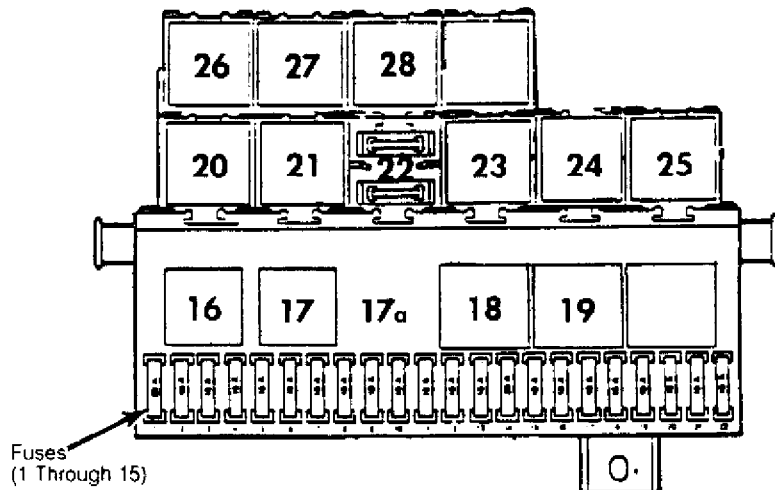
Sunday, March 19, 2000 01:44AM



- 16. Not Used
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- 27. Cold Start Valve Relay
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Load Reduction Relay

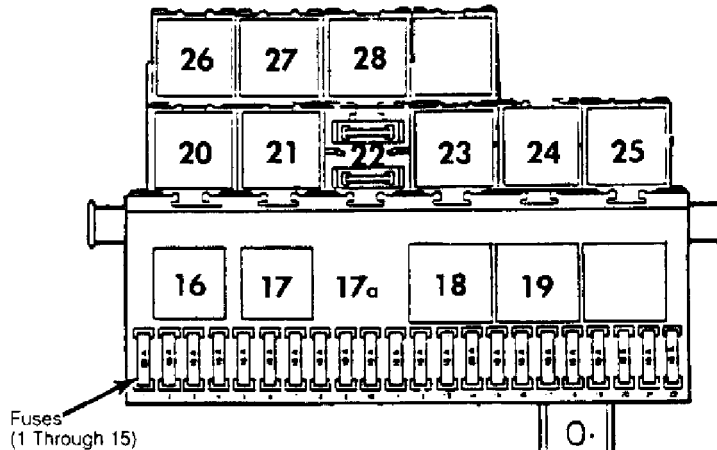
On fuse/relay panel.



- 16. Not Used
- 17. Load Reduction Relay
- 17a. Fuel Pump Relay Adapter
- 18. Intermittent Wiper Relay
- 19. Turn Signal/Hazard Flasher
- 20. Fuel Pump Relay
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- 29. Power Window Relay

Oxygen Sensor Power Relay

On fuse/relay panel.



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- 27. Cold Start Valve Relay
- 28. Fuse Panel (Not Used)
- 29. Power Window Relay

Power Window Relay

On fuse/relay panel.

ELECTRICAL COMPONENT LOCATOR

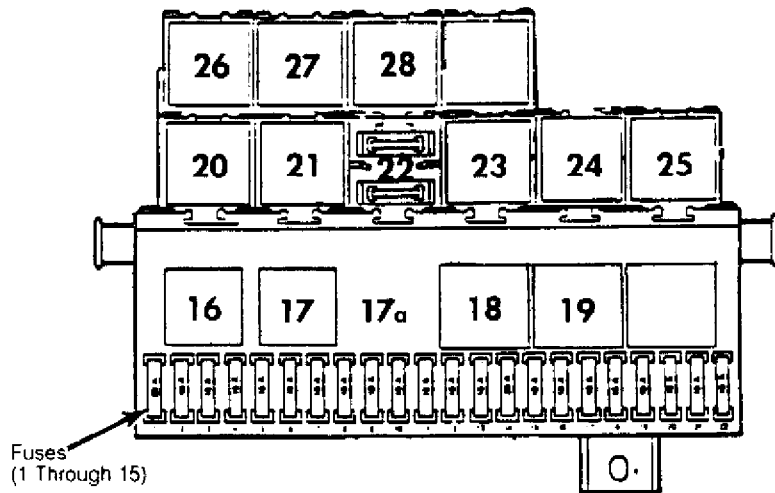
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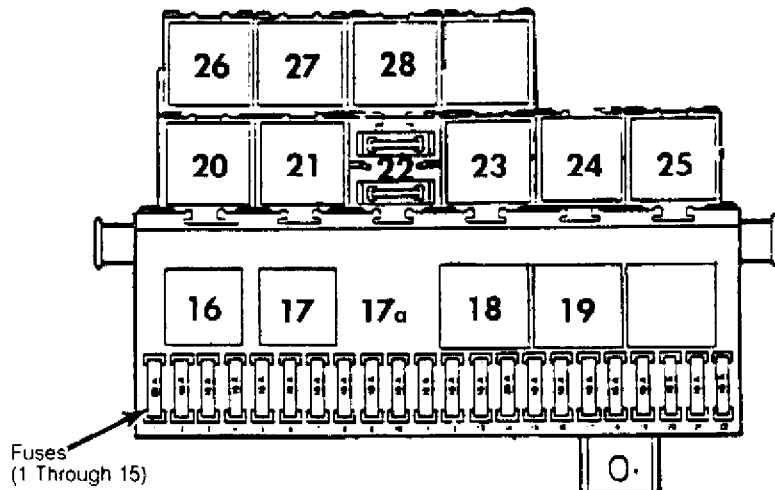
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- 16. Not Used
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- 23. Upshift Indicator Control Relay
- 24. Horn Relay
- 25. Seat Belt Warning Buzzer
- 26. Oxygen Sensor Power Relay
- 27. Cold Start Valve Relay
- 28. Fuse Panel (Not Used)
- 29. Power Window Relay

Rear Wiper Relay

On fuse/relay panel.



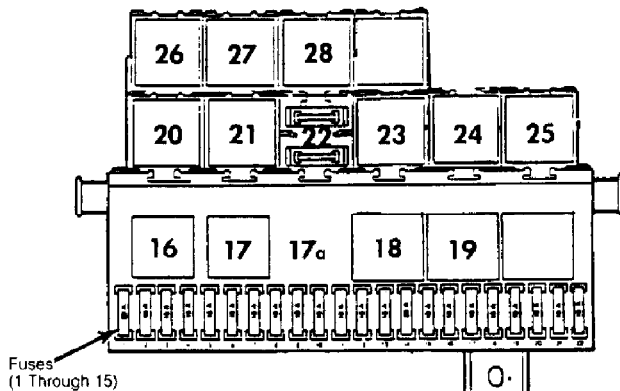
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- 17. Load Reduction Relay
- 17a. Fuel Pump Relay Adapter
- 18. Intermittent Wiper Relay
- 19. Turn Signal/Hazard Flasher
- 20. Fuel Pump Relay
- 21. Rear Wiper Relay
- 22. A/C Relay
- 23. Upshift Indicator Control Relay
- 24. Horn Relay
- 25. Seat Belt Warning Buzzer
- 26. Oxygen Sensor Power Relay
- 27. Cold Start Valve Relay
- 28. Fuse Panel (Not Used)
- 29. Power Window Relay

Seat Belt Warning Buzzer

On fuse/relay panel.

Sun Roof Relay

On sun roof motor.



- 16. Not Used
- 17. Load Reduction Relay
- 17a. Fuel Pump Relay Adapter
- 18. Intermittent Wiper Relay
- 19. Turn Signal/Hazard Flasher
- 20. Fuel Pump Relay
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- 27. Cold Start Valve Relay
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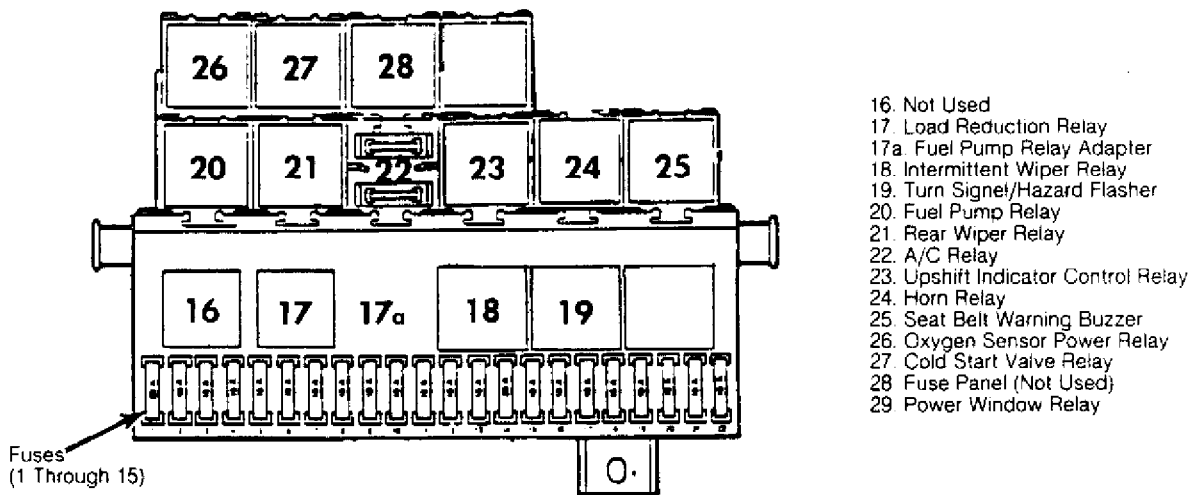
Turn Signal/Hazard Flasher

On fuse/relay panel.

ELECTRICAL COMPONENT LOCATOR

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Upshift Indicator Control
Relay

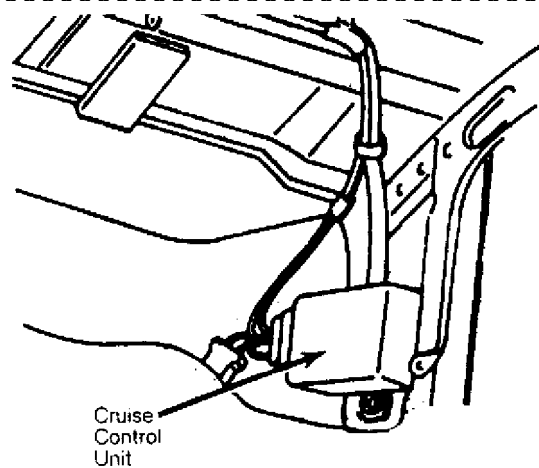
On fuse/relay panel.

CIRCUIT PROTECTION DEVICES

Component	Component Location
Fuse/Relay Panel	Under left side of dash.

CONTROL UNITS

Component	Component Location



Cruise Control Unit

Under right side of dash.

ELECTRICAL COMPONENT LOCATOR

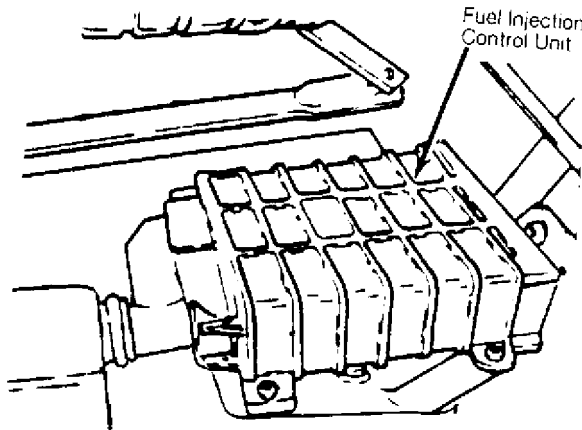
Article Text (p. 6)

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Fuel Injection Control Unit	On left rear corner of engine compartment.
Idle Stabilizer Control Unit	On left rear corner of engine compartment.
Ignition Control Unit	On left rear corner of engine compartment.
Oil Pressure Control Unit	On back of instrument cluster.

MOTORS

Component	Component Location
Fuel Pump	In top center of fuel tank.
Power Door Lock Pump	In left rear quarter panel.
Rear Washer Pump	On side of washer reservoir.
Rear Wiper Motor	In rear tailgate.
Windshield Washer Pump	On side of washer reservoir.
Windshield Wiper Motor	In cowl area, at rear of engine compartment.

SENDING UNITS & SENSORS

Component	Component Location

ELECTRICAL COMPONENT LOCATOR

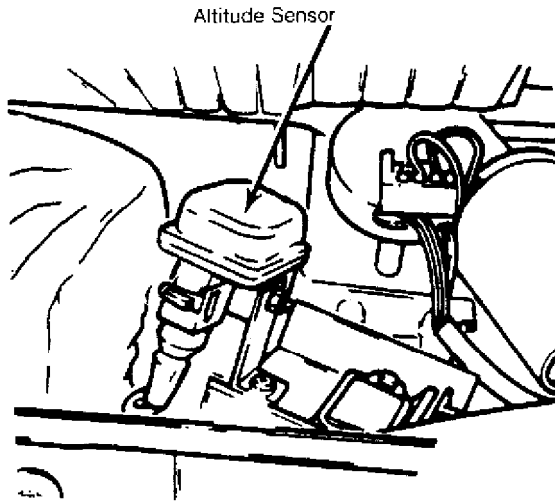
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1987 Volkswagen Quantum/Quantum Syncro

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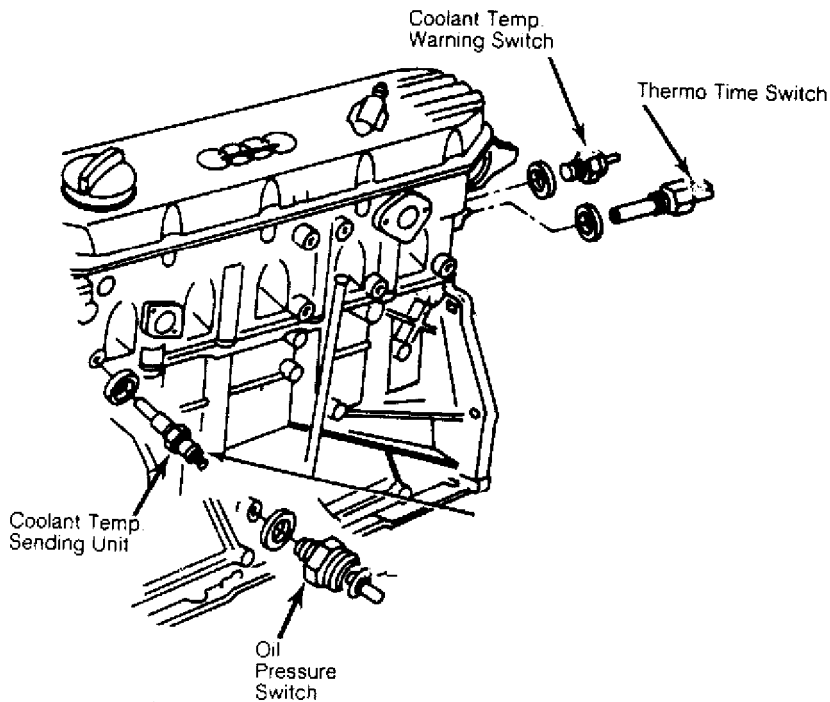
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Altitude Sensor

On left rear corner of engine compartment.



Coolant Temperature Sending Unit

On side of engine block.

ELECTRICAL COMPONENT LOCATOR

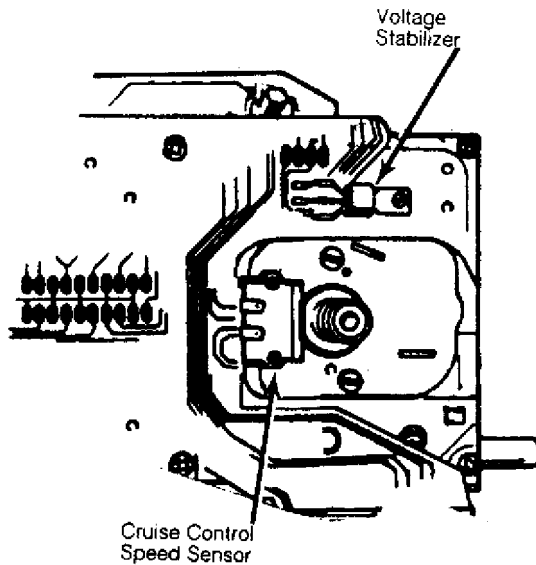
Article Text (p. 8)

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Cruise Control Speed Sensor	On back of instrument cluster.
Fuel Gauge Sending Unit	In fuel tank, integral with fuel pump.
Oil Temperature Sensor	In oil pump housing.
Oxygen Sensor	In exhaust manifold.

SOLENOIDS & SOLENOID VALVES

AA	AA
Component	Component Location
AA	AA
Power Door Lock Control Solenoid	In left front door.

SWITCHES

AA	AA
Component	Component Location
AA	AA
A/C Coolant Temperature Switch	In coolant supply hose, near expansion tank.
A/C Kickdown Switch	Below accelerator pedal.
A/C High/Low Pressure Switches	On top of receiver-drier.
A/C Microswitch	On side of A/C-heater control panel.
A/C Temperature Switch	On rear of A/C-heater control panel.

ELECTRICAL COMPONENT LOCATOR

Article Text (p. 9)

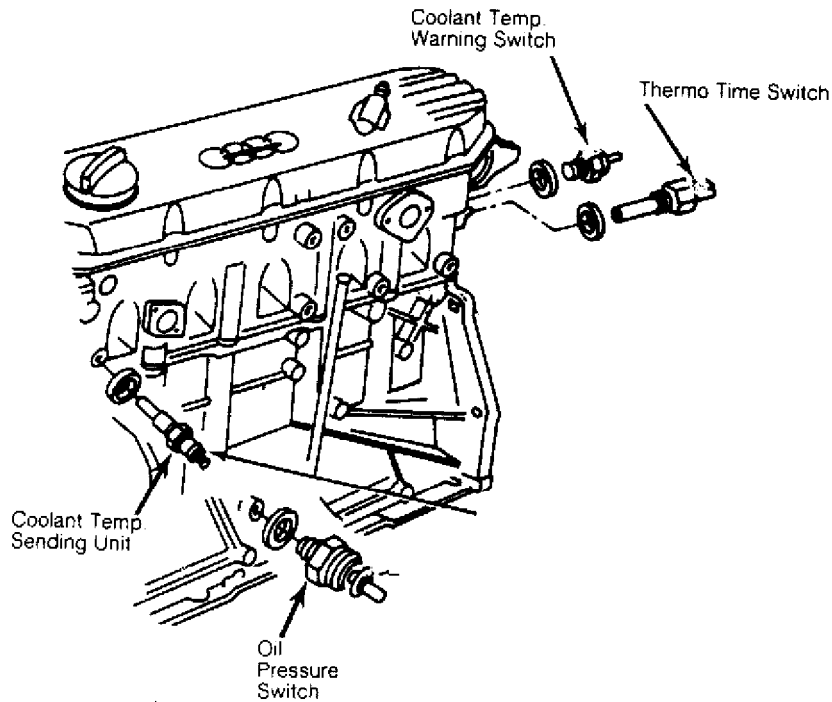
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Back-Up Light Switch (M/T)	On transmission.
Brake Fluid Level Switch	In brake fluid reservoir cap.
Brake/Stoplight Switch	On master cylinder.



Coolant Temp. Warning Switch	In rear of cylinder head.
Cooling Fan Thermoswitch	On left side of radiator.
Cruise/Brake Switch	On brake pedal assembly.
Cruise/Clutch Switch	On clutch pedal assembly.

ELECTRICAL COMPONENT LOCATOR

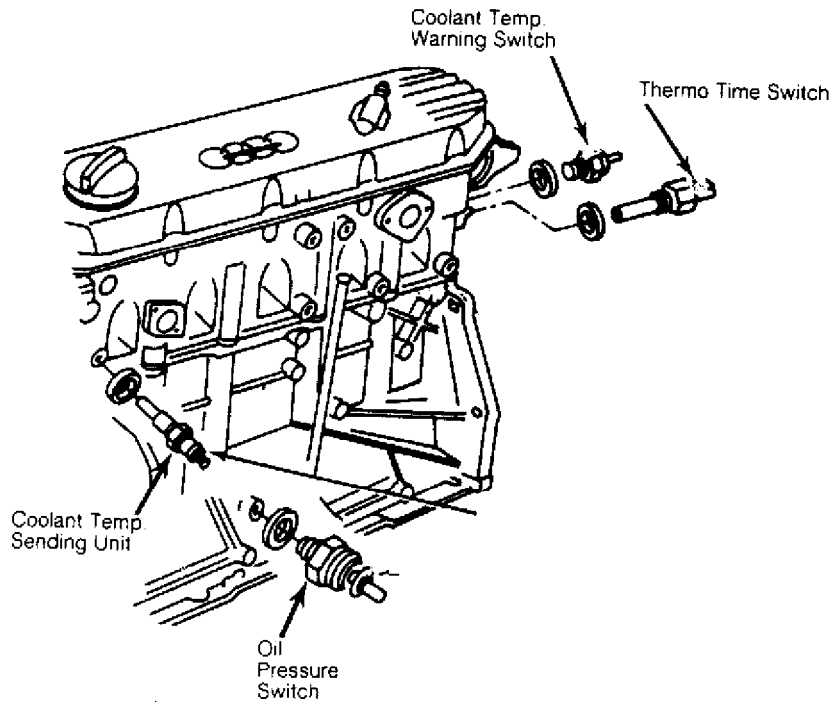
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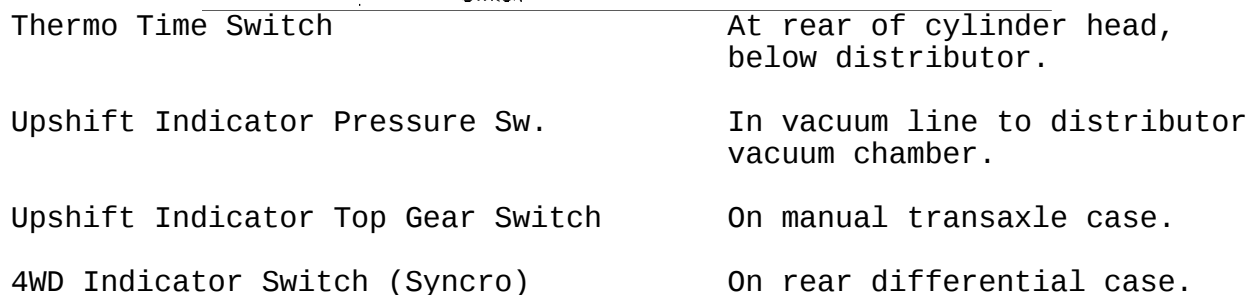


Oil Pressure Switch	On engine block, in front of dipstick tube.
Oil Pressure Warning Switches	
Low Pressure	In rear of cylinder head.
High Pressure	On oil filter bracket.
Oxygen Sensor Thermoswitch	In heater by-pass hose.
Parking Brake Switch	Under parking brake lever.
Seat Belt Switch	In driver's seat belt buckle.
Sun Roof Switches	On sun roof motor.

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Component	Component Location



ELECTRICAL COMPONENT LOCATOR

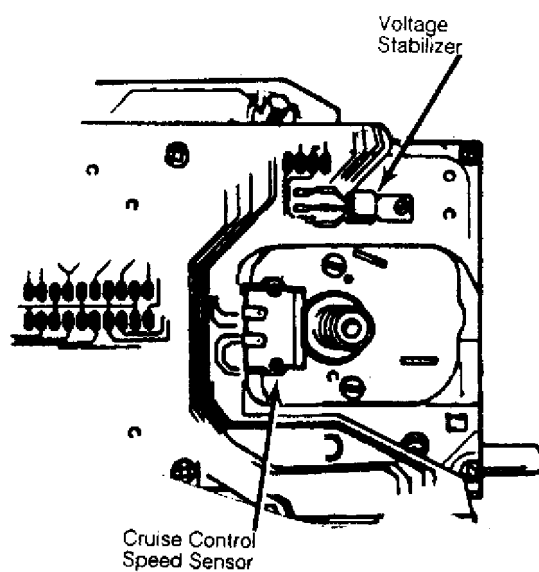
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Voltage Stabilizer

On back of instrument cluster.

END OF ARTICLE

ELECTROSTATIC DISCHARGE WARNING - BASIC INFORMATION

Article Text

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ARTICLE BEGINNING

GENERAL INFORMATION

Electrostatic Discharge (ESD) Warning - Basic Information

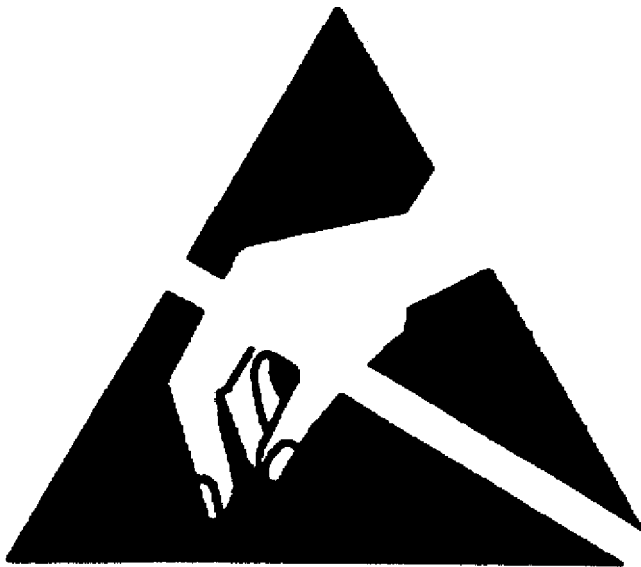
All Makes and Models

* PLEASE READ THIS FIRST *

NOTE: This article is intended for general information purposes only.

INTRODUCTION

All Electrostatic Discharge (ESD) sensitive components contain solid state circuits (transistors, diodes, semiconductors) that may become damaged when contacted with an electrostatic charge. The following information applies to all ESD sensitive devices. The ESD symbol shown in Fig. 1 may be used on schematics to indicate which components are ESD sensitive. See Fig. 1. Although different manufactures may display different symbols to represent ESD sensitive devices, the handling and measuring precautions and procedures are the same.



50112680

Fig. 1: Sample ESD Symbol

HANDLING STATIC-SENSITIVE CIRCUITS/DEVICES

When handling an electronic part that is ESD sensitive, the technician should follow these guidelines to reduce any possible electrostatic charge build-up on the technician's body and the electronic part.

ELECTROSTATIC DISCHARGE WARNING - BASIC INFORMATION

Article Text (p. 2)

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1) Always touch a known good ground source before handling the part. This should be repeated while handling the part and more frequently after sitting down from a standing position, sliding across the seat or walking a distance.

2) Avoid touching electrical terminals of the part, unless instructed by a diagnostic procedure.

3) DO NOT open the package of a new part until it is time to install the part.

4) Before removing the part from its package, ground the package to a known good ground source.

CHECKING STATIC-SENSITIVE CIRCUITS/DEVICES

1) Solid State circuits in electronic devices are shown greatly simplified in schematics. See Fig. 2. Due to the simplification of the electronic devices on the schematic, resistance measurements could be misleading or could lead to an electrostatic discharge. Always follow the recommended diagnostic procedure.

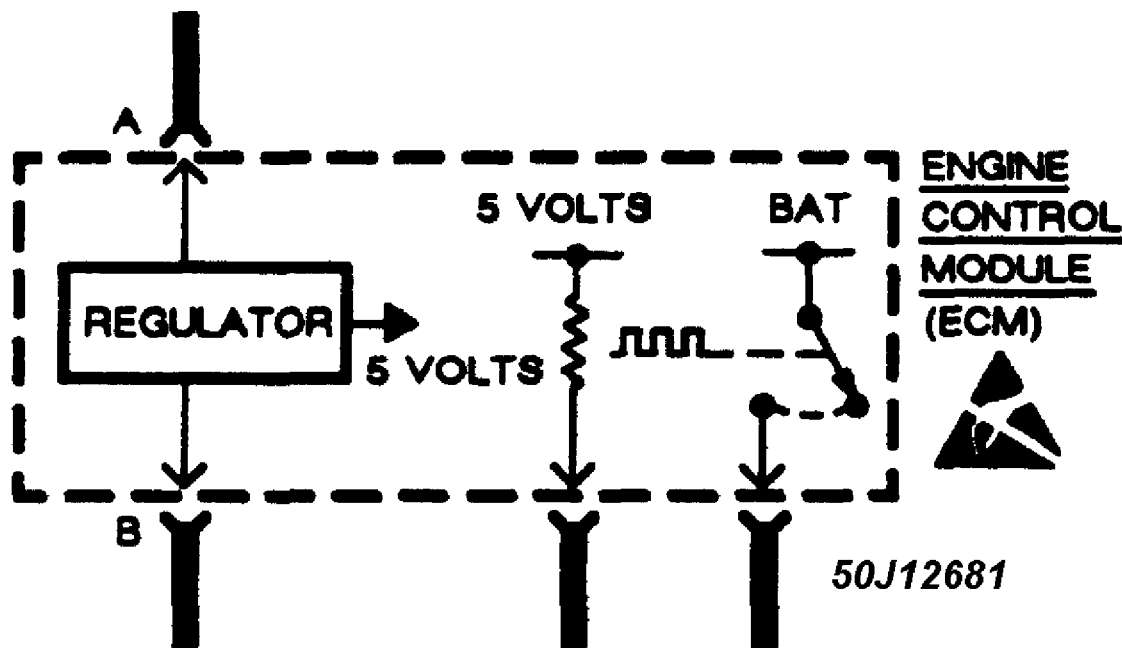


Fig. 2: Sample Schematic Showing Typical ESD Sensitive Device

2) Only measure resistance at the terminals of the devices when instructed by the recommended diagnostic procedure.

3) When using a voltmeter, be sure to connect the ground lead first.

END OF ARTICLE

EMISSION APPLICATION

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ARTICLE BEGINNING

1987 ENGINE EMISSIONS
Volkswagon Emission Control Applications

Cabriolet, Fox, Golf, Jetta, Quantum, Quantum Syncro,
Scirocco, Vanagon

EMISSION CONTROL DEVICE APPLICATIONS

EMISSION CONTROL DEVICE APPLICATIONS TABLE

AA

Vanagon

PCV, EVAP, OC, EGR, O2, ECU

All Other Models

PCV, EVAP, OC, TWC (1), O2, ECU, CIS-E

(1) - California models only.

AA

ABBREVIATION DEFINITIONS

ABBREVIATIONS DEFINITIONS TABLE

AA

Abbreviation

Description

CIS-E Electronic CIS

DC Digijet Control

ECU Electronic Control Unit

EGR Exhaust Gas Recirculation

EVAP Fuel Evaporative System

OC Oxidation Catalyst

O2 Oxygen Sensor

PCV Positive Crankcase Ventilation

TAC Thermostatic Air Cleaner

TWC Three-Way Catalyst

AA

END OF ARTICLE

EMISSION CONTROL VISUAL INSPECTION PROCEDURES

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ARTICLE BEGINNING

GENERAL INFORMATION

All Makes Emission Control Visual Inspection Procedures

All Models

PLEASE READ THIS FIRST

This article is provided for general information only. Not all information applies to all makes and models. For more complete information, see appropriate article(s) in the ENGINE PERFORMANCE Section.

EMISSION CONTROL LABELS

The vehicle manufacturer's emission control label, also known as the underhood tune-up label or Vehicle's Underhood Emission Control System (VECI) label, is located in the engine compartment. Information regarding year model of vehicle, engine size, number of cylinders, emission equipment or type, engine tune-up specifications, whether vehicle was manufactured for sale in California or is a Federal vehicle, vacuum hose routing schematic, etc., can be found on this label. See Fig. 1.

In addition to the VECI label, some emission control inspection and maintenance programs may require an additional label to be affixed to the vehicle in special circumstances. For example, in California, a Bureau Of Automotive Repair (BAR) engine label may be affixed to the left door post. A BAR engine label is only used when the vehicle has an engine change, approved modification or is a Specially Constructed (SPCN) or an acceptable Gray market vehicle. Check your state's emission control inspection and maintenance laws to determine if a similar label is used.

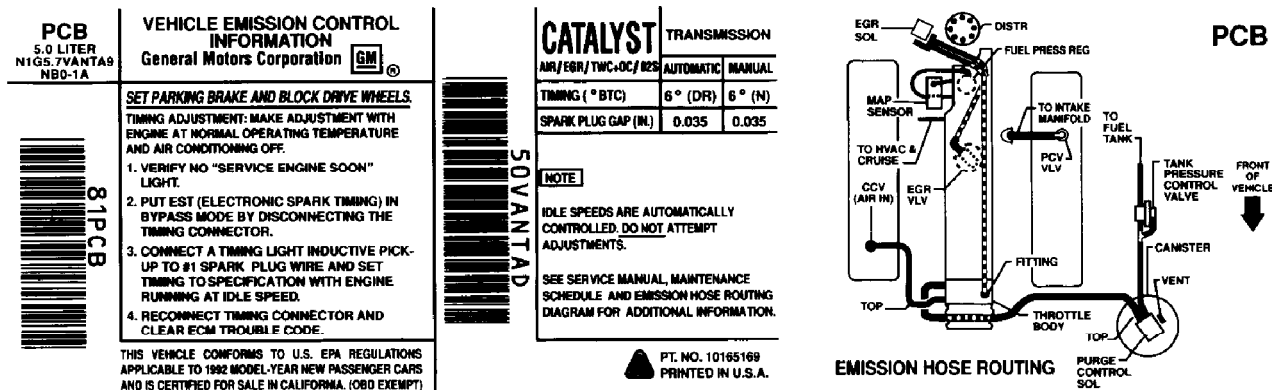


Fig. 1: Typical Emission Control Label
Courtesy of General Motors Corp.

EMISSION CONTROL VISUAL INSPECTION

EMISSION CONTROL VISUAL INSPECTION PROCEDURES

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NOTE: The following emission control visual inspection procedures should be used as a guide only. When performing a visual inspection, always follow your state's recommended inspection procedures.

A visual inspection is made to determine if any required emission control devices are missing, modified or disconnected. Missing, modified or disconnected systems must be made fully operational before a vehicle can be certified.

POSITIVE CRANKCASE VENTILATION (PCV)

PCV controls the flow of crankcase fumes into the intake manifold while preventing gases and flames from traveling in the opposite direction. PCV is either an open or closed system. See Fig. 2.

Ensure PCV system is installed as required. Verify valve, required hoses, connections, flame arresters, etc., are present, routed properly and in serviceable condition.

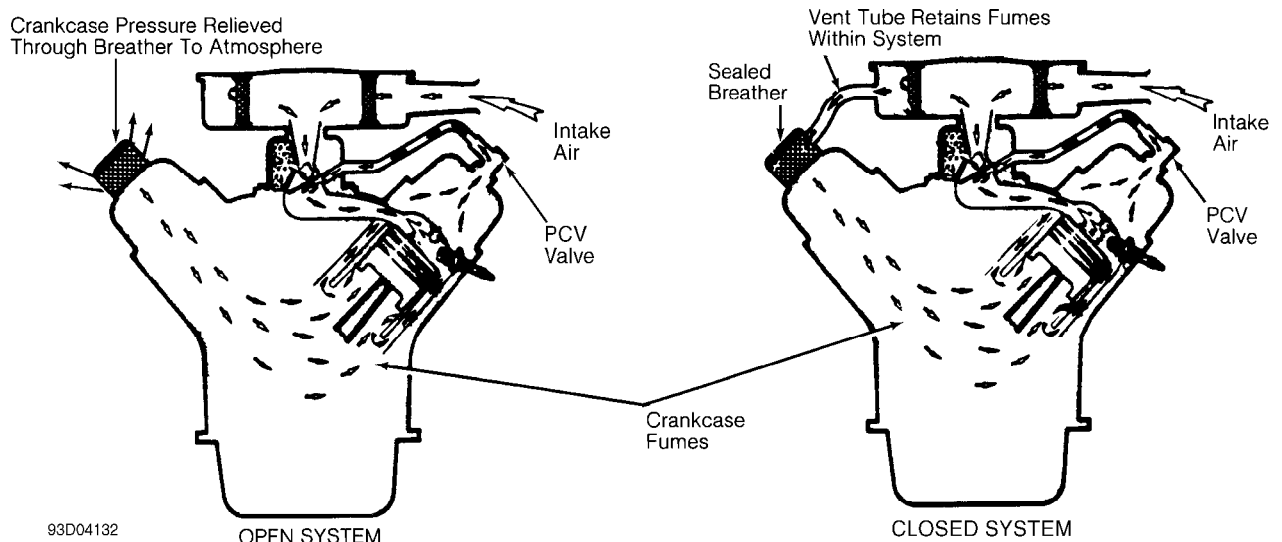


Fig. 2: Typical Open & Closed Type PCV System

THERMOSTATIC AIR CLEANER (TAC)

The TAC supplies warm air to air intake during cold engine operation. This system is active during cold engine warm-up only. Under all other operating conditions, air cleaner function is the same as any non-thermostatic unit.

Ensure required exhaust shroud, hot air duct, vacuum hoses and air cleaner components are present and installed properly. See Fig. 3. Ensure any required thermostatic vacuum switches are in place and vacuum hoses are installed and in serviceable condition. Also ensure air cleaner lid is installed right side up. Check for oversized air filter elements and for additional holes in the air cleaner housing.

EMISSION CONTROL VISUAL INSPECTION PROCEDURES

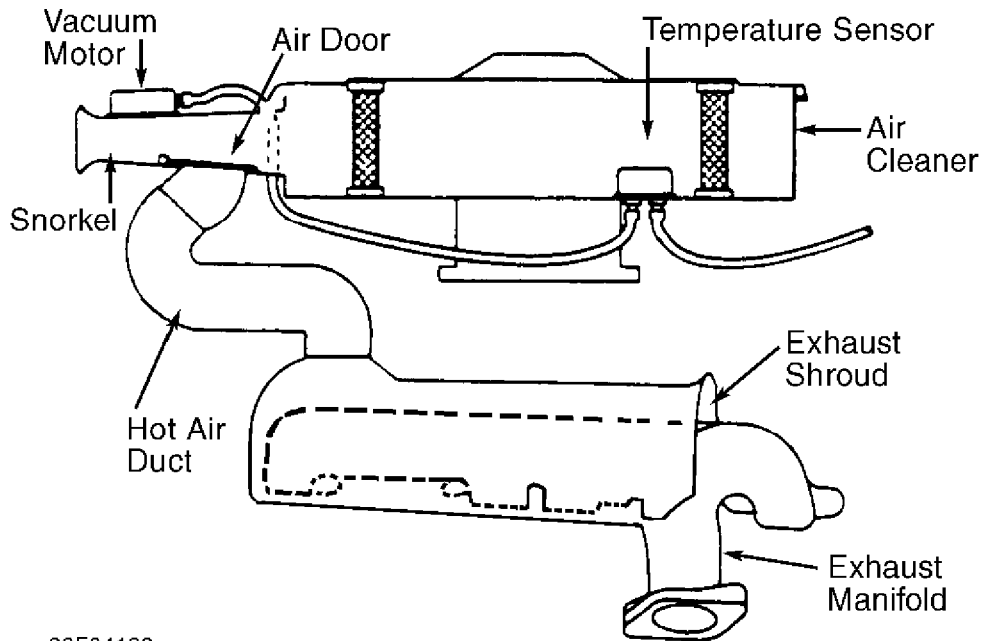
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93F04133
Fig. 3: Typical Thermostatic Air Cleaner System

FUEL EVAPORATIVE SYSTEM (EVAP)

The EVAP system allows for proper fuel system ventilation while preventing fuel vapors from reaching the atmosphere. This means that vapors must be caught and stored while the engine is off, which is when most fuel evaporation occurs. When the engine is started, these fuel vapors can be removed from storage and burned. In most systems, storage is provided by an activated charcoal (or carbon) canister. See Fig. 4. On a few early systems, charcoal canisters are not used. Instead, fuel vapors are vented into the PCV system and stored inside the crankcase.

The main components of a fuel evaporation system are a sealed fuel tank, a liquid-vapor separator and vent lines to a vapor-storing canister filled with activated charcoal. The filler cap is normally not vented to the atmosphere, but is fitted with a valve to allow both pressure and vacuum relief.

Although a few variations do exist between manufacturers, basic operation is the same for all systems. Check for presence of vapor storage canister or crankcase storage connections when required. Ensure required hoses, solenoids, etc., are present and connected properly. Check for proper type fuel tank cap. Check for any non-OEM or auxiliary fuel tanks for compliance and the required number of evaporation canisters.

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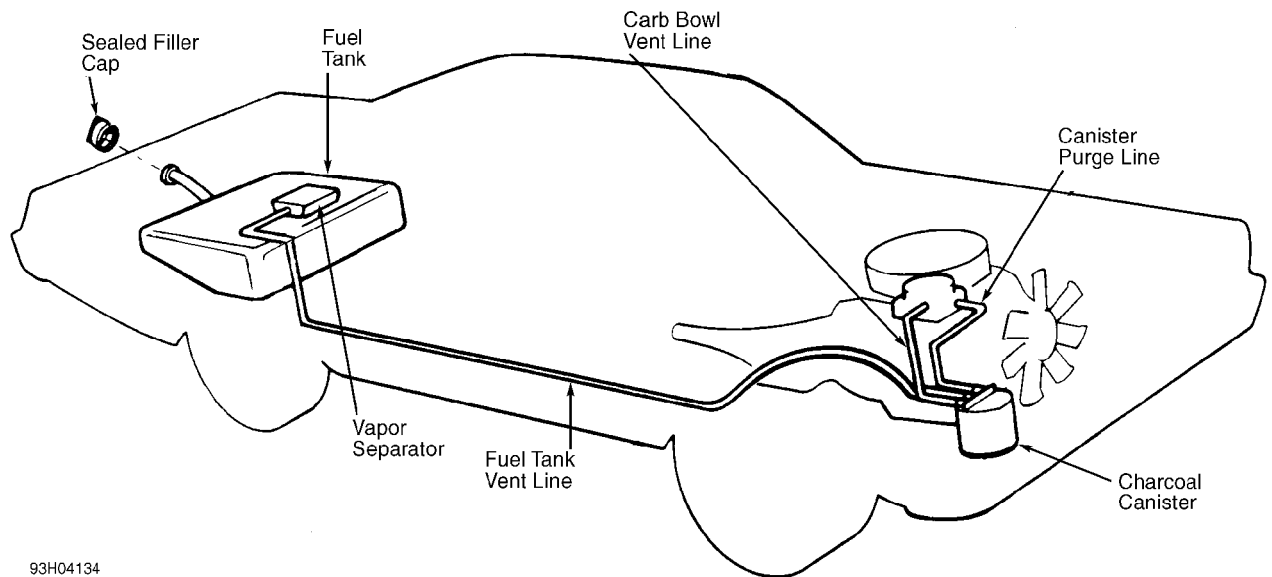
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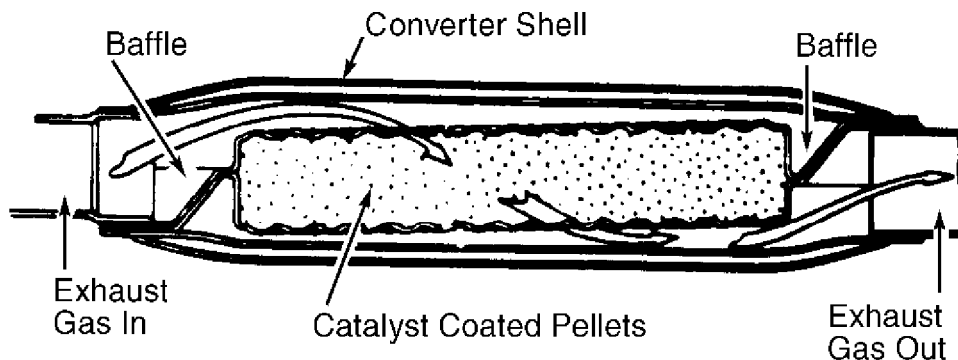
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Fig. 4: Typical Fuel Evaporative System

CATALYTIC CONVERTERS

Oxidation Catalyst (OC)

This type of converter is the most common. It may use pellets or monolith medium, depending upon application. See Fig. 5. Platinum and palladium (or platinum alone) are used as catalyst in this type of converter.

Visually check for presence of catalytic converter(s). Check for external damage such as severe dents, removed or damaged heat shields, etc. Also check for pellets or pieces of converter in the tailpipe.



93A04135
Fig. 5: Typical Oxidation Catalytic Converter (Pellet Type) Shown; Typical Three-Way Catalytic Converter Is Similar
Courtesy of General Motors Corp.

Three-Way Catalyst (TWC)

This type of converter is nearly identical to a conventional converter with the exception of the catalyst. See Fig. 5. The TWC converter uses rhodium, with or without platinum, as its catalyst. Rhodium helps reduce NO_x emissions, as well as HC and CO.

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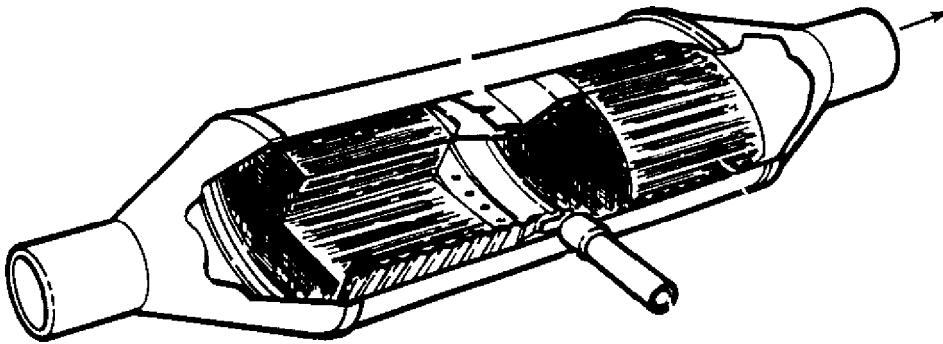
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Visually check for presence of catalytic converter(s). Also check for presence of any required air supply system for the oxidizing section of the converter. Check for external damage such as severe dents, removed or damaged heat shields, etc. Check for pellets or pieces of converter in the tailpipe.

Three-Way Catalyst + Oxidation Catalyst (TWC + OC)

This system contains a TWC converter and an OC converter in a common housing, separated by a small air space. See Fig. 6. The 2 catalysts are referred to as catalyst beds. Exhaust gases pass through the TWC first. The TWC bed performs the same function as it would as a separate device, reducing all 3 emissions. As exhaust gases leave the bed, they pass through the air space and into the second (OC) converter catalyst bed.

Visually check for presence of catalytic converter(s). Check for external damage such as severe dents, removed or damaged heat shields, etc. Check for pellets or pieces of converter in the tailpipe.



93C04136
Fig. 6: Typical Three-Way + Oxidation Catalytic Converter
Courtesy of General Motors Corp.

FILL PIPE RESTRICTOR (FR)

A fuel tank fill pipe restrictor is used to prohibit the introduction of leaded fuel into the fuel tank. Unleaded gasoline pump dispensers have a smaller diameter nozzle to fit fuel tank of vehicle requiring the use of unleaded fuel (vehicles equipped with catalytic converter).

Visually inspect fill pipe restrictor(s) for tampering, i.e., restrictor is oversize or the flapper is non-functional. If vehicle is equipped with an auxiliary fuel tank, ensure auxiliary fuel tank is also equipped with a fill pipe restrictor.

EXHAUST GAS RECIRCULATION (EGR) SYSTEM

Single Diaphragm EGR Valve

This type uses a single diaphragm connected to the valve by a shaft. Diaphragm is spring-loaded to keep valve closed in the absence

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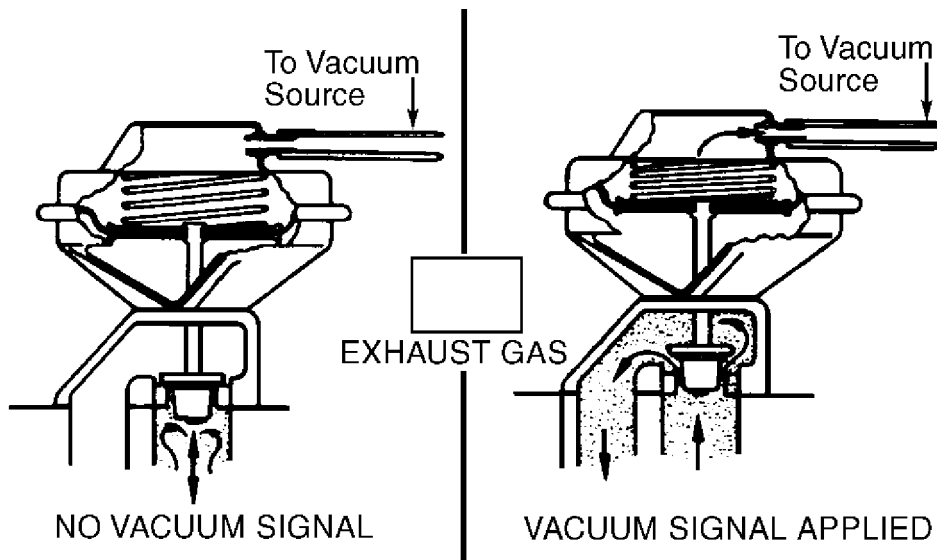
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of vacuum. As throttle valves open and engine speed increases, vacuum is applied to the EGR vacuum diaphragm, opening the EGR valve. This vacuum signal comes from a ported vacuum source. Variations in the vacuum signal control the amount of exhaust gas that is recirculated. See Fig. 7.

Verify EGR valve is present and not modified or purposely damaged. Ensure thermal vacuum switches, pressure transducers, speed switches, etc., (if applicable) are not by-passed or modified. Ensure vacuum hose(s) to EGR valve is not plugged.



93E04137
Fig. 7: Typical Single Diaphragm EGR Valve
Courtesy of General Motors Corp.

Dual Diaphragm EGR Valve

This type uses 2 diaphragms with different effective areas and 2 vacuum sources. Although similar to the single diaphragm type, the second diaphragm is added below the upper diaphragm and is rigidly attached to the valve seat. See Fig. 8. These diaphragms form a vacuum chamber which is connected to manifold vacuum.

During highway cruising when manifold vacuum is high in the center chamber, manifold vacuum tends to pull the valve closed. However, the vacuum signal applied to the top side of the upper diaphragm overcomes the downward spring force and the manifold vacuum pull, due to the diaphragm's larger piston. This regulates the amount of EGR.

When manifold vacuum is low during acceleration, the higher vacuum signal opens the valve, permitting more EGR. When manifold vacuum is high during highway cruising, the valve is only partially opened, reducing the amount of EGR.

Verify EGR valve is present and not modified or purposely damaged. Ensure thermal vacuum switches, pressure transducers, speed switches, etc., (if applicable) are not by-passed or modified. Ensure vacuum hose(s) to EGR valve is not plugged.

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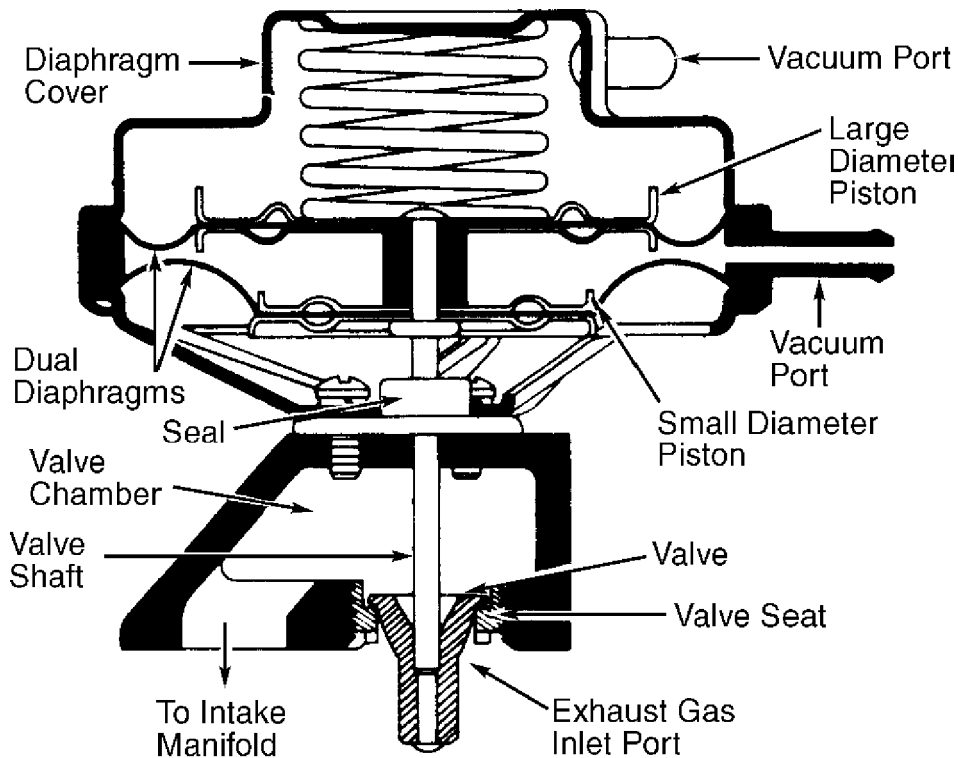
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CLOSED POSITION

Fig. 8: Typical Dual Diaphragm EGR Valve
Courtesy of General Motors Corp.

Positive Backpressure EGR (BP/EGR) Valve

This type uses both engine vacuum and exhaust backpressure to control the amount of EGR. It provides more recirculation during heavy engine loads than the single diaphragm EGR valve.

A small diaphragm-controlled valve inside EGR valve acts as a pressure regulator. The control valve gets an exhaust backpressure signal through the hollow valve shaft. This exhaust backpressure exerts a force on bottom of control valve diaphragm. The diaphragm plate contains 6 bleed holes to bleed air into the vacuum chamber when backpressure valve is in open position. See Fig. 9.

Verify EGR valve is present and not modified or purposely damaged. Ensure thermal vacuum switches, pressure transducers, speed switches, etc., (if applicable) are not by-passed or modified. Ensure vacuum hose(s) to EGR valve is not plugged.

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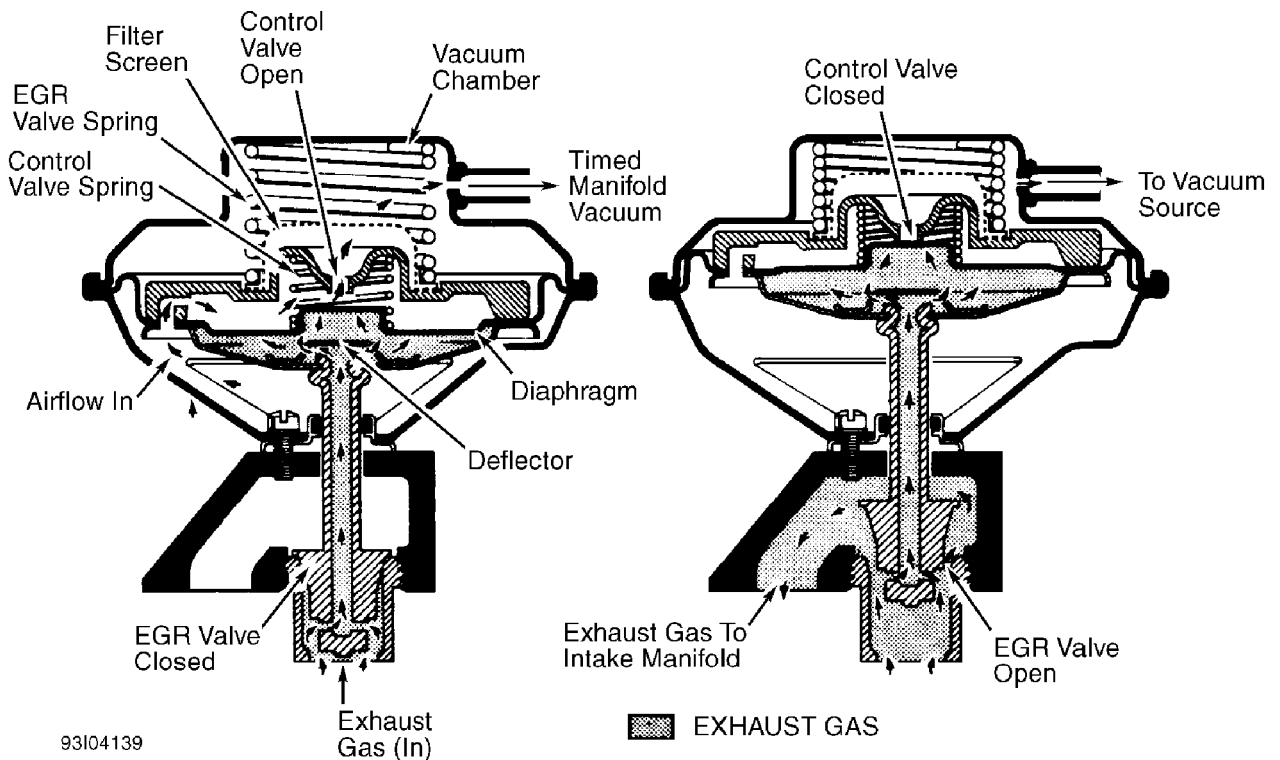


Fig. 9: Typical Positive Backpressure EGR Valve
Courtesy of General Motors Corp.

Negative Backpressure EGR (BP/EGR) Valve

This type has the same function as the positive BP/EGR valve except valve is designed to open with a negative exhaust backpressure. The control valve spring in the transducer is placed on the bottom side of the diaphragm. See Fig. 10.

When ported vacuum is applied to the main vacuum chamber, partially opening the valve, the vacuum signal from the manifold side (reduced by exhaust backpressure) is transmitted to the hollow stem of the valve. See Fig. 10. This enables the signal to act on the diaphragm, providing a specific flow. Thus, the EGR flow is a constant percentage of engine airflow.

Verify EGR valve is present and not modified or purposely damaged. Ensure thermal vacuum switches, pressure transducers, speed switches, etc., (if applicable) are not by-passed or modified. Ensure vacuum hose(s) to EGR valve is not plugged.

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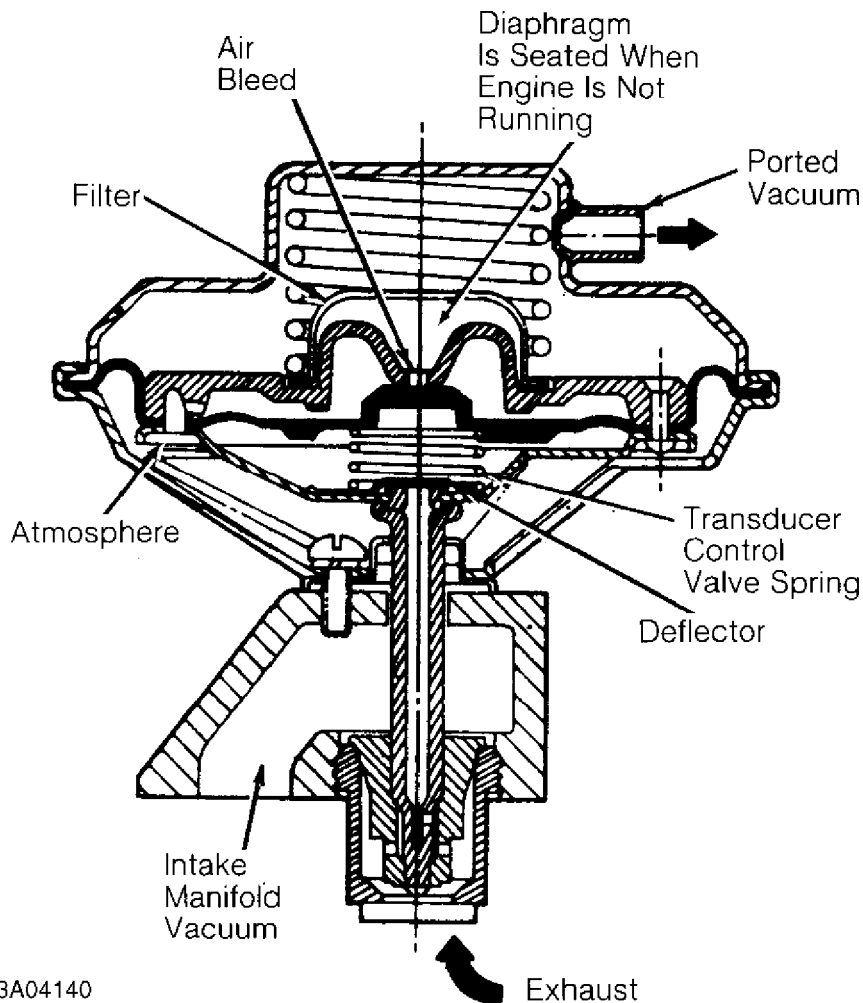


Fig. 10: Typical Negative Backpressure EGR Valve
Courtesy of General Motors Corp.

Digital EGR Valve

The digital EGR valve operates independently of engine manifold vacuum. This valve controls EGR flow through 3 orifices. These 3 orifices are opened and closed by electric solenoids. The solenoids are, in turn, controlled by the Electronic Control Module (ECM). When a solenoid is energized, the armature with attached shaft and swivel pintle is lifted, opening the orifice. See Fig. 11.

The ECM uses inputs from the Coolant Temperature Sensor (CTS), Throttle Position Sensor (TPS) and Mass Airflow (MAF) sensors to control the EGR orifices to make 7 different combinations for precise EGR flow control. At idle, the EGR valve allows a very small amount of exhaust gas to enter the intake manifold. This EGR valve normally operates above idle speed during warm engine operation.

Verify EGR valve is present and not modified or purposely damaged. Ensure thermal vacuum switches, pressure transducers, speed switches, etc., (if applicable) are not by-passed or modified. Ensure vacuum hose(s) to EGR valve is not plugged. Ensure electrical connector to EGR valve is not disconnected.

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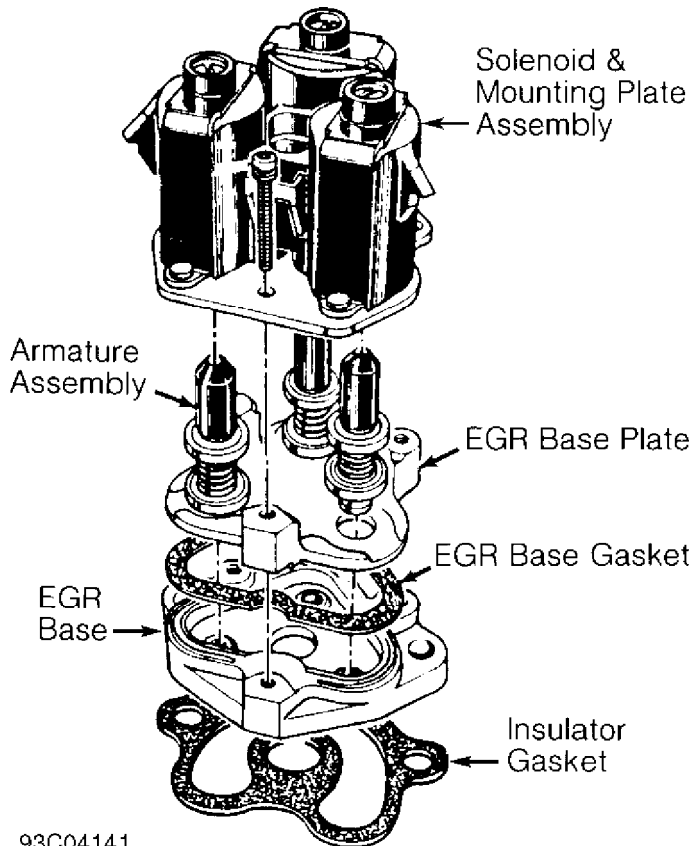
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Fig. 11: Typical Digital EGR Valve
Courtesy of General Motors Corp.

Integrated Electronic EGR Valve

This type functions similar to a ported EGR valve with a remote vacuum regulator. The internal solenoid is normally open, which causes the vacuum signal to be vented off to the atmosphere when EGR is not controlled by the Electronic Control Module (ECM). The solenoid valve opens and closes the vacuum signal, controlling the amount of vacuum applied to the diaphragm. See Fig. 12.

The electronic EGR valve contains a voltage regulator, which converts ECM signal and regulates current to the solenoid. The ECM controls EGR flow with a pulse width modulated signal based on airflow, TPS and RPM. This system also contains a pintle position sensor, which works similarly to a TPS sensor. As EGR flow is increased, the sensor output increases.

Verify EGR valve is present and not modified or purposely damaged. Ensure thermal vacuum switches, pressure transducers, speed switches, etc., (if applicable) are not by-passed or modified. Ensure electrical connector to EGR valve is not disconnected.

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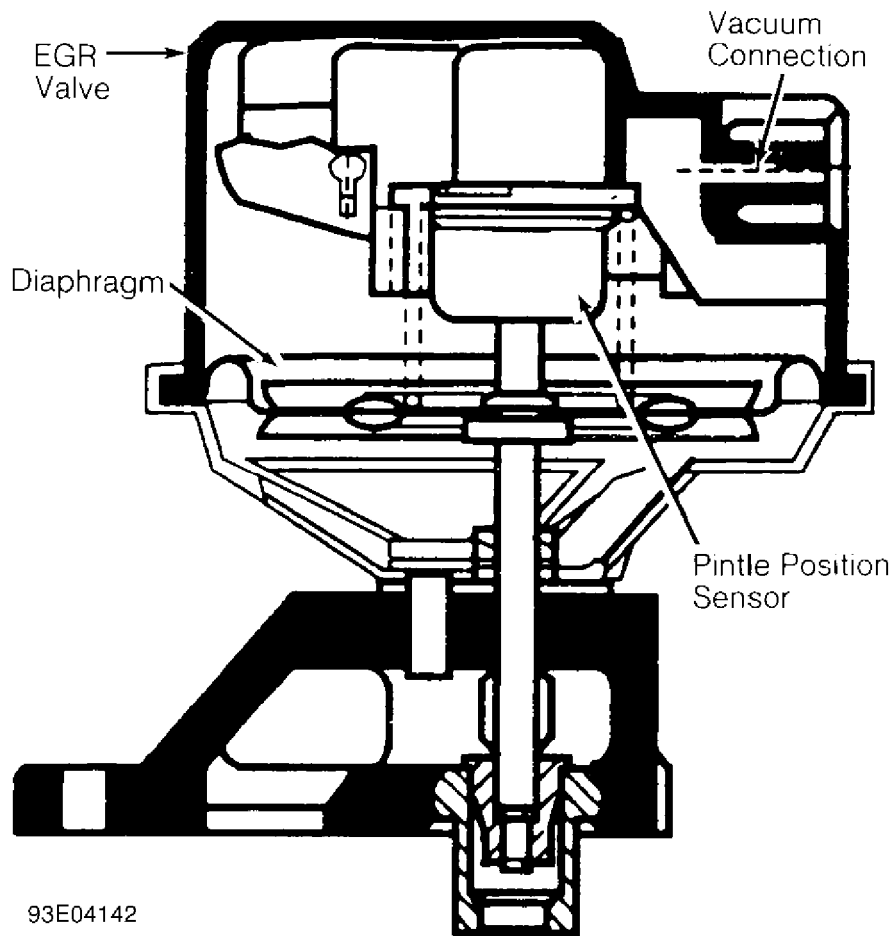


Fig. 12: Cutaway View Of Typical Integrated Electronic EGR Valve
Courtesy of General Motors Corp.

SPARK CONTROLS (SPK)

Spark control systems are designed to ensure the air/fuel mixture is ignited at the best possible moment to provide optimum efficiency and power and cleaner emissions.

Ensure vacuum hoses to the distributor, carburetor, spark delay valves, thermal vacuum switches, etc., are in place and routed properly. On Computerized Engine Controls (CEC), check for presence of required sensors (O₂, MAP, CTS, TPS, etc.). Ensure they have not been tampered with or modified.

Check for visible modification or replacement of the feedback carburetor, fuel injection unit or injector(s) with a non-feedback carburetor or fuel injection system. Check for modified emission-related components unacceptable for use on pollution-controlled vehicles.

AIR INJECTION SYSTEM (AIS)

Air Pump Injection System (AP)

The air pump is a belt-driven vane type pump, mounted to engine in combination with other accessories. The air pump itself

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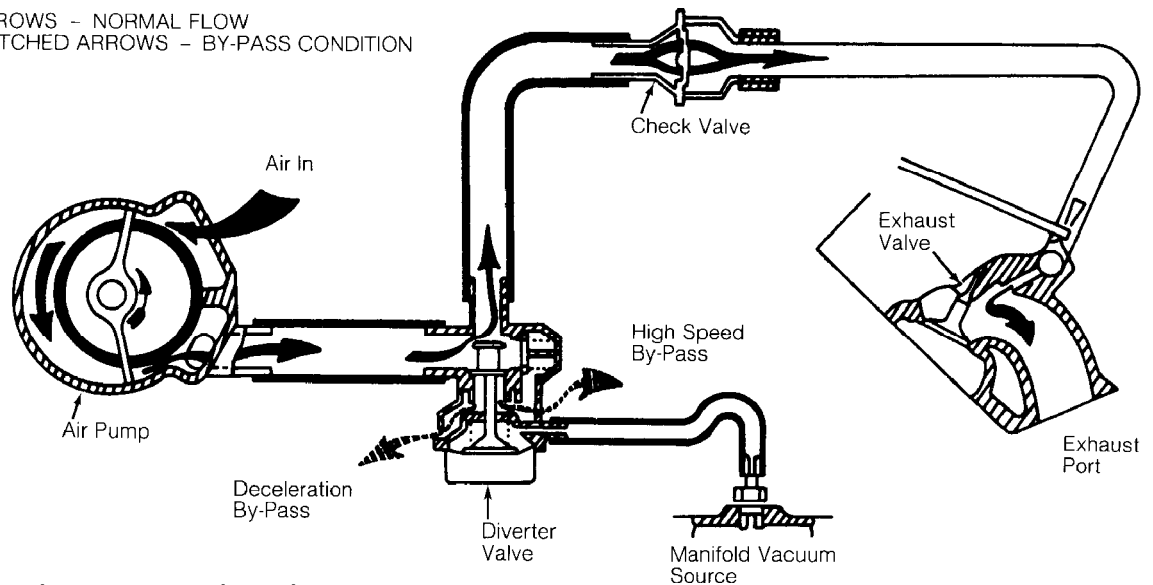
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consists of the pump housing, an inner air cavity, a rotor and a vane assembly. As the vanes turn in the housing, filtered air is drawn in through the intake port and pushed out through the exhaust port. See Fig. 13.

Check for missing or disconnected belt, check valve(s), diverter valve(s), air distribution manifolds, etc. Check air injection system for proper hose routing.

BLACK ARROWS - NORMAL FLOW
CROSS HATCHED ARROWS - BY-PASS CONDITION



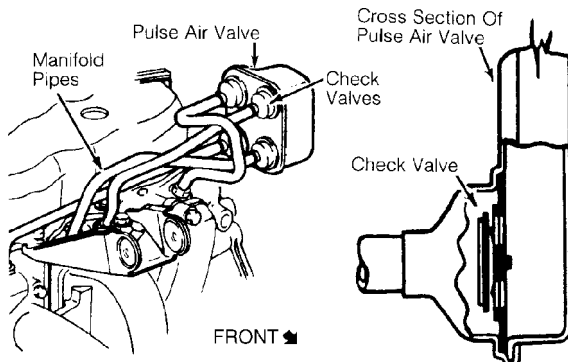
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Fig. 13: Typical Air Pump Injection System
Courtesy of General Motors Corp.

Pulsed Secondary Air Injection (PAIR) System

PAIR eliminates the need for an air pump and most of the associated hardware. Most systems consists of air delivery pipe(s), pulse valve(s) and check valve(s). The check valve prevents exhaust gases from entering the air injection system. See Fig. 14.

Ensure required check valve(s), diverter valve(s), air distribution manifolds, etc., are present. Check air injection system for proper hose routing.



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Fig. 14: Typical Pulsed Secondary Air Injection System
Courtesy of General Motors Corp.

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OXYGEN SENSOR (O2)

The O2 sensor is mounted in the exhaust system where it monitors oxygen content of exhaust gases. Some vehicles may use 2 O2 sensors. The O2 sensor produces a voltage signal which is proportional to exhaust gas oxygen concentration (0-3%) compared to outside oxygen (20-21%). This voltage signal is low (about .1 volt) when a lean mixture is present and high (1.0 volt) when a rich mixture is present.

As ECM compensates for a lean or rich condition, this voltage signal constantly fluctuates between high and low, crossing a reference voltage supplied by the ECM on the O2 signal line. This is referred to as cross counts. A problem in the O2 sensor circuit should set a related trouble code.

COMPUTERIZED ENGINE CONTROLS (CEC)

The CEC system monitors and controls a variety of engine/vehicle functions. The CEC system is primarily an emission control system designed to maintain a 14.7:1 air/fuel ratio under most operating conditions. When the ideal air/fuel ratio is maintained, the catalytic converter can control oxides of nitrogen (NOx), hydrocarbon (HC) and carbon monoxide (CO) emissions.

The CEC system consists of the following sub-systems: Electronic Control Module (ECM), input devices (sensors and switches) and output signals.

EARLY FUEL EVAPORATION (EFE)

The EFE valve is actuated by either a vacuum actuator or a bimetal spring (heat-riser type). The EFE valve is closed when engine is cold. The closed valve restricts exhaust gas flow from the exhaust manifold. This forces part of the exhaust gas to flow up through a passage below the carburetor. As the exhaust gas quickly warms the intake mixture, distribution is improved. This results in better cold engine driveability, shorter choke periods and lower emissions.

Ensure EFE valve in exhaust manifold is not frozen or rusted in a fixed position. On vacuum-actuated EFE system, check EFE thermal vacuum valve and check valve(s). Also check for proper vacuum hose routing. See Fig. 15.

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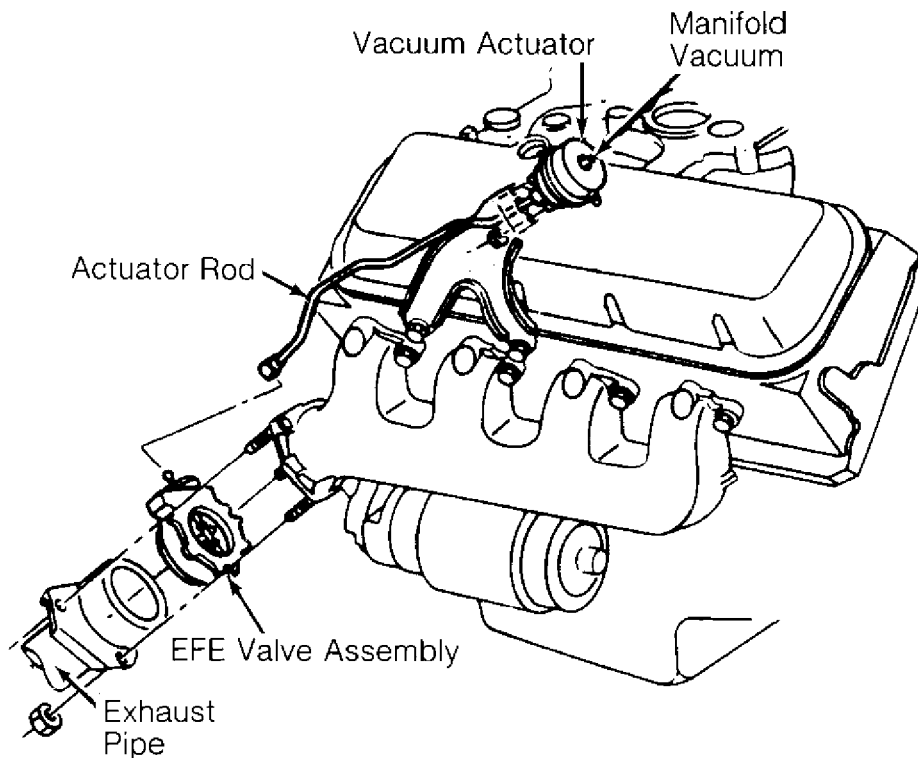
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Fig. 15: Typical Vacuum-Actuated EFE System
Courtesy of General Motors Corp.

EMISSION MAINTENANCE REMINDER LIGHT (EMR) (IF EQUIPPED)

If equipped, the EMR light (some models may use a reminder flag) reminds vehicle operator that an emission system maintenance is required. This indicator is activated after a predetermined time/mileage.

When performing a smog check inspection, ensure EMR indicator is not activated. On models using an EMR light, light should glow when ignition switch is turned to ON position and should turn off when engine is running.

If an EMR flag is present or an EMR light stays on with engine running, fail vehicle and service or replace applicable emission-related components. To reset an EMR indicator, refer to appropriate MAINTENANCE REMINDER LIGHTS in the MAINTENANCE section.

MALFUNCTION INDICATOR LIGHT (MIL)

The Malfunction Indicator Light (MIL) is used to alert vehicle operator that the computerized engine control system has detected a malfunction (when it stays on all the time with engine running). On some models, the MIL may also be used to display trouble codes.

As a bulb and system check, malfunction indicator light will glow when ignition switch is turned to ON position and engine is not running. When engine is started, light should go out.

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END OF ARTICLE

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ARTICLE BEGINNING

1987-88 ENGINE COOLING

Volkswagen Engine Cooling Fans

Cabriolet, Fox, Golf, GTI, Jetta, Scirocco,
Quantum & Vanagon

DESCRIPTION

The basic liquid cooling system consists of a radiator, water pump, thermostat, cooling fan, pressure cap, heater (if equipped), and various connecting hoses and cooling passages in the block and cylinder head. In addition, many cars use a fan clutch (incorporating a thermostatic control) or flexible fan blade. These reduce noise and power requirements at higher engine speeds. Other cars use a 2-speed electric cooling fan.

Some models may use a thermostatic vacuum switch to advance ignition timing in the event of overheating. Most models use a coolant recovery system to prevent loss of anti-freeze.

MAINTENANCE

DRAINING

Remove radiator cap and open heater control valve to maximum heat position. Open drain cocks or remove plugs in bottom of radiator and in engine block. In-line engines usually have one plug or cock, while "V" type engines will have two, one in each bank of cylinders.

CLEANING

A good cleaning compound removes most rust and scale. Follow manufacturer's instructions in the use of cleaner. If considerable rust and scale has to be removed, flushing should be used. Clean radiator air passages by blowing with compressed air from back to front of radiator.

FLUSHING

CAUTION: Some manufacturers use an aluminum and plastic radiator on some models (identified by a note below the filler neck). Material used for cleaning and flushing must be compatible with aluminum, according to manufacturer's recommendations.

1) Back flushing is a very effective means of removing rust and scale from a cooling system. For best results, the radiator, engine and heater core should be flushed separately.

2) To flush radiator, connect flushing gun to water outlet of radiator and disconnect water inlet hose. Use a leadaway hose, connected to radiator inlet, to prevent flooding engine. Use air in

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short bursts only, as this will prevent damage to radiator. Continue flushing until water runs clear.

3) To flush engine, first remove thermostat and replace housing. Connect flushing gun to water outlet of engine. Disconnect heater hoses from engine. Flush using short air bursts until water runs clean. Flush heater core as described for radiator. Make sure heater valve is set to maximum heat position before flushing heater.

REFILLING

Engine should be running while refilling cooling system to prevent air from being trapped in the engine block. After system is full, continue running engine until thermostat is open, then recheck fill level. Do not overfill system.

THERMOSTAT

1) Visually inspect thermostat for corrosion and proper sealing of valve and seat. If satisfactory, suspend thermostat and a thermometer in a container with a 50/50 mixture of anti-freeze and water. See Fig. 1.

2) Do not allow either thermostat or thermometer to touch bottom of container, as this concentration of heat could cause an incorrect reading. Heat water until thermostat just begins to open.

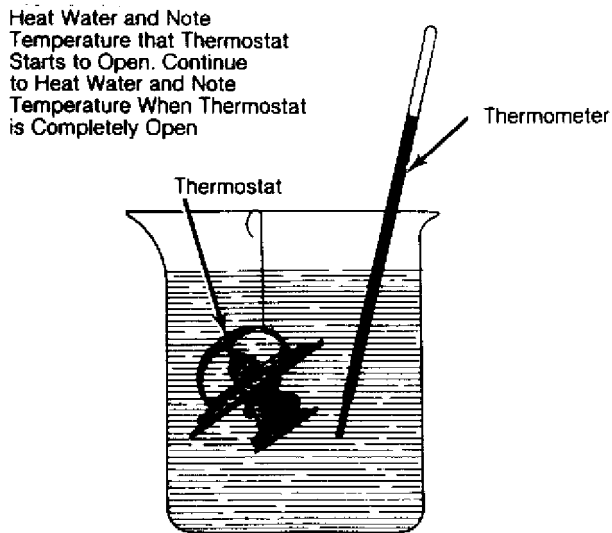


Fig. 1: Testing Thermostat in Anti-Freeze/Water Solution
Support thermometer so it does not touch bottom of container.

3) Read temperature on thermometer. This is the initial opening temperature and should be within specifications. Continue heating water until thermostat is fully open and note temperature. This is the fully opened temperature. If either reading is outside of specifications, replace thermostat, as it is not adjustable.

NOTE: General Motors Imports recommends hanging thermostat in 33% glycol solution at 25°F (4°C) above temperature stamped on

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thermostat. Valve should open. Remove thermostat from solution and place in similar solution at 10 °F (-12°C) below stamped temperature. Valve should close.

PRESSURE TESTING

A pressure testing tool is used to test both radiator cap and complete cooling system. Test as follows, following tool manufacturer's instructions.

Radiator Cap

Visually inspect radiator cap, then dip cap in water and connect to tester. Pump tester to bring pressure to upper limit of cap specifications. If cap fails to hold pressure within specifications, replace cap.

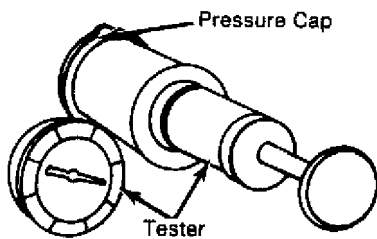


Fig. 2: Testing Radiator Pressure Cap
Wet cap gasket before testing.

Cooling System

1) With engine off, wipe radiator filler neck seat clean. Fill radiator to correct level. Attach tester to radiator and pump until pressure is at upper limit of radiator rating.

2) If pressure drops, inspect for external leaks. If no leaks are apparent, detach tester and run engine until normal operating temperature is obtained. Reattach tester and observe. If pressure builds up immediately, a possible leak exists from a faulty head gasket or crack in head or block.

CAUTION: Pressure may build up quickly. Release any excess pressure or cooling system damage may result.

3) If there is no immediate pressure build up, pump tester to within system pressure range (on radiator cap). Vibration of gauge pointer indicates compression or combustion leak into cooling system. Isolate leak by shorting each spark plug wire to cylinder block. Gauge pointer should stop or decrease vibration when leaking cylinder is shorted.

CAUTION: Do not disconnect spark plug wires while engine is operating, or operate engine with spark plug shorted for more than 1 minute, as catalytic converter may be damaged.

4) Remove engine and transmission (automatic only) oil

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dipsticks and check if water drops appear in oil. If so, a serious internal leak is indicated. If all checks are negative and system holds pressure for 2 minutes, there are no serious leaks in system.

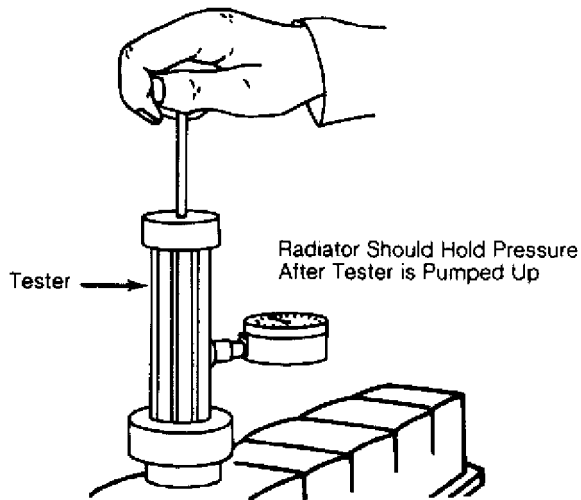


Fig. 3: Pressure Testing Cooling System
Pump up to specified pressure.

ANTI-FREEZE CONCENTRATION

NOTE: On models using aluminum engines or cooling system components, refer to Owners Manual for anti-freeze requirements and recommendations. Aluminum components require a different formulation of anti-freeze to prevent corrosion.

On all cooling systems, test anti-freeze concentration using anti-freeze tester. Tester should have a temperature-compensating feature, as failing to take temperature into consideration could cause an error as large as 30°F (16°C). Follow tester manufacturer's instructions for correct use of tester.

COOLANT RECOVERY SYSTEMS

DESCRIPTION

A coolant recovery system differs from other cooling systems in that an overflow bottle is connected to the radiator overflow hose. Overflow bottle is transparent or translucent to permit checking of coolant level without removing radiator cap. No adjustment or test is required except keeping vent hole or hose clean and checking pressure relief of radiator cap.

OPERATION

As coolant temperature rises and pressure in system exceeds

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pressure relief valve of radiator cap, excess coolant flows into overflow bottle. As engine cools and coolant contracts, vacuum is formed in the system. Vacuum draws coolant, stored in overflow bottle, back into radiator. In a properly maintained cooling system, the only coolant losses will be through evaporation.

Overflow bottle captures and releases coolant according to temperature. (See Fig. 4)

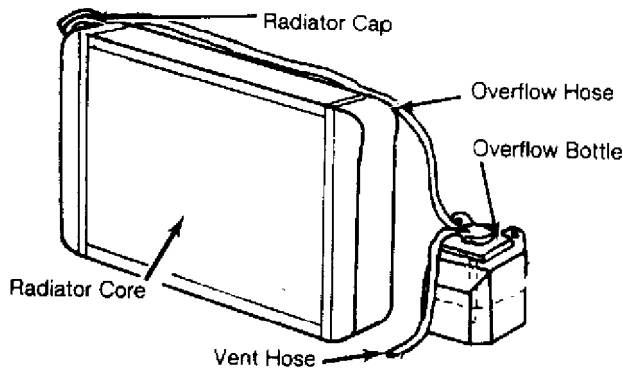


Fig. 4: Typical Coolant Recover System

THERMOSTATICALLY CONTROLLED ELECTRIC FANS

DESCRIPTION

Electrically-driven fans are actuated by thermal relay switches. Thermal switches turn fan motor on when necessary and shut fan motor off when not needed. Air conditioned vehicles are equipped with over-ride switches. These switches turn fan motor on whenever air conditioning system is operating. When system is turned off, fan motor control is returned to thermal relay.

THERMAL SWITCH OPERATION

Operation Temp.

Cut-In Temp.

Stage I 192-201°F (89-94°C)

Stage II 203-212°F (95-100°C)

Cut-Out Temp.

Stage I 178°F (81°C)

Stage II 189°F (87°C)

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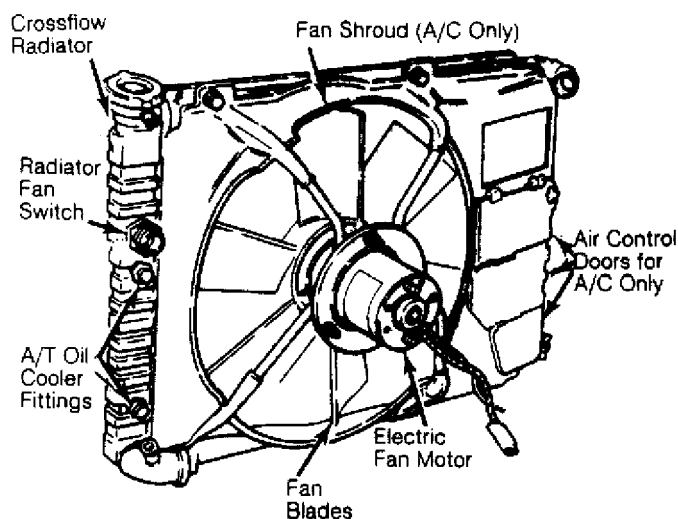


Fig. 5: Typical Thermostatically Controlled Electric Fan

TESTING

Disconnect fan motor wire connector and connect it with 14 gauge wire to a good 12-volt battery. If fan runs, motor is okay. This indicates car battery, thermal switch, radiator fan switch, coolant relay, timer relay, coolant temperature switch, or A/C relay may be defective. If fan motor does not run when connected directly to a good battery, replace fan motor.

VARIABLE SPEED COOLING FANS - FLEX-BLADE FANS

DESCRIPTION

This unit is a flexible blade assembly designed to flex blades as engine RPM increases. As RPM increases, blade pitch decreases, thereby saving power and decreasing noise level. Keep fan belt adjusted to proper tension as necessary.

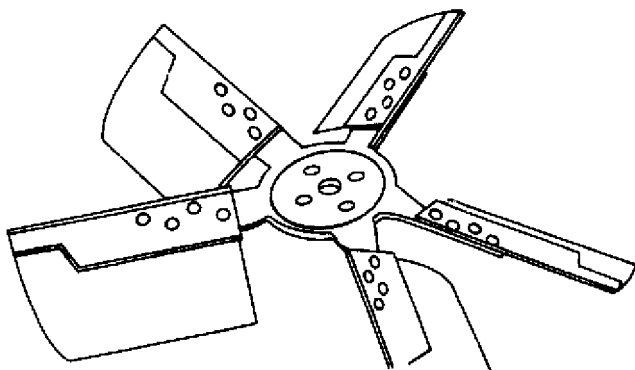


Fig. 6: Flex Blade Fan Assembly

VARIABLE SPEED COOLING FANS CLUTCH WITH THERMOSTATIC CONTROL

ENGINE COOLING FAN

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DESCRIPTION

Most air conditioned models use a thermostatically controlled fluid fan and torque control clutch. Thermal control drive is a silicone-filled coupling connecting fan to a fan pulley, and is operated by a control valve. Control valve is operated by a temperature sensitive bi-metallic coil or strip and controls flow of silicone through the clutch.

During periods of operation when radiator discharge air temperature is low, fan clutch speeds are slowed, decreasing load on fan belt. High radiator discharge air temperature causes bi-metallic coil or strip to allow a greater flow of silicone to enter clutch. This increases drag between driven member and driving member resulting in a higher fan speed and increased cooling.

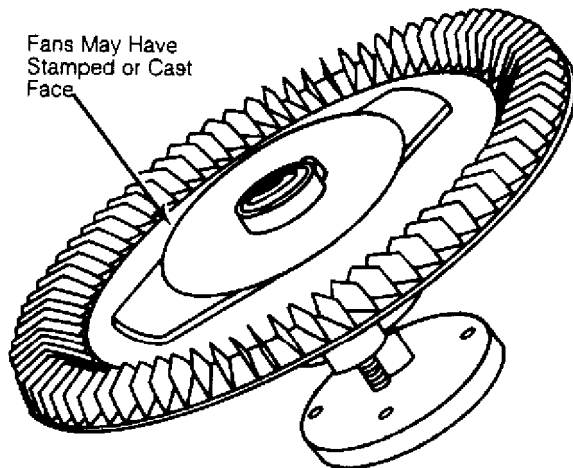


Fig. 7: Thermostatically Controlled Fan Assembly
Shown with stamped face and bi-metallic coil spring.

TESTING

In cases of engine overheating or insufficient air conditioning proceed with following tests:

- 1) Start with a cool engine to ensure complete fan clutch disengagement.
- 2) Cover radiator grille sufficiently to induce high engine temperature.
- 3) Start engine and operate at 2000 RPM. Turn on air conditioning if equipped.
- 4) A fan roar will be noticed when fan clutch engages.

NOTE: It will take approximately 5 to 10 minutes for temperature to become high enough to allow engagement of the fan clutch. While operating engine under these conditions, observe temperature light to prevent overheating. If hot light comes on, remove cover from radiator grille.

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5) When clutch engages, remove radiator grille cover and turn A/C off to assist in engine cooling.

6) After several minutes fan clutch should disengage. This can be determined by a reduction in fan speed and roar. If fan fails to function as described, it should be replaced.

NOTE: To avoid premature cooling system wear, always use the manufacturer's recommended coolant products and coolant mixture ratios.

END OF ARTICLE

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ARTICLE BEGINNING

Engine Overhaul Procedures - General Information
ALL PISTON ENGINES

*** PLEASE READ THIS FIRST ***

Examples used in this article are general in nature and do not necessarily relate to a specific engine or system. Illustrations and procedures have been chosen to guide mechanic through engine overhaul process. Descriptions of processes of cleaning, inspection, assembly and machine shop practice are included.

Always refer to appropriate engine overhaul article in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

ENGINE IDENTIFICATION

The engine may be identified from its Vehicle Identification Number (VIN) stamped on a metal tab. Metal tab may be located in different locations depending on manufacturer. Engine identification number or serial number is located on cylinder block. Location varies with manufacturer.

INSPECTION PROCEDURES

*** PLEASE READ THIS FIRST ***

NOTE: Always refer to appropriate engine overhaul article in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

GENERAL

Engine components must be inspected to meet manufacturer's specifications and tolerances during overhaul. Proper dimensions and tolerances must be met to obtain proper performance and maximum engine life.

Micrometers, depth gauges and dial indicator are used for checking tolerances during engine overhaul. Magnaflux, Magnaglo, dye-check, ultrasonic and x-ray inspection procedures are used for parts inspection.

MAGNETIC PARTICLE INSPECTION

Magnaflux & Magnaglo

Magnaflux is an inspection technique used to locate material flaws and stress cracks. The part in question is subjected to a strong magnetic field. The entire part, or a localized area, can be magnetized. The part is coated with either a wet or dry material that contains fine magnetic particles.

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Cracks which are outlined by the particles cause an interruption in the magnetic field. The dry powder method of Magnaflux can be used in normal light. A crack will appear as an obvious bright line.

Fluorescent liquid is used in conjunction with a blacklight in a second Magnaflux system called Magnaglo. This type of inspection demands a darkened room. The crack will appear as a glowing line in this process. Both systems require complete demagnetizing upon completion of the inspection. Magnetic particle inspection applies to ferrous materials only.

PENETRANT INSPECTION

Zyglo

The Zyglo process coats the material with a fluorescent dye penetrant. The part is often warmed to expand cracks that will be penetrated by the dye. When the coated part is subjected to inspection with a blacklight, a crack will glow brightly. Developing solution is often used to enhance results. Parts made of any material, such as aluminum cylinder heads or plastics, may be tested using this process.

Dye Check

Penetrating dye is sprayed on the previously cleaned component. Dye is left on component for 5-45 minutes, depending upon material density. Component is then wiped clean and sprayed with a developing solution. Surface cracks will show up as a bright line.

ULTRASONIC INSPECTION

If an expensive part is suspected of internal cracking, Ultrasonic testing is used. Sound waves are used for component inspection.

X-RAY INSPECTION

This form of inspection is used on highly stressed components. X-ray inspection maybe used to detect internal and external flaws in any material.

PRESSURE TESTING

Cylinder heads can be tested for cracks using a pressure tester. Pressure testing is performed by plugging all but one of the holes in the head and injecting air or water into the open passage. Leaks are indicated by the appearance of wet or damp areas when using water. When air is used, it is necessary to spray the head surface with a soap solution. Bubbles will indicate a leak. Cylinder head may also be submerged in water heated to specified temperature to check for cracks created during heat expansion.

CLEANING PROCEDURES

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NOTE: Always refer to appropriate engine overhaul article in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

GENERAL

All components of an engine do not have the same cleaning requirements. Physical methods include bead blasting and manual removal. Chemical methods include solvent blast, solvent tank, hot tank, cold tank and steam cleaning of components.

BEAD BLASTING

Manual removal of deposits may be required prior to bead blasting, followed by some other cleaning method. Carbon, paint and rust may be removed using bead blasting method. Components must be free of oil and grease prior to bead blasting. Beads will stick to grease or oil soaked areas causing area not to be cleaned.

Use air pressure to remove all trapped residual beads from components after cleaning. After cleaning internal engine parts made of aluminum, wash thoroughly with hot soapy water. Component must be thoroughly cleaned as glass beads will enter engine oil resulting in bearing damage.

CHEMICAL CLEANING

Solvent tank is used for cleaning oily residue from components. Solvent blasting sprays solvent through a siphon gun using compressed air.

The hot tank, using heated caustic solvents, is used for cleaning ferrous materials only. DO NOT clean aluminum parts such as cylinder heads, bearings or other soft metals using the hot tank. After cleaning, flush parts with hot water.

A non-ferrous part will be ruined and caustic solution will be diluted if placed in the hot tank. Always use eye protection and gloves when using the hot tank.

Use of a cold tank is for cleaning of aluminum cylinder heads, carburetors and other soft metals. A less caustic and unheated solution is used. Parts may be left in the tank for several hours without damage. After cleaning, flush parts with hot water.

Steam cleaning, with boiling hot water sprayed at high pressure, is recommended as the final cleaning process when using either hot or cold tank cleaning.

COMPONENT CLEANING

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NOTE: Always refer to appropriate engine overhaul article in the ENGINES section for complete overhaul procedures and

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specifications for the vehicle being repaired.

SHEET METAL PARTS

Examples of sheet metal parts are the rocker covers, front and side covers, oil pan and bellhousing dust cover. Glass bead blasting or hot tank may be used for cleaning.

Ensure all mating surfaces are flat. Deformed surfaces should be straightened. Check all sheet metal parts for cracks and dents.

INTAKE & EXHAUST MANIFOLDS

Using solvent cleaning or bead blasting, clean manifolds for inspection. If the intake manifold has an exhaust crossover, all carbon deposits must be removed. Inspect manifolds for cracks, burned or eroded areas, corrosion and damage to fasteners.

Exhaust heat and products of combustion cause threads of fasteners to corrode. Replace studs and bolts as necessary. On "V" type intake manifolds, the sheet metal oil shield must be removed for proper cleaning and inspection. Ensure that all manifold parting surfaces are flat and free of burrs.

CYLINDER HEAD REPLACEMENT

* PLEASE READ THIS FIRST *

NOTE: Always refer to appropriate engine overhaul article in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

REMOVAL

Remove intake and exhaust manifolds and valve cover. Cylinder head and camshaft carrier bolts (if equipped), should be removed only when the engine is cold. On many aluminum cylinder heads, removal while hot will cause cylinder head warpage. Mark rocker arm or overhead cam components for location.

Remove rocker arm components or overhead cam components. Components must be installed in original location. Individual design rocker arms may utilize shafts, ball-type pedestal mounts or no rocker arms. For all design types, wire components together and identify according to the corresponding valve. Remove cylinder head bolts. Note length and location. Some applications require cylinder head bolts be removed in proper sequence to prevent cylinder head damage. See Fig. 1. Remove cylinder head.

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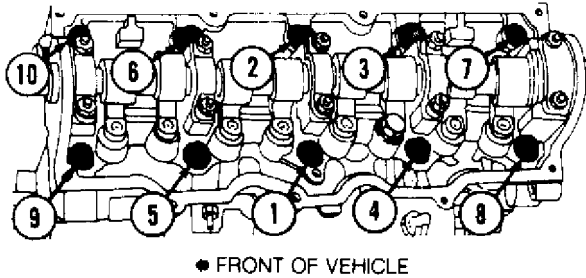


Fig. 1: Typical Cylinder Head Tightening or Loosening Sequence
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INSTALLATION

Ensure all surfaces and head bolts are clean. Check that head bolt holes of cylinder block are clean and dry to prevent block damage when bolts are tightened. Clean threads with tap to ensure accurate bolt torque.

Install head gasket on cylinder block. Some manufacturer's may recommend sealant be applied to head gasket prior to installation. Note that all holes are aligned. Some gasket applications may be marked so certain area faces upward. Install cylinder head using care not to damage head gasket. Ensure cylinder head is fully seated on cylinder block.

Some applications require head bolts be coated with sealant prior to installation. This is done if head bolts are exposed to water passages. Some applications require head bolts be coated with light coat of engine oil.

Install head bolts. Head bolts should be tightened in proper steps and sequence to specification. See Fig. 1. Install remaining components. Tighten all bolts to specification. Adjust valves if required. See VALVE ADJUSTMENT in this article.

NOTE: Some manufacturers require that head bolts be retightened after specified amount of operation. This must be done to prevent head gasket failure.

VALVE ADJUSTMENT

Engine specifications will indicate valve train clearance and temperature at which adjustment is to be made on most models. In most cases, adjustment will be made with a cold engine. In some cases, both a cold and a hot clearance will be given for maintenance convenience.

On some models, adjustment is not required. Rocker arms are tightened to specification and valve lash is automatically set. On some models with push rod actuated valve train, adjustment is made at push rod end of rocker arm while other models do not require adjustment.

Clearance will be checked between tip of rocker arm and tip of valve stem in proper sequence using a feeler gauge. Adjustment is made by rotating adjusting screw until proper clearance is obtained. Lock nut is then tightened. Engine will be rotated to obtain all valve adjustments to manufacturer's specifications.

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Some models require hydraulic lifter to be bled down and clearance measured. Different length push rods can be used to obtain proper clearance. Clearance will be checked between tip of rocker arm and tip of valve stem in proper sequence using a feeler gauge.

On overhead cam engines designed without rocker arms actuate valves directly on a cam follower. A hardened, removable disc is installed between the cam lobe and lifter. Clearance will be checked between cam heel and adjusting disc in proper sequence using a feeler gauge. Engine will be rotated to obtain all valve adjustments.

On overhead cam engines designed with rocker arms, adjustment is made at push rod end of rocker arm. Ensure that the valve to be adjusted is riding on the heel of the cam on all engines. Clearance will be checked between tip of rocker arm and tip of valve stem in proper sequence using a feeler gauge. Adjustment is made by rotating adjusting screw until proper clearance is obtained. Lock nut is then tightened. Engine will be rotated to obtain all valve adjustments to manufacturer's specifications.

CYLINDER HEAD OVERHAUL

* PLEASE READ THIS FIRST *

NOTE: Always refer to appropriate engine overhaul article in the **ENGINES** section for complete overhaul procedures and specifications for the vehicle being repaired.

DISASSEMBLY

Mark valves for location. Using valve spring compressor, compress valve springs. Remove valve locks. Carefully release spring compressor. Remove retainer or rotator, valve spring, spring seat and valve. See Fig. 2.

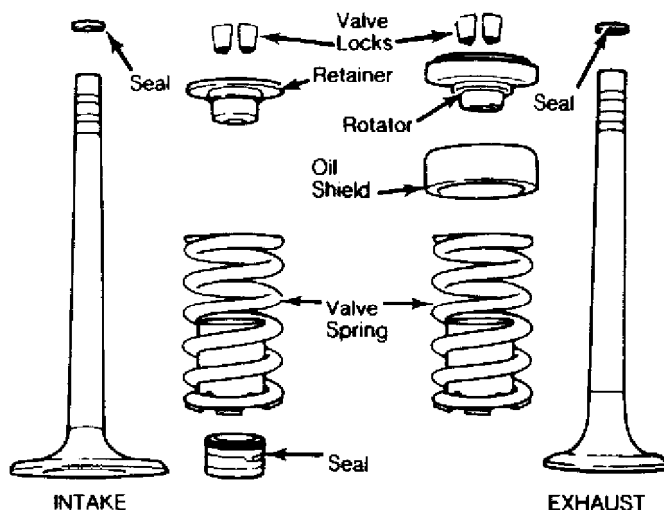


Fig. 2: Exploded View of Intake & Exhaust Valve Assemblies - Typical
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CLEANING & INSPECTION

Clean cylinder head and valve components using approved cleaning methods. Inspect cylinder head for cracks, damage or warped gasket surface. Place straightedge across gasket surface. Determine clearance at center of straightedge. Measure across both diagonals, longitudinal centerline and across the head at several points. See Fig. 3.

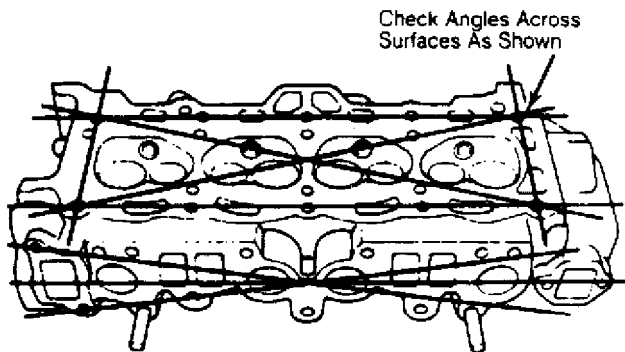


Fig. 3: Checking Cylinder Head for Warpage - Typical
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On cast cylinder heads, if warpage exceeds .003" (.08 mm) in a 6" span, or .006" (.15 mm) over total length, cylinder head must be resurfaced. On most aluminum cylinder heads, if warpage exceeds .002" (.05 mm) in any area, cylinder head must be resurfaced. Warpage specification may vary with manufacturer.

Cylinder head thickness should be measured to determine amount of material which can be removed before replacement is required. Cylinder head thickness must not be less than manufacturer's specifications.

If cylinder head required resurfacing, it may not align properly with intake manifold. On "V" type engines, misalignment is corrected by machining intake manifold surface that contacts cylinder head. Cylinder head may be machined on surface that contacts intake manifold.

Using oil stone, remove burrs or scratches from all sealing surfaces.

VALVE SPRINGS

Inspect valve springs for corroded or pitted valve spring surfaces which may lead to breakage. Polished spring ends caused by a rotating spring, indicates that spring surge has occurred. Replace springs showing evidence of these conditions.

Inspect valve springs for squareness using a 90 degree straightedge. See Fig. 4. Replace valve spring if out-of-square exceeds manufacturer's specification.

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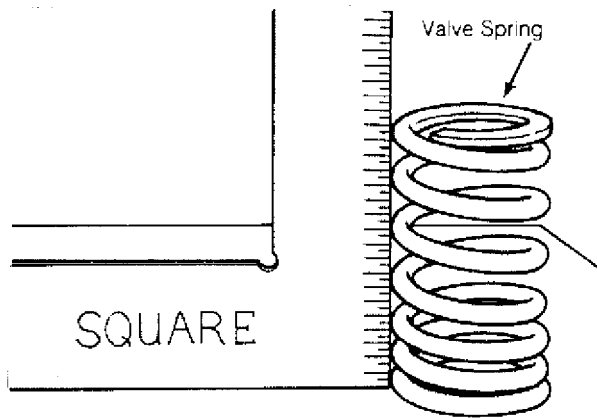


Fig. 4: Checking Valve Spring Squareness - Typical
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Using vernier caliper, measure free length of all valve springs. Replace springs if not within specification. Using valve spring tester, test valve spring pressure at installed and compressed heights. See Fig. 5.

Usually compressed height is installed height minus valve lift. Replace valve spring if not within specification. It is recommended to replace all valve springs when overhauling cylinder head.

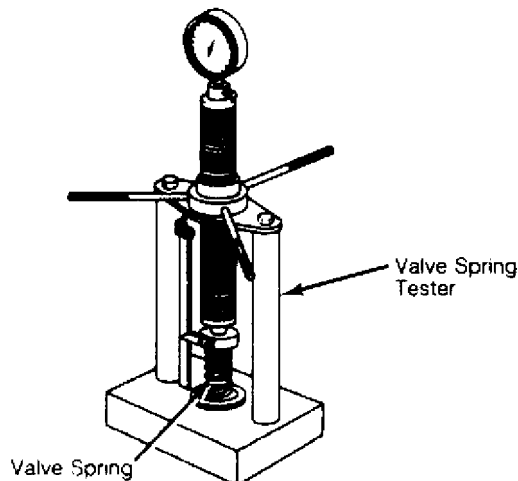


Fig. 5: Checking Valve Spring Pressure - Typical
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VALVE GUIDE

Measuring Valve Guide Clearance

Check valve stem-to-guide clearance. Ensure valve stem diameter is within specifications. Install valve in valve guide. Install dial indicator assembly on cylinder head with tip resting against valve stem just above valve guide. See Fig. 6.

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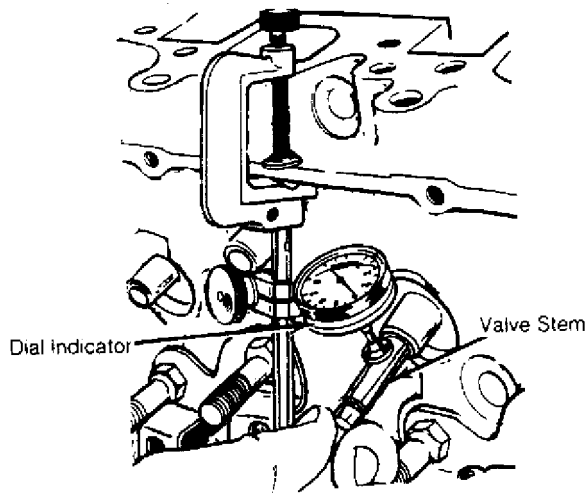


Fig. 6: Measuring Valve Stem-to-Guide Clearance - Typical
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Lower valve approximately 1/16" below valve seat. Push valve stem against valve guide as far as possible. Adjust dial indicator to zero. Push valve stem in opposite direction and note reading. Clearance must be within specification.

If valve guide clearance exceeds specification, valves with oversize stems may be used or valve guide must be replaced. On some applications, a false guide is installed, then reamed to proper specification. Valve guide reamer set is used to ream valve guide to obtain proper clearance for new valve.

Reaming Valve Guide

Select proper reamer for valve stem. Reamer must be of proper length to provide clean cut through entire length of valve guide. Install reamer in valve guide and rotate to cut valve guide. See Fig. 7.

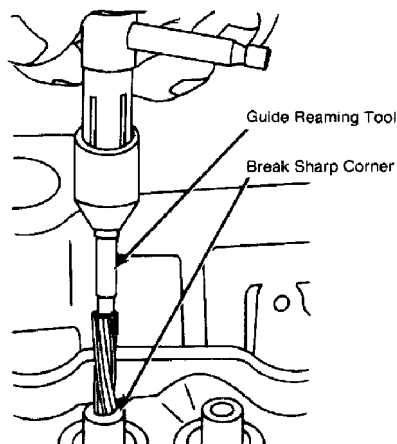


Fig. 7: Reaming Valve Guides - Typical
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Replacing Valve Guide

Replace valve guide if clearance exceeds specification. Valve guides are either pressed, hammered or shrunk in place, depending upon cylinder head design and type of metal used.

Remove valve guide from cylinder head by pressing or tapping on a stepped drift. See Fig. 8. Once valve guide is installed, distance from cylinder head to top of valve guide must be checked. This distance must be within specification.

Aluminum heads are often heated before installing valve guide. Guide is sometimes chilled in dry ice before installation. Combination of a heated head and chilled guide insures a tight guide fit upon assembly. The new guide must be reamed to specification.

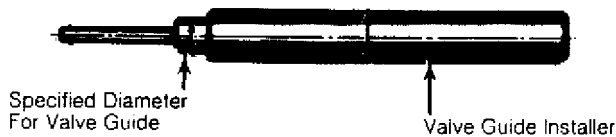


Fig. 8: Typical Valve Guide Remover & Installer
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VALVES & VALVE SEATS

Valve Grinding

Valve stem O.D. should be measured in several areas to indicate amount of wear. Replace valve if not within specification. Valve margin area should be measured to ensure that valve can be grounded. See Fig. 9.

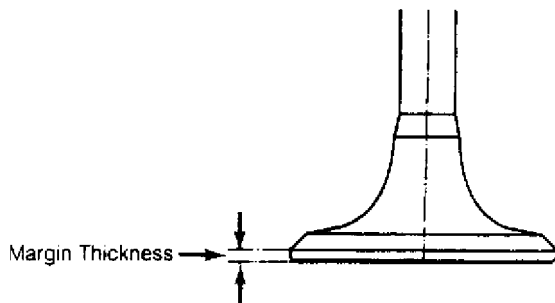


Fig. 9: Measuring Valve Head Margin - Typical
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If valve margin is less than specification, this will burn the valves. Valve must be replaced. Due to minimum margin dimensions during manufacture, some new type valves cannot be reground.

Resurface valve on proper angle specification using valve grinding machine. Follow manufacturer's instructions for valve grinding machine. Specifications may indicate a different valve face angle than seat angle.

Measure valve margin after grinding. Replace valve if not within specification. Valve stem tip can be refinished using valve

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grinding machine.

Valve Lapping

During valve lapping of recent designed valves, be sure to follow manufacturers recommendations. Surface hardening and materials used with some valves do not permit lapping. Lapping process will remove excessive amounts of the hardened surface.

Valve lapping is done to ensure adequate sealing between valve face and seat. Use either a hand drill or lapping stick with suction cup attached.

Moisten and attach suction cup to valve. Lubricate valve stem and guide. Apply a thin coat of fine valve grinding compound between valve and seat. Rotate lapping tool between the palms or with hand drill.

Lift valve upward off the seat and change position often. This is done to prevent grooving of valve seat. Lap valve until a smooth polished seat is obtained. Thoroughly clean grinding compound from components. Valve to valve seat concentricity should be checked. See VALVE SEAT CONCENTRICITY.

CAUTION: Valve guides must be in good condition and free of carbon deposits prior to valve seat grinding. Some engines contain an induction hardened valve seat. Excessive material removal will damage valve seats.

Valve Seat Grinding

Select coarse stone of correct size and angle for seat to be ground. Ensure stone is true and has a smooth surface. Select correct size pilot for valve guide dimension. Install pilot in valve guide. Lightly lubricate pilot shaft. Install stone on pilot. Move stone off and on the seat approximately 2 times per second during grinding operation.

Select a fine stone to finish grinding operation. Grinding stones with 30 and 60 degree angles are used to center and narrow the valve seat as required. See Fig. 10.

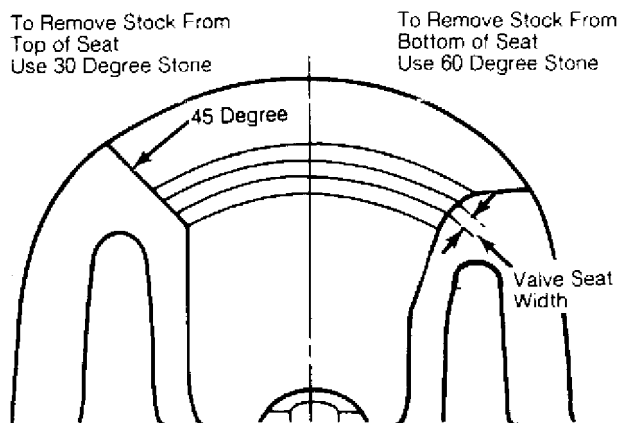


Fig. 10: Adjusting Valve Seat Width - Typical
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Valve Seat Replacement

Replacement of valve seat inserts is done by cutting out the old insert and machining an oversize insert bore. Replacement oversize insert is usually chilled and the cylinder head is sometimes warmed. Valve seat is pressed into the head. This operation requires specialized machine shop equipment.

Valve Seat Concentricity

Using dial gauge, install gauge pilot in valve guide. Position gauge arm on the valve seat. Adjust dial indicator to zero. Rotate arm 360 degrees and note reading. Runout should not exceed specification.

To check valve-to-valve seat concentricity, coat valve face lightly with Prussian Blue dye. Install valve and rotate it on valve seat. If pattern is even and entire seat is coated at valve contact point, valve is concentric with the seat.

REASSEMBLY

Valve Stem Installed Height

Valve stem installed height must be checked when new valves are installed or when valves or valve seats have been ground. Install valve in valve guide. Measure distance from tip of valve stem to spring seat. See Fig. 11. Distance must be within specifications.

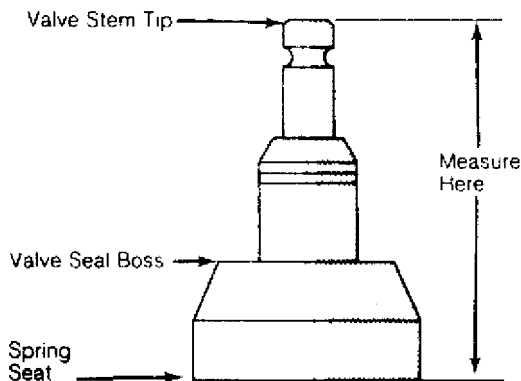


Fig. 11: Measuring Valve Stem Installed Height - Typical
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Remove valve and grind valve stem tip if height exceeds specification. Valve tips are surface hardened. DO NOT remove more than .010" (.25 mm) from tip. Chamfer sharp edge of reground valve tip. Recheck valve stem installed height.

VALVE STEM OIL SEALS

Valve stem oil seals must be installed on valve stem. See Fig. 2. Seals are needed due to pressure differential at the ends of valve guides. Atmospheric pressure above intake guide, combined with manifold vacuum below guide, causes oil to be drawn into the cylinder.

Exhaust guides also have pressure differential created by

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exhaust gas flowing past the guide, creating a low pressure area. This low pressure area draws oil into the exhaust system.

Replacement (On Vehicle)

Mark rocker arm or overhead cam components for location.

Remove rocker arm components or overhead cam components. Components must be installed in original location. Remove spark plugs. Valve stem oil seals may be replaced by holding valves against seats using air pressure.

Air pressure must be installed in cylinder using an adapter for spark plug hole. An adapter can be constructed by welding air hose connection to spark plug body with porcelain removed.

Install adapter in spark plug hole. Apply a minimum of 140 psi (9.8 kg/cm²) to adapter. Air pressure should hold valve closed. If air pressure does not hold valve closed, check for damaged or bent valve. Cylinder head must be removed for service.

Using valve spring compressor, compress valve springs. Remove valve locks. Carefully release spring compressor. Remove retainer or rotator and valve spring. Remove valve stem oil seal.

If oversized valves have been installed, oversized oil seals must be used. Coat valve stem with engine oil. Install protective sleeve over end of valve stem. Install new oil seal over valve stem and seat on valve guide. Remove protective sleeve. Install spring seat, valve spring and retainer or rotator. Compress spring and install valve locks. Remove spring compressor. Ensure valve locks are fully seated.

Install rocker arms or overhead cam components. Tighten all bolts to specification. Adjust valves if required. Remove adapter. Install spark plugs, valve cover and gasket.

VALVE SPRING INSTALLED HEIGHT

Valve spring installed height should be checked during reassembly. Measure height from lower edge of valve spring to the upper edge. DO NOT include valve spring seat or retainer. Distance must be within specifications. If valves and/or seats have been ground, a valve spring shim may be required to correct spring height. See Fig. 12.

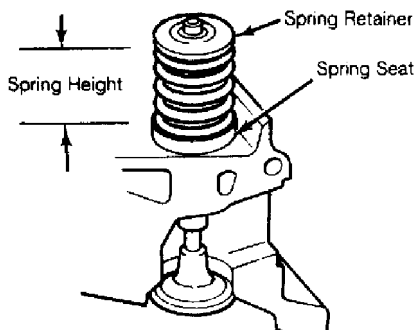


Fig. 12: Measuring Valve Spring Installed Height - Typical
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ROCKER ARMS & ASSEMBLIES

Rocker Studs

Rocker studs are either threaded or pressed in place.

Threaded studs are removed by locking 2 nuts on the stud. Unscrew the stud by turning the jam nut. Coat the stud threads with Loctite and install. Tighten to specification.

Pressed in stud can be removed using a stud puller. Ream the stud bore to proper specification and press in a new oversize stud. Pressed in studs are often replaced by cutting threads in the stud bore to accept a threaded stud.

Rocker Arms & Shafts

Mark rocker arms for location. Remove rocker arm retaining bolts. Remove rocker arms. Inspect rocker arms, shafts, bushings and pivot balls (if equipped) for excessive wear. Inspect rocker arms for wear in valve stem contact area. Measure rocker arm bushing I.D. Replace bushings if excessively worn.

The rocker arm valve stem contact point can be reground, using special fixture for valve grinding machine. Remove minimum amount of material as possible. Ensure all oil passages are clear. Install rocker arms in original locations. Ensure rocker arm is properly seated in push rod. Tighten bolts to specification. Adjust valves if required. See VALVE ADJUSTMENT in this article.

Pushrods

Remove rocker arms. Mark push rods for location. Remove push rods. Push rods can be steel or aluminum, solid or hollow. Hollow pushrods must be internally cleaned to ensure oil passage to the rocker arms is cleaned. Check the pushrod for damage, such as loose ends on steel tipped aluminum types.

Check push rod for straightness. Roll push rod on a flat surface. Using feeler gauge, check clearance at center. Replace push rod if bent. The push rod can also be supported at each end and rotated. A dial indicator is used to detect bends in the push rod.

Lubricate ends of push rod and install push rod in original location. Ensure push rod is properly seated in lifter. Install rocker arm. Tighten bolts to specification. Adjust valves if required. See VALVE ADJUSTMENT in this article.

LIFTERS

Hydraulic Lifters

Before replacing a hydraulic lifter for noisy operation, ensure noise is not caused by worn rocker arms or valve tips. Hydraulic lifter assemblies must be installed in original locations. Remove the rocker arm assembly and push rod. Mark components for location. Some applications require intake manifold, or lifter cover removal. Remove lifter retainer plate (if used). To remove lifters, use a hydraulic lifter remover or magnet. Different type lifters are used. See Fig. 13.

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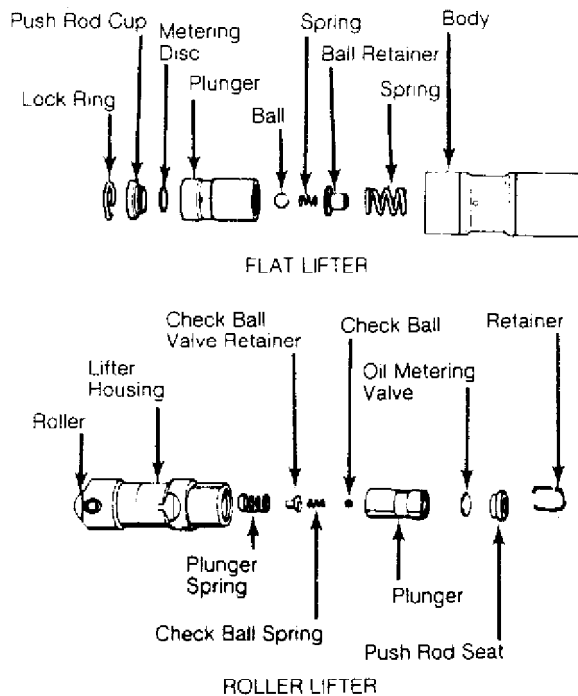


Fig. 13: Typical Hydraulic Valve Lifter Assemblies - Typical
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On sticking lifters, disassemble and clean lifter. DO NOT mix lifter components or positions. Parts are select-fitted and are not interchangeable. Inspect all components for wear. Note amount of wear in lifter body-to-camshaft contact area. Surface must have smooth and convex contact face. If wear is apparent, carefully inspect cam lobe.

Inspect push rod contact area and lifter body for scoring or signs of wear. If body is scored, inspect lifter bore for damage and lack of lubrication. On roller type lifters, inspect roller for flaking, pitting, loss of needle bearings and roughness during rotation.

Measure lifter body O.D. in several areas. Measure lifter bore I.D. of cylinder block. Some models offer oversized lifters. Replace lifter if damaged.

If lifter check valve is not operating, obstructions may be preventing it from closing or valve spring may be broken. Clean or replace components as necessary.

Check plunger operation. Plunger should drop to bottom of the body by its own weight when assembled dry. If plunger is not free, soak lifter in solvent to dissolve deposits.

Lifter leak-down test can be performed on lifter. Lifter must be filled with special test oil. New lifters contain special test oil. Using lifter leak-down tester, perform leak-down test following manufacturer's instructions. If leak-down time is not within specifications, replace lifter assembly.

Lifters should be soaked in clean engine oil several hours prior to installation. Coat lifter base, roller (if equipped) and lifter body with ample amount of Molykote or camshaft lubricant. See

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Fig. 13. Install lifter in original location. Install remaining components. Valve lash adjustment is not required on most hydraulic lifters. Preload of hydraulic lifter is automatic. Some models may require adjustment.

Mechanical Lifters

Lifter assemblies must be installed in original locations. Remove rocker arm assembly and push rod. Mark components for location. Some applications require intake manifold or lifter cover removal. Remove lifter retainer plate (if used). To remove lifters, use lifter remover or magnet.

Inspect push rod contact area and lifter body for scoring or signs of wear. If body is scored, inspect lifter bore for damage and lack of lubrication. Note amount of wear in lifter body-to-camshaft contact area. Surface must have smooth and convex contact face. If wear is apparent, carefully inspect cam lobe.

Coat lifter base, roller (if equipped) and lifter body with ample amount of Molykote or camshaft lubricant. Install lifter in original location. Install remaining components. Tighten bolts to specification. Adjust valves. See VALVE ADJUSTMENT in this article.

PISTONS, CONNECTING RODS & BEARINGS

* PLEASE READ THIS FIRST *

NOTE: Always refer to appropriate engine overhaul article in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

RIDGE REMOVAL

Ridge in cylinder wall must be removed prior to piston removal. Failure to remove ridge prior to removing pistons will cause piston damage in piston ring locations.

With the piston at bottom dead center, place a rag in the bore to trap metal chips. Install ridge reamer in cylinder bore. Adjust ridge reamer using manufacturer's instructions. Remove ridge using ridge reamer. DO NOT remove an excessive amount of material. Ensure ridge is completely removed.

PISTON & CONNECTING ROD REMOVAL

Note top of piston. Some pistons may contain a notch, arrow or be marked "FRONT". Piston must be installed in proper direction to prevent damage with valve operation.

Check that connecting rod and cap are numbered for cylinder location and which side of cylinder block the number faces. Proper cap and connecting rod must be installed together. Connecting rod cap must be installed on connecting rod in proper direction to ensure bearing lock procedure. Mark connecting rod and cap if necessary. Pistons must be installed in original location.

Remove cap retaining nuts or bolts. Remove bearing cap.

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Install stud protectors on connecting rod bolts. This protects cylinder walls from scoring during removal. Ensure proper removal of ridge. Push piston and connecting rod from cylinder. Connecting rod boss can be tapped with a wooden dowel or hammer handle to aid in removal.

PISTON & CONNECTING ROD

Disassembly

Using ring expander, remove piston rings. Remove piston pin retaining rings (if equipped). On pressed type piston pins, special fixtures and procedures according to manufacturer must be used to remove piston pins. Follow manufacturer's recommendations to avoid piston distortion or breakage.

Cleaning

Remove all carbon and varnish from piston. Pistons and connecting rods may be cleaned in cold type chemical tank. Using ring groove cleaner, clean all deposits from ring grooves. Ensure all deposits are cleaned from ring grooves to prevent ring breakage or sticking. DO NOT attempt to clean pistons using wire brush.

Inspection

Inspect pistons for nicks, scoring, cracks or damage in ring areas. Connecting rod should be checked for cracks using Magnaflux procedure. Piston diameter must be measured in manufacturers specified area.

Using telescopic gauge and micrometer, measure piston pin bore of piston in 2 areas, 90 degrees apart. This is done to check diameter and out-of-round.

Install proper bearing cap on connecting rod. Ensure bearing cap is installed in proper location. Tighten bolts or nuts to specification. Using inside micrometer, measure inside diameter in 2 areas, 90 degrees apart.

Connecting rod I.D. and out-of-round must be within specification. Measure piston pin bore I.D. and piston pin O.D. All components must be within specification. Subtract piston pin diameter from piston pin bore in piston and connecting rod to determine proper fit.

Connecting rod length must be measured from center of crankshaft journal inside diameter to center of piston pin bushing using proper caliper. Connecting rods must be the same length. Connecting rods should be checked on an alignment fixture for bent or twisted condition. Replace all components which are damaged or not within specification.

PISTON & CYLINDER BORE FIT

Ensure cylinder is checked for taper, out-of-round and properly honed prior to checking piston and cylinder bore fit. See CYLINDER BLOCK in this article. Using dial bore gauge, measure cylinder bore. Measure piston at right angle to piston pin in center

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of piston skirt area. Subtract piston diameter from cylinder bore diameter. The difference is piston-to-cylinder clearance. Clearance must be within specification. Mark piston for proper cylinder location.

ASSEMBLING PISTON & CONNECTING ROD

Install proper fitted piston on connecting rod for proper cylinder. Ensure piston marking on top of piston marked is in correspondence with connecting rod and cap number. See Fig. 14.

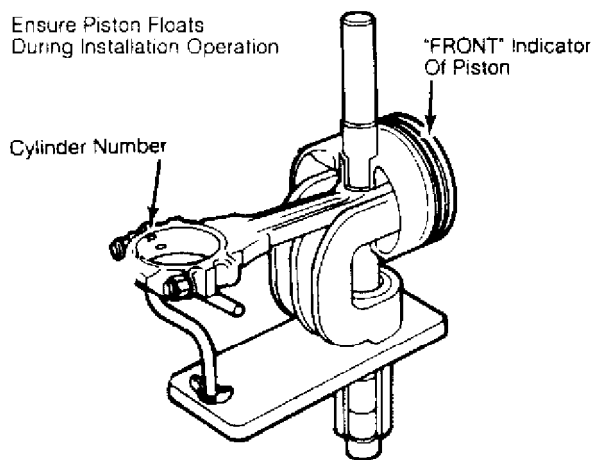


Fig. 14: Piston Pin Installation - Typical
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Lubricate piston pin and install in connecting rod. Ensure piston pin retainers are fully seated (if equipped). On pressed type piston pins, follow manufacturer's recommended procedure to avoid distortion or breakage.

CHECKING PISTON RING CLEARANCES

Piston rings must be checked for side clearance and end gap. To check end gap, install piston ring in cylinder which it is to be installed. Using an inverted piston, push ring to bottom of cylinder in smallest cylinder diameter.

Using feeler gauge, check ring end gap. See Fig. 15. Piston ring end gap must be within specification. Ring breakage will occur with insufficient ring end gap.

On some manufacturers, insufficient ring end gap may be corrected by using a fine file while other manufacturers recommend using another ring set. Mark rings for proper cylinder installation after checking end gap.

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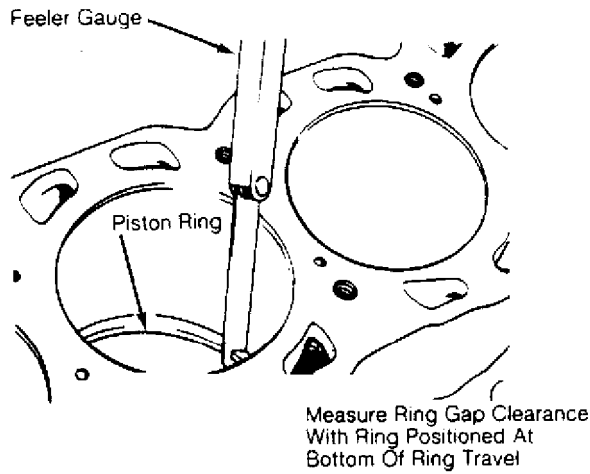


Fig. 15: Checking Piston Ring End Gap - Typical
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For checking side clearance, install rings on piston. Using feeler gauge, measure clearance between piston ring and piston ring land. Check side clearance in several areas around piston. Side clearance must be within specification.

If side clearance is excessive, piston ring grooves can be machined to accept oversized piston rings (if available). Normal practice is to replace piston.

PISTON & CONNECTING ROD INSTALLATION

Cylinders must be honed prior to piston installation. See CYLINDER HONING under CYLINDER BLOCK in this article.

Install upper connecting rod bearings. Lubricate upper bearings with engine oil. Install lower bearings in rod caps. Ensure bearing tabs are properly seated. Position piston ring gaps according to manufacturers recommendations. See Fig. 16. Lubricate pistons, rings and cylinder walls.

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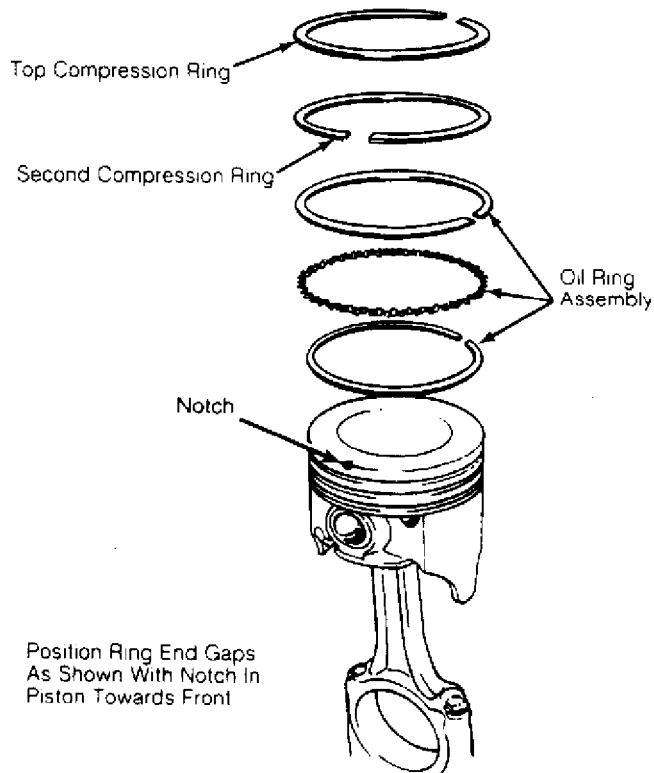


Fig. 16: Typical Piston Ring End Gap Positioning - Typical
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Install ring compressor. Use care not to rotate piston rings. Compress rings with ring compressor. Install plastic tubing protectors over connecting rod bolts. Install piston and connecting rod assembly. Ensure piston notch, arrow or "FRONT" mark is toward front of engine. See Fig. 17.

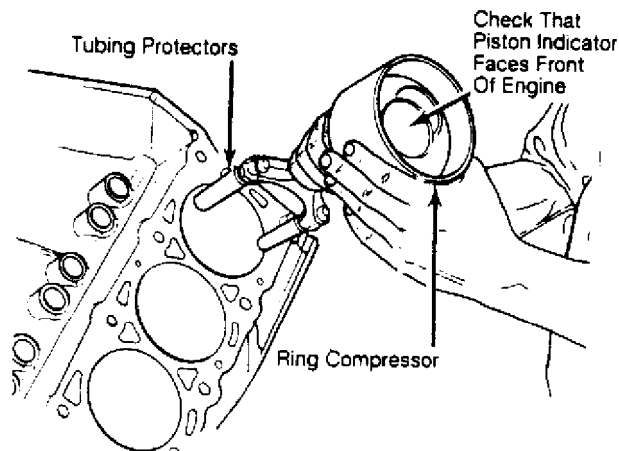


Fig. 17: Installing Piston & Connecting Rod Assembly - Typical
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Carefully tap piston into cylinder until rod bearing is

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seated on crankshaft journal. Remove protectors. Install rod cap and bearing. Lightly tighten connecting rod bolts. Repeat procedure for remaining cylinders. Check bearing clearance. See MAIN & CONNECTING ROD BEARING CLEARANCE in this article.

Once clearance is checked, lubricate journals and bearings. Install bearing caps. Ensure marks are aligned on connecting rod and cap. Tighten rod nuts or bolts to specification. Ensure rod moves freely on crankshaft. Check connecting rod side clearance. See CONNECTING ROD SIDE CLEARANCE in this article.

CONNECTING ROD SIDE CLEARANCE

Position connecting rod toward one side of crankshaft as far as possible. Using feeler gauge, measure clearance between side of connecting rod and crankshaft. See Fig. 18. Clearance must be within specifications.

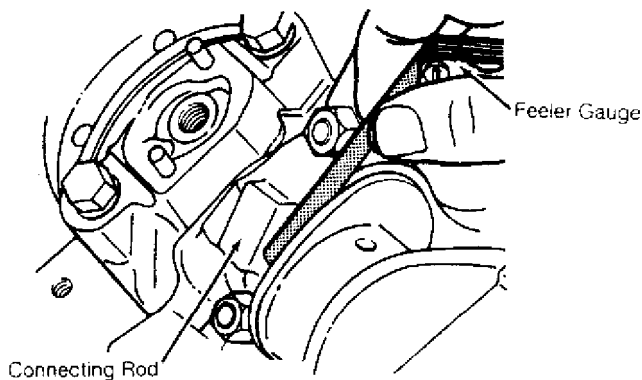


Fig. 18: Measuring Connecting Rod Side Clearance - Typical
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Check for improper bearing installation, wrong bearing cap or insufficient bearing clearance if side clearance is insufficient. Connecting rod may require machining to obtain proper clearance. Excessive clearance usually indicates excessive wear at crankshaft. Crankshaft must be repaired or replaced.

MAIN & CONNECTING ROD BEARING CLEARANCE

Plastigage Method

Plastigage method may be used to determine bearing clearance. Plastigage can be used with an engine in service or during reassembly. Plastigage material is oil soluble.

Ensure journals and bearings are free of oil or solvent. Oil or solvent will dissolve material and false reading will be obtained. Install small piece of Plastigage along full length of bearing journal. Install bearing cap in original location. Tighten bolts to specification.

CAUTION: DO NOT rotate crankshaft while Plastigage is installed.
Bearing clearance will not be obtained if crankshaft is

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rotated.

Remove bearing cap. Compare Plastigage width with scale on Plastigage container to determine bearing clearance. See Fig. 19. Rotate crankshaft 90 degrees. Repeat procedure. This is done to check journal eccentricity. This procedure can be used to check oil clearance on both connecting rod and main bearings.

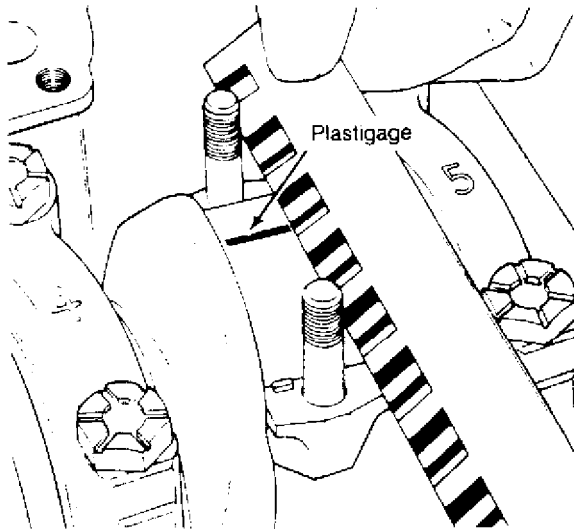


Fig. 19: Measuring Bearing Clearance - Typical
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Micrometer & Telescopic Gauge Method

A micrometer is used to determine journal diameter, taper and out-of-round dimensions of the crankshaft. See **CLEANING & INSPECTION** under **CRANKSHAFT & MAIN BEARINGS** in this article.

With crankshaft removed, install bearings and caps in original location on cylinder block. Tighten bolts to specification. On connecting rods, install bearings and caps on connecting rods. Install proper connecting rod cap on corresponding rod. Ensure bearing cap is installed in original location. Tighten bolts to specification.

Using a telescopic gauge and micrometer or inside micrometer measure inside diameter of connecting rod and main bearings bores. Subtract each crankshaft journal diameter from the corresponding inside bore diameter. This is the bearing clearance.

CRANKSHAFT & MAIN BEARINGS

* PLEASE READ THIS FIRST *

NOTE: Always refer to appropriate engine overhaul article in the **ENGINES** section for complete overhaul procedures and specifications for the vehicle being repaired.

REMOVAL

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Ensure all main bearing caps are marked for location on cylinder block. Some main bearing caps have an arrow stamped on it which must face front of engine. Remove main bearing cap bolts. Remove main bearing caps. Carefully remove crankshaft. Use care not to bind crankshaft in cylinder block during removal.

CLEANING & INSPECTION

Thoroughly clean crankshaft using solvent. Dry with compressed air. Ensure all oil passages are clear and free of sludge, rust, dirt, and metal chips.

Inspect crankshaft for scoring and nicks. Inspect crankshaft for cracks using Magnaflux procedure. Inspect rear seal area for grooving or damage. Inspect bolt hole threads for damage. If pilot bearing or bushing is used, check pilot bearing or bushing fit in crankshaft. Inspect crankshaft gear for damaged or cracked teeth. Replace gear if damaged. Check that oil passage plugs are tight (if equipped).

Using micrometer, measure all journals in 4 areas to determine journal taper, out-of-round and undersize. See Fig. 20. Some crankshafts can be reground to the next largest undersize, depending on the amount of wear or damage. Crankshafts with rolled fillet cannot be reground and must be replaced.

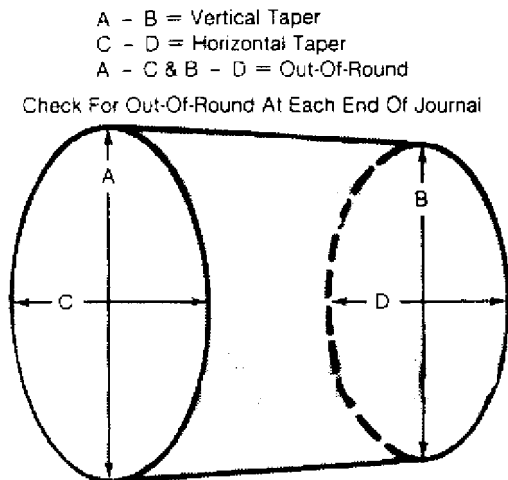


Fig. 20: Measuring Crankshaft Journal - Typical
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Crankshaft journal runout should be checked. Install crankshaft in "V" blocks or bench center. Position dial indicator with tip resting on the main bearing journal area. See Fig. 21. Rotate crankshaft and note reading. Journal runout must not exceed specification. Repeat procedure on all main bearing journals. Crankshaft must be replaced if runout exceeds specification.

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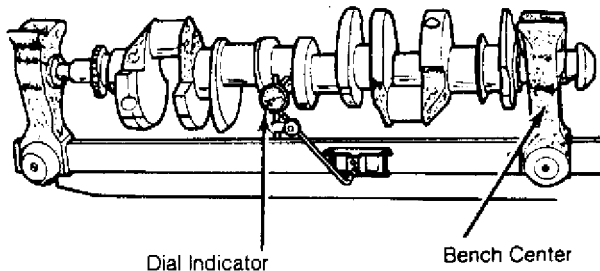


Fig. 21: Measuring Crankshaft Main Bearing Journal Runout - Typical
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INSTALLATION

Install upper main bearing in cylinder block. Ensure lock tab is properly located in cylinder block. Install bearings in main bearing caps. Ensure all oil passages are aligned. Install rear seal (if removed).

Ensure crankshaft journals are clean. Lubricate upper main bearings with clean engine oil. Carefully install crankshaft. Check each main bearing clearance using Plastigage method. See MAIN & CONNECTING ROD BEARING CLEARANCE in this article.

Once clearance is checked, lubricate lower main bearing and journals. Install main bearing caps in original location. Install rear seal in rear main bearing cap (if removed). Some rear main bearing caps require sealant to be applied in corners to prevent oil leakage.

Install and tighten all bolts except thrust bearing cap to specification. Tighten thrust bearing cap bolts finger tight only. Thrust bearing must be aligned. On most applications, crankshaft must be moved rearward then forward. Procedure may vary with manufacturer. Thrust bearing cap is then tighten to specification. Ensure crankshaft rotates freely. Crankshaft end play should be checked. See CRANKSHAFT END PLAY in this article.

CRANKSHAFT END PLAY

Dial Indicator Method

Crankshaft end play can be checked using dial indicator. Mount dial indicator on rear of cylinder block. Position dial indicator tip against rear of crankshaft. Ensure tip is resting against flat surface.

Pry crankshaft rearward. Adjust dial indicator to zero. Pry crankshaft forward and note reading. Crankshaft end play must be within specification. If end play is not within specification, check for faulty thrust bearing installation or worn crankshaft. Some applications offer oversized thrust bearings.

Feeler Gauge Method

Crankshaft end play can be checked using feeler gauge. Pry crankshaft rearward. Pry crankshaft forward. Using feeler gauge, measure clearance between crankshaft and thrust bearing surface. See Fig. 22.

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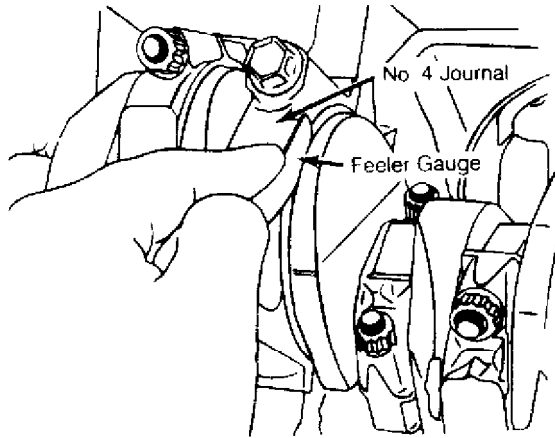


Fig. 22: Checking Crankshaft End Play - Typical
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Crankshaft end play must be within specification. If end play is not within specification, check for faulty thrust bearing installation or worn crankshaft. Some applications offer oversized thrust bearings.

CYLINDER BLOCK

* PLEASE READ THIS FIRST *

NOTE: Always refer to appropriate engine overhaul article in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

BLOCK CLEANING

Only cast cylinder blocks should be hot tank cleaned. Aluminum cylinder blocks should be cleaned using cold tank method. Cylinder block is cleaned in order to remove carbon deposits, gasket residue and water jacket scale. Remove oil galley plugs, freeze plugs and cam bearings prior to block cleaning.

BLOCK INSPECTION

Visually inspect the block. Check suspected areas for cracks using the Dye Penetrant inspection method. Block may be checked for cracks using the Magnaflux method.

Cracks are most commonly found at the bottom of the cylinders, the main bearing saddles, near expansion plugs and between the cylinders and water jackets. Inspect lifter bores for damage. Inspect all head bolt holes for damaged threads. Threads should be cleaned using tap to ensure proper head bolt torque. Consult machine shop concerning possible welding and machining (if required).

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CYLINDER BORE INSPECTION

Inspect the bore for scuffing or roughness. Cylinder bore is dimensionally checked for out-of-round and taper using dial bore gauge. For determining out-of-round, measure cylinder parallel and perpendicular to the block centerline. Difference in the 2 readings is the bore out-of-round. Cylinder bore must be checked at top, middle and bottom of piston travel area.

Bore taper is obtained by measuring bore at the top and bottom. If wear has exceeded allowable limits, block must be honed or bored to next available oversize piston dimension.

CYLINDER HONING

Cylinder must be properly honed to allow new piston rings to properly seat. Cross-hatching at correct angle and depth is critical to lubrication of cylinder walls and pistons.

A flexible drive hone and power drill are commonly used. Drive hone must be lubricated during operation. Mix equal parts of kerosene and SAE 20w engine oil for lubrication.

Apply lubrication to cylinder wall. Operate cylinder hone from top to bottom of cylinder using even strokes to produce 45 degree cross-hatch pattern on the cylinder wall. DO NOT allow cylinder hone to extend below cylinder during operation.

Recheck bore dimension after final honing. Wash cylinder wall with hot soapy water to remove abrasive particles. Blow dry with compressed air. Coat cleaned cylinder walls with lubricating oil.

DECK WARPAGE

Check deck for damage or warped head sealing surface. Place a straightedge across gasket surface of the deck. Using feeler gauge, measure clearance at center of straightedge. Measure across width and length of cylinder block at several points.

If warpage exceeds specifications, deck must be resurfaced. If warpage exceeds manufacturer's maximum tolerance for material removal, replace block.

DECK HEIGHT

Distance from the crankshaft centerline to the block deck is termed the deck height. Measure and record front and rear main journals of crankshaft. To compute this distance, install crankshaft and retain with center main bearing and cap only. Measure distance from the crankshaft journal to the block deck, parallel to the cylinder centerline.

Add one half of the main bearing journal diameter to distance from crankshaft journal to block deck. This dimension should be checked at front and rear of cylinder block. Both readings should be the same.

If difference exceeds specifications, cylinder block must be repaired or replaced. Deck height and warpage should be corrected at

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the same time.

MAIN BEARING BORE & ALIGNMENT

For checking main bearing bore, remove all bearings from cylinder block and main bearing caps. Install main bearing caps in original location. Tighten bolts to specification. Using inside micrometer, measure main bearing bore in 2 areas 90 degrees apart. Determine bore size and out-of-round. If diameter is not within specification, block must be align-bored.

For checking alignment, place a straightedge along centerline of main bearing saddles. Check for clearance between straightedge and main bearing saddles. Block must be align-bored if clearance is present.

EXPANSION PLUG REMOVAL & INSTALLATION

Removal

Drill a hole in the center of expansion plug. Remove with screwdriver or punch. Use care not to damage sealing surface.

Installation

Ensure sealing surface is free of burrs. Coat expansion plug with sealer. Use a wooden dowel or pipe of slightly smaller diameter, install expansion plug. Ensure expansion plug is evenly located.

OIL GALLERY PLUG REMOVAL & INSTALLATION

Removal

Remove threaded oil gallery plugs using the appropriate wrench. Soft, press-in plugs are removed by drilling into plug and installing a sheet metal screw. Remove plug with slide hammer or pliers.

Installation

Ensure threads or sealing surface is clean. Coat threaded oil gallery plugs with sealer and install. Replacement soft press-in plugs are driven in place with a hammer and drift.

CAMSHAFT

* PLEASE READ THIS FIRST *

NOTE: Always refer to appropriate engine overhaul article in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

CLEANING & INSPECTION

Clean camshaft with solvent. Ensure all oil passages are clear. Inspect cam lobes and bearing journals for pitting, flaking or scoring. Using micrometer, measure bearing journal O.D.

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Support camshaft at each end with "V" blocks. Position dial indicator with tip resting on center bearing journal. Rotate camshaft and note reading. If reading exceeds specification, replace camshaft.

Check cam lobe lift by measuring base circle of camshaft using micrometer. Measure again at 90 degrees to tip of cam lobe. Cam lift can be determined by subtracting base circle diameter from tip of cam lobe measurement.

Different lift dimensions are given for intake and exhaust cam lobes. Reading must be within specifications. Replace camshaft if cam lobes or bearing journals are not within specifications.

Inspect camshaft gear for chipped, eroded or damaged teeth. Replace gear if damaged. On camshafts using thrust plate, measure distance between thrust plate and camshaft shoulder. Replace thrust plate if not within specification.

CAMSHAFT BEARINGS

Removal & Installation

Remove the camshaft rear plug. The camshaft bearing remover is assembled with its shoulder resting on the bearing to be removed according to manufacturer's instructions. Tighten puller nut until bearing is removed. Remove remaining bearings, leaving front and rear bearings until last. These bearings act as guide for camshaft bearing remover.

To install new bearings, puller is rearranged to pull bearings toward the center of block. Ensure all lubrication passages of bearing are aligned with cylinder block. Coat new camshaft rear plug with sealant. Install camshaft rear plug. Ensure plug is even in cylinder block.

CAMSHAFT INSTALLATION

Lubricate bearing surfaces and cam lobes with ample amount of Molykote or camshaft lubricant. Carefully install camshaft. Use care not to damage bearing journals during installation. Install thrust plate retaining bolts (if equipped). Tighten bolts to specification. On overhead camshafts, install bearing caps in original location. Tighten bolts to specification. Check end play.

CAMSHAFT END PLAY

Using dial indicator, check end play. Position dial indicator on front of engine block. Position indicator tip against camshaft. Push camshaft toward rear of engine and adjust indicator to zero.

Move camshaft forward and note reading. Camshaft end play must be within specification. End play may be adjusted by relocating gear, shimming thrust plate or replacing thrust plate depending on manufacturer.

TIMING CHAINS & BELTS

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NOTE: Always refer to appropriate engine overhaul article in the **ENGINES** section for complete overhaul procedures and specifications for the vehicle being repaired.

TIMING CHAINS

Timing chains will stretch during operation. Limits are placed upon amount of stretch before replacement is required. Timing chain stretch will alter ignition timing and valve timing.

To check timing chain stretch, rotate crankshaft to eliminate slack from one side of timing chain. Mark reference point on cylinder block. Rotate crankshaft in opposite direction to eliminate slack from remaining side of timing chain. Force other side of chain outward and measure distance between reference point and timing chain. See Fig. 23. Replace timing chain and gears if not within specification.

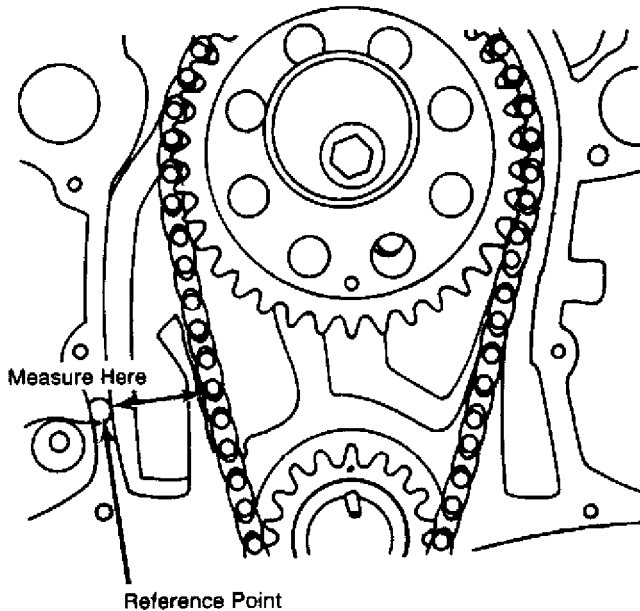


Fig. 23: Measuring Timing Chain Stretch - Typical
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Timing chains must be installed so that timing marks on camshaft gear and crankshaft gear are aligned according to manufacturer. See Fig. 24.

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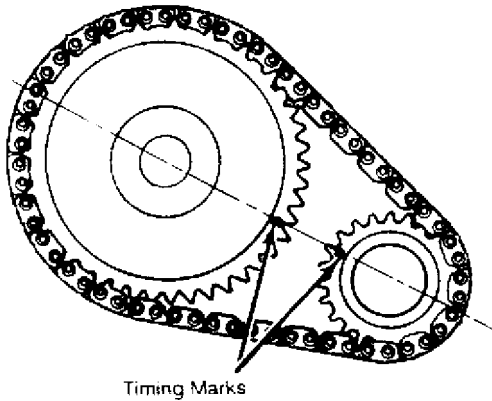


Fig. 24: Timing Gear Mark Alignment - Typical
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TIMING BELTS

Cogged tooth belts are commonly used on overhead cam engines. Inspect belt teeth for rounded corners or cracking. Replace belt if cracked, damaged, missing teeth or oil soaked.

Used timing belt must be installed in original direction of rotation. Inspect all sprocket teeth for wear. Replace all worn sprockets. Sprockets are marked for timing purposes. Engine is positioned so that crankshaft sprocket mark will be upward. Camshaft sprocket is aligned with reference mark on cylinder head and timing belt is installed. See Fig. 25.

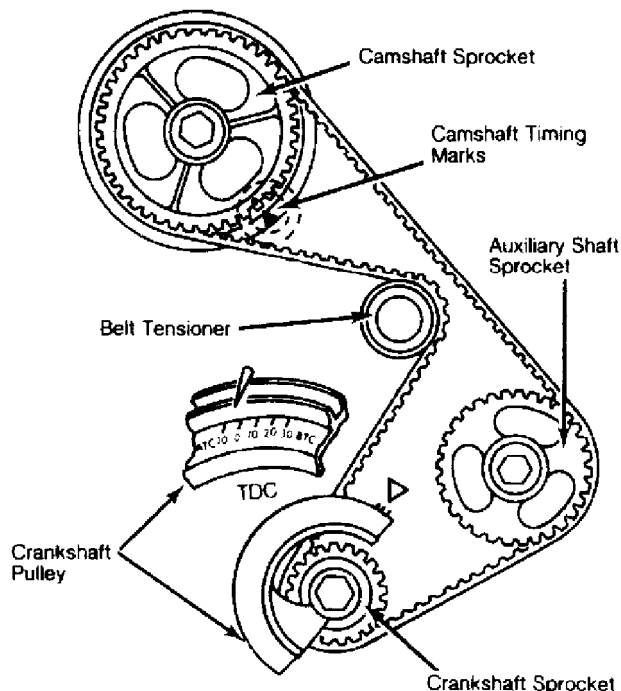


Fig. 25: Timing Belt Sprocket Alignment - Typical
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TENSION ADJUSTMENTS

If guide rails are used with spring loaded tensioners, ensure at least half of original rail thickness remains. Spring loaded tensioner should be inspected for damage.

Ensure all timing marks are aligned. Adjust belt tension using manufacturer's recommendations. Belt tension may require checking using tension gauge. See Fig. 26.

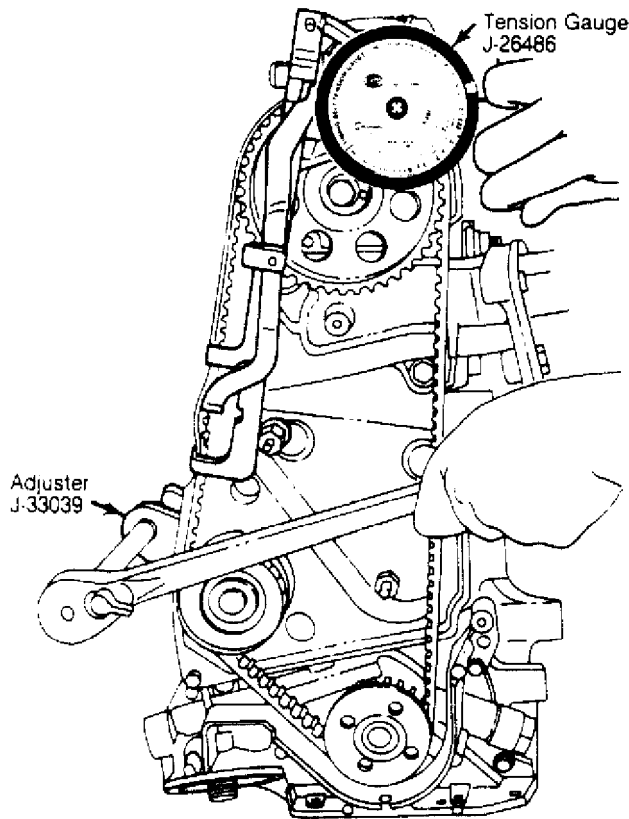


Fig. 26: Timing Belt Tension Adjustment - Typical
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TIMING GEARS

* PLEASE READ THIS FIRST *

NOTE: Always refer to appropriate engine overhaul article in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

TIMING GEAR BACKLASH & RUNOUT

On engines where camshaft gear operates directly on crankshaft gear, gear backlash and runout must be checked. To check backlash, install dial indicator with tip resting on tooth of camshaft gear. Rotate camshaft gear as far as possible. Adjust indicator to

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zero. Rotate camshaft gear in opposite direction as far as possible and note reading.

To determine timing gear runout, mount dial indicator with tip resting on face edge of camshaft gear. Adjust indicator to zero. Rotate camshaft gear 360 degrees and note reading. If backlash or runout exceed specifications, replace camshaft and/or crankshaft gear.

REAR MAIN OIL SEAL

* PLEASE READ THIS FIRST *

NOTE: Always refer to appropriate engine overhaul article in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

INSTALLATION

One-Piece Type Seal

For one-piece type oil seal installation, coat block contact surface of seal with sealer if seal is not factory coated. Ensure seal surface is free of burrs. Lubricate seal lip with engine oil and press seal into place using proper oil seal installer. See Fig. 27.

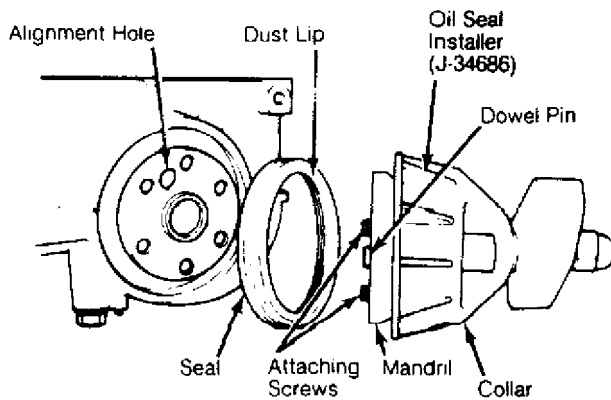


Fig. 27: Installing Typical One-Piece Oil Seal
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Rope Type Seal

For rope type rear main oil seal installation, press seal lightly into its seat. Using seal installer, fully seat seal in bearing cap or cylinder block.

Trim seal ends even with block parting surface. Some applications require sealer to be applied on main bearing cap prior to installation. See Fig. 28.

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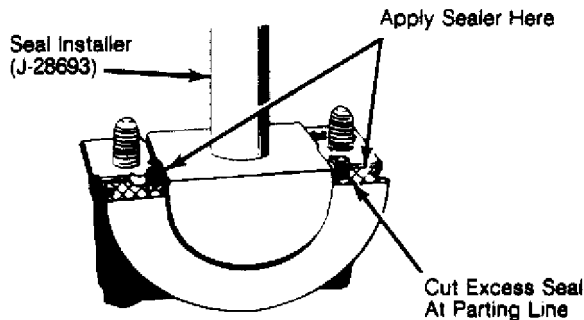


Fig. 28: Typical Rope Seal Installation
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Split-Rubber Type Seal

Follow manufacturers procedures when installing split-rubber type rear main oil seals. Installation procedures vary with engine type. See appropriate ENGINE article in this section. See Fig. 29.

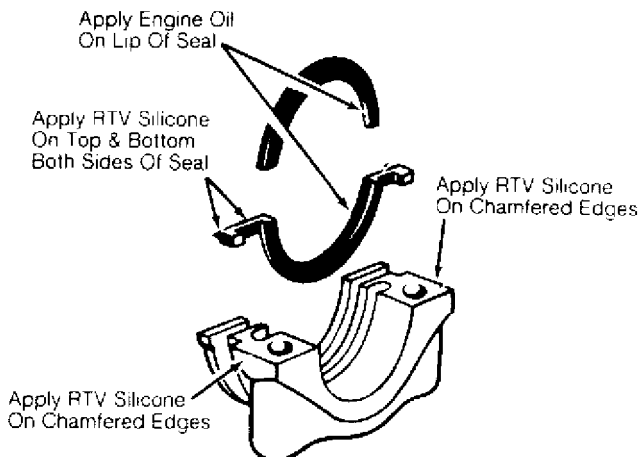


Fig. 29: Typical Split-Rubber Seal Installation
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OIL PUMP

* PLEASE READ THIS FIRST *

NOTE: Always refer to appropriate engine overhaul article in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

ROTOR-TYPE

Oil pump rotors must be marked for location prior to removal. See Fig. 30. Remove outer rotor and measure thickness and diameter. Measure inner rotor thickness. Inspect shaft for scoring or wear. Inspect rotors for pitting or damage. Inspect cover for grooving or wear. Replace components if worn or damaged.

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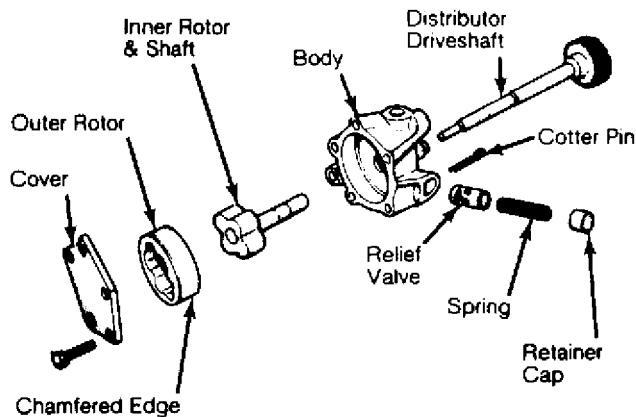


Fig. 30: Typical Rotor Type Oil Pump

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Measure outer rotor-to-body clearance. Replace pump assembly if clearance exceeds specification. Measure clearance between rotors. See Fig. 31. Replace shaft and both rotors if clearance exceeds specifications.

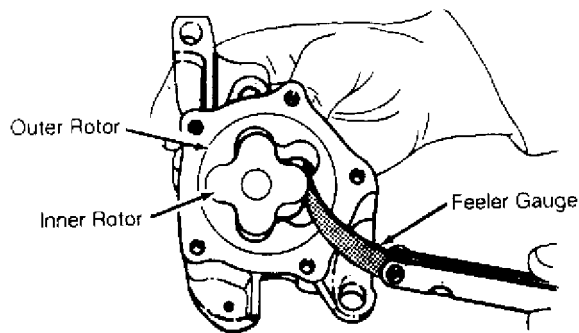


Fig. 31: Measuring Rotor Clearance - Typical

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Install rotors in pump body. Position straightedge across pump body. Using feeler gauge, measure clearance between rotors and straightedge. Pump cover wear is measured using a straightedge and feeler gauge. Replace pump if clearance exceeds specification.

GEAR TYPE

Oil pump gears must be marked for location prior to removal. See Fig. 32. Remove gears from pump body. Inspect gears for pitting or damage. Inspect cover for grooving or wear.

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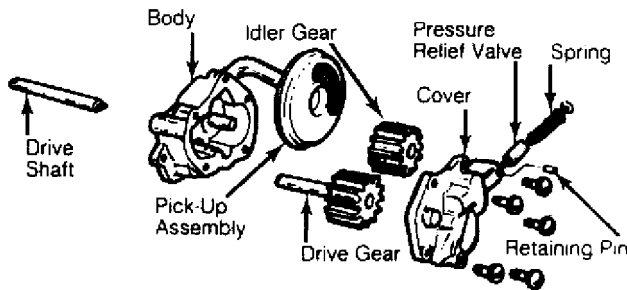


Fig. 32: Typical Gear Type Oil Pump

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Measure gear diameter and length. Measure gear housing cavity depth and diameter. See Fig. 33. Replace components if worn or damaged.

Pump cover wear is measured using a straightedge and feeler gauge. Pump is to be replaced if warpage or wear exceeds specifications or mating surface of pump cover is scratched or grooved.

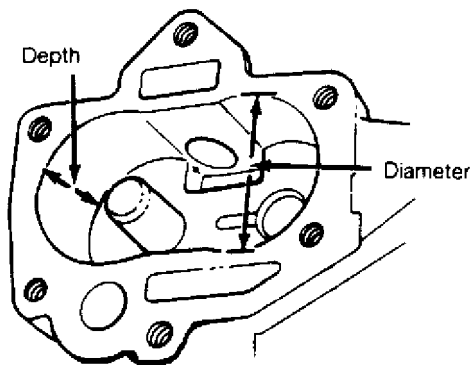


Fig. 33: Measuring Oil Pump Gear Cavity - Typical

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BREAK-IN-PROCEDURE

* PLEASE READ THIS FIRST *

NOTE: Always refer to appropriate engine overhaul article in the **ENGINES** section for complete overhaul procedures and specifications for the vehicle being repaired.

ENGINE PRE-OILING

Engine pre-oiling should be done prior to operation to prevent engine damage. A lightly oiled pump will cavitate unless oil pump cavities are filled with engine oil or petroleum jelly.

Engine pre-oiling can be done using pressure oiler (if available). Connect pressure oiler to cylinder block oil passage such as oil pressure sending unit. Operate pressure oiler long enough

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to ensure correct amount of oil has filled crankcase. Check oil level while pre-oiling.

If pressure oiler is not available, disconnect ignition system. Remove oil pressure sending unit and replace with oil pressure test gauge. Using starter motor, rotate engine starter until gauge shows normal oil pressure for several seconds. DO NOT crank engine for more than 30 seconds to avoid starter motor damage.

Ensure oil pressure has reached the most distant point from the oil pump. Reinstall oil pressure sending unit. Reconnect ignition system.

INITIAL START-UP

Start the engine and operate engine at low speed while checking for coolant, fuel and oil leaks. Stop engine. Recheck coolant and oil level. Adjust if necessary.

CAMSHAFT

Break-in procedure is required when a new or reground camshaft has been installed. Operate and maintain engine speed between 1500-2500 RPM for approximately 30 minutes. Procedure may vary due to manufacturers recommendations.

PISTON RINGS

Piston rings require a break-in procedure to ensure seating of rings to cylinder walls. Serious damage may occur to rings if correct procedures are not followed.

Extremely high piston ring temperatures are produced obtained during break-in process. If rings are exposed to excessively high RPM or high cylinder pressures, ring damage can occur. Follow piston ring manufacturer's recommended break-in procedure.

FINAL ADJUSTMENTS

Check or adjust ignition timing and dwell (if applicable). Adjust valves (if necessary). Adjust carburetion or injection idle speed and mixture. Retighten cylinder heads (if required). If cylinder head or block is aluminum, retighten bolts when engine is cold. Follow the engine manufacturer's recommended break-in procedure and maintenance schedule for new engines.

NOTE: Some manufacturer's require that head bolts be retightened after specified amount of operation. This must be done to prevent head gasket failure.

END OF ARTICLE

FUEL EVAPORATION SYSTEM

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ARTICLE BEGINNING

1987 Fuel Evaporation Systems
VOLKSWAGEN

Gasoline Models

DESCRIPTION

The sealed fuel evaporation system prevents fuel vapor from escaping into the atmosphere. The system consists of a fuel tank, expansion tank(s), charcoal canister, fuel tank breather gravity valve(s), control valve, and connecting lines and hoses.

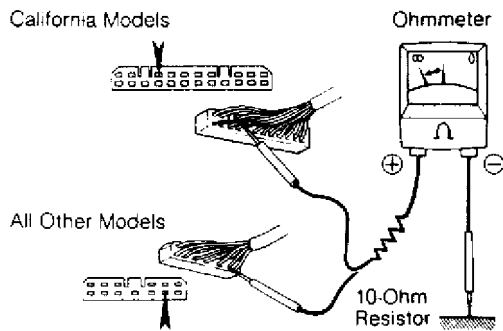


Fig. 1: Jetta, Fox, Golf & GTI Fuel Evaporation System

OPERATION

As fuel expands in tank, vapor is forced out of tank through an upper vent port. On all models except Vanagon, vapor flows up through a gravity valve and into an expansion tank where liquid fuel condenses and returns to fuel tank as temperature drops. On Vanagon models, vapor flows up from fuel tank vent lines into a left and a right expansion tank.

Fuel vapor then flows from an upper vent port on expansion tank (from gravity vent valves on Vanagon), through a control valve, and into the charcoal canister, where it is absorbed until manifold vacuum pulls it out of canister for burning.

When the engine is running at speeds greater than idle, a vacuum signal opens control valve and canister vapor is drawn from canister, through control valve and into intake manifold for burning.

FUEL EVAPORATION SYSTEM

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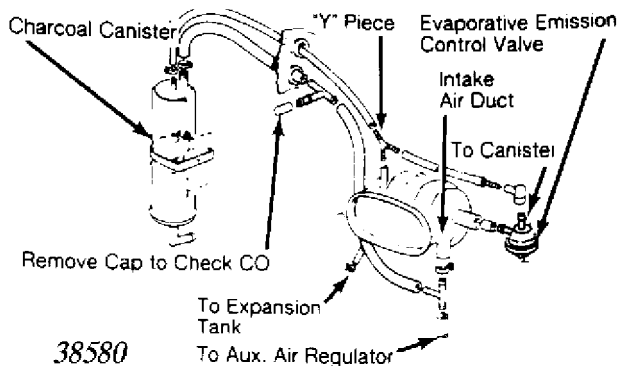


Fig. 2: Cabriolet, Scirocco & Quantum Canister-to-Intake Manifold Flow

Courtesy of Volkswagen United States, Inc.

TESTING

EVAPORATIVE EMISSION CONTROL VALVE

All Models Except Vanagon

1) Remove hose leading to canister from control valve. Blow into valve. Check that air flow is blocked and that air does not leak from valve seams.

2) Remove hose from control valve's vacuum advance port. Remove vacuum retard hose from distributor. Connect it to control valve's vacuum advance port. Remove hoses from other 2 valve ports.

3) Start engine. Blow air into valve's canister port. Check that air flow is blocked and that air does not leak from valve seams. If valve performs incorrectly in either test, replace valve.

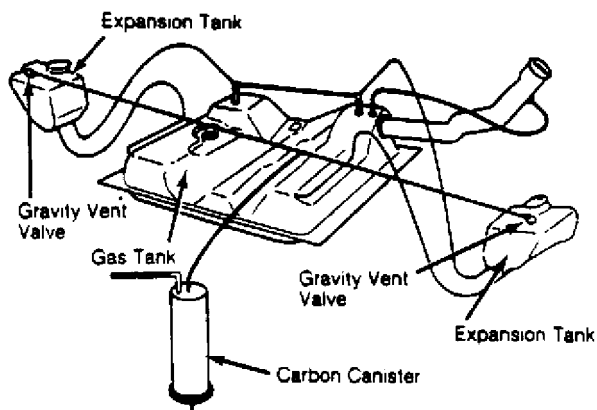


Fig. 3: Vanagon Fuel Evaporation System

GRAVITY VALVE

All Models Except Vanagon

1) Remove hoses from gravity valve. Remove valve from body, above and to the right of the fuel tank. See Fig. 4. Attach one end of a hose to valve's expansion tank port. Submerge other end of hose

FUEL EVAPORATION SYSTEM

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in water.

2) Hold valve vertically. Blow into valve's port to fuel separator. Check that air flows through valve into water. Gradually tilt valve while blowing air into it. Check that air stops flowing through valve when it is tilted at a 45 degree angle. If valve does not function properly, replace it.

Vanagon Models

Ensure that each gravity vent valve is open when in the vertical (upright) position and closed when tilted 180 degrees.

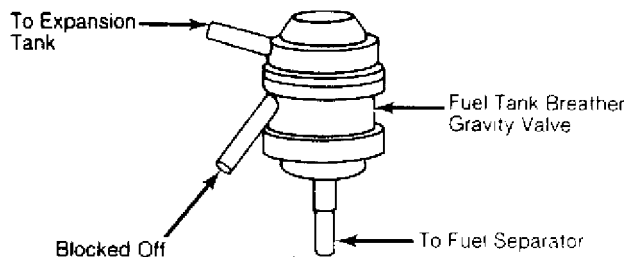


Fig. 4: Checking Gravity Valve Operation (All Models Except Vanagon)

Hold valve vertically when testing.

MAINTENANCE

Visually inspect entire system every 15,000 miles. Check for leaks and damaged or deteriorated hoses and components.

END OF ARTICLE

FUEL INJECTION SYSTEM - BOSCH CIS

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System consists of mixture control unit (airflow sensor and fuel distributor), control pressure (warm-up) regulator, auxiliary air regulator, cold start valve, thermo time switch, fuel injectors, fuel pump, filter, oxygen sensor, Electronic Control Unit (ECU), frequency valve and catalytic converter.

Some models use additional components, such as thermo vacuum valve, hot start pulse relay or constant idle speed control system.

OPERATION

MIXTURE CONTROL UNIT

Airflow sensor housing contains sensor plate which moves in cone-shaped venturi. All engine intake air is drawn past sensor plate.

Movement of sensor plate lever changes position of control plunger in fuel distributor. Control plunger is used to meter amount of fuel injected into each cylinder. Movement of plate is controlled by amount of air flowing through airflow sensor housing.

Fuel distribution pressure to each injector is equal. Pressure regulating valves in fuel distributor equalize system pressure. These valves are not adjustable.

CONTROL PRESSURE REGULATOR

Control pressure regulator (or warm-up regulator) modulates system fuel pressure before it goes to top of plunger in fuel distributor. See Fig. 2.

During cold start operation, reduced control pressure allows plate to open farther with same airflow. This supplies more fuel (richer mixture) to injectors until normal operating temperature is reached. As engine warms up, control pressure regulator increases control pressure, causing leaner air/fuel mixture.

Bi-metallic strip in control pressure regulator changes spring pressure on control diaphragm. As strip heats up, it will bend and increase spring pressure on control diaphragm. This will increase control pressure. Some regulators have altitude compensation function that changes with barometric pressure.

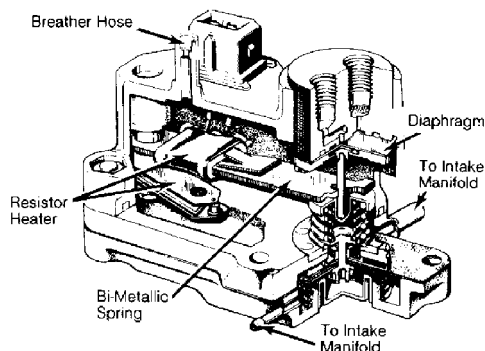


Fig. 2: Control Pressure Regulator

Pressure-compensated type is shown; all types are similar.

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AUXILIARY AIR REGULATOR

During cold start operation, auxiliary air regulator provides additional air to engine to increase idle speed. It allows intake air to by-pass throttle plates which are closed at idle.

Heating coil in regulator is connected to fuel pump circuit. As coil warms up, air passage gradually closes.

COLD START VALVE

Cold start valve is mounted on intake manifold and sprays fuel during starting. It provides additional enrichment so engine will start easily. Valve is powered through starter circuit and grounded through thermo time switch. It operates only while cold engine is being cranked.

THERMO TIME SWITCH & HOT START PULSE RELAY

Thermo time switch provides ground for cold start valve. It is affected by engine temperature and starter current. Depending on engine coolant temperature, switch will take from 3-10 seconds to open. Injection through cold start valve will stop when thermo time switch opens.

Some models use hot start pulse relay to improve hot starting. While starter is being operated on cold engine, pulse relay allows cold start valve to spray small amounts of fuel at regular intervals after thermo time switch opens. On hot engines, pulse relay allows cold start valve to spray fuel after 2 seconds of starter operation. It then shuts off and sprays periodically until engine starts.

FUEL INJECTORS

Fuel injectors in CIS system open at a pre-set pressure. Fuel is always present in lines between fuel distributor and injectors to ensure good starting. As pressure from fuel distributor increases (when engine is started), valves open and spray constantly. Amount of fuel injected will be determined by position of control plunger in fuel distributor. See Fig. 3.

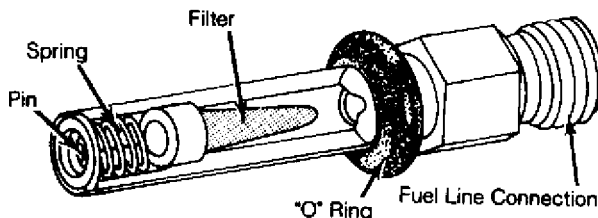


Fig. 3: Bosch CIS (Lambda) Fuel Injector
Pin in injector vibrates to atomize fuel.

FUEL PUMP

FUEL INJECTION SYSTEM - BOSCH CIS

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Electric fuel pump is used to provide fuel pressure of 60-80 psi (4.2-5.6 kg/cm²). To aid in starting, check valve in pump maintains pressure in lines when engine is not running. Fuel accumulator and line pressure regulator "O" ring also act to hold pressure in system.

Fuel pump is controlled by relay to prevent it from continuing to operate if engine stalls. It can be wired in several ways. There are 2 common circuits that are used to switch on the airflow sensor or coil. These components are energized by ignition system. When testing system, fuel pump relay must be by-passed.

OXYGEN SENSOR

Oxygen sensor is located in exhaust manifold and measures amount of unburned oxygen in exhaust gas. If oxygen is low (rich mixture), higher voltage will be generated by sensor. If oxygen is high (lean mixture), lower voltage will be generated. Voltage signal from oxygen sensor is sent to ECU which controls fuel mixture through frequency valve.

ECU & FREQUENCY VALVE

ECU continually corrects air/fuel mixture, based on signals from oxygen sensor. ECU sends signals to frequency valve, which is located in fuel line between upper and lower halves of fuel distributor. Frequency valve operates at constant frequency (70 Hz) as soon as engine is running.

When frequency valve is closed, fuel pressure to injectors is determined by spring in each pressure regulating valve. When frequency valve is open, fuel pressure decreases in lower half of fuel distributor, tension on spring is relieved, and more fuel is directed to cylinders. See Fig. 4.

ECU grounds connection for frequency valve in different length pulses. This will open and close valve to ensure continuous regulation of fuel mixture. When engine is cold, ratio of valve open to valve closed is about 60/40.

After engine warms up, voltage produced by oxygen sensor determines amount of time frequency valve must be open or closed. This ratio can be read with special tester or with dwell meter (on most models). Dwell reading of 45 degrees indicates ratio of 50% open, 50% closed.

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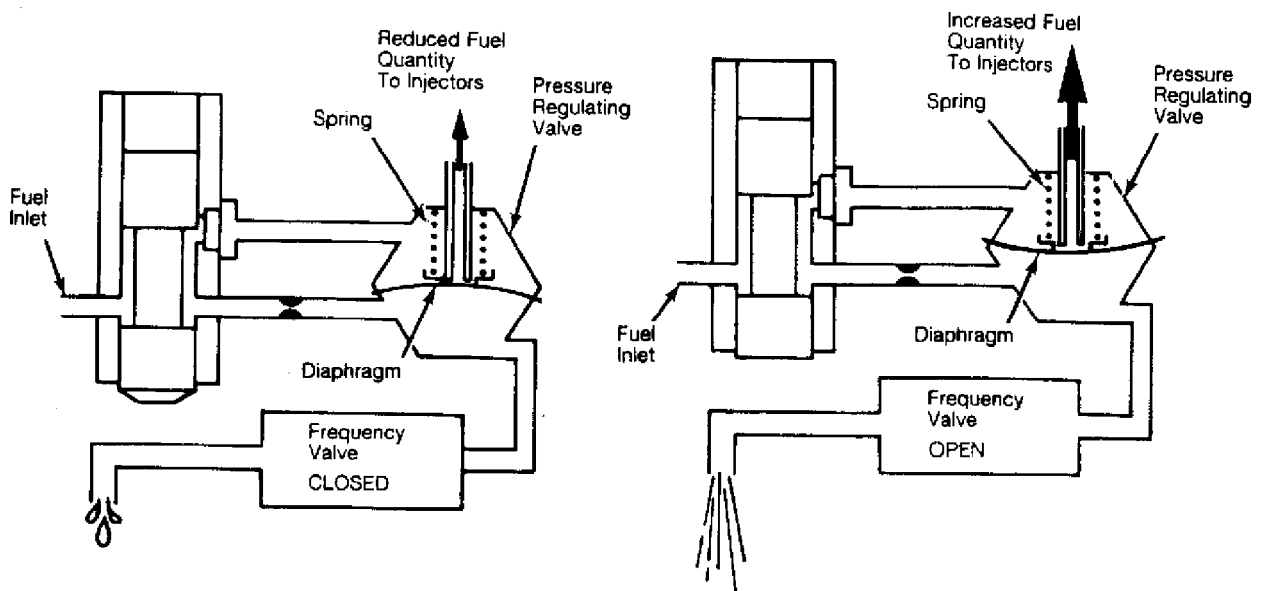


Fig. 4: Effect Of Frequency Valve On Fuel Distributor

ELECTRONIC IDLE SPEED CONTROL SYSTEMS

This system maintains constant idle speed by varying amount of air by-passing throttle valve through air control valve. Air control valve is operated by idle speed ECU which receives engine information from throttle switch, coolant temperature sensor, and ignition coil.

TESTING

* PLEASE READ THIS FIRST *

NOTE: Testing procedures described below will apply to all models using CIS (Lambda) system unless otherwise noted. Not all models will use all components.

PREPARATION FOR TESTING

- 1) All CIS systems are very sensitive to air leaks. Check condition of rubber boots, hoses and gaskets. Other areas of air leakage are injector "O" rings, cold start valve, oil filler cap and dipstick.
- 2) Install pressure gauge to perform fuel pressure tests. On all models, pressure gauge is installed in line between control pressure regulator and fuel distributor. See Fig. 5.

FUEL INJECTION SYSTEM - BOSCH CIS

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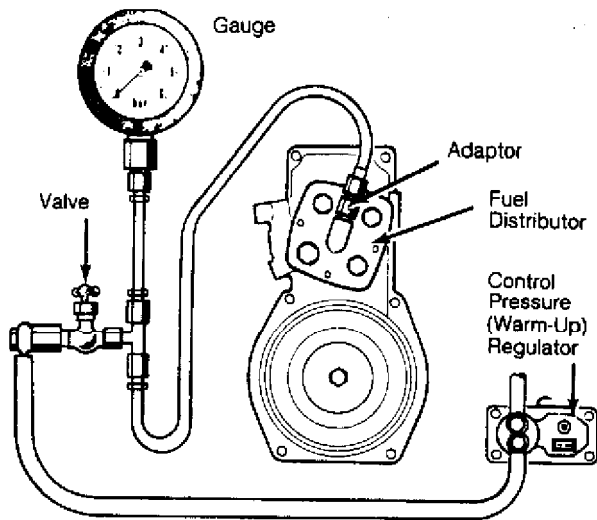


Fig. 5: Pressure Gauge Installation

After installation, bleed pressure gauge by opening and closing valve several times.

3) To operate fuel pump with engine not running, disconnect safety contact switch connector on airflow sensor. Turn ignition on. Place pressure gauge as low as possible in engine compartment. Open and close valve 5 times to bleed gauge. Place valve in open position and hang out of the way. Turn pump off.

AIRFLOW SENSOR

1) Remove rubber bellows above airflow sensor plate. Unplug electrical connectors on auxiliary air regulator and control pressure regulator. Operate fuel pump for 10 seconds to build up control pressure.

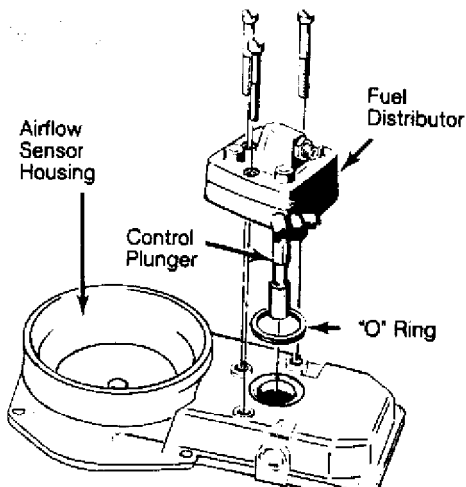


Fig. 6: Removing Fuel Distributor Control Plunger

DO NOT allow control plunger to drop from fuel distributor.

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2) Lift sensor plate slowly with magnet or pliers. Use care to avoid damage to sensor plate or venturi surfaces. Resistance due to control plunger pressure should be felt through entire lift. Release plate and allow it to return to rest position slowly. Lever and control plunger should follow. See Fig. 7.

3) Lift plate and return it rapidly to rest position. Plunger should be heard hitting lever as it moves slowly to rest position. If not, control plunger is sticking. Remove 3 screws from fuel distributor and lift off of airflow sensor housing. Be careful not to drop control plunger. See Fig. 6.

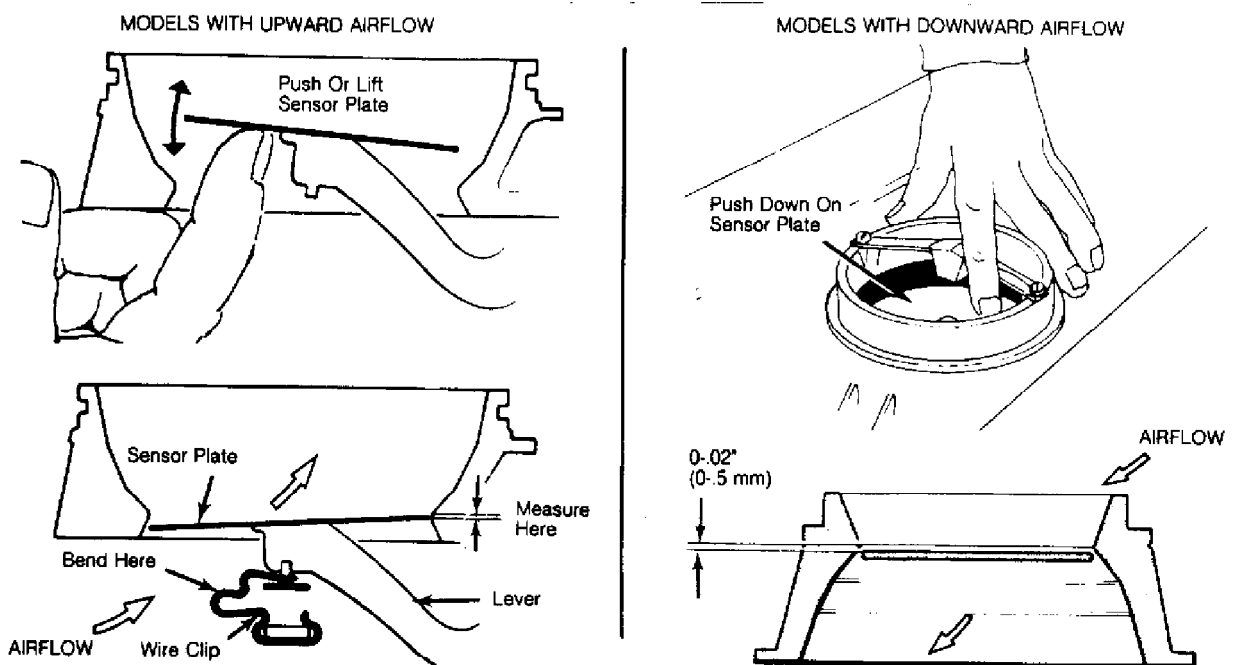


Fig. 7: Checking Sensor Plate Operation & Adjustment

4) Clean plunger in gasoline. Remove any deposits with finger nail. DO NOT use tools. Slide plunger in and out while turning it. If any sticking or binding is felt, replace fuel distributor.

5) Reinstall fuel distributor. Plate should be centered in housing. If not, loosen center bolt and align plate with .004" (.10 mm) feeler gauge at 4 points around rim. Using Loctite, install and tighten bolt.

6) Check airflow sensor plate height adjustment. Plate should be even with bottom rim or .02" (.5 mm) lower. If not, bend spring clip or reposition stop pin (tap lightly with punch) to set plate height. See Fig. 7.

CONTROL PRESSURE TEST (COLD ENGINE)

1) Testing must be done on cold engine. Unplug electrical connectors at auxiliary air valve and control pressure regulator. Place valve on pressure gauge in open position and operate fuel pump. Check control pressure.

2) Reading should fall in shaded area of graph. Check

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ambient air temperature and read correct area of graph. See Fig. 8.
If control pressure is not correct, retest with new control pressure regulator. Control pressure regulator cannot be adjusted.

NOTE: Some control pressure regulators have atmospheric pressure compensation. If so, fuel pressures will vary depending upon barometric pressure.

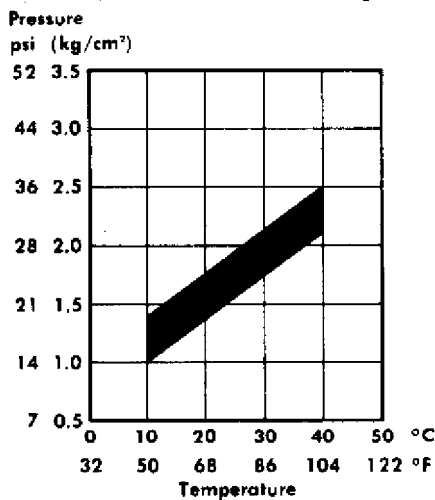


Fig. 8: Control Pressure Test (Cold Engine) Graphs

CONTROL PRESSURE TEST (WARM ENGINE)

1) Connect plug to control pressure regulator. Leave auxiliary air valve and airflow sensor (if equipped) plugs disconnected. Place valve for pressure gauge in open position and operate fuel pump.

2) After about 5 minutes, control pressure should rise to specified level. See CIS (LAMBDA) FUEL PRESSURES table. On models with vacuum hose connected to control pressure regulator, leave hose connected to read pressure.

3) Start engine and allow to idle. Pressure should remain same or rise slightly. On models with control pressure regulator vacuum line, remove and plug hose. Pressure should drop.

4) If pressure does not reach level specified, disconnect plug at control pressure regulator. Check for voltage across terminals with test lamp or voltmeter. At least 11.5 volts should be present. If not, check wiring. If voltage is present and pressure is not correct, replace control pressure regulator.

CIS (LAMBDA) FUEL PRESSURES

Application

Volkswagen

System Pressure psi (kg/cm²)..... 68-78 (4.7-5.4)

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Control Pressure (Warm)(1) psi (kg/cm²)..... 50-53 (3.4-3.7)
Residual Pressure psi (kg/cm²).....(2) 35 (2.4)
Injector Opening Pressure psi (kg/cm²)..... 50-58 (3.4-4.0)

(1) - Engine oil temperature 122-158°F (50-70°C).

(2) - After 20 minutes.

AA

SYSTEM (LINE) PRESSURE TEST

1) Close valve on pressure gauge. With engine off, operate fuel pump. Pressure should rise to level specified. See CIS (LAMBDA) FUEL PRESSURES table. If pressure is too low, check fuel pump output.

2) Disconnect fuel return line from fuel distributor and run hose from fuel distributor to container. Operate fuel pump and measure output after 30 seconds. See FUEL PUMP OUTPUT SPECIFICATIONS table. If not as specified, check fuel lines, filter, accumulator and pump.

FUEL PUMP OUTPUT SPECIFICATIONS

AA

Application	30 Sec. Flow Rate Qts. (L)
-------------	-------------------------------

Volkswagen	.80 (.76)
------------------	-----------

AA

3) If pressure is too high, check for kinked or blocked fuel return line. If lines are clear, system pressure regulator must be adjusted. Turn pump off, loosen return line fitting, and relieve pressure.

4) Loosen line pressure regulator nut. Remove shims, spring(s) and plunger. Raise system pressure by adding shims; lower pressure by removing shims. Be sure "O" rings are in good condition. If piston is scored or damaged, complete fuel distributor must be replaced. See Fig. 9.

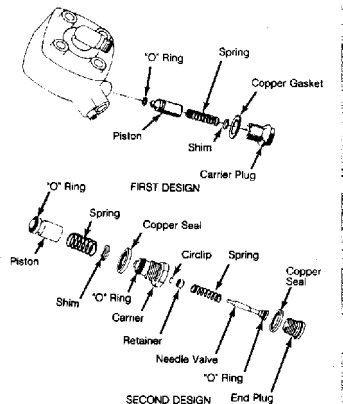


Fig. 9: Line Pressure Regulator
Replace complete fuel distributor if piston is damaged.

FUEL INJECTION SYSTEM - BOSCH CIS

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RESIDUAL PRESSURE & INTERNAL LEAK TESTS

1) After correct warm engine control pressure has been obtained, stop fuel pump and note pressure drop. Pressure gauge valve should be in open position. Minimum pressure after 20 minutes must be as specified. See CIS (LAMBDA) FUEL PRESSURES table.

2) If pressure drops too rapidly, run pump again and close valve. Stop pump and observe pressure. If values are now correct, control pressure regulator is faulty and must be replaced.

3) If pressure still drops, check all connections, fuel pump check valve, cold start valve and fuel injectors.

COLD START VALVE, THERMO TIME SWITCH & PULSE RELAY

CAUTION: DO NOT connect jumper wire directly to battery during testing procedure. Sparks may occur when wire is touched to battery and create a FIRE danger.

1) If engine coolant is below 85°F (30°C), disconnect plug on cold start valve and connect test lamp across terminals. Remove coil high tension wire to prevent starting. Operate starter.

2) On models without pulse relay, test lamp will light for several seconds, then go out. On models with pulse relay, lamp will continue to flash off and on. If lamp does not light, test thermo time switch for continuity below opening temperature. If good, check wiring to starter terminal.

3) Remove cold start valve from manifold but leave fuel line connected. Place valve in container. See Fig. 10. Connect jumper wire from one terminal to ground, and from other terminal of cold start valve to switch. Other side of switch should be connected to source of battery voltage. Operate fuel pump.

4) Turn ignition on. Cold start injector should spray. Turn switch off, but leave fuel pump running. Injector should stop spraying. Wipe off nozzle. No drops should form within one minute with pump running. Replace cold start valve that is faulty. Install original valve if good, ensure that "O" ring is properly positioned.

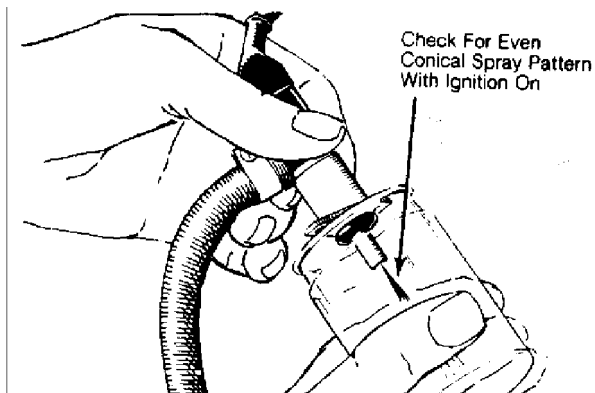


Fig. 10: Testing Cold Start Injector Valve
Valve should not drip after shutting off.

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FUEL INJECTORS

1) Remove injectors but leave hoses connected. Place injectors in individual measuring containers. Operate fuel pump to build up pressure, then turn pump off.

2) Lift airflow sensor plate half-way to operate injectors until one container has filled to 3.4 oz. (.10L). Volume of fuel in other containers should not vary more than 10-20%. Spray pattern must be even and cone-shaped.

3) If one injector does not conform to specifications, switch hoses between it and another (good) injector at fuel distributor and retest. If problem remains with injector, injector is faulty or fuel line is restricted. If problem goes to other (good) injector, fuel distributor must be replaced.

4) Relieve system pressure and remove gauge. Reconnect fuel lines and turn on pump to build up pressure. Injectors may leak slightly, but should stop leaking within 15 seconds. If fuel drops form, check airflow sensor plate height, sticking control plunger or incorrect injector opening pressure.

5) Remove injectors from vehicle and use injector tester to determine opening pressure. See Fig. 11. Check readings against specifications. See CIS (LAMBDA) FUEL PRESSURES table. Replace injectors if faulty.

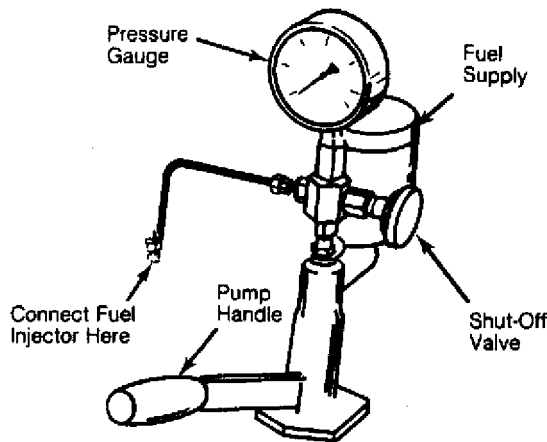


Fig. 11: Testing Fuel Injectors

Replace injectors if opening pressure is not in limits.

AUXILIARY AIR REGULATOR

1) Disconnect hoses from auxiliary air regulator. Use mirror and small flashlight to inspect valve opening. See Fig. 12. At room temperature, valve should be slightly open. Valve should close within 5 minutes after cold engine starts.

2) If valve does not operate properly, check for power at connector with engine running. Connect test lamp across connector terminals. If lamp does not light, check fuse and wiring.

3) If lamp lights, check resistance of auxiliary air regulator. If no resistance is measured, regulator is defective. Ensure electrical connections are tight and terminals are clean,

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prior to measuring resistance.

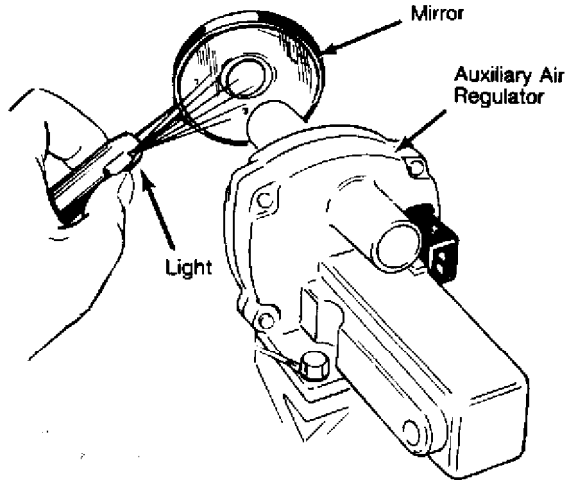


Fig. 12: Checking Auxiliary Air Regulator Operation
Valve should close after engine is running for 5 minutes.

LAMBDA SYSTEM CHECKS

PREPARATION FOR CHECKS

1) Frequency valve is operated by pulsating voltage from ECU. By measuring this signal, mixture function of system can be tested and changed. A high-quality dwell meter is used to check and adjust frequency valve control and duty cycle.

2) Connect tachometer and oil temperature gauge. Ensure A/C is off and transmission lever is in Park. Throttle valve lever must be against idle stop. Accelerator Bowden cable must be tension free at throttle lever. Adjust if necessary. Engine oil must be at operating temperature of 176°F (80°C). Check and adjust idle speed if necessary.

3) Connect dwell meter to 2-wire testing connector. Connector (Blue/White wire) is behind throttle valve housing.

4) The color-coded wire should be connected to positive (+) lead of dwell meter. Other wire in connector is ground and should be connected to negative (-) lead of dwell meter. Set dwell meter on 4-cylinder scale. Start engine and run until warm.

OPERATION CHECK & ADJUSTMENT

1) Remove fuel pump relay and connect jumper wire across sockets corresponding to terminals No. 30 and 87. Remove plug at airflow sensor (if equipped). Turn ignition on.

2) Frequency valve should operate, making buzzing noise. Dwell meter should indicate 45-65 degrees. Disconnect wire from oxygen sensor and touch wire end to ground. Readings on dwell meter should rise. Ground one end of 1.5-volt flashlight battery, and touch positive end to sensor wire. Readings should drop to less than 15 degrees.

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3) On models with throttle enrichment switch, operate throttle. Readings should be higher at idle or wide open throttle.

4) If engine is cold, enrichment switches will be closed. Disconnect lead at temperature sender. Readings should drop slightly. If engine is hot, connect temperature sender lead to ground. Reading should rise.

5) If starter enrichment relay is used, disconnect high tension lead at coil and crank engine. Readings should rise above normal level. If vacuum switches are used, apply vacuum to switch and note readings. Level should be higher with switch closed, and lower with switch open.

6) Connect oxygen sensor and start engine. With cold engine, dwell reading should be stable. When engine warms up, meter needle should fluctuate 10-20 degrees. It may be necessary to run engine faster than idle to heat oxygen sensor to create needle fluctuation.

7) Connect CO meter to exhaust test point. With oxygen sensor disconnected, reading should be stable on dwell meter. Note CO reading. With sensor lead grounded, reading should rise and CO increase. With lead connected to flashlight battery, reading and CO should decrease.

8) If dwell reading does not rise with sensor grounded, check sensor wiring. See ELECTRICAL TESTING in this article. If wiring is good, replace control unit. If dwell rises, but CO does not, check frequency valve and wiring. See ELECTRICAL TESTING. Replace if necessary.

9) If dwell does not decrease with battery connected to sensor lead, check sensor wiring and replace control unit if wires are good. If dwell decreases but CO does not, check frequency valve wiring and replace valve if wiring is good.

10) Adjust CO to rich level (3%) with oxygen sensor still disconnected. Reconnect sensor. Reading should drop at least 1%. If not, replace oxygen sensor.

ELECTRICAL TESTING

NOTE: ECU is located near glove box.

1) Locate ECU and press locking tabs back to disconnect connector. All connectors are wired with pin numbers in same location. Use volt-ohmmeter for testing.

2) Refer to wiring diagram for pin locations. With fuel pump relay jumper wire in place, turn ignition on and check for battery voltage at terminals No. 8 and 15 (18 and 1 on Jetta). Connect ground lead of voltmeter to terminals No. 5 and 16 (2, 10 and 22 on Jetta) while checking for battery voltage to ensure these wires make good ground connection.

3) If battery voltage is not available at terminal No. 8 or 18, check Lambda and fuel pump relays. If there is no voltage at terminal No. 15 or 1, check frequency valve connector. One wire should have battery voltage and other wire should have continuity to terminal No. 15 or 1. Frequency valve should have 2-3 ohms resistance. Repair or replace as necessary.

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4) Disconnect oxygen sensor and check for continuity between sensor lead and terminal No. 2 (11 on Jetta). No continuity should exist between ground and lead wire.

5) All models use switches for enrichment signal. All switches provide continuity to ground when switch is closed. Actuate throttle to test throttle valve switches.

6) Thermal switches can be checked by removing switch and heating in water. Repair wiring or replace switches as necessary.

7) After testing is completed, reconnect ECU, oxygen sensor and all switches. Remove fuel pump relay jumper wire and testing equipment.

REMOVAL & INSTALLATION

* PLEASE READ THIS FIRST *

CAUTION: Always disconnect battery and relieve fuel pressure before removing component parts.

MIXTURE CONTROL UNIT

1) On most models, top of mixture control unit must be removed to extract mixture screw plug or steel ball which blocks access opening. Tap plug or ball out with pin punch.

2) Clean around all fuel line connections. Remove fuel lines and wipe up any spilled fuel. Disconnect electrical wiring and remove rubber boot to manifold. Remove Allen screws and lift off mixture control unit.

3) To install, reverse removal procedure. Replace gaskets and seals. Check for leaks after installation.

FUEL DISTRIBUTOR

1) Remove mixture control unit. Remove 3 screws from top of fuel distributor. Lift fuel distributor carefully to ensure that plunger does not fall out.

2) Only line pressure regulator shims may be replaced. If either control plunger or regulator piston is scored, replace fuel distributor. Be sure new "O" ring is in place when installing fuel distributor.

CONTROL PRESSURE REGULATOR

Disconnect electrical plug and vacuum lines (if equipped). Remove fuel lines and wipe up any spilled fuel. Remove bolts and regulator. To install, reverse removal procedure.

AUXILIARY AIR REGULATOR

Remove and plug hoses. Disconnect electrical plug. Remove regulator and mounting bolts. Reverse removal procedure to install.

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COLD START VALVE

Remove electrical connector and fuel line. Loosen mounting bolts and remove cold start valve. Check "O" ring or gasket. Replace if necessary. Install valve.

FUEL INJECTORS

- 1) Clean area around valves. Hold valve securely and remove fuel line fitting. DO NOT allow valve to turn as damage may result.
- 2) Remove retaining plate if present, and pull valves out carefully. DO NOT remove insulator sleeve.
- 3) To install, reverse removal procedure. Replace "O" rings and lubricate with a drop of oil. Place injectors in sleeve and press until seated. Tighten fuel lines and check for leaks.

THERMO TIME SWITCH

Drain coolant below level of switch. Be careful not to damage connectors on switch while removing. Coat threads of sensor with sealant and reinstall.

FREQUENCY VALVE

- 1) Disconnect electrical connector. Hold small nut at hose and loosen larger valve nut. DO NOT spill gasoline on rubber mounting insulator as it will cause rubber to swell.
- 2) Remove return lines at fuel distributor and/or control pressure regulator. To install, reverse removal procedure. Use new gaskets. Check for leaks after installation.

ECU

Disconnect multi-plug connector from ECU behind glove box. Remove mounting bolts and ECU. To install, reverse removal procedure.

OXYGEN SENSOR

- 1) Disconnect wiring from sensor. Remove shield from sensor (if equipped). Remove sensor. Coat threads of new sensor with anti-seize compound. Take care not to get compound into slots on end of sensor.
- 2) Install sensor and tighten to 25-30 ft. lbs. (35-41 N.m) on all other models. Refit shield and connect sensor wire.

WIRING DIAGRAMS

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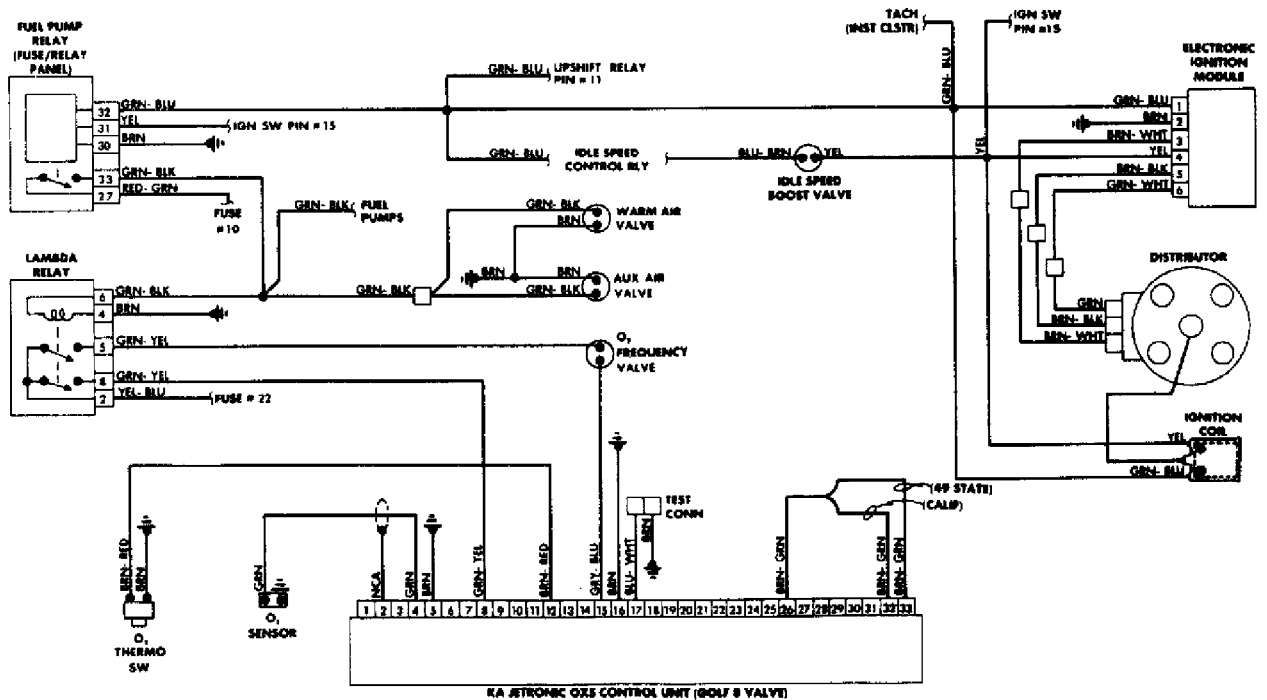
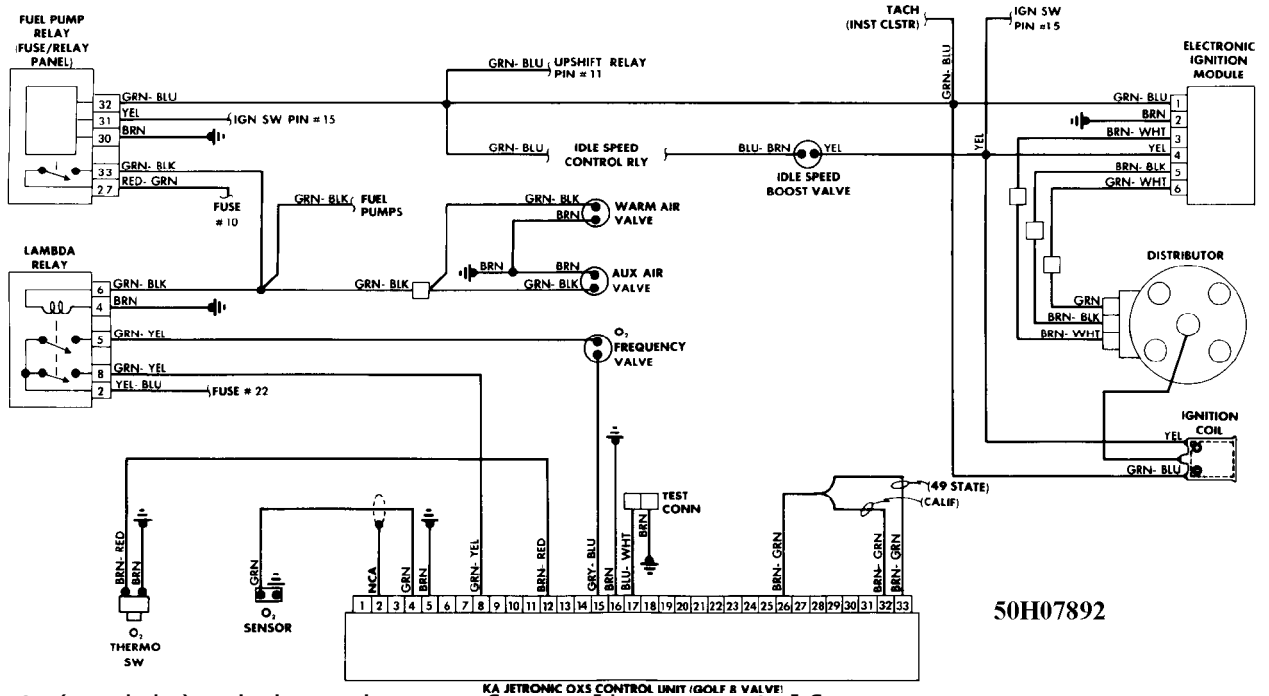


Fig. 13: CIS (Lambda) Wiring Diagram for Volkswagen Cabriolet



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Fig. 14: CIS (Lambda) Wiring Diagram for Volkswagen Golf

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FUEL PUMP - ELECTRIC

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ARTICLE BEGINNING

1987 Electric Fuel Pumps
BOSCH

Volkswagen

DESCRIPTION

Bosch electric fuel pumps are 12-volt, positive displacement roller cell type. Operating pressure is determined by one or more external fuel pressure regulators in the engine compartment. Fuel pumps include an external replaceable discharge check valve, to prevent fuel from returning to the tank when pump is turned off. Some pumps may also incorporate a damper chamber on the outlet, to prevent pulsations in the fuel lines.

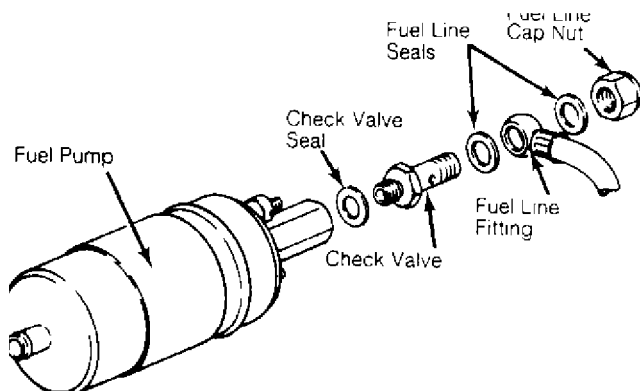


Fig. 1: View of Bosch Electric Fuel Pump
Courtesy of Volvo Cars of North America.

OPERATION

Fuel pumps are actuated by relays when ignition switch is in "START" or "RUN" position, and are protected from circuit overload by fuses and/or fusible links. Fuel is circulated through pump rotor and brushes to the fuel outlet. Pumps are not serviceable and should be replaced when not operating properly. For fuel pump test procedures, see appropriate FUEL INJECTION article in this section.

REMOVAL & INSTALLATION

Removal

1) Fuel pressure must be relieved prior to any component removal. Carefully remove and plug fuel lines to prevent spillage. Disconnect electrical connections.

NOTE: Do not allow smoking, open flame or sparks in area while servicing fuel system components. Disconnect battery ground

FUEL PUMP - ELECTRIC

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terminal prior to removing pump.

2) Remove mounting bolts and retain rubber insulating grommets for reinstallation. Rotate fuel pump as required to clear chassis and remove from vehicle.

Installation

1) Be sure rubber grommets and insulation are installed correctly or noise and vibration will result.

2) Hook all fuel lines and return lines to proper fittings, and be sure they are tight to avoid air and/or fuel leaks.

3) Route fuel lines so they will not vibrate or rub against other body parts. Test system for leaks with engine running.

END OF ARTICLE

FUSES & CIRCUIT BREAKERS

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ARTICLE BEGINNING

1983-88 Fuses & Circuit Breakers
Volkswagen

Quantum

FUSES & CIRCUIT BREAKERS

The fuse panel is located under the left side of the dashboard by the driver's knee. Fuses are numbered from left to right.

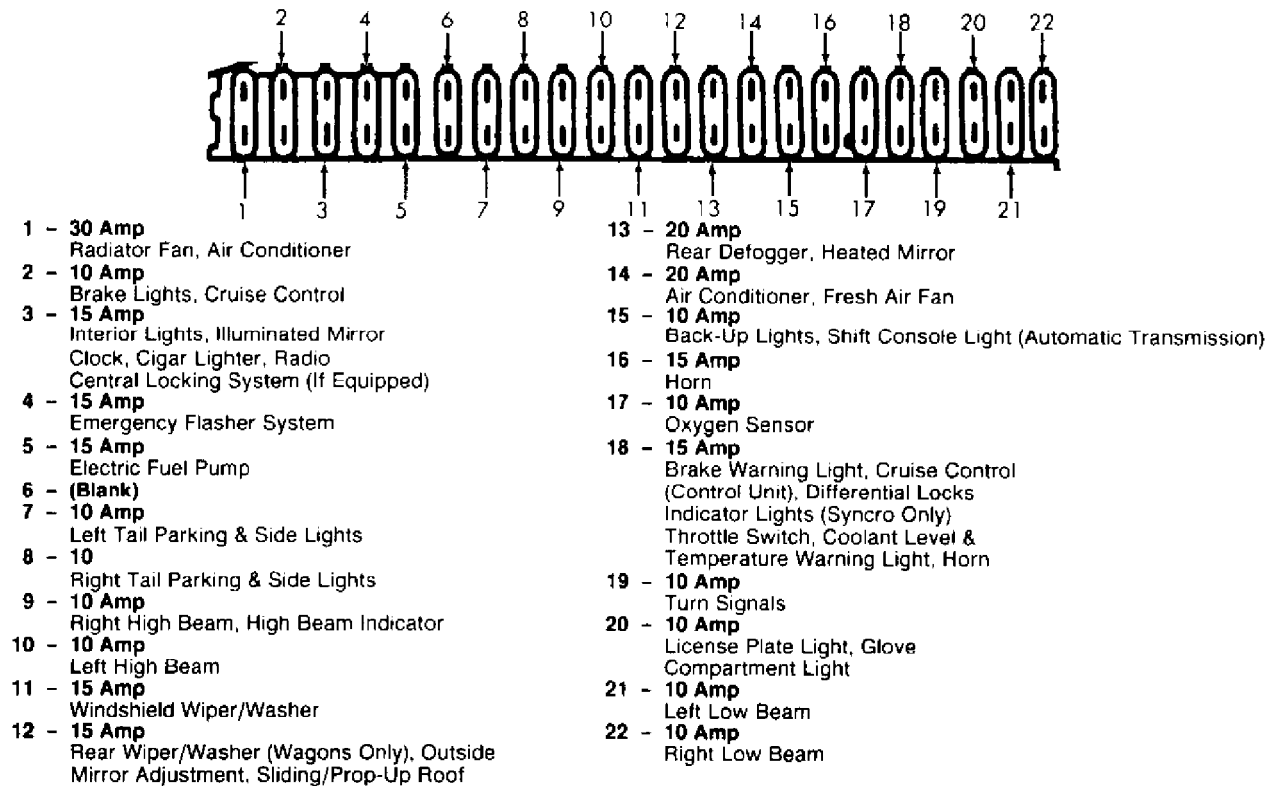


Fig. 1: Fuse Panel Identification
Courtesy of Volkswagen United States, Inc.

FUSES & CIRCUIT BREAKERS

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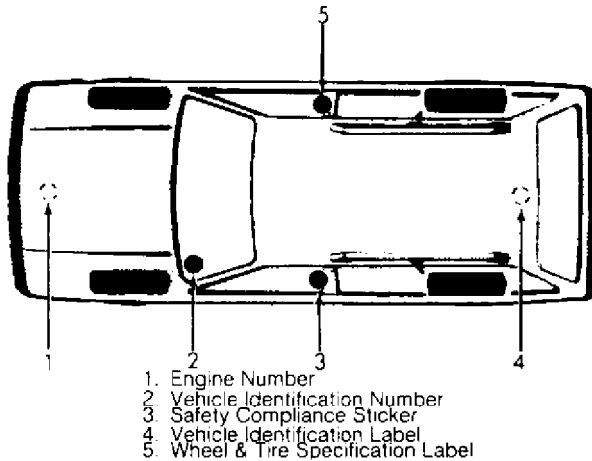


Fig. 2: Information Label Location
Courtesy of Volkswagen United States, Inc.

CAUTIONS & WARNINGS

CAUTION: Contact with live components of ignition system while engine is running could lead to a fatal electric shock.

CAUTION: Brake pedal requires extreme pressure to stop the vehicle when the engine is not running.

CAUTION: Disconnect negative battery cable before servicing any air bag system or steering column component. After any repair, check system by turning the ignition key to the "ON" position from passenger's side of vehicle in case of accidental air bag inflation.

CAUTION: When battery is disconnected, vehicles equipped with computers may lose memory data. When battery power is restored, driveability problems may exist on some vehicles. These vehicles may require a relearn procedure. See COMPUTER RELEARN article in the GENERAL INFORMATION section.

END OF ARTICLE

GEAR TOOTH CONTACT PATTERNS

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ARTICLE BEGINNING

GENERAL INFORMATION

Gear Tooth Contact Patterns

* PLEASE READ THIS FIRST *

The following article is for GENERAL INFORMATION purposes only. Information does not SPECIFICALLY apply to all years, makes and models, but is to be used as a general reference guide.

INSPECTION

PRELIMINARY INSPECTION

Wipe lubricant from internal parts. Rotate gears and inspect for wear or damage. Mount dial indicator to housing, and check backlash at several points around ring gear. Backlash must be within specifications at all points. If no defects are found, check gear tooth contact pattern.

GEAR TOOTH CONTACT PATTERN

NOTE: Drive pattern should be well centered on ring gear teeth. Coast pattern should be centered, but may be slightly toward toe of ring gear teeth.

1) Paint ring gear teeth with marking compound. Wrap cloth or rope around drive pinion flange to act as brake. Rotate ring gear until clear tooth contact pattern is obtained.

2) Contact pattern will indicate whether correct pinion bearing mounting shim has been installed and if drive gear backlash has been set properly. Backlash between drive gear and pinion must be maintained within specified limits, until correct tooth pattern is obtained.

GEAR TOOTH CONTACT PATTERNS

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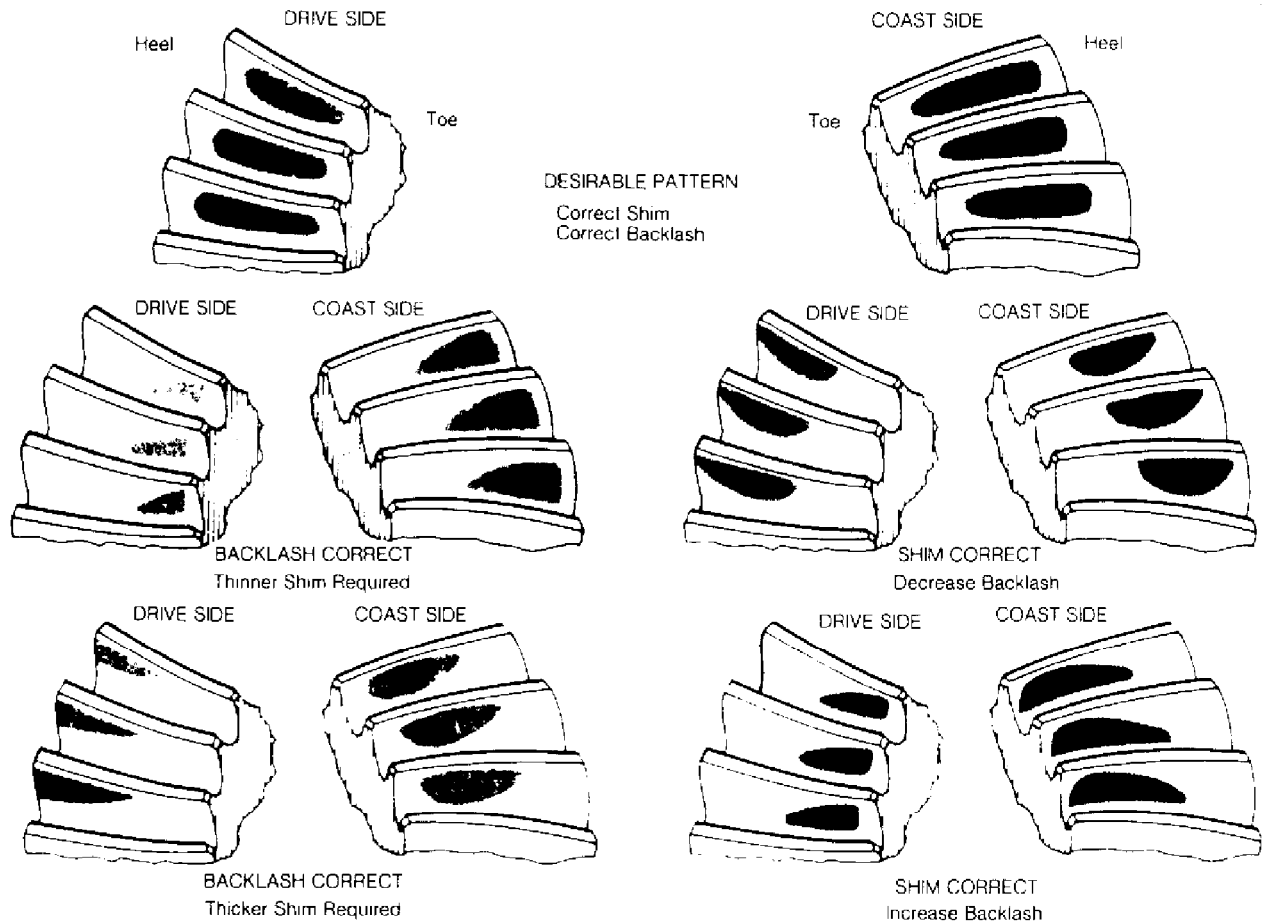


Fig. 1: Drive Axle Gear Tooth Patterns

ADJUSTMENTS

GEAR BACKLASH & PINION SHIM CHANGES

NOTE: Backlash is adjusted by either moving shims from one side of differential case to the other or by turning adjusting nuts on which side bearing races ride. Changing of pinion shims alters the distance from face of pinion of centerline of ring gear.

1) With no change in backlash, moving pinion further from ring gear moves drive pattern toward heel and top of tooth, and moves coast pattern toward toe and top of tooth.

2) With no change in backlash, moving pinion closer to ring gear moves drive pattern toward toe and bottom of tooth, and moves coast pattern toward heel and bottom of tooth.

3) With no change in pinion shim thickness, an increase in backlash moves ring gear further from pinion. Drive pattern moves toward heel and top of tooth, and coast pattern moves toward heel and top of tooth.

GEAR TOOTH CONTACT PATTERNS

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4) With no change in pinion shim thickness, decrease in backlash moves ring gear closer to pinion gear. Drive pattern moves toward toe and bottom of tooth, and coast pattern moves toward toe and bottom of tooth.

END OF ARTICLE

GENERAL COOLING SYSTEM SERVICING

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ARTICLE BEGINNING

GENERAL INFORMATION

General Cooling System Servicing

* PLEASE READ THIS FIRST *

The following article is for general information only. Information may not apply to all years, makes and models. See specific article in the ENGINE COOLING section.

DESCRIPTION

The basic liquid cooling system consists of a radiator, water pump, thermostat, electric or belt-driven cooling fan, pressure cap, heater, and various connecting hoses and cooling passages in the block and cylinder head.

MAINTENANCE

DRAINING

Remove radiator cap and open heater control valve to maximum heat position. Open drain cocks or remove plugs in bottom of radiator and engine block. In-line engines usually have one plug or drain cock, while "V" type engines will have 2, one in each bank of cylinders.

CLEANING

A good cleaning compound removes most rust and scale. Follow manufacturer's instructions in the use of cleaner. If considerable rust and scale has to be removed, cooling system should be flushed. Clean radiator air passages with compressed air.

FLUSHING

CAUTION: Some manufacturers use an aluminum and plastic radiator. Flushing solution must be compatible with aluminum.

Back Flushing

Back flushing is an effective means of removing cooling system rust and scale. The radiator, engine and heater core should be flushed separately.

Radiator

To flush radiator, connect flushing gun to water outlet of radiator and disconnect water inlet hose. To prevent flooding engine, use a hose connected to radiator inlet. Use air in short bursts to prevent damage to radiator. Continue flushing until water runs clear.

Engine

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To flush engine, remove thermostat and replace housing. Connect flushing gun to water outlet of engine. Flush using short air bursts until water runs clean.

Heater Core

Flush heater core as described for radiator. Ensure heater control valve is set to maximum heat position before flushing heater.

REFILLING

To prevent air from being trapped in engine block, engine should be running when refilling cooling system. After system is full, continue running engine until thermostat is open, then recheck fill level. Do not overfill system.

TESTING

THERMOSTAT

1) Visually inspect thermostat for corrosion and proper sealing of valve and seat. If okay, suspend thermostat and thermometer in a 50/50 mixture of coolant and water. See Fig. 1. Do not allow thermostat or thermometer to touch bottom of container. Heat water until thermostat just begins to open.

2) Read temperature on thermometer. This is the initial opening temperature and should be within specification. Continue heating water until thermostat is fully open and note temperature. This is the fully opened temperature. If either reading is not to specification, replace thermostat.

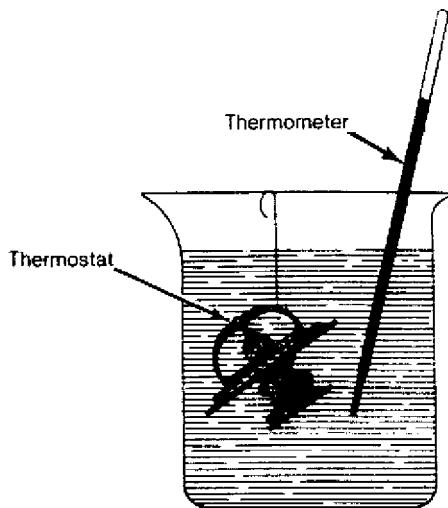


Fig. 1: Testing Thermostat in Anti-Freeze/Water Solution

PRESSURE TESTING

A pressure tester is used to check both radiator cap and complete cooling system. Test components as follows, following tool

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manufacturer's instructions.

Radiator Cap

Visually inspect radiator cap, then dip cap into water and connect to tester. Pump tester to bring pressure to upper limit of cap specification. If cap fails to hold pressure, replace cap.

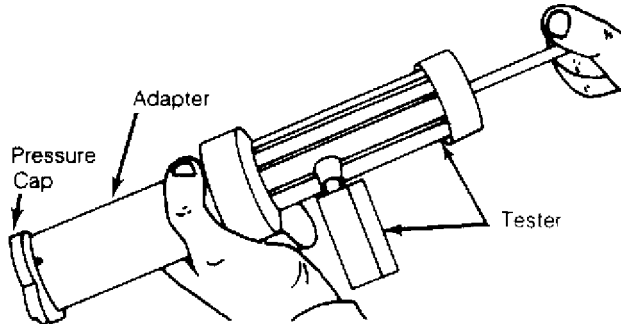


Fig. 2: Testing Radiator Pressure Cap

Cooling System

1) With engine off, wipe radiator filler neck seat clean. Fill radiator to correct level. Attach tester to radiator and pump until pressure is at upper level of radiator rating.

2) If pressure drops, inspect for external leaks. If no leaks are apparent, detach tester and run engine until normal operating temperature is reached. Reattach tester and observe. If pressure builds up immediately, a possible leak exists from a faulty head gasket or crack in head or block.

NOTE: Pressure may build up quickly. Release any excess pressure or cooling system damage may result.

3) If there is no immediate pressure build up, pump tester to within system pressure range (on radiator cap). Vibration of gauge pointer indicates compression or combustion leak into cooling system. Isolate leak by shorting each spark plug wire to cylinder block. Gauge pointer should stop or decrease vibration when leaking cylinder is shorted.

END OF ARTICLE

HOW TO USE SYSTEM WIRING DIAGRAMS

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ARTICLE BEGINNING

GENERAL INFORMATION Using Wiring Diagrams

All Models

INTRODUCTION

Mitchell obtains wiring diagrams and technical service bulletins, containing wiring diagram changes from the domestic and import manufacturers. These are checked for accuracy and are all redrawn into a consistent format for easy use.

In the past, when cars were simpler, diagrams were simpler. All components were connected by wires and diagrams seldom exceeded 4 pages in length. Today, some wiring diagrams require more than 16 pages. It would be impractical to expect a service technician to trace a wire from page 1 across every page to page 16.

Removing some of the wiring maze reduces eyestrain and time wasted searching across several pages. Today the majority of Mitchell diagrams follow a much improved format, which permits space for internal switch details.

Wiring diagrams are drawn in a "top-down" format. The diagrams are drawn with the power source at the top of the diagram and the ground point at the bottom of the diagram. Components locations are identified on the wiring diagrams. Any wires that don't connect directly to a component are identified on the diagram to indicate where they go.

COLOR ABBREVIATIONS

COLOR ABBREVIATIONS TABLE

AA

Color	Normal	Optional
Black	BLK	BK
Blue	BLU	BU
Brown	BRN	BN
Clear	CLR	CR
Dark Blue	DK BLU	DK BU
Dark Green	DK GRN	DK GN
Green	GRN	GN
Gray	GRY	GY
Light Blue	LT BLU	LT BU
Light Green	LT GRN	LT GN
Orange	ORG	OG
Pink	PNK	PK
Purple	PPL	PL
Red	RED	RD
Tan	TAN	TN

HOW TO USE SYSTEM WIRING DIAGRAMS

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Violet		VIO		VI
White		WHT		WT
Yellow		YEL		YL

XX

IDENTIFYING WIRING DIAGRAM ABBREVIATIONS

NOTE: Abbreviations used on Mitchell diagrams are normally self-explanatory. If necessary see ABBREVIATIONS article in GENERAL INFORMATION.

IDENTIFYING WIRING DIAGRAM SYMBOLS

NOTE: Standard wiring symbols are used in Mitchell diagrams. The illustration below will help clarify any symbols that are not easily understood at a glance. Most components are labeled "Motor", "Switch" or "Relay" in addition to being drawn with the standard symbol.

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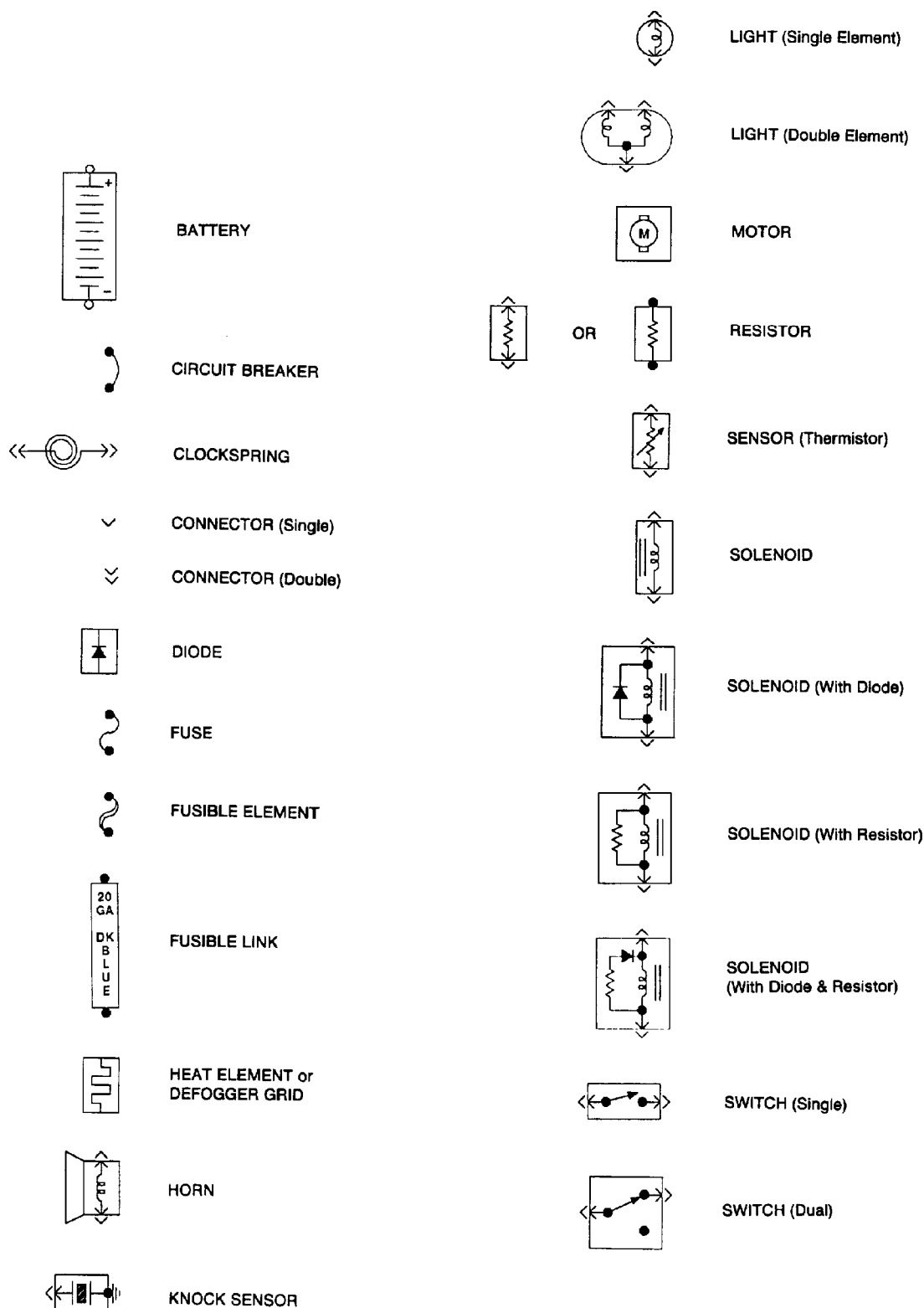


Fig. 1: Identifying Wiring Diagram Symbols

WIRING DIAGRAM COMPONENT LOCATIONS

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When trying to locate a component in a wiring diagram and you don't know the specific system where it is located, use this handy component locator to find the system wiring diagram in which the component is located. Then, go to that system and locate the component within the wiring diagram.

For example, if you don't know the specific system in which the ignition switch is located, look up ignition switch in the wiring diagram component location tables and go to the appropriate wiring diagram(s) which contain either full or partial views of the ignition switch. The full view of the ignition switch is located in Power Distribution.

The first listing for the component will be the full or most complete view of the component. Additional listings will be partial views of the component. Not all components are used on all models.

All components will have a partial view in Ground Distribution and Power Distribution. Data Link Connectors show connecting circuits between modules. Alternate names for components may be listed in wiring diagram component locations tables.

WIRING DIAGRAM COMPONENT LOCATIONS TABLE

XX

Component	Wiring Diagram
-----------	----------------

ABS Electronic Control Unit	Anti-Lock Brakes Data Link Connectors
ABS Hydraulic Unit	Anti-Lock Brakes
Acceleration Sensor	Anti-Lock Brakes
Accessory Delay Relay	Power Windows
A/C Compressor Clutch Relay	Engine Performance
A/C Sensor	Engine Performance
A/C Pressure Switch	Engine Performance
Adaptive Lamp Control Module	Exterior Lights
Air Bag(s)	Air Bag Restraint System
Air Bag Module	Air Bag Restraint System
Air Bag Sensor(s)	Air Bag Restraint System
Air Injection Pump Relay	Engine Performance
Air Temperature Sensor	Overhead Console
Alternator (Generator)	Generators & Regulators
Anti-Theft Control Module	Anti-Theft System Starters
Autolamp Control Relay	Headlight Systems Daytime Running Lights
Automatic Shutdown (ASD) Relay	Engine Performance Generators & Regulators
Autostick Switch	Engine Performance
Auxiliary Battery Relay	Generators & Regulators
Back-Up Lights	Back-Up Lights Exterior Lights
Barometric (BARO) Pressure Sensor	Engine Performance
Battery	Power Distribution
Battery Temperature Sensor	Engine Performance

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Body Control Module	Body Control Computer
	Anti-Theft System
	Daytime Running Lights
	Engine Performance
	Headlight Systems
	Warning Systems
Boost Control Solenoid	Engine Performance
Boost Sensor	Engine Performance
Brake Fluid Level Switch	Analog Instrument Panels
Brake On/Off (BOO) Switch	Cruise Control Systems
	Engine Performance
	Shift Interlock Systems
Buzzer Module	Warning Systems
Camshaft Position (CMP) Sensor	Engine Performance
Central Control Module	Anti-Theft System
Clockspring	Air Bag Restraint System
	Cruise Control Systems
	Steering Column Switches
Clutch Pedal Position Switch	Starters
Clutch Start Switch	Starters
Combination Meter	Analog Instrument Panels
Constant Control Relay Module (CCRM)	Engine Performance
	Electric Cooling Fans
Convenience Center	Power Distribution
	Illumination/Interior Lights
Convertible Top Motor	Power Convertible Top
Convertible Top Switch	Power Convertible Top
Crankshaft Position (CKP) Sensor	Engine Performance
Cruise Control Module	Cruise Control Systems
Cruise Control Switch	Cruise Control Systems
Condenser Fan Relay(s)	Electric Cooling Fans
Data Link Connector (DLC)	Engine Performance
Daytime Running Lights Module	Daytime Running Lights
	Exterior Lights
Defogger Relay	Rear Window Defogger
Diagnostic Energy Reserve Module (DERM)	Air Bag Restraint System
Discriminating Sensor (Air Bag)	Air Bag Restraint System
Distributor	Engine Performance
Door Lock Actuators	Power Door Locks
	Remote Keyless Entry
Door Lock Relay(s)	Power Door Locks
Electrochromic Mirror	Power Mirrors
Electronic Level Control (ELC)	
Height Sensor	Electronic Suspension
Electronic Level Control (ELC) Module	Electronic Suspension
Engine Coolant Temperature (ECT)	
Sending Unit	Analog Instrument Panels
Engine Coolant Temperature (ECT) Sensor	Engine Performance
Engine Control Module	Engine Performance
	Generators & Regulators
	Starters
ETACS ECU	Warning Systems

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	Power Windows
	Remote Keyless Entry
Evaporative (EVAP) Emissions Canister	Engine Performance
EVAP Canister Purge Solenoid	Engine Performance
EVAP Canister Vent Solenoid	Engine Performance
Exhaust Gas Recirculation (EGR) Valve	Engine Performance
Fuel Tank Vacuum Sensor	Engine Performance
Fog Lights	Headlight Systems
	Daytime Running Lights
Fog Light Relay	Headlight Systems
	Daytime Running Lights
Fuel Door Release Solenoid	Power Fuel Door Release
Fuel Gauge Sending Unit	Analog Instrument Panels
Fuel Injectors	Engine Performance
Fuel Pump	Engine Performance
Fuel Pump Relay	Engine Performance
	Power Distribution
Fuse/Relay Block	Power Distribution
Fusible Links	Power Distribution
	Generators & Regulators
	Starters
Generator	Generators & Regulators
	Engine Performance
	Power Distribution
Generic Electronic Module (GEM)	Body Control Modules
	Electronic Suspension
Glow Plug Relay	Engine Performance
Glow Plugs	Engine Performance
Grounds	Ground Distribution
Headlight Door Module	Headlight Doors
Headlight Relay	Headlight Systems
	Daytime Running Lights
Headlights	Headlight Systems
	Daytime Running Lights
Heated Oxygen Sensor(s) (HO2S)	Engine Performance
Heated Windshield Control Module	Heated Windshields
Height Sensor	Electronic Suspension
Horns	Steering Column Switches
Horn Relay	Steering Column Switches
Idle Air Control (IAC) Motor/Valve	Engine Performance
Ignition Coil(s)	Engine Performance
Ignition Key Lock Cylinder	Anti-Theft System
Ignition Module	Engine Performance
Ignition Switch	Power Distribution
	Engine Performance
	Generators & Regulators
	Starters
Illuminated Entry Module	Illumination/Interior Lights
Illumination Lights	Illumination/Interior Lights
Impact Sensor	Air Bag Restraint System
Inertia Fuel Shutoff Switch	Engine Performance
Inhibit Relay	Starters

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Instrument Cluster	Analog Instrument Panels
Intake Air Temperature (IAT) Sensor	Engine Performance
Interior Lights	Illumination/Interior Lights
Interlock Switch	Starters
Junction Block	Power Distribution
Keyless Entry Receiver	Remote Keyless Entry
Key Reminder Switch	Starters
Knock Sensor	Engine Performance
Lamp Control Module	Exterior Lights
License Plate Lamp	Exterior Lights
Lighting Control Module	Lighting Control Modules
	Anti-Theft System
	Daytime Running Lights
	Headlight Systems
Lower Relay	Power Convertible Top
Malfunction Indicator Light (MIL)	Engine Performance
	Instrument Panels
Manifold Absolute Pressure (MAP) Sensor	Engine Performance
Mass Airflow (MAF) Sensor	Engine Performance
Mega Fuse	Generators & Regulators
Memory Seat/Mirror Module	Memory Systems
Mirror Defogger	Rear Window Defogger
Moon Roof Motor	Power Moon Roof
Moon Roof Relay	Power Moon Roof
Multi-Function Control Module	Warning Systems
Neutral Safety Switch	Starters
Oil Level Switch	Engine Performance
Oil Pressure Switch/Sending Unit	Analog Instrument Panels
	Engine Performance
Overhead Console	Overhead Console
Oxygen Sensor(s) (O2S)	Engine Performance
Parking Brake Switch	Analog Instrument Panels
Park Lights	Exterior Lights
Park/Neutral Position Switch	Starters
	Engine Performance
	Anti-Theft System
	Body Control Module
Perimeter Lighting Control Relay	Exterior Lights
Power Amplifier	Power Antennas
Power Antenna Module	Power Antennas
Power Antenna Motor	Power Antennas
Power Distribution Center	Power Distribution
	Generators & Regulators
	Starters
Power Door Lock Motors	Power Door Locks
Power Mirror Motors	Power Mirrors
	Memory Systems
Power Sliding Door Controller	Power Sliding Side Door
Power Seat Motors	Power Seats
	Memory Systems
Power Steering Pressure Switch	Engine Performance
Power Top Motor	Power Convertible Top

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Power Top Relay(s)	Power Convertible Top
Powertrain Control Module	Engine Performance
	Analog Instrument Panels
	Cruise Control Systems
	Data Link Connectors
	Generators & Regulators
	Starters
Power Window Motors	Power Windows
Power Window Relay(s)	Power Windows
Radiator Fan Motor(s)	Electric Cooling Fans
Radiator Fan Relay(s)	Engine Performance
	Electric Cooling Fans
Rainsense Module	Wiper/Washer Systems
Raise Relay	Power Convertible Top
Remote Anti-Theft Personality (RAP) Module	Anti-Theft System
	Starters
	Warning Systems
Seat Belt Pretensioners	Air Bag Restraint System
Seat Belt Retractor Solenoid	Passive Restraints
Seat Belt Switch	Air Bag Restraint System
	Passive Restraints
Shift Interlock Solenoid	Shift Interlock Systems
Shift Lock Actuator	Shift Interlock Systems
Side Marker Lights	Exterior Lights
SIR Coil Assembly (Clockspring)	Air Bag Restraint System
Slip Ring (Clockspring)	Air Bag Restraint System
	Steering Column Switches
SRS Control Module	Air Bag Restraint System
Starter Motor	Starters
Starter Interrupt Relay	Starters
Starter Solenoid	Starters
Starter Relay	Starters
Steering Wheel Position Sensor	Anti-Lock Brakes
Stoplights	Exterior Lights
Stoplight Switch	Engine Performance
	Cruise Control Systems
	Anti-Lock Brakes
Sun Roof ECU	Power Sun Roof
Sun Roof Motor	Power Sun Roof
Sun Roof Position Sensor	Power Sun Roof
Taillights	Exterior Lights
Throttle Position (TP) Sensor	Engine Performance
Torque Converter Clutch Solenoid/Switch	Engine Performance
Traction Control Switch	Anti-Lock Brakes
Trailer Tow Connector	Exterior Lights
Trailer Tow Relay	Exterior Lights
Transmission/Transaxle	Engine Performance
Transmission Control Module (TCM)	Engine Performance
	Starters
Transmission Range Sensor	Starters
	Back-Up Lights
	Engine Performance

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Transmission Range Switch		Back-Up Lights
		Engine Performance
		Anti-Theft System
Turn Signal Flasher		Exterior Lights
Turn Signal Lights		Exterior Lights
Twilight Sentinel Switch		Headlight Systems
		Daytime Running Lights
Vapor Canister Leak Detection Pump		Engine Performance
Vehicle Control Module (VCM)		Engine Performance
Vehicle Dynamic Module		Electronic Suspension
Vehicle Speed Control Servo		Cruise Control Systems
Vehicle Speed Sensor		Data Link Connectors
		Analog Instrument Panels
		Cruise Control Systems
		Electronic Suspension
Voltage Regulator		Generators & Regulators
Water-In-Fuel Sensor		Engine Performance
		Analog Instrument Panels
Wheel Speed Sensors		Anti-Lock Brakes
Window Timer Module		Power Convertible Top
Windshield Intermittent Wiper Relay		Wiper/Washer Systems
Windshield Washer Motor		Wiper/Washer Systems
Wiper Motor		Wiper/Washer Systems
AA		

END OF ARTICLE

IGNITION SYSTEM - BOSCH HALL EFFECT

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ARTICLE BEGINNING

DISTRIBUTORS & IGNITION SYSTEMS

Bosch Hall Effect Electronic Ignition

DESCRIPTION

The typical Bosch Hall Effect electronic ignition system consists of an ignition coil, distributor with Hall Effect sending unit, Hall Ignition Control Unit (ICU) vacuum and centrifugal advance mechanisms (some models).

The Volkswagen Jetta GLI, GTI and 16-valve models also incorporate a knock control unit.

OPERATION

The Hall Effect sending unit in the distributor receives voltage from the knock control unit or directly from the electronic Ignition Control Unit (ICU). A trigger wheel (shutter blades) mounted on the distributor shaft passes in and out of the air gap of the Hall Effect sending unit, resulting in signal pulses. See Fig. 6. There is one trigger wheel shutter/window for each engine cylinder.

On models without timing/knock control units, vacuum and centrifugal advance mechanisms are used. Signals from the distributor Hall sending unit are sent back to the Hall control unit, which opens and closes the primary circuit to the ignition coil, firing the spark plugs.

On models utilizing a knock control unit, vacuum and centrifugal advance mechanisms are not used. The distributor Hall sending unit signal goes directly to the knock control unit which modifies the trigger signal to the ignition coil based on RPM, knock sensor input, and vacuum. On Volkswagen 16-valve models, throttle switch position signal is also used.

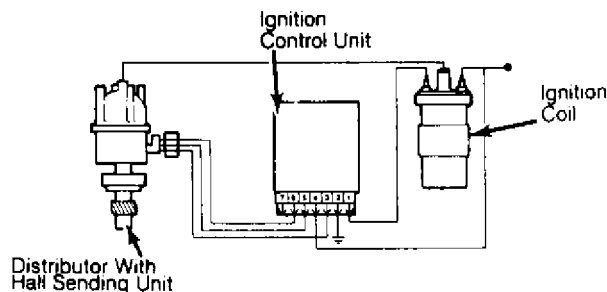


Fig. 1: Typical Hall Effect System Schematic (W/O Knock Unit)
Courtesy of Audi of America, Inc.

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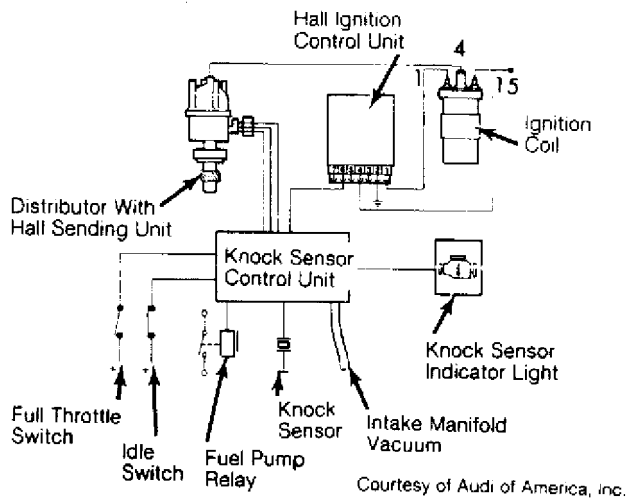


Fig. 2: Typical Hall Effect System Schematic (With Knock Unit)
Courtesy of Audi of America, Inc.

ADJUSTMENTS

No adjustments, except spark plug gap and base timing, are necessary as all advance functions are computer controlled.

PRE-TEST PROCEDURES

- 1) Ensure battery is fully charged before making tests. Ensure there is fuel in tank. Check all ignition wiring. Remove any spark plug wire and connect test spark plug to wire. Test spark plug must have electrode gap set at .16" (4 mm). Ensure spark plug is well grounded.
- 2) Crank engine. If spark is present, check ignition timing and adjust if necessary. Check fuel system to ensure engine is receiving sufficient fuel. If not, repair fuel system.
- 3) DO NOT connect any condenser to terminal No. 1 of ignition coil. Connect and disconnect test instruments only when ignition is off. DO NOT touch or remove high tension wires when engine is running or cranking.
- 4) Disconnect ignition wires only when ignition is off. DO NOT crank engine unless high tension wire is removed from distributor cap and grounded with a jumper wire.
- 5) DO NOT use a battery charger for more than one minute with battery cables connected or exceed 16.5 volts while charging.

TROUBLE SHOOTING

NOTE: See the TROUBLE SHOOTING - BASIC PROCEDURES article in the GENERAL TROUBLE SHOOTING section.

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TESTING

NOTE: To eliminate possible damage to electronic components, a voltmeter with minimum 10 megaohm input impedance should be used for all voltage checks.

VACUUM ADVANCE TEST

Connect timing light to engine. Start and run engine at idle. Verify idle speed and base timing are set to specification. Disconnect and plug vacuum hoses at distributor advance and retard diaphragms (if equipped). Increase engine speed to 2500 RPM. Check ignition timing. Connect vacuum hose and verify that ignition timing advances.

CENTRIFUGAL ADVANCE TEST

Connect timing light to engine. Start and run engine at idle. Verify idle speed and base timing are set to specification. Disconnect and plug vacuum hoses from distributor vacuum advance and retard diaphragms (if equipped). Check ignition timing. Gradually increase engine speed and check that ignition timing advances.

VACUUM RETARD TEST

1) Connect tachometer and timing light to engine. Connect Vacuum Advance Tester (VAG 1368) according to manufacturer's instructions. Remove both plugs from idle stabilizer (if equipped) and connect together.

2) Start and run engine at 900 RPM. Disconnect vacuum advance hose from unit and check ignition base timing and idle speed. Adjust if necessary. Disconnect vacuum retard hose from unit. Plug hose.

3) Bring base timing mark back to pointer by using dial on timing light and read vacuum retard. Retard should be 8-11 degrees. After testing, reconnect idle stabilizer plugs. Reconnect vacuum hoses.

IGNITION COIL RESISTANCE CHECK

1) Using ohmmeter, check ignition coil primary and secondary resistance. Disconnect coil primary and secondary ignition leads. Connect ohmmeter leads across primary terminals No. 1 and 15 at coil. Note primary resistance value.

2) Move ohmmeter lead from positive terminal (No. 15) and insert into coil high voltage tower. Note secondary resistance value. If resistance values are not to specification, replace ignition coil.

IGNITION COIL RESISTANCE (Ohms) TABLE

XX

Application	Primary	Secondary
Except 16-Valve	.52-.76	2400-3500
16-Valve	.6-.8	6500-8500

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0.52-0.76 Ohms



2.4-3.5 Ohms



Fig. 3: Ignition Coil Resistance Check
Courtesy of Audi of America, Inc.

SPARK PLUG WIRES & ROTOR

1) Check coil wire resistance. If radio suppression wires are used, reading should be 1200-2800 ohms. If not, reading should be zero ohms.

2) Check resistance of spark plug wires. If radio suppression wires are used, reading should be 4600-7400 ohms. If not, reading should be 600-1400 ohms. Check spark plug connectors. If radio suppression connectors are used, reading should be 4000-6000 ohms. If not, reading should be 600-1400 ohms.

3) Check rotor and spark plug wire distributor cap connectors. Resistance should be 600-1400 ohms. Ensure rotor is marked "R1".

IGNITION CONTROL UNIT (ICU)

1) Remove connector from Ignition Control Unit (ICU) located above glove box or behind left kick panel and connect voltmeter to connector terminals No. 2 and 4. Turn ignition on. Voltage should read about 12 volts. If voltage is not present, repair open in terminal No. 2 (ground circuit) or open or short in circuit No. 15 (wire from positive side of ignition coil).

2) Reconnect ICU connector. Disconnect coil wire from distributor cap center terminal and connect to ground using a jumper wire. Remove protective cover to gain access to rear of control unit connector.

3) Connect digital voltmeter across rear of connector at terminals No. 3 and 6 of the control unit (4 and 6 on models with knock control unit, 2 and 6 on Volkswagen 16-valve). Turn ignition switch to "START" position. Voltage should be displayed while cranking engine. If NO voltage is displayed, see HALL EFFECT SENDING UNIT test.

4) Turn ignition off. On Volkswagen 16-valve models, disconnect 15-wire connector of knock control unit. Disconnect 3-wire connector from distributor on all other models. Connect positive

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voltmeter lead to terminal No. 15 of coil. Connect negative voltmeter lead to terminal No. 1 of coil.

5) Turn ignition on. Voltmeter should show voltage and must drop to zero volts within 1-2 seconds. If voltage does not drop, replace Hall control unit. If voltage drops, install short jumper lead to center terminal of distributor 3-wire connector (terminal No. 12 of knock control unit on Volkswagen 16-valve models). Lightly tap lead to ground. Voltage must rise to a minimum of 2 volts for a short time. If voltage rise is not indicated, replace Hall control unit.

HALL SENDING UNIT

Voltage Supply Check (Without Knock Control Unit)

1) Remove 3-wire connector from Hall sending unit at distributor. Connect voltmeter to the outside connector terminals. With ignition on, 9-12 volts should be indicated.

2) If voltage is not correct, check harness between control unit and hall sending unit for open or short. If no open or short exists, access rear of ignition control unit connector. With ignition on, check voltage on terminals No. 4 and 5 of ignition control unit. See Fig. 4. If no voltage is present at either terminal, check voltage supply to and from ignition coil terminal No. 15. of knock control unit.

Voltage Supply Check (With Knock Control Unit)

1) Remove 3-wire connector from distributor unit. Connect voltmeter to the outside terminals. With ignition on, 5-12 volts should be indicated.

2) If voltage is not correct, check Hall Effect harness for open or short. Check terminal No. 3 of knock control unit for continuity to ground. Check voltage supply from terminal No. 15 of knock control unit.

3) If voltage is present on both terminals, check ignition control module terminal No. 2 for continuity to ground. If voltage is indicated on terminal No. 4 only, control unit is faulty.

Hall Sending Unit Test (Without Knock Control Unit)

1) Perform Hall sending unit VOLTAGE SUPPLY CHECK. Turn ignition off. With 3-wire connector installed at distributor, move protective cover to gain access to rear of connector.

2) Remove distributor cap, rotor and dust cover. Connect voltmeter across terminals No. 1 and 2 at rear of 3-wire connector. Turn ignition on.

3) Turn crankshaft until trigger wheel blade blocks Hall sender. See Fig. 5. Voltmeter reading should be greater than 4.0 volts. Turn crankshaft until trigger wheel slot is fully aligned with Hall sending unit. Voltmeter should read 0-.5 volts.

4) If voltmeter readings do not show a voltage difference while testing, replace Hall sending unit. If voltmeter readings are correct, check for same voltage readings at terminals No. 5 and 6 of the Hall ignition control unit (4 and 6 on models with knock control unit, 2 and 6 on Volkswagen 16-valve). If readings are not identical,

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check wire harness from Hall sending unit to ignition control unit.

Hall Sending Unit Test (With Knock Control Unit)

1) Perform Hall sending unit VOLTAGE SUPPLY CHECK. Turn ignition off. With 3-wire connector installed at distributor, move protective cover to gain access to rear of connector.

2) Connect voltmeter across terminals No. 1 and 2 at rear of 3-wire connector. Remove coil high voltage lead and ground with jumper wire.

3) Turn ignition switch to "START" position. Voltage should be indicated while starter is actuated.

4) If voltmeter does not show voltage reading while cranking, replace Hall sending unit. If voltmeter shows voltage while cranking, check for same voltage readings at Hall Ignition Control Unit terminals No. 4 and 6 (2 and 6 on Volkswagen 16-valve).

5) If readings are not identical, check wire harness from Hall sending unit to knock control unit and from knock control unit to Hall ignition control unit. See Fig. 4.

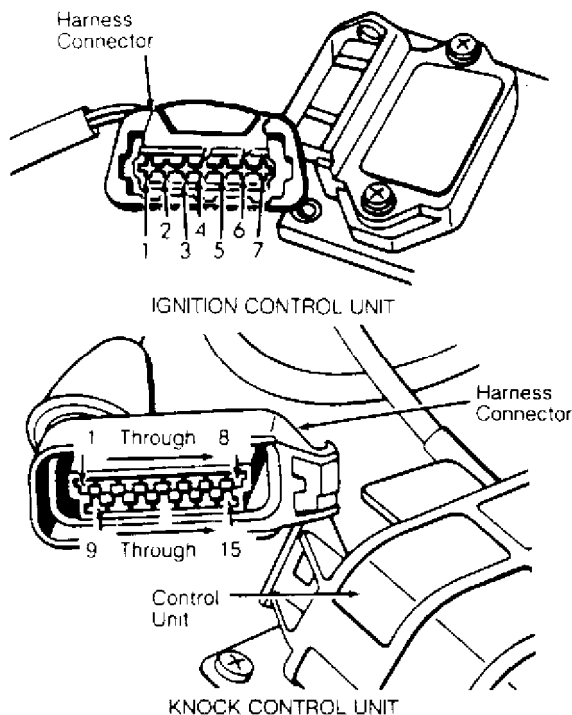


Fig. 4: 7-Pin ICU Connector & 15-Pin Knock Sensor Connector
Courtesy of Volkswagen United States, Inc.

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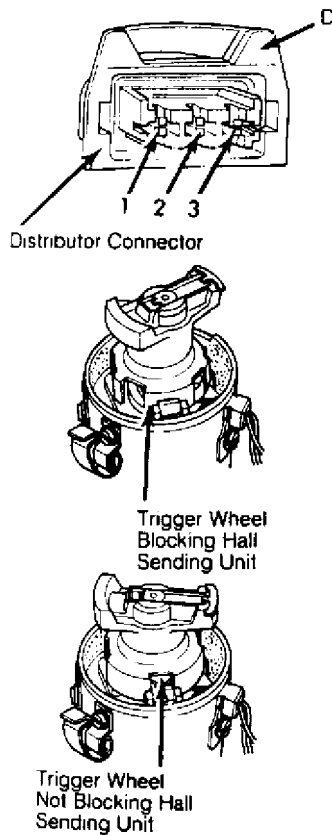


Fig. 5: Positioning Distributor for Hall Effect Testing
Courtesy of Audi of America, Inc.

KNOCK SENSOR CONTROL UNIT

NOTE: For complete testing of Volkswagen knock control system (except Volkswagen 16-valve models), manufacturer recommends the use of Special System Tester.

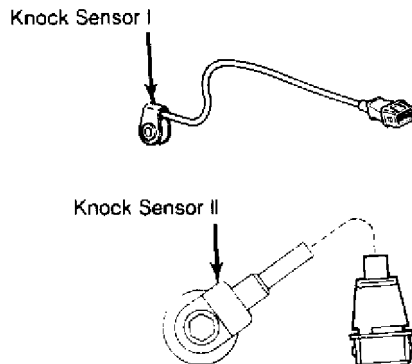


Fig. 6: Knock Sensor Identification
Courtesy of Audi of America, Inc.

Voltage Tests (Volkswagen 16-Valve)

1) Perform HALL ELECTRONIC IGNITION CONTROL UNIT (ICU) test.

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Turn ignition off. Disconnect knock sensor control unit 15-wire connector. Turn ignition on. Check voltage between terminals No. 3 and 5 of 15-wire connector. Reading should be approximately battery voltage.

2) Measure voltage between terminals No. 3 and 6 of 15-wire connector. Voltage should read about battery voltage. Open throttle valve. Voltage should drop to zero volts. If voltage does not drop, check idle switch.

3) Measure voltage at terminals No. 3 and 8 while slowly opening throttle. As throttle reaches full open position, battery voltage should be indicated. If battery voltage is not indicated, check full throttle switch.

4) Turn ignition off. Reconnect knock control unit 15-wire connector. Disconnect Hall distributor sending unit 3-wire connector.

5) Connect positive voltmeter lead to terminal No. 15 of coil. Connect negative voltmeter lead to terminal No. 1 of coil. Install short jumper lead to center terminal of distributor 3-wire connector.

6) Turn ignition on. Voltmeter should show voltage and should drop to zero volts within 1-2 seconds. Lightly tap lead to ground. Voltage should rise to a minimum of 2 volts for a short time. If voltage rise is not indicated, replace knock control unit.

Continuity & Resistance Tests (Volkswagen GLI & GTI)

1) With ignition off, disconnect knock sensor control unit. Connect voltmeter negative lead to terminal No. 3 and positive lead to terminal No. 5 at connector. Turn ignition on.

2) Meter should indicate battery voltage. If no voltage is present, check fuse No. 18 on fuse block. If okay, check ground connection at intake manifold. Check wire No. 5 to ignition switch.

3) Connect voltmeter negative lead to terminal No. 3 and positive lead to terminal No. 8 at connector. Turn ignition on. Actuate full throttle switch. Meter should indicate battery voltage.

4) If no voltage is present, voltage supply (center wire) to throttle switch is open. If not, full throttle switch is defective. Replace full throttle switch.

5) Connect voltmeter negative lead to terminal No. 3 and positive lead to terminal No. 6 at connector. Turn ignition on. Meter should indicate battery voltage. If no voltage is present, wire to idle switch is open. If not, idle switch is improperly adjusted and/or defective.

6) Connect voltmeter negative lead to terminal No. 3 and positive lead to terminal No. 10 at connector. Turn ignition on. Meter should indicate battery voltage. If no voltage is present, wire to fuel pump relay is open. Repair wire as necessary.

7) Turn ignition off. Connect ohmmeter between connector terminals No. 2 and 3. Ensure CIS-E fuel control unit is connected. Ohmmeter reading must be 90,000-100,000 ohms. If reading is incorrect, wire No. 2 to CIS-E control unit is open. If not, CIS-E control unit is defective.

8) Connect ohmmeter between connector terminals No. 3 and 4. Connect test connector in engine compartment to ground. Ohmmeter

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should indicate continuity to ground.

9) Connect ohmmeter between connector terminals No. 3 and 11. Ohmmeter should indicate continuity. If no continuity is indicated, ground wire between terminals No. 3 and 11 is open. On some models terminal No. 11 may not be used.

10) Connect ohmmeter between connector terminals No. 3 and 12. Disconnect Hall control unit and install a jumper wire between terminals No. 2 and 6. Ohmmeter should indicate continuity.

11) Connect ohmmeter between connector terminals No. 3 and 13. Ohmmeter should indicate one milliohm. If reading is incorrect, wires to knock sensor are open or knock sensor is defective.

12) Connect ohmmeter between connector terminals No. 13 and 14 to measure the resistance of the knock sensor. Ohmmeter should indicate approximately 300,000 ohms for a type I sensor and approximately infinity for a type II sensor. If reading is incorrect, wires to knock sensor are open or knock sensor is defective.

13) Connect ohmmeter between connector terminals No. 7 and 15. Disconnect Hall Effect sending unit and install a jumper wire between terminals No. 1 and 3. Ohmmeter should indicate continuity.

14) Connect ohmmeter between connector terminals No. 7 and 9. Disconnect Hall Effect sending unit and install a jumper wire between middle terminal (Green/Purple wire) and outer terminal (Brown/White wire). Ohmmeter should indicate continuity.

Fault Diagnosis (Volkswagen 16-Valve)

1) Connect voltmeter positive lead to positive post of battery. Connect voltmeter negative lead to single Blue/Brown or Brown/Blue wire connector in engine compartment (pin No. 4 of knock control unit). Turn ignition on. Voltmeter should indicate near battery voltage. Start engine. Voltage on meter should drop (a slight voltage signal may remain).

2) Accelerate engine to 3000 RPM (one time only). If voltage remains near zero volts, test is completed. If higher voltage signal returns, a knock fault has been detected. Connect a jumper wire to Blue/Brown connector. Hold jumper to ground for a minimum of 3 seconds and then remove. Voltmeter should start pulsing at this time.

3) If meter pulses in a pattern of 2 per interval, the knock sensor control unit or knock sensor circuit is faulty. Check knock sensor torque. Check for open or short circuit in knock sensor wiring. If knock sensor torque is correct and wiring is okay, knock sensor is defective. Connect ohmmeter across connector to knock sensor. Resistance should measure 300,000 ohms on type-1 knock sensor. Resistance should measure infinity on type-2 knock sensor.

4) If meter pulses in a pattern of 3 per interval, fault exists in pressure sensor (vacuum) circuit. Check White vacuum hose to knock sensor control unit for damage. If no faults are found, internal pressure sensor in knock unit is faulty.

Timing Advance Test (Volkswagen 16-Valve)

1) Perform KNOCK CONTROL FAULT DIAGNOSIS test. If knock sensor circuit is okay, ensure terminal No. 11 at ignition control unit is being used and grounded. Connect Timing Tester (VW 1367).

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Start and run engine at idle. Base ignition timing will be indicated on tester. Adjust if necessary.

2) With engine running, pull vacuum hose off ignition control unit. Increase engine speed to 4300 RPM (engine code RD). Note reading on tester. To determine ignition timing advance, subtract base ignition timing from reading.

3) Ignition timing advance should be 14-16 degrees. If timing is incorrect, check ground wire at terminal No. 11 of ignition control unit connector. If wire is okay, ignition control unit is defective.

IDLE & FULL THROTTLE SWITCH (VOLKSWAGEN 16-VALVE)

Switch Voltage Supply Test

1) Unplug common connector (Black wire) to throttle switches. Turn ignition on. Check voltage between ground and terminal from CIS-E control unit.

2) Voltmeter reading should be 12 volts. Turn ignition off. If reading is incorrect, check for open circuit in wiring between throttle switches and terminal No. 1 of CIS-E control unit. Repair as necessary.

3) If wiring is not faulty, check voltage supply to terminal No. 1 of CIS-E control unit (relay panel pin D2).

Switch Continuity Test

1) Ensure ignition is off. Remove electrical connector CIS-E control unit. Connect ohmmeter between idle switch terminals No. 1 and No. 5.

2) Manually operate throttle linkage from closed to half-throttle positions. When throttle is closed continuity should exist. When throttle is open continuity should not exist.

3) Reconnect ohmmeter leads across CIS-E connector full throttle switch terminals No. 1 and 13. Manually operate throttle linkage from closed to full throttle. When full throttle is reached, continuity should exist.

4) If continuity does not change as indicated or continuity is constant, inspect wiring from control unit to throttle switches. If wiring is not faulty, replace defective switches.

END OF ARTICLE

INSTRUMENT PANEL - STANDARD

Article Text

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ARTICLE BEGINNING

Switches & Instrument Panels
VOLKSWAGEN

DESCRIPTION

Instrumentation for most models includes speedometer, fuel gauge and temperature gauge. Optional instruments include clock, tachometer, voltmeter and oil temperature gauge. All models have a headlight switch mounted on the dashboard. Other switches on the instrument panel control the hazard flashers, rear window defogger and optional equipment. Levers on the steering column control high beams, turn signals and wiper/washers. Switches are retained in place by spring clips.

OPERATION

The cluster gauges receive power from a printed circuit. A voltage regulator attached to the printed circuit controls voltage to the fuel and temperature gauges. Light emitting diodes (LEDs) are used for most warning lights. The diodes may be replaced by pulling them out of the printed circuit sockets.

TESTING

NOTE: Volkswagen Tester (1301) is required for all resistance tests. Tester settings are numerical. Settings do not indicate resistance in ohms. Resistance value in ohms is not available.

FUEL GAUGE

1) Disconnect wire from fuel tank sending unit. Connect VW tester between wire and ground. Turn ignition on and allow 2 minutes for gauge reading to stabilize. Use the FUEL GAUGE TESTING table to compare gauge reading. It should be within one pointer width of specification.

2) If gauge needle does not move, check continuity between sender wire and gauge. If needle moves, but does not match specifications, replace gauge. If gauge works correctly with tester, but not sending unit, replace sending unit.

FUEL GAUGE TESTING

AA

Application	Dial Setting	Indicator
Vanagon (W/O Tach.),		
Quantum, Fox	55	Full
	560	Empty
Vanagon (W/Tach.)	50	Full

INSTRUMENT PANEL - STANDARD

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	320	Empty
All Others	52	Full
	550	Empty

XX

TEMPERATURE GAUGE

1) Disconnect sending unit wire. Connect VW tester between wire and ground. Turn ignition on and allow 2 minutes for gauge reading to stabilize. Use the TEMPERATURE GAUGE TESTING table to compare gauge reading. It should be within one pointer width of specification.

2) If gauge needle does not move, check continuity between sender wire and gauge. If needle moves but does not match specifications, replace gauge. If gauge works correctly with tester but not sending unit, replace sending unit.

TEMPERATURE GAUGE TESTING

XX

Application	Dial Setting	Indicator
Vanagon, Quantum		
Fox	500	Cold
	62	Hot
All Others	510	Cold
	50	Hot

XX

VOLTAGE REGULATOR

1) If only one gauge is inoperative, regulator is not defective. If both fuel and temperature gauges are inoperative, voltage regulator may be faulty or have a bad ground connection.

2) Partially remove instrument cluster. Position cluster so regulator can be reached with voltmeter probes. Leave chassis harness connected. Ensure ground connection at regulator is tight.

3) Turn ignition on. Connect voltmeter negative lead (-) to center terminal of regulator. Connect positive lead (+) to terminal "A". See Fig. 1. Meter reading should be 10 volts with an allowable tolerance of .5 volt. If voltage reading exceeds tolerance, replace voltage regulator.

INSTRUMENT PANEL - STANDARD

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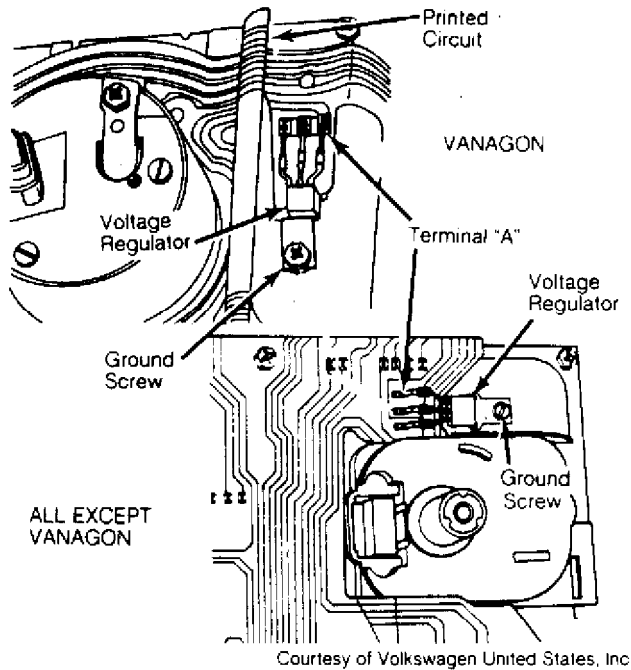


Fig. 1: Testing Voltage Regulator
Courtesy of Volkswagen United States, Inc.

REMOVAL & INSTALLATION

INSTRUMENT CLUSTER

Removal & Installation (Vanagon & Vanagon Syncro)

Disconnect battery ground. Reach behind cluster hood and pull back of hood up. Pull hazard switch forward. Pull brake warning light housing toward front of vehicle. Remove 4 mounting screws and remove cluster. To install, reverse removal procedure.

Removal & Installation (Quantum & Quantum Syncro)

Disconnect battery ground. Remove steering wheel. Remove trim panel above steering column. Remove 4 retaining screws and instrument cluster trim. Remove top instrument cluster retaining screw and tip cluster outward. Remove speedometer cable and wiring connector from cluster. Remove instrument cluster. To install, reverse removal procedure.

Removal & Installation (Fox)

Disconnect battery ground. Remove steering wheel. Carefully remove covers from vacant switch position. Depress switch spring retainer and remove switches from instrument panel. Disconnect wire connectors from switches. Remove 4 instrument cluster trim retaining screws. Remove instrument cluster trim panel. Remove 2 instrument cluster retaining screws. Remove speedometer cable. Disconnect cluster wire connector and remove instrument cluster. To install, reverse removal procedure.

INSTRUMENT PANEL - STANDARD

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Removal & Installation (Cabriolet & Scirocco)

Disconnect battery ground. Remove steering wheel. Pull tilt shelf downward. Remove 3 shelf retaining screws and remove shelf. Remove 3 instrument panel lower retaining screws and pry off 3 clips. Remove 2 instrument trim retaining screws and remove instrument panel trim. Remove center instrument cluster screw and tip instrument panel cluster forward. Remove speedometer cable and wiring connector from back of cluster. Remove instrument panel cluster. To install, reverse removal procedure.

Removal & Installation (Golf, GTI, Jetta & Jetta GLI)

Remove temperature control knobs, levers and trim plate. Remove radio or convenience tray. Remove switches from instrument panel trim plate. Remove instrument panel trim plate. Remove 2 mounting screws and pull instrument cluster outward. Remove speedometer cable, vacuum hoses, and electrical connections. To install, reverse removal procedures.

COMBINATION SWITCH

Removal

Pull off horn pad and remove steering wheel securing nut. Remove steering wheel. Remove column cover. Disconnect wiring and remove 3 switch screws. Remove switches.

Installation

Install switches on column. Place steering wheel on column and check that clearance between wheel and turn signal switch is 1/16-1/8" (2-4 mm). Move spacer sleeve up or down to adjust clearance. Tighten steering wheel nut to 36 ft. lbs. (50 N.m) and replace pad.

WIRING DIAGRAMS

NOTE: For wiring diagrams, see chassis wiring in WIRING DIAGRAMS section.

END OF ARTICLE

JACKING & HOISTING

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ARTICLE BEGINNING

1987 Jacking & Hoisting VOLKSWAGEN

NOTE: These illustrations are not intended to represent exact structure of each vehicle's frame, underbody or body outline. They are presented only to give the mechanic some point of reference.

FRAME & UNDERBODY

The following illustrations indicate areas (parts) of the underbody and frame which may be used to raise and support the vehicle, using either floor jack or hoist. These points are indicated by shaded areas on the frame. See Fig. 1.

OUTERBODY

Those points designated on the outline of the body were specifically designed to facilitate the use of the vehicle's own jack. These jacking points are indicated by circular dots on the outline of the body. See Fig. 1. If floor jack or hoist is employed, extreme care should be exercised to avoid damaging the outer body shell.

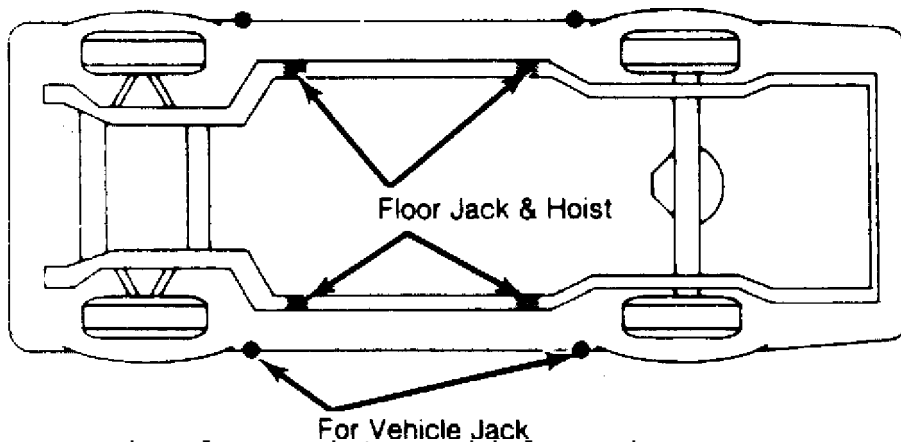


Fig. 1: Floor Jack, Floor Hoist & Vehicle Jack

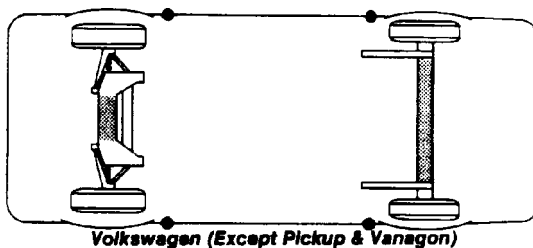


Fig. 2: Volkswagen (Except Vanagon) Lifting Points

JACKING & HOISTING

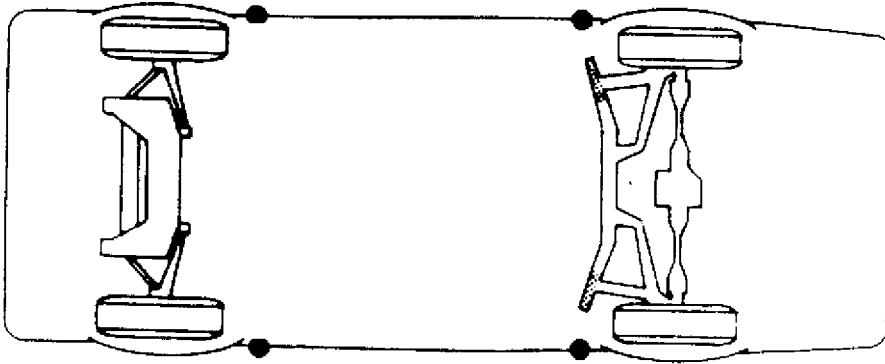
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Volkswagen Vanagon

Fig. 3: Vanagon Lifting Points

END OF ARTICLE

LOOSE CRUISE CONTROL CABLE MAY NOT RETURN TO IDLE

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ARTICLE BEGINNING

NHTSA RECALL BULLETIN

Models: 1987 Volkswagen Quantum/Quantum Syncro
1987 Volkswagen Vanagon
1988 Volkswagen Quantum/Quantum Syncro
1988 Volkswagen Vanagon
1989 Volkswagen Vanagon
Number of Affected Vehicles: 300
Beginning Date of Manufacture: 1987 AUG
Ending Date of Manufacture: 1988 DEC

VEHICLE DESCRIPTION:

Van camper type vehicle.

DESCRIPTION OF DEFECT:

When using the cruise control the accelerator cable tension may allow the cable to sag and become entangled with the water pipe bracket impeding its return to idle position.

FAULT:

Design

SYSTEM:

Cruise control.

CONSEQUENCE OF DEFECT:

Failure to return to idle position could lead to an accident.

CORRECTIVE ACTION:

The present accelerator cable bracket will be replaced.

ADDITIONAL INFORMATION:

The National Highway Traffic Safety Administration operates Monday through Friday from 8:00 AM to 4:00 PM, Eastern Time. For more information call (800) 424-9393 or (202) 366-0123. For the hearing impaired, call (800) 424-9153.

END OF ARTICLE

MAINTENANCE INFORMATION

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ARTICLE BEGINNING

1983-88 MAINTENANCE

Volkswagen Maintenance Information

1983-88 Quantum,

1986-88 Quantum Syncro

* PLEASE READ THIS FIRST *

NOTE: For scheduled maintenance intervals and the related fluid capacities, fluid specifications and labor times for major service intervals, see SCHEDULED SERVICES article below:

- * SCHEDULED SERVICES - GASOLINE
- * SCHEDULED SERVICES - TURBO DIESEL

Warranty information and specifications for fluid capacities, lubrication specifications, wheel and tire size, and battery type are covered in this article.

MODEL IDENTIFICATION

VIN LOCATION

The Vehicle Identification Number (VIN) is located on the left side of the dash panel at the base of the windshield. The VIN chart explains the code characters.

VIN CODE ID EXPLANATION

Numbers preceding the explanations in the legend below refer to the sequence of characters as listed on VIN identification label. See VIN example below.

0AAA
3 (VIN) W V W A G 9 3 3 2 F N 0 9 9 7 1 7 3
3 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 3
AAU

1 - Manufacturing Country

- W * Germany
- 3 * Mexico
- 9 * Brazil

2-3 - Manufacturer

- VW * Volkswagen

4 - Series

- A * 2-Door Base (1983)
- C * 2-Door GL (1983)

MAINTENANCE INFORMATION

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E * 4-Door Base (1983)
E * 4-Door Wagon Base (1983)
F * 4-Door GL (1984-86)
F * 4-Door GL (1986.5-88)
F * 4-Door Wolfsburg (1984)
G * 4-Door GL (1983)
G * 4-Door Wagon GL (1983-85)
G * 4-Door Wolfsburg Wagon GL (1984)

5 - Engine

A * 1.7L 4-Cyl. FI Gas, 74 HP (1983 Base)
B * 2.1L 5-Cyl. Gas, 100 HP (1983-84 GL)
B * 2.2L 5-Cyl. Gas, 110 HP (1985-88 GL)
B * 2.2L 5-Cyl. Gas, 115 HP (1986-88 Syncro)
C * 1.8L 4-Cyl. FI Gas, 88 HP (1984-85)
H * 1.6L Turbo Diesel 68 HP (1983-85)

6 - Restraint System

0 * Active
9 * Passive

7-8 - Model

16 * Quantum Syncro Wagon 4WD (1986.5-88)
32 * Quantum 2 Door (1983)
32 * Quantum 4 Door (1983-88)
33 * Quantum Wagon (1983-88)

9 - VIN Check Digit

2 * Computer Selected Check Number

10 - Vehicle Model Year

D * 1983
E * 1984
F * 1985
G * 1986
H * 1987
J * 1988

11 - Assembly Plant

A * Ingolstadt
B * Brussels
E * Emden
G * Graz
H * Hanover
K * Osnabruk
M * Mexico
N * Neckarsulm
P * Brazil
S * Stuttgart
W * Wolfsburg

12-17 - Serial Number

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- * Sequential Production Number

MAINTENANCE SERVICE INFORMATION

SEVERE & NORMAL SERVICE DEFINITIONS

NOTE: Use the Severe Service schedule if the vehicle to be serviced is operated under ANY (one or more) of these conditions:

Service is recommended at mileage intervals based on vehicle operation. Service schedules are based on the following primary operating conditions:

Normal Service

- * Driven More Than 10 Miles Daily
- * No Operating Conditions From Severe Service Schedule

Severe Service (Unique Driving Conditions)

- * Short Trips (10 Miles) In Freezing Temperatures
- * Towing Or Heavily Loaded
- * Severe Dust Conditions
- * Hot Weather, Stop-And-Go Driving
- * Extensive Idling Conditions (Taxi Or Delivery Service)

CAMSHAFT TIMING BELT

CAUTION: Failure to replace a faulty camshaft timing belt may result in serious engine damage.

The condition of camshaft drive belts should always be checked on vehicles which have more than 50,000 miles. Although some manufacturers do not recommend belt replacement at a specified mileage, others require it at 60,000-100,000 miles. A camshaft drive belt failure may cause extensive damage to internal engine components on most engines, although some designs do not allow piston-to-valve contact. These designs are often called "Free Wheeling".

Many manufacturers changed their maintenance and warranty schedules in the mid-1980's to reflect timing belt inspection and/or replacement at 50,000-60,000 miles. Most service interval schedules in this manual reflect these changes.

Belts or components should be inspected and replaced if any of the following conditions exist:

- * Cracks Or Tears In Belt Surface
- * Missing, Damaged, Cracked Or Rounded Teeth
- * Oil Contamination
- * Damaged Or Faulty Tensioners
- * Incorrect Tension Adjustment

Manufacturer recommends inspecting camshaft timing belt at

MAINTENANCE INFORMATION

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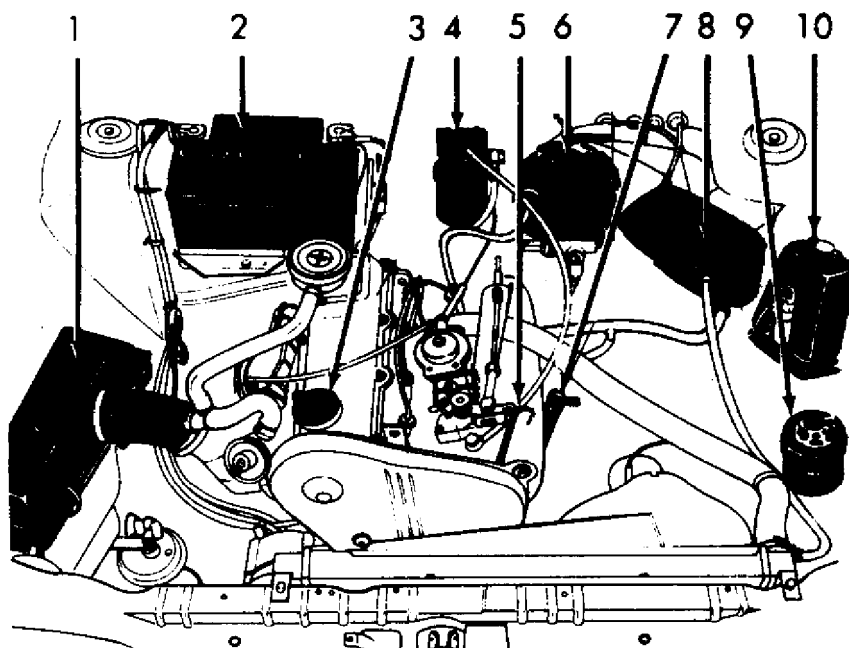
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20,000 mile intervals, and replacement as necessary.

SERVICE POINT LOCATIONS

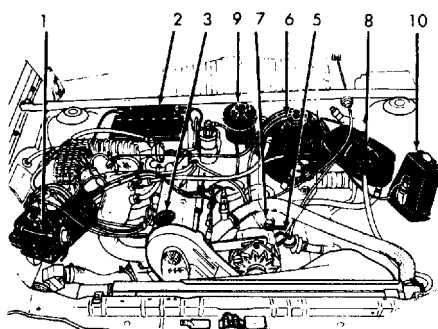


DIESEL ENGINE

- | | |
|--------------------------|----------------------------------|
| 1. Air Cleaner | 6. Brake Fluid Reservoir |
| 2. Battery | 7. ATF Dipstick |
| 3. Engine Oil Filler Cap | 8. Engine Coolant Expansion Tank |
| 4. Fuel Filter (Diesel) | 9. Power Steering Reservoir |
| 5. Engine Oil Dipstick | 10. Windshield Washer Reservoir |

93G45787

Fig. 1: Service Point Locations (Diesel Engine)
Courtesy of Volkswagen United States, Inc.



GASOLINE ENGINE

- | | |
|--------------------------|----------------------------------|
| 1. Air Cleaner | 6. Brake Fluid Reservoir |
| 2. Battery | 7. ATF Dipstick |
| 3. Engine Oil Filler Cap | 8. Engine Coolant Expansion Tank |
| 4. Fuel Filter (Diesel) | 9. Power Steering Reservoir |
| 5. Engine Oil Dipstick | 10. Windshield Washer Reservoir |

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Fig. 2: Service Point Locations (Gasoline Engine)
Courtesy of Volkswagen United States, Inc.

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ADDITIONAL DIESEL SERVICE INFORMATION

DIESEL FUEL FILTER MAINTENANCE

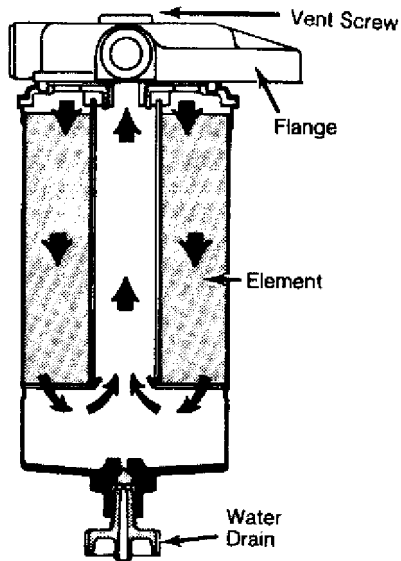


Fig. 3: Components of Fuel Filter
Courtesy of Volkswagen United States, Inc.

NOTE: For more information regarding diesel fuel filter service refer to the FUEL INJECTION SYSTEM - DIESEL article in the FUEL SYSTEMS section.

ALIGNING CAMSHAFT TIMING MARKS

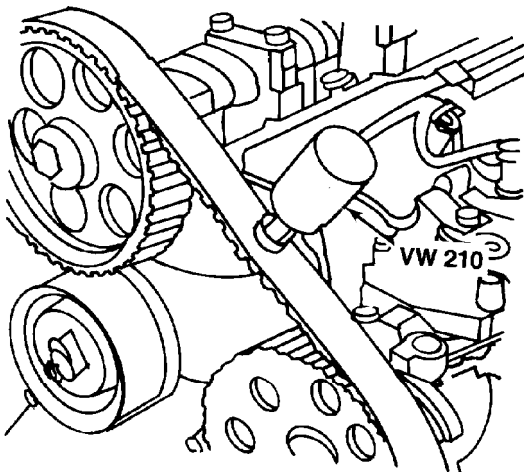


Fig. 4: Setting Camshaft Timing Marks (Diesel)
Courtesy of Volkswagen United States, Inc.

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NOTE: For more information regarding camshaft timing belt service refer to the 1.6L 4-CYL DIESEL/TURBO DIESEL article in the ENGINE MECHANICAL section.

ADJUSTING FUEL INJECTION PUMP TIMING - DIESEL

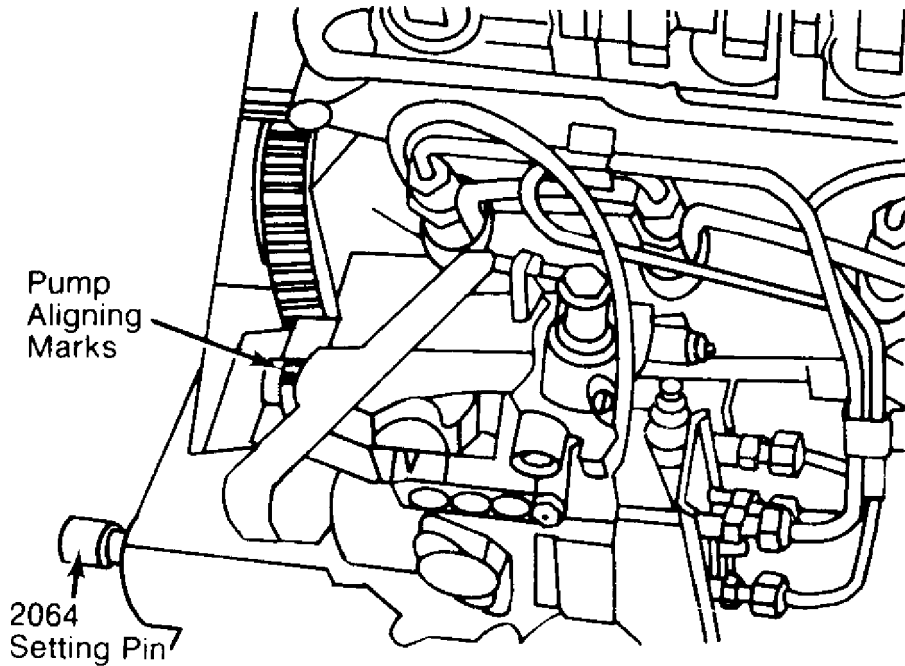


Fig. 5: Fuel Injection Pump Timing Mark Alignment (Diesel)
Courtesy of Volkswagen United States, Inc.

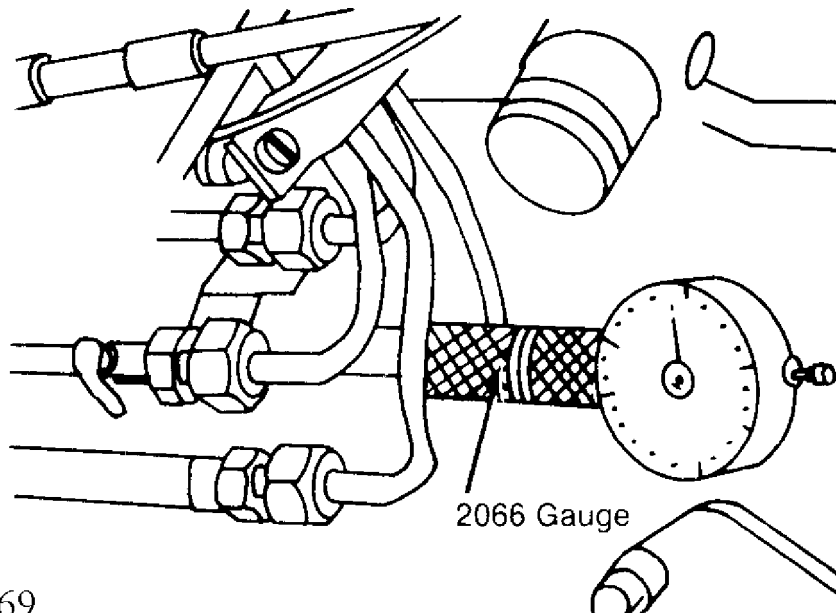


Fig. 6: Adjusting Injection Pump Timing (Diesel)
Courtesy of Volkswagen United States, Inc.

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NOTE: For more information regarding fuel injection system service refer to the FUEL INJECTION SYSTEM - DIESEL article in the FUEL SYSTEMS section.

ADJUSTING IDLE SPEED - DIESEL

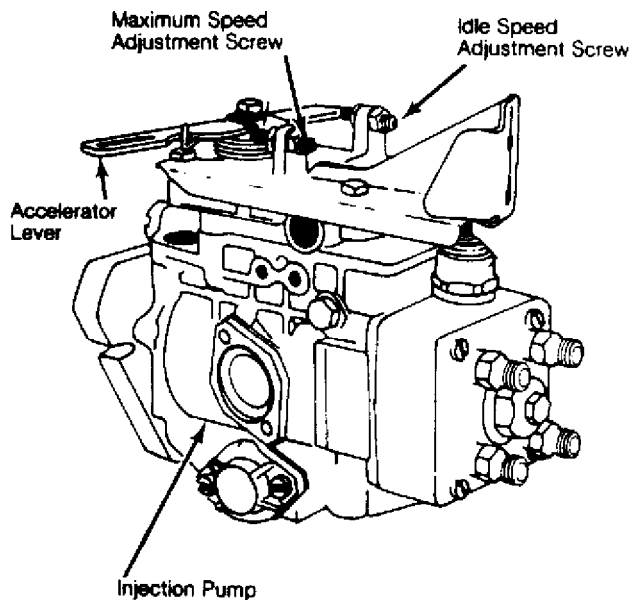


Fig. 7: Idle and Maximum Speed Adjustment
Courtesy of Volkswagen United States, Inc.

NOTE: For more information regarding diesel idle speed adjustment refer to the TUNE-UP - DIESEL article in the ENGINE PERFORMANCE section.

VALVE CLEARANCE ADJUSTMENT - DIESEL

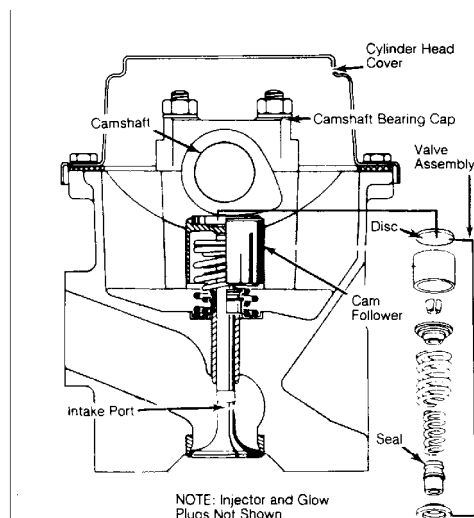


Fig. 8: End View of Camshaft and Valve Assembly
Courtesy of Volkswagen United States, Inc.

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NOTE: For more information regarding valve clearance adjustments refer to the 1.6L 4-CYL DIESEL/TURBO DIESEL article in the ENGINE MECHANICAL section.

ADDITIONAL GASOLINE SERVICE INFORMATION

FUEL FILTER REPLACEMENT - GASOLINE ENGINES

CAUTION: Some vehicle may stall or exhibit poor performance after the fuel filter is replaced.

NOTE: For more information regarding fuel filter replacement refer to the GROUP 20, NO. 87-02 FUEL FILTER REPLACE SYMP article in the TSB section.

ALIGNING CAMSHAFT TIMING MARKS - 1.7L 4-CYL.

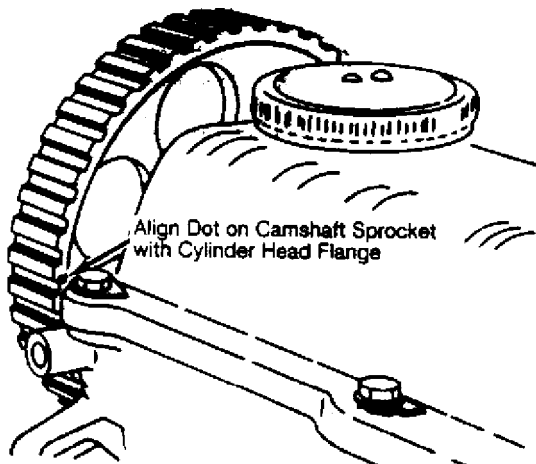


Fig. 9: Camshaft Sprocket Positioning (Gasoline)
Courtesy of Volkswagen United States, Inc.

NOTE: For more information regarding camshaft timing belt service refer to the 1.7L 4-CYL article in the ENGINE MECHANICAL section.

VALVE CLEARANCE ADJUSTMENT - 1.7L 4-CYL. GASOLINE

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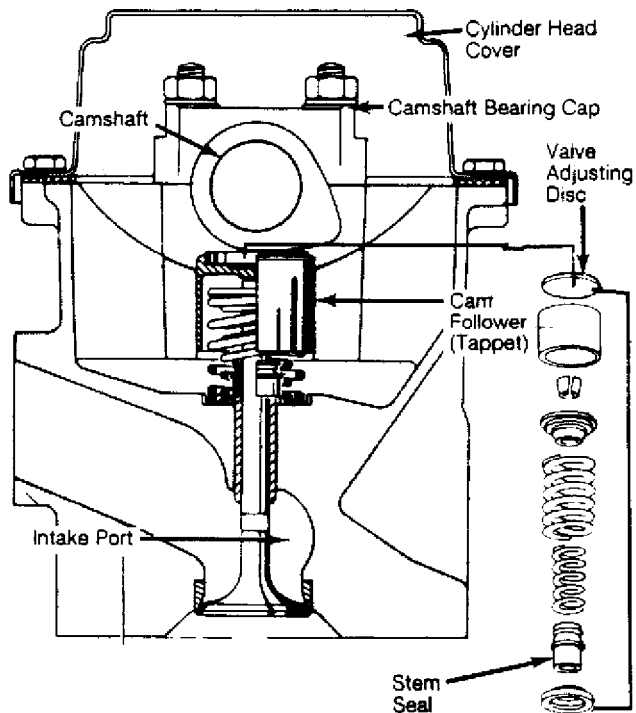


Fig. 10: Assembled View of Valve and Camshaft
Courtesy of Volkswagen United States, Inc.

NOTE: For more information regarding valve clearance adjustments refer to the 1.7L 4-CYL article in the ENGINE MECHANICAL section.

ALIGNING CAMSHAFT TIMING MARKS - 1.8L 4-CYL.

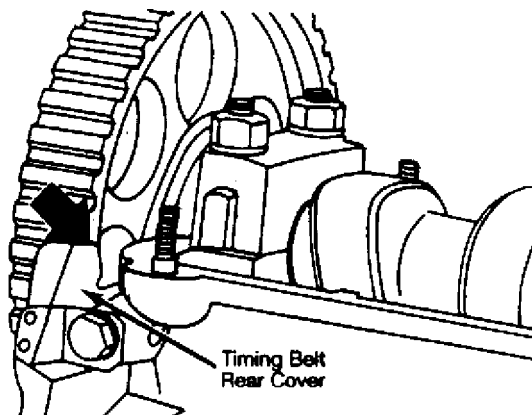


Fig. 11: Setting Camshaft Timing Mark
Courtesy of Volkswagen United States, Inc.

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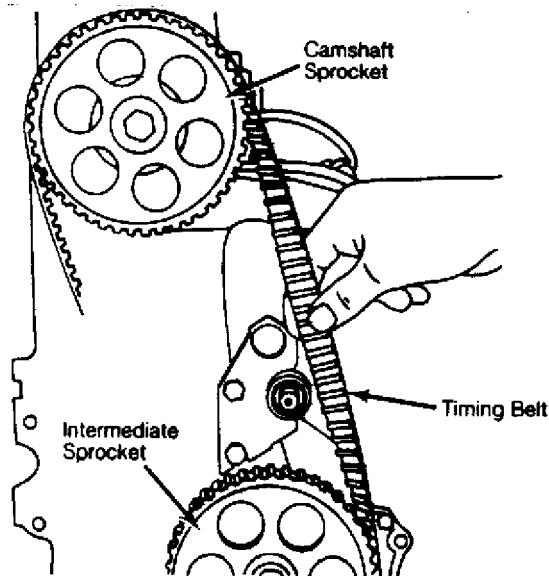


Fig. 12: Adjusting Timing Belt Tension
Courtesy of Volkswagen United States, Inc.

NOTE: For more information regarding camshaft timing belt service refer to the 1.8L 4-CYL article in the ENGINE MECHANICAL section.

ALIGNING CAMSHAFT TIMING MARKS - 5-CYL.

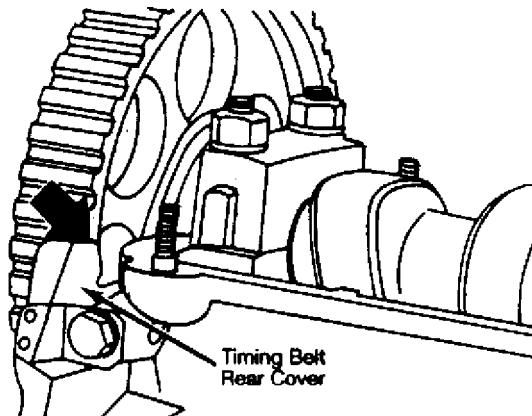


Fig. 13: Camshaft Sprocket Positioning (Gasoline)
Courtesy of Volkswagen United States, Inc.

NOTE: For more information regarding camshaft timing belt service refer to the 2.22L 5-CYL article in the ENGINE MECHANICAL section.

VALVE CLEARANCE ADJUSTMENT - 5-CYL. GASOLINE (1983-85)

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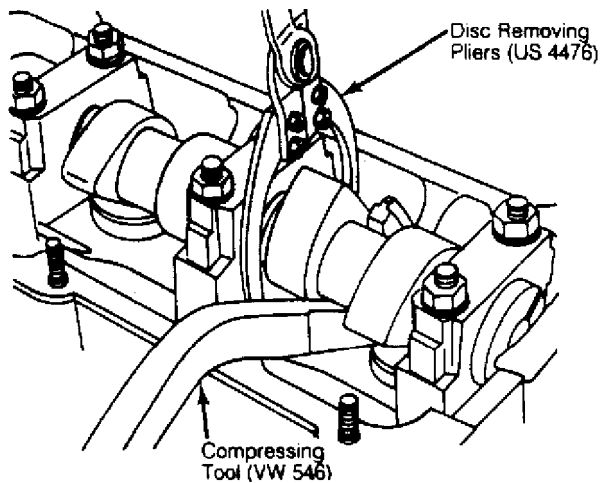


Fig. 14: Compressing Cam Follower to Replace Adjusting Disc
Courtesy of Volkswagen United States, Inc.

NOTE: For more information regarding valve clearance adjustments refer to the 2.22L 5-CYL article in the ENGINE MECHANICAL section.

JACKING & HOISTING POINTS

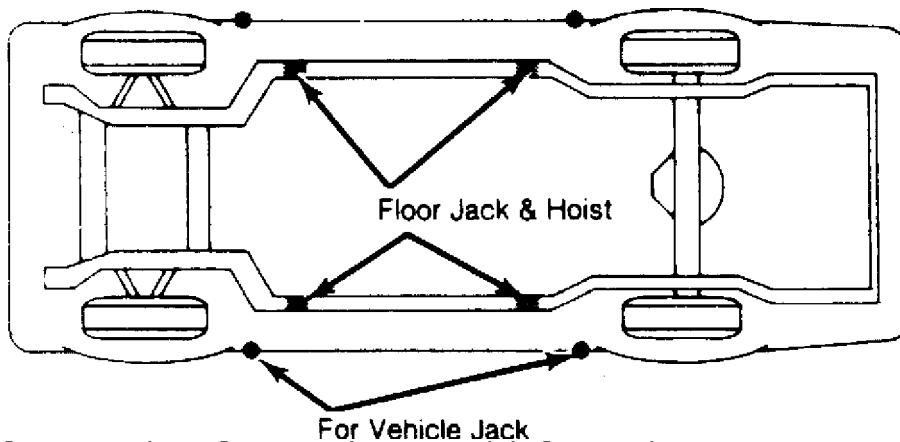


Fig. 15: Floor Jack, Floor Hoist & Vehicle Jack
Courtesy of Volkswagen United States, Inc.

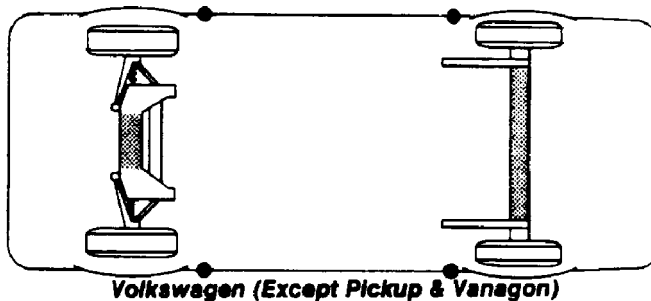


Fig. 16: Vehicle Lifting Points
Courtesy of Volkswagen United States, Inc.

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NOTE: For more information regarding jacking and hoisting points refer to the JACKING & HOISTING article in the WHEEL ALIGNMENT section.

INFORMATION LABEL LOCATIONS

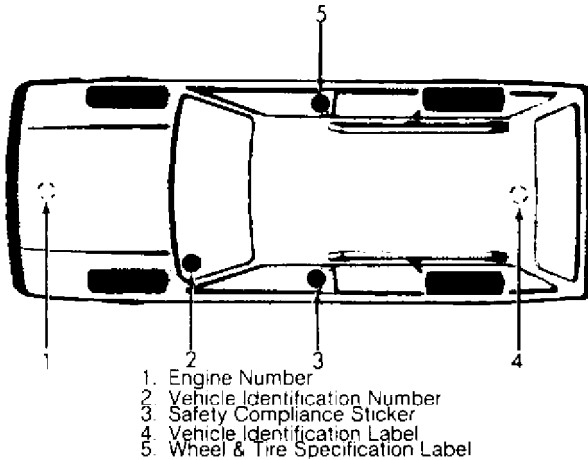


Fig. 17: Information Label Locations
Courtesy of Volkswagen United States, Inc.

SERVICE LABOR TIMES

SERVICE LABOR TIMES TABLE (HOURS)

AA

Application	15,000/45,000		30,000 (60,000)	
	Mile Service		Mile Service	
	(1)	(2)	(1)	(2)

Turbo Diesel Engine (3)				
Automatic Transmission	1.5		2.8	(3.0)
Manual Transmission	1.7		2.2	(2.4)
4-Cylinder Gasoline Engine (4)				
Automatic Transmission	1.5		3.2	(3.6)
Manual Transmission	1.7		2.6	(3.0)
5-Cylinder Gasoline Engine (5)				
Automatic Transmission	1.5		3.2	(3.6 (6))
Manual Transmission	1.7		2.6	(3.0 (6))

- (1) - Add .2 hr. if equipped with A/C.
(2) - Add .1 hr. if equipped with cruise control.
(3) - Add 1.8 hrs. for replacing camshaft timing belt.
(4) - Add 1.6 hrs. for replacing camshaft timing belt.
(5) - Add 2.1 hrs. for replacing camshaft timing belt.
(6) - Add .2 hr. for Quattro models.

AA

LUBRICATION SPECIFICATIONS

MAINTENANCE INFORMATION

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LUBRICATION SPECIFICATIONS TABLE

AA

Application	Fluid Specifications
-------------	----------------------

Automatic Transaxle	Dexron-IIIE ATF
---------------------------	-----------------

Brake Fluid	DOT 4 Brake Fluid (SAE J1703)
-------------------	-------------------------------

Coolant	50/50 Mix Water & Ethylene Glycol
---------------	-----------------------------------

Engine Oil (1)	
----------------	--

Ambient Temperatures	
----------------------	--

Greater Than 50°F (10°C)	SAE 20W-50 API SG/CD
--------------------------------	----------------------

14° To 50°F (-10° To +10°C)	SAE 10W-40 API SG/CD
-----------------------------------	----------------------

Less Than 14°F (-10°C)	SAE 5W-30 API SG/CD
------------------------------	---------------------

Power Steering Fluid	VW Hydraulic Oil G-002-000
----------------------------	----------------------------

Manual Transaxle	Hypoid Gear Oil SAE 75W-90 API GL-4 Or SAE 75W-90 (G50 Synthetic)
------------------------	--

Final Drive (A/T)	
-------------------	--

(Differential)	SAE 75W-90 (G50 Synthetic Gear Oil)
----------------------	-------------------------------------

Final Drive & Front	
---------------------	--

Differential (AWD)	Hypoid Gear Oil SAE 75W-90 API/GL-5
--------------------------	-------------------------------------

Manual Transmission	Hypoid Gear Oil SAE 75W-90 API/GL-4
---------------------------	-------------------------------------

Wheel Bearings	NLGI Grade 2 Category GC-LB
----------------------	-----------------------------

Drive Shaft U-Joints	NLGI Grade 2 Category GC-LB
----------------------------	-----------------------------

Steering Linkage (2)(3)	NLGI Grade 2 Category GC-LB
-------------------------------	-----------------------------

Ball Joints (2)(4)	NLGI Grade 2 Category GC-LB
--------------------------	-----------------------------

Weatherstrip	Dielectric Silicone Grease
--------------------	----------------------------

(1) - SAE 15W-40 or 20W-40 engine oil is recommended for extreme conditions or extended highway operation.

(2) - Use low pressure grease gun to prevent seal damage.

(3) - Fill until lubricant squeezes out from the base of seals.

(4) - Fill ball joint until seal starts to swell.

AA

FLUID CAPACITIES

FLUID CAPACITIES TABLE

AA

Application	Quantity (1)
-------------	--------------

A/C System R-12 Refrigerant	
-----------------------------	--

1983-85 (4/85)	34 Ozs.
----------------------	---------

(5/85) 1985-88	38 Ozs.
----------------------	---------

Cooling System	
----------------	--

4-Cylinder	5.3 Qts. (5.0L)
------------------	-----------------

5-Cylinder	8.1 Qts. (7.7L)
------------------	-----------------

Diesel	6.2 Qts. (5.9L)
--------------	-----------------

Engine Oil (2)	
----------------	--

Diesel	3.8 qts. (3.6L)
--------------	-----------------

4-Cylinder	3.4 qts. (3.2L)
------------------	-----------------

5-Cylinder	
------------	--

1983-86	3.8 qts. (3.6L)
---------------	-----------------

1987-88	3.7 qts. (3.5L)
---------------	-----------------

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Fuel Tank	
Quantum	16.0 gals. (60L)
Syncro	18.5 gals. (70L)
Automatic Transaxle	
Fluid Change	3.2 Qts. (3.0L)
Dry Fill	5.9 Qts. (5.6L)
Final Drive (Differential)	
A/T (3)	0.8 Qt. (.75L)
Manual Transaxle (4)	
4-Cyl. (013)	2.1 Qts. (2.0L)
Diesel (013)	2.1 Qts. (2.0L)
5-Cyl. (093)	2.5 Qts. (2.35L)
Syncro (016)	2.1 Qts. (2.0L)
Rear Axle (Syncro)	0.8 Qt. (.75L)

- (1) - Capacities are recommended or calculated levels. Always use dipstick (if available) to measure level.
(2) - Includes filter change.
(3) - Lifetime fill.
(4) - Single case includes manual transaxle & differential.

AA

WHEEL & TIRE SPECIFICATIONS

Wheel and tire sizes vary according to vehicle and equipment and can be found on the tire information label on each vehicle. Wheel and tire specifications and tire inflation pressures are listed on a label on the right door post of 2-door vehicles and on the right rear door post of 4-door vehicles.

NOTE: Snow chains must be used on drive wheels, in pairs only.

WHEEL TIGHTENING

Tighten all wheel lug nuts to 80 ft. lbs. (110 N.m).

BATTERY SPECIFICATIONS

CAUTION: When battery is disconnected, vehicles equipped with computers may lose memory data. When battery power is restored, driveability problems may exist on some vehicles. These vehicles may require a relearn procedure. See COMPUTER RELEARN PROCEDURES article in the GENERAL INFORMATION section.

All models use BCI group 41 batteries with cold crank rating of 690 amps.

CAUTIONS & WARNINGS

BATTERY WARNING

MAINTENANCE INFORMATION

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WARNING: When battery is disconnected, vehicles equipped with computers may lose memory data. When battery power is restored, driveability problems may exist on some vehicles. These vehicles may require a relearn procedure. See COMPUTER RELEARN PROCEDURES article in GENERAL INFORMATION section.

REPLACING BLOWN FUSES

Before replacing a blown fuse, remove ignition key, turn off all lights and accessories to avoid damaging the electrical system. Be sure to use fuse with the correct indicated amperage rating. The use of an incorrect amperage rating fuse may result in a dangerous electrical system overload.

BRAKE PAD REPLACEMENT

WARNING: Use caution when checking and/or changing brake pads, some pads may contain asbestos which can irritate eyes and may cause other health hazards. A water based solution should be used to clean brake dust from wheel and brake components. DO NOT use compressed air to blow off brake dust.

BRAKE SYSTEM

CAUTION: If brake warning light comes on while driving it indicates a low fluid level or failure in one of the braking circuits. If the brake pedal can be depressed further than normal it is an indication that one of the brake circuits is not functioning. Stop vehicle and check brake reservoir fluid level. If level is below MIN mark, DO NOT drive vehicle. Have it towed to a repair shop. If level is between the MIN and MAX marks, proceed cautiously to a repair shop.

BRAKE PAD WEAR INDICATOR

Indicator will cause a squealing or scraping noise, warning that brake pads need replacement.

BRAKE PEDAL PRESSURE WITH ENGINE NOT RUNNING

CAUTION: Brake pedal requires extreme pressure to stop the vehicle when the engine is not running.

CATALYTIC CONVERTER

Continued operation of vehicle with a severe malfunction could cause converter to overheat, resulting in possible damage to converter and vehicle.

Any modification to the exhaust system on turbo models, which reduces exhaust backpressure, will lead to lean fuel mixtures and

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excessive spark advance. This could cause serious engine damage.

COOLANT (PROPYLENE-GLYCOL FORMULATIONS)

To avoid possible damage to vehicle use only ethylene-glycol based coolants with a mixture ratio from 44-68% anti-freeze. DO NOT use 100% anti-freeze as it will cause the formation of cooling system deposits. This results in coolant temperatures of over 300°F (149°C) which can melt plastics. 100% anti-freeze has a freeze point of only -8°F (-22°C).

CAUTION: Propylene-Glycol Mixtures has a smaller temperature range than Ethylene-Glycol. The temperature range (freeze-boil) of a 50/50 Anti-Freeze/Water Mix is as follows:

Propylene-Glycol -26°F (-32°C) - 257°F (125°C)

Ethylene-Glycol -35°F (-37°C) - 263°F (128°C)

CAUTION: Propylene-Glycol/Ethylene-Glycol Mixtures can cause the destabilization of various corrosion inhibitors. Also Propylene-Glycol/Ethylene-Glycol has a different specific gravity than Ethylene-Glycol coolant, which will result in inaccurate freeze point calculations.

DIESEL FUEL ANTI-FUNGAL ADDITIVES

CAUTION: If fuel contamination due to fungi or other microorganisms is suspected a fuel additive with a biocide may be used. Follow the manufacturers dosage as recommended on product label. Use biocides ONLY when necessary, excessive use can may cause other fuel system problems.

DIESEL FUEL CONTAMINATION

WARNING: Diesel fuel system may be contaminated with fungi or other microorganisms. Keep contaminated fuel away from open skin cuts or sores to prevent skin irritation or infection.

DIESEL FUEL REQUIREMENTS

CAUTION: All diesel engines are to use Diesel Fuel #2 when the outside temperature is above 20°F (-7°C). In temperatures that are below 20°F (-7°C) use Diesel Fuel #1, this will reduce the chance of the fuel thickening and forming wax.

Note: A Diesel Fuel #1 & #2 combination (Blended Fuel) may be used, and is recommended for mild winter driving.

STARTING FLUID USE (DIESEL)

WARNING: DO NOT USE starting fluids (ether) or flammable liquids to aid the starting of a Diesel engine. NEVER pour diesel fuel, flammable liquids or starting fluids into the air

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cleaner canister, air intake or turbocharger housing in an attempt to start the vehicle. A flash fire may result causing personal injury.

ELECTRIC SHOCK HAZARD

WARNING: Contact with live components of ignition system while engine is running could lead to a fatal electric shock.

ELECTROSTATIC DISCHARGE SENSITIVE (ESD) PARTS

WARNING: Many solid state electrical components can be damaged by static electricity (ESD). Some will display a warning label, but many will not. Discharge personal static electricity by touching a metal ground point on the vehicle prior to servicing any ESD sensitive component.

ENGINE OIL

CAUTION: Never use non-detergent or straight mineral oil.

FUEL SYSTEM SERVICE

WARNING: Relieve fuel system pressure prior to servicing any fuel system component (fuel injection models).

HALOGEN BULBS

Halogen bulbs contain pressurized gas which may explode if overheated. DO NOT touch glass portion of bulb with bare hands. Eye protection should be worn when handling or working around halogen bulbs.

RADIATOR CAP

CAUTION: Always disconnect the fan motor when working near the radiator fan. The fan is temperature controlled and could start at any time even when the ignition key is in the OFF position. DO NOT loosen or remove radiator cap when cooling system is hot.

RADIATOR FAN

WARNING: Keep hands away from radiator fan. Fan is controlled by a thermostatic switch which may come on or run for up to 15 minutes even after engine is turned off.

TURBOCHARGED MODELS

CAUTION: Do not race engine immediately after starting. When stopping engine, allow engine to idle for approximately 60 seconds before shutting it off. Failure to do so may cause

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turbocharger damage due to lack of oil flowing to the turbocharger bearings.

WARRANTY INFORMATION

CAUTION: Due to the different warranties offered in various regions and the variety of after-market extended warranties available, please refer to the warranty package that came with the vehicle to verify all warranty options.

BASIC NEW CAR WARRANTY

The manufacturer warrants to the original retail customer, and any subsequent purchaser, that every vehicle imported and sold as a new vehicle to a retail customer will be free of defects in material and workmanship for 2 years or 24,000 miles, whichever comes first, after the date of delivery to the first retail customer, or after the vehicle was first placed in service.

LIMITED WARRANTY

Warrants cars to be free of defects in materials or workmanship for a period of 2 years or 24,000 miles, whichever comes first.

LIMITED POWER TRAIN WARRANTY

Covers the engine, transmission and drivetrain for a period of 5 years or 50,000 miles, whichever occurs first.

ANTI-CORROSION

Covers holes caused by corrosion in body sheet metal for 6 years, without respect to mileage, so long as the inspection and maintenance services are performed.

EMISSION CONTROL SYSTEM

Manufacturer warrants to the initial purchaser and each subsequent purchaser that this vehicle is designed, built, and equipped so as to conform at the time of sale with all U.S. and California Air Resources Board emission regulations applicable at the time of manufacture and that this vehicle is free from defects in materials and workmanship which cause it to fail to conform with applicable regulations within the first 5 years or 50,000 miles, whichever occurs first.

FUSES & CIRCUIT BREAKERS

The fuse panel is located under the left side of the dashboard by the driver's knee. Fuses are numbered from left to right.

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NOTE: On all models, fuse specifications are listed on inside of panel cover.

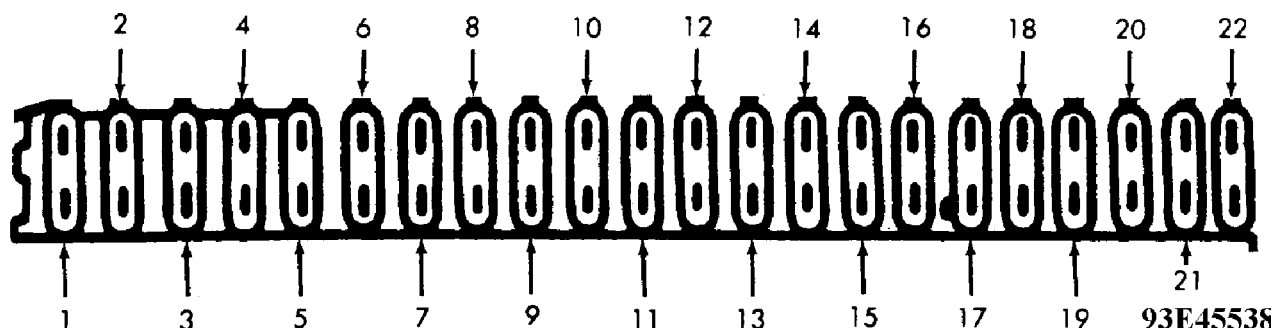


Fig. 18: Fuse Panel Identification
Courtesy of Volkswagen United States, Inc.

Fuse & Circuit Breaker Identification

- 1 - 30 Amp (Green)
Radiator Fan, Air Conditioner
- 2 - 10 Amp (Red)
Brakelights, Cruise Control
- 3 - 15 Amp (Blue)
Interior Lights, Illuminated Mirror, Clock, Cigar Lighter,
Radio, Central Locking System (If Equipped)
- 4 - 15 Amp (Blue)
Emergency Flasher System
- 5 - 15 Amp (Blue)
Electric Fuel Pump
- 6 - Blank
- 7 - 10 Amp (Red)
Left Tail Parking & Side Lights
- 8 - 10 Amp (Red)
Right Tail Parking & Side Lights
- 9 - 10 Amp (Red)
Right Headlight High Beam, High Beam Indicator
- 10 - 10 Amp (Red)
Left Headlight High Beam
- 11 - 15 Amp (Blue)
Windshield Wiper/Washer
- 12 - 15 Amp (Blue)
Rear Wiper/Washer (Wagons Only), Power Mirrors
- 13 - 20 Amp
Rear Defogger, Heated Mirror
- 14 - 20 Amp
Air Conditioner, Fresh Air Fan
- 15 - 10 Amp (Red)
Back-Up Lights, Shift Console Light (Automatic Transmission)
- 16 - 15 Amp
Horn
- 17 - 10 Amp
Oxygen Sensor
- 18 - 15 Amp

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BRAKE Warning Light, Cruise Control (Control Unit),
Differential Locks, Indicator Lights (Syncro), Throttle
Switch, Coolant Level & Temperature Warning Light, Horn

19 - 10 Amp (Red)

Turn Signals

20 - 10 Amp (Red)

Dome/Luggage/Vanity Mirror Lights, Clock, Radio, Central
Locking System, Multi-Function Indicator, Alarm System

20 - 10 Amp (Red)

License Plate Light, Glove Compartment Light

21 - 10 Amp (Red)

Left Low Beam

22 - 10 Amp (Red)

Right Low Beam

END OF ARTICLE

MAINTENANCE REMINDER LIGHT RESET PROCEDURES

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ARTICLE BEGINNING

1983-96 MAINTENANCE

Volkswagen Maintenance Reminder Light Reset Procedures

EGR MAINTENANCE LIGHT (IF EQUIPPED)

EGR light comes on at 15,000 mile intervals to indicate EGR servicing is required. After checking EGR system, reset mileage counter. See RESETTING MILEAGE COUNTER.

OXYGEN SENSOR WARNING LIGHT (IF EQUIPPED)

Oxygen sensor (OXS) light comes on at 30,000 mile intervals to indicate oxygen sensor replacement. After installing new sensor, reset mileage counter. See RESETTING MILEAGE COUNTER.

RESETTING MILEAGE COUNTER (IF EQUIPPED)

1) On some Rabbit and Pickup models, remove instrument panel cover plate. Reach into opening at top left corner of speedometer and pull release arm to reset counter. See Fig. 1. Left arm resets EGR counter, right arm resets oxygen sensor.

2) On Vanagon models, locate mileage counter under spare tire or under driver's floorboard (in-line with speedometer cable). Using a pointed instrument, depress reset button. Ensure light is out.

3) On all other models, locate mileage counter (in-line with speedometer cable) and push white reset button. See Fig. 1. Ensure light is out.

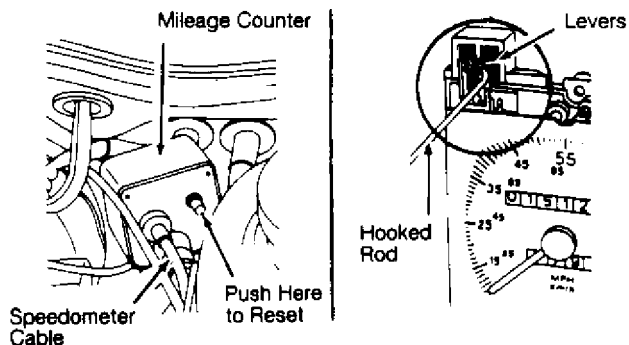


Fig. 1: Resetting Mileage Counters
Courtesy of Volkswagen United States, Inc.

SERVICE REMINDER INDICATOR (SRI) DISPLAY

CABRIO, GOLF III, GTI, JETTA III (1993-95) JETTA (1996)

1) One of four service codes may be displayed on instrument cluster according to mileage driven. Each service code displayed determines type or level of maintenance required. Service code will

MAINTENANCE REMINDER LIGHT RESET PROCEDURES

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flash for approximately 3 seconds in odometer display window as ignition is turned on. When servicing becomes due (every 7500 miles), appropriate service code will flash for approximately 60 seconds. The four service codes available for display are as follows:

- * IN 00 (No Service Necessary)
- * OEL (Oil Change Service) Every 7500 Miles
- * IN 01 (Inspection Service) Every 15,000 Miles
- * IN 02 (Additional Servicing Work) Every 30,000 Miles

2) After performing required maintenance, each effected service code displayed must be reset individually. For example, at 15,000 miles service codes OEL and IN 01 will both need to be reset.

3) To reset service codes, turn ignition on. Press and hold odometer reset button located below speedometer. While holding button, press clock reset button (lower button for digital clock) located to left of fuel gauge. Release buttons. Programming mode is now activated. Service code OEL1.S (distance counter) should be displayed.

4) Press clock reset button once more. 7500 miles should now be indicated on display. Desired mileage for reset may be attained by pressing clock reset button. Mileage displayed will decrease in increments of 500 miles each time button is pressed. This feature should only be used to calibrate mileage when instrument cluster is replaced. When desired mileage is displayed, press odometer reset button.

5) Service code OEL2.S (time counter) should be displayed. Press clock reset button. 6 (months) will be indicated on display. Time counter for next oil change may be set by pressing clock reset button if instrument cluster was replaced. When desired time is displayed, press odometer reset button.

6) Service code IN 01.S (time counter) should be displayed. Press clock reset button. 12 (months) will be indicated on display. Time counter for next maintenance interval may be set by pressing clock reset button if instrument cluster was replaced. When desired time is displayed, press odometer reset button.

7) Service code IN 02.S (distance counter) should be displayed. Press clock reset button. 30,000 (miles) will be indicated on display. Desired mileage for reset may be attained by pressing clock reset button. Mileage displayed will decrease in increments of 500 miles each time button is pressed. This feature should only be used to calibrate mileage when instrument cluster is replaced. When desired mileage is displayed, turn ignition off. Programming is now stored in memory.

END OF ARTICLE

METRIC CONVERSIONS

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ARTICLE BEGINNING

GENERAL INFORMATION

METRIC CONVERSIONS

METRIC CONVERSIONS

Metric conversions are making life more difficult for the mechanic. In addition to doubling the number of tools required, metric-dimensioned nuts and bolts are used alongside English components in many new vehicles. The mechanic has to decide which tool to use, slowing down the job. The tool problem can be solved by trial and error, but some metric conversions aren't so simple. Converting temperature, lengths or volumes requires a calculator and conversion charts, or else a very nimble mind. Conversion charts are only part of the answer though, because they don't help you "think" metric, or "visualize" what you are converting. The following examples are intended to help you "see" metric sizes:

LENGTH

Meters are the standard unit of length in the metric system. The smaller units are 10ths (decimeter), 100ths (centimeter), and 1000ths (millimeter) of a meter. These common examples might help you to visualize the metric units:

- * A meter is slightly longer than a yard (about 40 inches).
- * An aspirin tablet is about one centimeter across (.4 inches).
- * A millimeter is about the thickness of a dime.

VOLUME

Cubic meters and centimeters are used to measure volume, just as we normally think of cubic feet and inches. Liquid volume measurements include the liter and milliliter, like the English quarts or ounces.

- * One teaspoon is about 4 cubic centimeters.
- * A liter is about one quart.
- * A liter is about 61 cubic inches.

WEIGHT

The metric weight system is based on the gram, with the most common unit being the kilogram (1000 grams). Our comparable units are ounces and pounds:

- * A kilogram is about 2.2 pounds.
- * An ounce is about 28 grams.

TORQUE

Article Text (p. 2)

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```

UAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA~
³TO CONVERT                      ³TO                      ³ MULTIPLY BY      ³
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA~
³LENGTH                          ³                        ³                ³
³Millimeters (mm)               ³Inches              ³    .03937          ³
³Inches                         ³Millimeters         ³    25.4            ³
³Meters (M)                     ³Feet               ³    3.28084         ³
³Feet                           ³Meters             ³    .3048           ³
³Kilometers(Km)                 ³Miles              ³    .62137          ³
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA~
³AREA                            ³                        ³                ³
³Square Centimeters (cmý)       ³Square Inches      ³    .155            ³
³Square Inches                  ³Square Centimeters ³    6.45159        ³
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA~
³VOLUME                          ³                        ³                ³
³Cubic Centimeters              ³Cubic Inches       ³    .06103          ³

```

METRIC CONVERSIONS

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3Cubic Inches	3Cubic Centimeters	3	16.38703	3
3Liters	3Cubic Inches	3	61.025	3
3Cubic Inches	3Liters	3	.01639	3
3Liters	3Quarts	3	1.05672	3
3Quarts	3Liters	3	.94633	3
3Liters	3Pints	3	2.11344	3
3Pints	3Liters	3	.47317	3
3Liters	3Ounces	3	33.81497	3
3Ounces	3Liters	3	.02957	3
AA~				
3WEIGHT	3	3		3
3Grams	3Ounces	3	.03527	3
3Ounces	3Grams	3	28.34953	3
3Kilograms	3Pounds	3	2.20462	3
3Pounds	3Kilograms	3	.45359	3
AA~				
3WORK	3	3		3
3Centimeter Kilograms	3Inch Pounds	3	.8676	3
3Pounds/Sq. Inch	3Kilograms/Sq. Centimeter	3	.07031	3
3Bar	3Pounds/Sq. Inch	3	14.504	3
3Pounds/Sq. Inch	3Bar	3	.06895	3
3Atmosphere	3Pounds/Sq. Inch	3	14.696	3
3Pounds/Sq. Inch	3Atmosphere	3	.06805	3
AA~				
3TEMPERATURE	3	3		3
3Centigrade Degrees	3Fahrenheit Degrees	3	$(\text{°C} \times 9) / 5 + 32$	3
3Fahrenheit Degrees	3Centigrade Degrees	3	$(\text{°F} - 32) \times (5) / 9$	3
AAU				

CONVERSION FACTORS (Cont.)

UAA~			
3INCHES	DECIMALS	mm	3
AA~			
3			3
31/64	.016	.397	3
31/32	.031	.794	3
33/64	.047	1.191	3
31/16	.063	1.588	3
35/64	.078	1.984	3
33/32	.094	2.381	3
37/64	.109	2.778	3
31/8	.125	3.175	3
39/64	.141	3.572	3
35/32	.156	3.969	3
311/64	.172	4.366	3
33/16	.188	4.763	3
313/64	.203	5.159	3
37/32	.219	5.556	3
315/64	.234	5.953	3
31/4	.250	6.350	3
317/64	.266	6.747	3
39/32	.281	7.144	3

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END OF ARTICLE

METRIC CONVERSIONS

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ARTICLE BEGINNING

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METRIC CONVERSIONS

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TORQUE

Torque is somewhat complicated. The term describes the amount of effort exerted to turn something. A chosen unit of weight or force is applied to a lever of standard length. The resulting leverage is called torque. In our standard system, we use the weight of one pound applied to a lever a foot long, resulting in the unit called a foot-pound. A smaller unit is the inch-pound (the lever is one inch long).

Metric units include the meter kilogram (lever one meter long with a kilogram of weight applied) and the Newton-meter (lever one meter long with force of one Newton applied). Some conversions are:

- * A meter kilogram is about 7.2 foot pounds.
- * A foot pound is about 1.4 Newton-meters.
- * A centimeter kilogram (cmkg) is equal to .9 inch pounds.

PRESSURE

Pressure is another complicated measurement. Pressure is described as a force or weight applied to a given area. Our common unit is pounds per square inch. Metric units can be expressed in several ways. One is the kilogram per square centimeter (kg/cm²). Another unit of pressure is the Pascal (force of one Newton on an area of one square meter), which equals about 4 ounces on a square yard. Since this is a very small amount of pressure, we usually see the kiloPascal, or kPa (1000 Pascals). Another common automotive term for pressure is the bar (used by German manufacturers), which equals 10 Pascals. Thoroughly confused? Try the examples below:

- * Atmospheric pressure at sea level is about 14.7 psi.
- * Atmospheric pressure at sea level is about 1 bar.
- * Atmospheric pressure at sea level is about 1 kg/cm².
- * One pound per square inch is about 7 kPa.

CONVERSION FACTORS

CONVERSION FACTORS

TO CONVERT	TO	MULTIPLY BY
LENGTH		
Millimeters (mm)	Inches	.03937
Inches	Millimeters	25.4
Meters (M)	Feet	3.28084
Feet	Meters	.3048
Kilometers (Km)	Miles	.62137
AREA		
Square Centimeters (cm ²)	Square Inches	.155
Square Inches	Square Centimeters	6.45159

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For Volkswagen Technical Site

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[illegible][illegible][illegible][illegible][illegible]

INCHES	DECIMALS	mm
1/64	.016	.397
1/32	.031	.794
3/64	.047	1.191
1/16	.063	1.588
5/64	.078	1.984
3/32	.094	2.381
7/64	.109	2.778
1/8	.125	3.175
9/64	.141	3.572
5/32	.156	3.969
11/64	.172	4.366
3/16	.188	4.763
13/64	.203	5.159
7/32	.219	5.556
15/64	.234	5.953
1/4	.250	6.350

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END OF ARTICLE

PCV SYSTEM

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ARTICLE BEGINNING

1987 Crankcase Ventilation
VOLKSWAGEN

DESCRIPTION

Closed crankcase ventilation systems usually consist of one or more of the following: PCV valve, oil separator, blow-by filter and connecting hoses. For illustrations of typical PCV systems, see Fig. 1.

OPERATION & SERVICE PROCEDURES

All closed crankcase systems draw crankcase blow-by, vapors and gases into the combustion system rather than allowing it to escape to the atmosphere. Crankcase gases mix with air/fuel mixture and are burned in the combustion chamber. This is accomplished with one or more of the following components:

PCV VALVE

Most crankcase ventilation systems use a PCV valve. It is basically a one-way check valve, held closed by spring pressure when engine is not running. This prevents hydrocarbon fumes from collecting in intake manifold which can result in hard starting.

When engine is running, manifold vacuum pulls PCV valve open allowing crankcase fumes to enter intake manifold. If engine backfires through intake manifold, PCV valve closes and stops any flow of gases. This prevents ignition of fumes in crankcase.

The PCV valve is usually located in a valve cover, intake manifold or in-line. To check, idle engine and place finger over PCV valve hose connection. If vacuum is not felt, PCV valve is defective. Generally, if PCV valve operation is questionable, replacement is recommended.

CAUTION: Do not suck air through PCV valve. Fuel vapor and petroleum substances inside PCV valve are harmful.

OIL SEPARATOR

Some systems utilize an oil separator to separate engine oil from crankcase vapor. Oil collected in the oil separator returns to the oil pan by an oil return hose.

BLOW-BY FILTER

The PCV system usually contains one or more filters to filter gases and/or fresh air before entering intake system. These

PCV SYSTEM Article Text (p. 2)

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filters should be checked occasionally and replaced as necessary.

CONNECTING HOSES & PIPES

All crankcase ventilation systems use connecting hoses and pipes to carry crankcase gases, engine vacuum and/or outside air. Hoses and pipes should be checked for clogging and leaks and replaced as necessary.

NOTE: Following figures are representative of typical crankcase ventilation systems for various manufacturers.

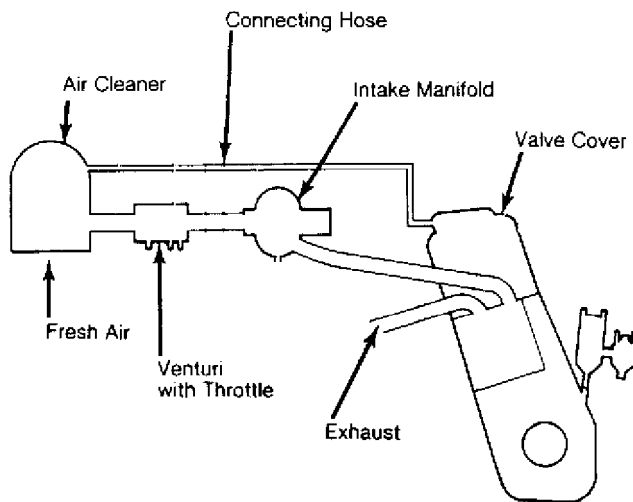


Fig. 1: Volkswagen Crankcase Ventilation System
Courtesy of Volkswagen United States, Inc.

END OF ARTICLE

POSSIBLE STALLING DUE TO RESTRICTED FUEL FLOW

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ARTICLE BEGINNING

NHTSA RECALL BULLETIN

Models: 1986 Volkswagen Vanagon
1987 Volkswagen Quantum/Quantum Syncro
1987 Volkswagen Vanagon
Number of Affected Vehicles: 15500
Beginning Date of Manufacture: 1985 AUG
Ending Date of Manufacture: 1987 JAN

VEHICLE DESCRIPTION:

Van type vehicles.

DESCRIPTION OF DEFECT:

Usage of fuel with Reid pressure up to 14 psi could, under high engine load and high ambient temperatures, lead to stalling.

FAULT:

Does not meet specs, Material, Heat treatment

SYSTEM:

Fuel tank.

CONSEQUENCE OF DEFECT:

Fuel flow could become restricted and cause the engine to stall.

CORRECTIVE ACTION:

Install a new fuel tank, containing a redesigned fuel filter, as well as modified control units.

ADDITIONAL INFORMATION:

The National Highway Traffic Safety Administration operates Monday through Friday from 8:00 AM to 4:00 PM, Eastern Time. For more information call (800) 424-9393 or (202) 366-0123. For the hearing impaired, call (800) 424-9153.

END OF ARTICLE

PRE-ALIGNMENT CHECKS

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ARTICLE BEGINNING

Wheel Alignment

PRE-ALIGNMENT INSPECTION PROCEDURES

PRE-ALIGNMENT CHECKS

Before making wheel alignment adjustment, perform the following checks:

- 1) Tires should be equal in size and runout must not be excessive. Tires and wheels should be in balance, and inflated to manufacturer's specifications.
- 2) Wheel bearings must be properly adjusted. Steering linkage and suspension must not have excessive looseness. Check for wear in tie rod ends and ball joints.
- 3) Steering gear box must not have excessive play. Check and adjust to manufacturer's specifications.
- 4) Vehicle must be at curb height with full fuel load and spare tire in vehicle. No extra load should be on vehicle.
- 5) Vehicle must be level with floor and with suspension settled. Jounce front and rear of vehicle several times and allow it to settle to normal curb height.
- 6) If steering wheel is not centered with front wheels in straight-ahead position, correct by shortening one tie rod adjusting sleeve and lengthening opposite sleeve equal amounts.
- 7) Ensure wheel lug nuts are tightened to torque specifications.

END OF ARTICLE

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ARTICLE BEGINNING

1983-88 MAINTENANCE

Volkswagen Maintenance & Service Intervals (Gasoline)

Quantum

Quantum Syncro (1986-88)

*** PLEASE READ THIS FIRST ***

NOTE: All SERVICE SCHEDULES are listed for normal service vehicles. If vehicle is operated under severe service conditions, see SEVERE SERVICE REQUIREMENTS (PERFORM W/SERVICE SCHEDULES) for items requiring additional maintenance.

NOTE: This article contains scheduled maintenance service information. Fluid types and capacities listed with each service in this article are only those necessary to perform that scheduled service. For specifications pertaining to fluid capacities for the entire vehicle, fuse and circuit breaker identification, wheel and tire size, battery type, warranty information, or model identification refer to the MAINTENANCE INFORMATION article in this section.

CAUTIONS & WARNINGS

BATTERY WARNING

WARNING: When battery is disconnected, vehicles equipped with computers may lose memory data. When battery power is restored, driveability problems may exist on some vehicles. These vehicles may require a relearn procedure. See COMPUTER RELEARN PROCEDURES article in GENERAL INFORMATION section.

REPLACING BLOWN FUSES

Before replacing a blown fuse, remove ignition key, turn off all lights and accessories to avoid damaging the electrical system. Be sure to use fuse with the correct indicated amperage rating. The use of an incorrect amperage rating fuse may result in a dangerous electrical system overload.

BRAKE PAD REPLACEMENT

WARNING: Use caution when checking and/or changing brake pads, some pads may contain asbestos which can irritate eyes and may cause other health hazards. A water based solution should be used to clean brake dust from wheel and brake components. DO NOT use compressed air to blow off brake dust.

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BRAKE SYSTEM

CAUTION: If brake warning light comes on while driving it indicates a low fluid level or failure in one of the braking circuits. If the brake pedal can be depressed further than normal it is an indication that one of the brake circuits is not functioning. Stop vehicle and check brake reservoir fluid level. If level is below MIN mark, DO NOT drive vehicle. Have it towed to a repair shop. If level is between the MIN and MAX marks, proceed cautiously to a repair shop.

BRAKE PAD WEAR INDICATOR

Indicator will cause a squealing or scraping noise, warning that brake pads need replacement.

BRAKE PEDAL PRESSURE WITH ENGINE NOT RUNNING

CAUTION: Brake pedal requires extreme pressure to stop the vehicle when the engine is not running.

CATALYTIC CONVERTER

Continued operation of vehicle with a severe malfunction could cause converter to overheat, resulting in possible damage to converter and vehicle.

Any modification to the exhaust system on turbo models, which reduces exhaust backpressure, will lead to lean fuel mixtures and excessive spark advance. This could cause serious engine damage.

COOLANT (PROPYLENE-GLYCOL FORMULATIONS)

To avoid possible damage to vehicle use only ethylene-glycol based coolants with a mixture ratio from 44-68% anti-freeze. DO NOT use 100% anti-freeze as it will cause the formation of cooling system deposits. This results in coolant temperatures of over 300°F (149°C) which can melt plastics. 100% anti-freeze has a freeze point of only -8°F (-22°C).

CAUTION: Propylene-Glycol Mixtures has a smaller temperature range than Ethylene-Glycol. The temperature range (freeze-boil) of a 50/50 Anti-Freeze/Water Mix is as follows:

Propylene-Glycol -26°F (-32°C) - 257°F (125°C)

Ethylene-Glycol -35°F (-37°C) - 263°F (128°C)

CAUTION: Propylene-Glycol/Ethylene-Glycol Mixtures can cause the destabilization of various corrosion inhibitors. Also Propylene-Glycol/Ethylene-Glycol has a different specific gravity than Ethylene-Glycol coolant, which will result in inaccurate freeze point calculations.

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ELECTRIC SHOCK HAZARD

WARNING: Contact with live components of ignition system while engine is running could lead to a fatal electric shock.

ELECTROSTATIC DISCHARGE SENSITIVE (ESD) PARTS

WARNING: Many solid state electrical components can be damaged by static electricity (ESD). Some will display a warning label, but many will not. Discharge personal static electricity by touching a metal ground point on the vehicle prior to servicing any ESD sensitive component.

ENGINE OIL

CAUTION: Never use non-detergent or straight mineral oil.

FUEL SYSTEM SERVICE

WARNING: Relieve fuel system pressure prior to servicing any fuel system component (fuel injection models).

HALOGEN BULBS

Halogen bulbs contain pressurized gas which may explode if overheated. DO NOT touch glass portion of bulb with bare hands. Eye protection should be worn when handling or working around halogen bulbs.

RADIATOR CAP

CAUTION: Always disconnect the fan motor when working near the radiator fan. The fan is temperature controlled and could start at any time even when the ignition key is in the OFF position. DO NOT loosen or remove radiator cap when cooling system is hot.

RADIATOR FAN

WARNING: Keep hands away from radiator fan. Fan is controlled by a thermostatic switch which may come on or run for up to 15 minutes even after engine is turned off.

SERVICE POINT LOCATIONS

SCHEDULED SERVICES - GASOLINE

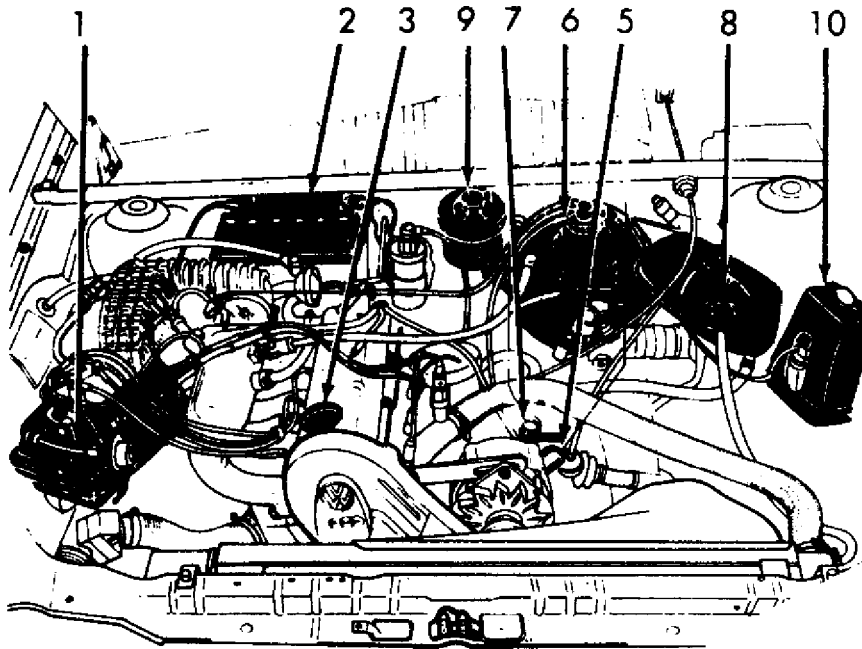
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GASOLINE ENGINE

- | | |
|--------------------------|----------------------------------|
| 1. Air Cleaner | 6. Brake Fluid Reservoir |
| 2. Battery | 7. ATF Dipstick |
| 3. Engine Oil Filler Cap | 8. Engine Coolant Expansion Tank |
| 4. Fuel Filter (Diesel) | 9. Power Steering Reservoir |
| 5. Engine Oil Dipstick | 10. Windshield Washer Reservoir |

93H45788

Fig. 1: Service Point Locations (Gasoline Engine)
Courtesy of Volkswagen United States, Inc.

ADDITIONAL GASOLINE SERVICE INFORMATION

ALIGNING CAMSHAFT TIMING MARKS - 1.7L 4-CYL.

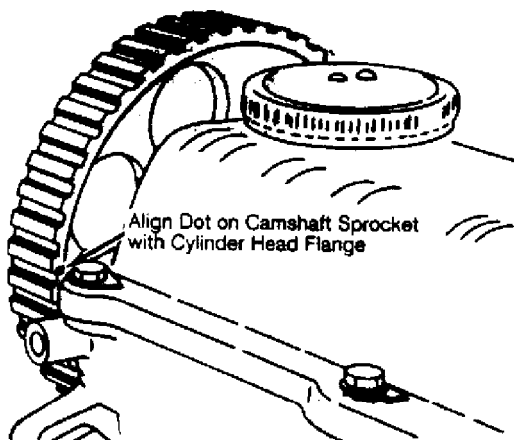


Fig. 2: Camshaft Sprocket Positioning (Gasoline)
Courtesy of Volkswagen United States, Inc.

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NOTE: For more information regarding camshaft timing belt service refer to the 1.7L 4-CYL article in the ENGINE MECHANICAL section.

VALVE CLEARANCE ADJUSTMENT - 1.7L 4-CYL. GASOLINE

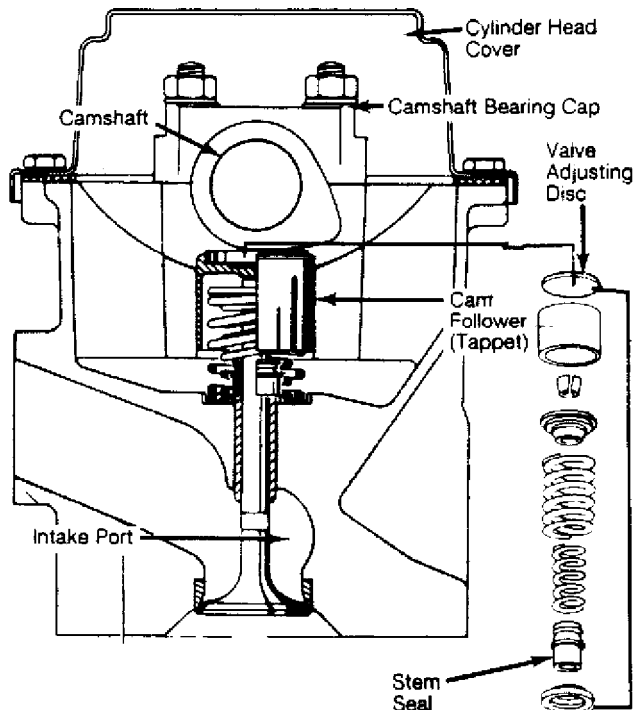


Fig. 3: Assembled View of Valve and Camshaft
Courtesy of Volkswagen United States, Inc.

NOTE: For more information regarding valve clearance adjustments refer to the 1.7L 4-CYL article in the ENGINE MECHANICAL section.

ALIGNING CAMSHAFT TIMING MARKS - 1.8L 4-CYL.

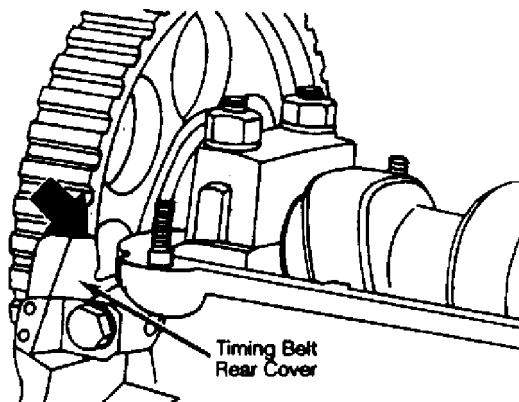


Fig. 4: Setting Camshaft Timing Mark
Courtesy of Volkswagen United States, Inc.

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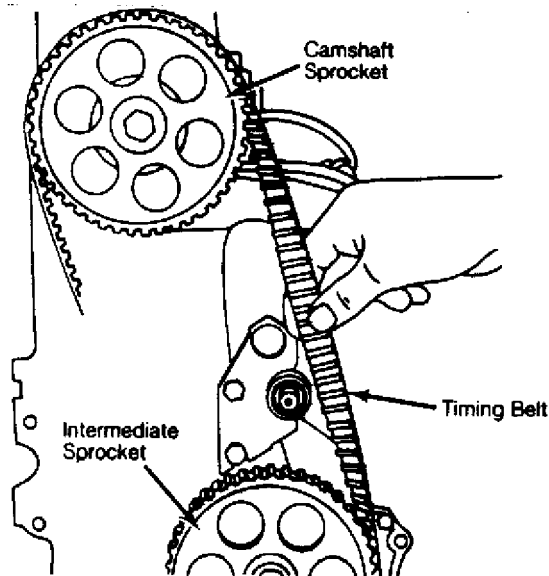


Fig. 5: Adjusting Timing Belt Tension
Courtesy of Volkswagen United States, Inc.

NOTE: For more information regarding camshaft timing belt service refer to the 1.8L 4-CYL article in the ENGINE MECHANICAL section.

ALIGNING CAMSHAFT TIMING MARKS - 5-CYL.

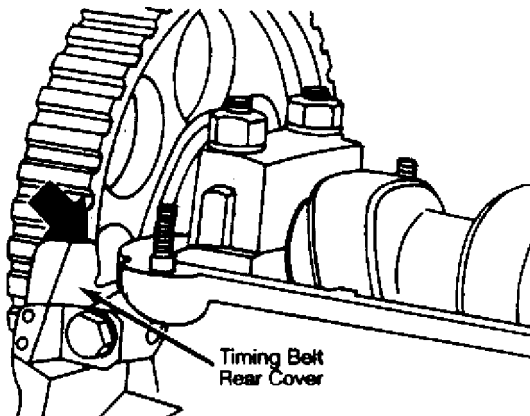


Fig. 6: Camshaft Sprocket Positioning (Gasoline)
Courtesy of Volkswagen United States, Inc.

NOTE: For more information regarding camshaft timing belt service refer to the 2.22L 5-CYL article in the ENGINE MECHANICAL section.

VALVE CLEARANCE ADJUSTMENT - 5-CYL. GASOLINE (1983-85)

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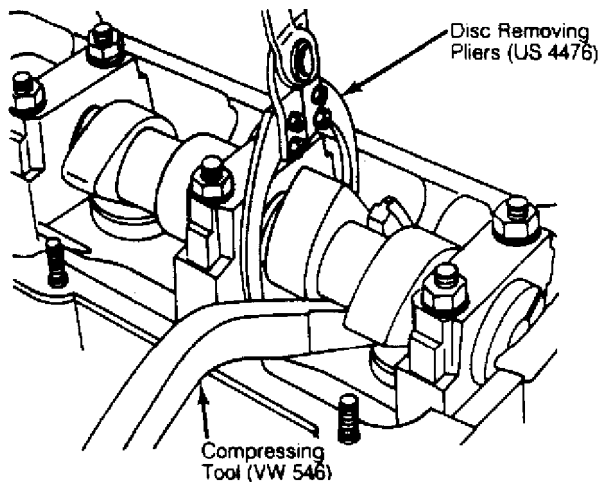


Fig. 7: Compressing Cam Follower to Replace Adjusting Disc
Courtesy of Volkswagen United States, Inc.

NOTE: For more information regarding valve clearance adjustments refer to the 2.22L 5-CYL article in the ENGINE MECHANICAL section.

JACKING & HOISTING POINTS

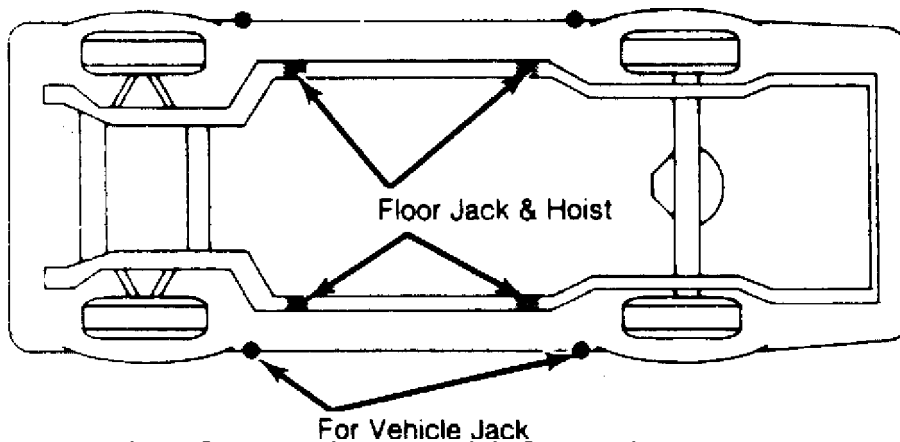


Fig. 8: Floor Jack, Floor Hoist & Vehicle Jack
Courtesy of Volkswagen United States, Inc.

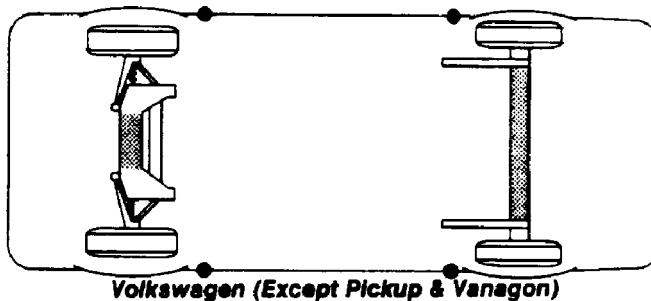


Fig. 9: Vehicle Lifting Points
Courtesy of Volkswagen United States, Inc.

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NOTE: For more information regarding jacking and hoisting points refer to the JACKING & HOISTING article in the WHEEL ALIGNMENT section.

INFORMATION LABEL LOCATIONS

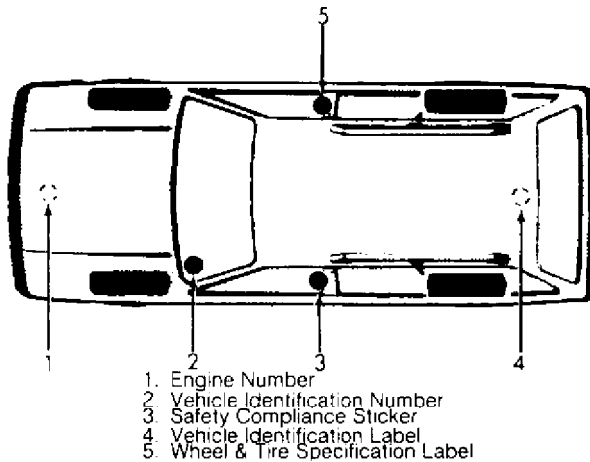


Fig. 10: Information Label Locations
Courtesy of Volkswagen United States, Inc.

CAMSHAFT TIMING BELT REPLACEMENT INFORMATION

CAUTION: Failure to replace a faulty camshaft timing belt may result in serious engine damage.

The condition of camshaft drive belts should always be checked on vehicles which have more than 50,000 miles. Although some manufacturers do not recommend belt replacement at a specified mileage, others require it at 60,000-100,000 miles. A camshaft drive belt failure may cause extensive damage to internal engine components on most engines, although some designs do not allow piston-to-valve contact. These designs are often called "Free Wheeling".

Many manufacturers changed their maintenance and warranty schedules in the mid-1980's to reflect timing belt inspection and/or replacement at 50,000-60,000 miles. Most service interval schedules in this manual reflect these changes.

Belts or components should be inspected and replaced if any of the following conditions exist:

- * Cracks Or Tears In Belt Surface
- * Missing, Damaged, Cracked Or Rounded Teeth
- * Oil Contamination
- * Damaged Or Faulty Tensioners
- * Incorrect Tension Adjustment

Inspect timing belt at 20,000 mile intervals. Replace belt as necessary.

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Condition	Action	Item	Perform Every (1)
Short Trips In Freezing Temperatures	Replace	Engine Oil & Filter	3,750 Miles or 3 Months
Towing Or Heavily Loaded	Replace	Engine Oil & Filter	3,750 Miles or 3 Months
Severe Dust Conditions	Replace	Engine Oil & Filter	3,750 Miles or 3 Months
Hot Weather, Stop-And-Go Driving	Replace	Engine Oil & Filter	3,750 Miles or 3 Months
	Replace	A/T Fluid	15,000 Miles

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```
3          3 Replace 3 A/T Fluid 3          15,000 Miles 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 Extensive Idling 3 Replace 3 Engine Oil & 3 3,750 Miles or 3 Months 3
3          3          3 Filter 3          3          3
3          AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3          3 Replace 3 A/T Fluid 3          15,000 Miles 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3          3
3(1) - Perform these services at the mileage or number of months 3
3 (since the last time), whichever comes first. 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
```

NORMAL MAINTENANCE SERVICE SCHEDULES

CAUTION: The following service schedules refer to vehicles driven under normal operating conditions. For vehicles driven under severe conditions, additional services may be necessary. See SEVERE SERVICE REQUIREMENTS (PERFORM W/SERVICE SCHEDULES) above in this article for additional service requirements.

7500 MILE (12,000 KM) SERVICE

7500 MILE (12,000 KM) SERVICE

```
UAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 Service Or Inspect 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Check Fluid Levels 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Inspect Coolant Hoses and Clamps 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Inspect Brake System 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Inspect Exhaust System 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Inspect CV Joint Boots 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Lubricate Chassis 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 Replace 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Engine Oil 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Oil Filter 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 Lubrication Specifications 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 Application Specification 3
3 3
3 Engine Oil 3
3 Ambient Temperatures 3
3 Greater Than 50°F (10°C) ..... SAE 20W-50 API SG/CD 3
3 14° To 50°F (-10° To +10°C) ..... SAE 10W-40 API SG/CD 3
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3      3  Diagnostic System Read Out                                     3

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AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3   3   Inspect For Fluid Leaks                                                         3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3   3   Check/Adjust Valve Clearance                                                       3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3   3   Check/Adjust Idle Speed                                                            3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3   3   Perform Compression Test                                                           3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3   3   Check Crankcase Ventilation System                                                  3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3   3   Check Fuel Evaporation System                                                      3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3   3   Check EGR System (Reset Mileage Counter - If Applicable)                        3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3   3   Check Fluid Levels                                                                3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3   3   Inspect Coolant Hoses and Clamps                                                  3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3   3   Cooling & Heating System                                                          3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3   3   Check Coolant Strength                                                            3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3   3   Inspect/Adjust Accessory Drive Belts (Replace if Required)                    3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3   3   Windshield Washer System                                                         3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3   3   Clean Battery and Battery Terminals                                              3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3   3   Throttle Linkage                                                                3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3   3   Inspect Fuel/Tank/Cap/Lines                                                       3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3   3   Intake Air System                                                                3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3   3   Clutch Hydraulic System                                                           3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3   3   Inspect CV Joint Boots                                                            3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3   3   Drive Shafts For Leaks & Damage                                                  3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3   3   Check Operation of Horn, Wipers/Washers & All Exterior Lights                3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3   3   Inspect Condition of Wiper Blades                                                3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3   3   Check Headlight Alignment                                                        3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3   3   Check Seat Belt Webbing and Release Mechanisms                                3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3   3   Check Parking Brake Operation                                                    3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3   3   Check Shift/Clutch Interlock Operation                                          3

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AA			
3	3	Inspect Brake System Hoses & Lines	3
AA			
3	3	Brake Discs & Calipers	3
AA			
3	3	Inspect Front Brake Pads & Rotors	3
AA			
3	3	Inspect Rear Brake Linings & Drums	3
AA			
3	3	Lubricate Chassis	3
AA			
3	3	Inspect Steering Linkage/Front Suspension	3
AA			
3	3	Suspension & Wheel Bearings	3
AA			
3	3	Steering Operation, Tie Rods, Gear Box & Boots	3
AA			
3	3	Lubricate Weatherstripping with Silicone	3
AA			
3	3	Lubricate Door Hinges	3
AA			
3	3	Lubricate Door Locks	3
AA			
3	3	Check Body Drain Holes	3
AA			
3	3	Inspect Shocks/Struts for Leakage	3
AA			
3	3	Inspect Tire Wear Pattern	3
AA			
3	3	Rotate Tires and Adjust Air Pressure (Including Spare)	3
AA			
3		Replace	3
AA			
3	3	Engine Oil	3
AA			
3	3	Oil Filter	3
AA			
3	3	Clean Air Filter Element (Replace if Required)	3
AA			
3	3	Spark Plugs (Except California Models)	3
AA			
3	3	Fuel Filter	3
AA			
3		Lubrication Specifications	3
AA			
3	Application	Specification	3
3			3
3	Automatic Transaxle	Dexron-II E ATF	3
3	Brake Fluid	DOT 4 Brake Fluid (SAE J1703)	3
3	Coolant	50/50 Mix Water & Ethylene Glycol	3
3	Engine Oil (1)		3
3	Ambient Temperatures		3

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3 Greater Than 140 F (-10C) .. SAE 15W-40 Or 20W-50 API SG/CD 3
3 140-500F (-10 To +10C) SAE 10W-30 Or 10W-40 API SG/CD 3
3 Less Than 500F (10C) SAE 5W-30 Or 5W-40 API SG/CD 3
3 Power Steering Fluid VW Hydraulic Oil G-002-000 3
3 Manual Transaxle Hypoid Gear Oil SAE 75W-90 API GL-4 3
3 Or SAE 75W-90 (G50 Synthetic) 3

3 Final Drive (A/T & M/T) 3
3 (Differential) SAE 75W-90 (G50 Synthetic Gear Oil) 3
3 Wheel Bearings NLGI Grade 2 Category GC-LB 3
3 Steering Linkage (2)(3) NLGI Grade 2 Category GC-LB 3
3 Ball Joints (2)(4) NLGI Grade 2 Category GC-LB 3
3 Weatherstrip Dielectric Silicone Grease 3

3 (1) - SAE 15W-40 or 20W-40 engine oil is recommended for extreme 3
3 conditions or extended highway operation. 3
3 (2) - Use low pressure grease gun to prevent seal damage. 3
3 (3) - Fill until lubricant squeezes out from the base of seals. 3
3 (4) - Fill ball joint until seal starts to swell. 3

3 ~~~~~ 3
3 Fluid Capacities 3

3 ~~~~~ 3
3 Application (1) Quantity 3

3 Cooling System 5.2 Qts. (5.0L) 3
3 Engine Oil (2) 4.7 Qts. (4.5L) 3
3 Automatic Transaxle 3
3 Fluid Change 3.2 Qts. (3.0L) 3
3 Dry Fill 5.9 Qts. (5.6L) 3
3 Final Drive (Differential) 3
3 A/T (3) 0.8 Qt. (.75L) 3
3 Manual Transaxle (4) 2.0 Qts. (1.9L) 3

3 (1) - Capacities are recommended or calculated levels. Always use 3
3 dipstick (if available) to measure level. 3
3 (2) - Includes filter change. 3
3 (3) - Lifetime fill. 3
3 (4) - Single case includes manual transaxle & differential. 3

3 ~~~~~ 3
3 Service Labor Times 3

3 ~~~~~ 3
3 Application (1)(2)(3)(4) Hours 3

3 4-Cylinder 3
3 Automatic Transmission 1.5 3
3 Manual Transmission 1.7 3
3 5-Cylinder 3
3 Automatic Transmission 1.5 3
3 Manual Transmission 1.7 3

3 (1) - When replacing camshaft timing belt, add 1.6 hrs. for 3
3 4-cylinder and 2.1 hrs. for 5-cylinder gasoline engines. 3
3 (2) - Add .2 hr. if equipped with A/C. 3

Article Text (p. 15)

For Volkswagen Technical Site

Sunday, March 19, 2000 01:47AM

- [illegible]

22,500 MILE (36,000 KM) SERVICE

3 Service Or Inspect **3**

[illegible]

3	3	Verify Last Major Service Was Performed	3
----------	----------	---	----------

[illegible]

3 3 Check Fluid Levels 3

[illegible]

3 **3** Inspect Camshaft Timing Belt (Replace if Required) **3**

[illegible]

3 3 Inspect Coolant Hoses and Clamps 3

[illegible]

3	3	Inspect Brake System	3
----------	----------	-----------------------------	----------

[illegible]

3	3	Inspect Exhaust System	3
----------	----------	------------------------	----------

[illegible]

3 3 Inspect CV Joint Boots 3

[illegible]

3 Lubricate Chassis

[illegible]

3 Replace **3**

[illegible]

3	3	Engine Oil	3
---	---	------------	---

[illegible]

3	3	Oil Filter	3
---	---	------------	---

[illegible]

3 Lubrication Specifications 3

[illegible]

3 Application **Specification 3**

3 3

3 Engine Oil **3**

3 Ambient Temperatures

3 Greater Than 140 F (-100C) .. SAE 15W-40 Or 20W-50 API SG/CD **3**

3 140-500F (-100 To +100C) SAE 10W-30 Or 10W-40 API SG/CD **3**

3 Less Than 50°F (10°C) SAE 5W-30 Or 5W-40 API SG/CD **3**

AAAAAAAAAAAAAAAAAAAAAA\A/A'AAA'

3 Fluid Capacities 3

[illegible]

3 Application (1) Quantity **3**

3

3 Engine Oil (2) 4.7 Qts. (4.5L) **3**

3 **3**

³ (1) - Capacities are recommended or calculated levels. Always use ³

3 dipstick (if available) to measure level. **3**

3 (2) - Includes filter change. **3**

[illegible]

SCHEDULED SERVICES - GASOLINE

Article Text (p. 16)

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Sunday, March 19, 2000 01:47AM

30,000 MILE (48,000 KM) SERVICE

30,000 MILE (48,000 KM) SERVICE

```

3 Service Or Inspect 3
3 3 Verify Last Major Service Was Performed 3
3 3 Diagnostic System Read Out 3
3 3 Inspect For Fluid Leaks 3
3 3 Check/Adjust Valve Clearance 3
3 3 Check/Adjust Idle Speed 3
3 3 Perform Compression Test 3
3 3 Check Crankcase Ventilation System 3
3 3 Check Fuel Evaporation System 3
3 3 Check EGR System (Reset Mileage Counter - If Applicable) 3
3 3 Check Fluid Levels 3
3 3 Inspect Coolant Hoses and Clamps 3
3 3 Cooling & Heating System 3
3 3 Crankcase Ventilation System 3
3 3 Check Coolant Strength 3
3 3 Inspect/Adjust Accessory Drive Belts (Replace if Required) 3
3 3 Windshield Washer System 3
3 3 Clean Battery and Battery Terminals 3
3 3 Throttle Linkage 3
3 3 Fuel System 3
3 3 Intake Air System 3
3 3 Clutch Hydraulic System 3
3 3 Inspect CV Joint Boots 3
3 3 Drive Shafts For Leaks & Damage 3
```

Article Text (p. 17)

For Volkswagen Technical Site

Sunday, March 19, 2000 01:47AM

3	3	Check Operation of Horn, Wipers/Washers & All Exterior Lights	3
3	3	Inspect Condition of Wiper Blades	3
3	3	Check Headlight Alignment	3
3	3	Check Seat Belt Webbing and Release Mechanisms	3
3	3	Check Parking Brake Operation	3
3	3	Check Shift/Clutch Interlock Operation	3
3	3	Inspect Brake System Hoses & Lines	3
3	3	Brake Discs & Calipers	3
3	3	Inspect Front Brake Pads & Rotors	3
3	3	Inspect Rear Brake Linings & Drums	3
3	3	Lubricate Chassis	3
3	3	Inspect Steering Linkage/Front Suspension	3
3	3	Suspension & Wheel Bearings	3
3	3	Steering Operation, Tie Rods, Gear Box & Boots	3
3	3	Lubricate Weatherstripping with Silicone	3
3	3	Lubricate Door Hinges	3
3	3	Lubricate Door Locks	3
3	3	Check Body Drain Holes	3
3	3	Inspect Shocks/Struts for Leakage	3
3	3	Inspect Tire Wear Pattern	3
3	3	Rotate Tires and Adjust Air Pressure (Including Spare)	3
3		Replace	3
3	3	Engine Oil	3
3	3	Oil Filter	3
3	3	Air Filter Element	3
3	3	Spark Plugs	3

SCHEDULED SERVICES - GASOLINE

Article Text (p. 18)

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Sunday, March 19, 2000 01:47AM

Oxygen Sensor (Reset Mileage Counter - If Applicable)		
Fuel Filter		
Change Automatic Transaxle Fluid & Clean Strainer		
Drain, Flush and Refill Engine Coolant		
Drain, Refill and Bleed Brake System Fluid		
Lubrication Specifications		
Application	Specification	
Automatic Transaxle	Dexron-IIe ATF	
Brake Fluid	DOT 4 Brake Fluid (SAE J1703)	
Coolant	50/50 Mix Water & Ethylene Glycol	
Engine Oil (1)		
Ambient Temperatures		
Greater Than 140°F (-10°C)	SAE 15W-40 Or 20W-50 API SG/CD	
140-500°F (-10 To +10°C)	SAE 10W-30 Or 10W-40 API SG/CD	
Less Than 50°F (10°C)	SAE 5W-30 Or 5W-40 API SG/CD	
Power Steering Fluid	VW Hydraulic Oil G-002-000	
Manual Transaxle	Hypoid Gear Oil SAE 75W-90 API GL-4	
	Or SAE 75W-90 (G50 Synthetic)	
Final Drive (A/T & M/T)		
(Differential)	SAE 75W-90 (G50 Synthetic Gear Oil)	
Wheel Bearings	NLGI Grade 2 Category GC-LB	
Steering Linkage (2)(3)	NLGI Grade 2 Category GC-LB	
Ball Joints (2)(4)	NLGI Grade 2 Category GC-LB	
Weatherstrip	Dielectric Silicone Grease	
(1) - SAE 15W-40 or 20W-40 engine oil is recommended for extreme conditions or extended highway operation.		
(2) - Use low pressure grease gun to prevent seal damage.		
(3) - Fill until lubricant squeezes out from the base of seals.		
(4) - Fill ball joint until seal starts to swell.		
Fluid Capacities		
Application	(1) Quantity	
Cooling System	5.2 Qts. (5.0L)	
Engine Oil (2)	4.7 Qts. (4.5L)	
Automatic Transaxle		
Fluid Change	3.2 Qts. (3.0L)	
Dry Fill	5.9 Qts. (5.6L)	
Final Drive (Differential)		
A/T (3)	0.8 Qt. (.75L)	
Manual Transaxle (4)	2.0 Qts. (1.9L)	

SCHEDULED SERVICES - GASOLINE

Article Text (p. 19)

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3 (1) - Capacities are recommended or calculated levels. Always use 3
3 dipstick (if available) to measure level. 3
3 (2) - Includes filter change. 3
3 (3) - Lifetime fill. 3
3 (4) - Single case includes manual transaxle & differential. 3
3 ~~~~~ 3
3 Service Labor Times 3
3 ~~~~~ 3
3 Application (1)(2)(3) Hours 3
3 3 3
3 4-Cylinder 3
3 Automatic Transmission 3.2 3
3 Manual Transmission 2.6 3
3 5-Cylinder 3
3 Automatic Transmission 3.2 3
3 Manual Transmission 2.6 3
3 3
3 (1) - When replacing camshaft timing belt, add 1.6 hrs. for 3
3 4-cylinder and 2.1 hrs. for 5-cylinder gasoline engines. 3
3 (2) - Add .2 hr. if equipped with A/C. 3
3 (3) - Add .1 hr. if equipped with cruise control. 3
3 ~~~~~ 3

37,500 MILE (60,000 KM) SERVICE

37,500 MILE (60,000 KM) SERVICE
3 ~~~~~ 3
3 Service Or Inspect 3
3 ~~~~~ 3
3 3 Verify Last Major Service Was Performed 3
3 ~~~~~ 3
3 3 Check Fluid Levels 3
3 ~~~~~ 3
3 3 Inspect Coolant Hoses and Clamps 3
3 ~~~~~ 3
3 3 Inspect Brake System 3
3 ~~~~~ 3
3 3 Inspect Exhaust System 3
3 ~~~~~ 3
3 3 Inspect CV Joint Boots 3
3 ~~~~~ 3
3 3 Lubricate Chassis 3
3 ~~~~~ 3
3 Replace 3
3 ~~~~~ 3
3 3 Engine Oil 3
3 ~~~~~ 3
3 3 Oil Filter 3
3 ~~~~~ 3
3 Lubrication Specifications 3
3 ~~~~~ 3
3 Application Specification 3

SCHEDULED SERVICES - GASOLINE

Article Text (p. 20)

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Sunday, March 19, 2000 01:48AM

```
3
3 Engine Oil 3
3 Ambient Temperatures 3
3 Greater Than 140 F (-100C) .. SAE 15W-40 Or 20W-50 API SG/CD 3
3 140-500F (-100 To +100C) .... SAE 10W-30 Or 10W-40 API SG/CD 3
3 Less Than 500F (100C) ..... SAE 5W-30 Or 5W-40 API SG/CD 3
3 Fluid Capacities 3
3 Application (1) Quantity 3
3 Engine Oil (2) ..... 4.7 Qts. (4.5L) 3
3 (1) - Capacities are recommended or calculated levels. Always use 3
3 dipstick (if available) to measure level. 3
3 (2) - Includes filter change. 3
3
```

45,000 MILE (72,000 KM) SERVICE

```
45,000 MILE (72,000 KM) SERVICE
3 Service Or Inspect 3
3 Verify Last Major Service Was Performed 3
3 Diagnostic System Read Out 3
3 Inspect For Fluid Leaks 3
3 Check/Adjust Valve Clearance 3
3 Inspect Camshaft Timing Belt (Replace if Required) 3
3 Check/Adjust Idle Speed 3
3 Perform Compression Test 3
3 Check Crankcase Ventilation System 3
3 Check Fuel Evaporation System 3
3 Check EGR System (Reset Mileage Counter - If Applicable) 3
3 Check Fluid Levels 3
3 Inspect Coolant Hoses and Clamps 3
3 Cooling & Heating System 3
3 Crankcase Ventilation System 3
3
```

SCHEDULED SERVICES - GASOLINE

Article Text (p. 21)

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Sunday, March 19, 2000 01:48AM

3	3	Check Coolant Strength	3
3	3	Inspect/Adjust Accessory Drive Belts (Replace if Required)	3
3	3	Windshield Washer System	3
3	3	Clean Battery and Battery Terminals	3
3	3	Throttle Linkage	3
3	3	Fuel System	3
3	3	Intake Air System	3
3	3	Clutch Hydraulic System	3
3	3	Inspect CV Joint Boots	3
3	3	Drive Shafts For Leaks & Damage	3
3	3	Check Operation of Horn, Wipers/Washers & All Exterior Lights	3
3	3	Inspect Condition of Wiper Blades	3
3	3	Check Headlight Alignment	3
3	3	Check Seat Belt Webbing and Release Mechanisms	3
3	3	Check Parking Brake Operation	3
3	3	Check Shift/Clutch Interlock Operation	3
3	3	Inspect Brake System Hoses & Lines	3
3	3	Brake Discs & Calipers	3
3	3	Inspect Front Brake Pads & Rotors	3
3	3	Inspect Rear Brake Linings & Drums	3
3	3	Lubricate Chassis	3
3	3	Inspect Steering Linkage/Front Suspension	3
3	3	Suspension & Wheel Bearings	3
3	3	Steering Operation, Tie Rods, Gear Box & Boots	3
3	3	Lubricate Weatherstripping with Silicone	3
3	3	Lubricate Door Hinges	3

SCHEDULED SERVICES - GASOLINE

Article Text (p. 22)

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3	3	Lubricate Door Locks	3
3	3	Check Body Drain Holes	3
3	3	Inspect Shocks/Struts for Leakage	3
3	3	Inspect Tire Wear Pattern	3
3	3	Rotate Tires and Adjust Air Pressure (Including Spare)	3
3		Replace	3
3	3	Engine Oil	3
3	3	Oil Filter	3
3	3	Clean Air Filter Element (Replace if Required)	3
3	3	Spark Plugs (Except California Models)	3
3	3	Fuel Filter	3
3		Lubrication Specifications	3
3	Application	Specification	3
3			3
3	Automatic Transaxle	Dexron-II E ATF	3
3	Brake Fluid	DOT 4 Brake Fluid (SAE J1703)	3
3	Coolant	50/50 Mix Water & Ethylene Glycol	3
3	Engine Oil (1)		3
3	Ambient Temperatures		3
3	Greater Than 140 F (-10C)	SAE 15W-40 Or 20W-50 API SG/CD	3
3	140-500F (-10 To +10C)	SAE 10W-30 Or 10W-40 API SG/CD	3
3	Less Than 500F (10C)	SAE 5W-30 Or 5W-40 API SG/CD	3
3	Power Steering Fluid	VW Hydraulic Oil G-002-000	3
3	Manual Transaxle	Hypoid Gear Oil SAE 75W-90 API GL-4	3
3		Or SAE 75W-90 (G50 Synthetic)	3
3	Final Drive (A/T & M/T)		3
3	(Differential)	SAE 75W-90 (G50 Synthetic Gear Oil)	3
3	Wheel Bearings	NLGI Grade 2 Category GC-LB	3
3	Steering Linkage (2)(3)	NLGI Grade 2 Category GC-LB	3
3	Ball Joints (2)(4)	NLGI Grade 2 Category GC-LB	3
3	Weatherstrip	Dielectric Silicone Grease	3
3			3
3	(1) - SAE 15W-40 or 20W-40 engine oil is recommended for extreme		3
3	conditions or extended highway operation.		3
3	(2) - Use low pressure grease gun to prevent seal damage.		3
3	(3) - Fill until lubricant squeezes out from the base of seals.		3
3	(4) - Fill ball joint until seal starts to swell.		3
3	Fluid Capacities		3

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[illegible]

Inspect CV Joint Boots

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Article Text (p. 24)

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```
3 3 Lubricate Chassis 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 Replace 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Engine Oil 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Oil Filter 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 Lubrication Specifications 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 Application Specification 3
3 3
3 Engine Oil 3
3 Ambient Temperatures 3
3 Greater Than 140 F (-10C) .. SAE 15W-40 Or 20W-50 API SG/CD 3
3 140-500F (-10 To +10C) .... SAE 10W-30 Or 10W-40 API SG/CD 3
3 Less Than 500F (10C) ..... SAE 5W-30 Or 5W-40 API SG/CD 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 Fluid Capacities 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 Application (1) Quantity 3
3 3
3 Engine Oil (2) ..... 4.7 Qts. (4.5L) 3
3 3
3 (1) - Capacities are recommended or calculated levels. Always use 3
3 dipstick (if available) to measure level. 3
3 (2) - Includes filter change. 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
```

60,000 MILE (96,000 KM) SERVICE

```
60,000 MILE (96,000 KM) SERVICE
UAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 Service Or Inspect 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Verify Last Major Service Was Performed 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Diagnostic System Read Out 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Inspect For Fluid Leaks 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Check/Adjust Valve Clearance 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Check/Adjust Idle Speed 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Perform Compression Test 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Check Crankcase Ventilation System 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Check Fuel Evaporation System 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Check EGR System (Reset Mileage Counter - If Applicable) 3
```

SCHEDULED SERVICES - GASOLINE

Article Text (p. 25)

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```

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Check Fluid Levels 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Inspect Coolant Hoses and Clamps 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Cooling & Heating System 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Crankcase Ventilation System 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Check Coolant Strength 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Inspect/Adjust Accessory Drive Belts (Replace if Required) 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Windshield Washer System 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Clean Battery and Battery Terminals 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Throttle Linkage 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Fuel System 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Intake Air System 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Clutch Hydraulic System 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Inspect CV Joint Boots 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Drive Shafts For Leaks & Damage 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Check Operation of Horn, Wipers/Washers & All Exterior Lights 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Inspect Condition of Wiper Blades 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Check Headlight Alignment 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Check Seat Belt Webbing and Release Mechanisms 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Check Parking Brake Operation 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Check Shift/Clutch Interlock Operation 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Inspect Brake System Hoses & Lines 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Brake Discs & Calipers 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Inspect Front Brake Pads & Rotors 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Inspect Rear Brake Linings & Drums 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Lubricate Chassis 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Inspect Steering Linkage/Front Suspension 3

```

SCHEDULED SERVICES - GASOLINE

Article Text (p. 26)

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Sunday, March 19, 2000 01:48AM

AA		
3	3 Suspension & Wheel Bearings	3
AA		
3	3 Steering Operation, Tie Rods, Gear Box & Boots	3
AA		
3	3 Lubricate Weatherstripping with Silicone	3
AA		
3	3 Lubricate Door Hinges	3
AA		
3	3 Lubricate Door Locks	3
AA		
3	3 Check Body Drain Holes	3
AA		
3	3 Inspect Shocks/Struts for Leakage	3
AA		
3	3 Inspect Tire Wear Pattern	3
AA		
3	3 Rotate Tires and Adjust Air Pressure (Including Spare)	3
AA		
3	3 Replace	3
AA		
3	3 Engine Oil	3
AA		
3	3 Oil Filter	3
AA		
3	3 Spark Plugs	3
AA		
3	3 Oxygen Sensor (Reset Mileage Counter - If Applicable)	3
AA		
3	3 Air Filter Element	3
AA		
3	3 Fuel Filter	3
AA		
3	3 Change Automatic Transaxle Fluid & Clean Strainer	3
AA		
3	3 A/T Differential Oil Level (Replace if Required)	3
AA		
3	3 Manual Transaxle Fluid Level (Replace if Required)	3
AA		
3	3 Drain, Flush and Refill Engine Coolant	3
AA		
3	3 Drain, Refill and Bleed Brake System Fluid	3
AA		
3	3 Lubrication Specifications	3
AA		
3	Application	Specification 3
3		3
3	Automatic Transaxle	Dexron-IIe ATF 3
3	Brake Fluid	DOT 4 Brake Fluid (SAE J1703) 3
3	Coolant	50/50 Mix Water & Ethylene Glycol 3
3	Engine Oil (1)	3
3	Ambient Temperatures	3

Article Text (p. 27)

For Volkswagen Technical Site

Sunday, March 19, 2000 01:48AM

3 (2) - Add 2 hr. if equipped with A/C

Article Text (p. 28)

For Volkswagen Technical Site

Sunday, March 19, 2000 01:48AM

- [illegible]

67,500 MILE (108,000 KM) SERVICE

3 Service Or Inspect **3**

[illegible]

3	3	Verify Last Major Service Was Performed	3
----------	----------	--	----------

[illegible]

3 3 Check Fluid Levels 3

[illegible]

3 **3** Inspect Camshaft Timing Belt (Replace if Required) **3**

[illegible]

3 3 Inspect Coolant Hoses and Clamps 3

[illegible]

3 3 Inspect Brake System 3

[illegible]

3	3	Inspect Exhaust System	3
---	---	------------------------	---

[illegible]

3	3	Inspect CV Joint Boots	3
---	---	------------------------	---

[illegible]

3 3 Lubricate Chassis 3

~~~~~

3 Replace 3

**A**

```

3      3  Engine Oil

```

~~~~~

```

3      3  Oil Filter
3

```

[illegible]

3 Lubrication Specifications 3

~~~~~

3 Application

Specification 3

**3** Application **3** Specification

3 Engine Oil 3

### 3 Ambient Temperatures

3 Greater Than 140 F (-100C) SAE 15W-40 Or 20W-50 API SG/CD 3

3 140-500E (-100 To +100C) SAE 10W-30 Or 10W-40 APT SG/CD 3

3 Less Than 50°F (10°C) SAE 5W-30 Or 5W-40 APT SG/CD 3

---

3 Fluid Capacities 3

Fluid Capacities

| Application |  |  | (1) Quantity |
|-------------|--|--|--------------|
| 3           |  |  | 3            |

| Application | (1) Quantity |
|-------------|--------------|
| 3           | 3            |

|   |                |        |        |   |
|---|----------------|--------|--------|---|
| 3 | Engine Oil (2) | 4.70±s | (4.51) | 3 |
|---|----------------|--------|--------|---|

3 Engine Oil (2) ..... 4.7 QTS. (4.5L) 3

3 (1) - Capacities are recommended or calculated levels. Always use 3

(1) - Capacities are recommended or calculated levels. Always use dipstick (if available) to measure level

3 (2) Includes filter change

(2) - Includes Filter Change.  
 #####

## Article Text (p. 29)

For Volkswagen Technical Site

Sunday, March 19, 2000 01:48AM

75,000 MILE (120,000 KM) SERVICE

|   |                    |   |
|---|--------------------|---|
| 3 | Service Or Inspect | 3 |
|---|--------------------|---|

|   |   |                                         |   |
|---|---|-----------------------------------------|---|
| 3 | 3 | Verify Last Major Service Was Performed | 3 |
|---|---|-----------------------------------------|---|

|          |          |                            |          |
|----------|----------|----------------------------|----------|
| <b>3</b> | <b>3</b> | Diagnostic System Read Out | <b>3</b> |
|----------|----------|----------------------------|----------|

|          |          |                                |          |
|----------|----------|--------------------------------|----------|
| <b>3</b> | <b>3</b> | <b>Inspect For Fluid Leaks</b> | <b>3</b> |
|----------|----------|--------------------------------|----------|

|          |          |                              |          |
|----------|----------|------------------------------|----------|
| <b>3</b> | <b>3</b> | Check/Adjust Valve Clearance | <b>3</b> |
|----------|----------|------------------------------|----------|

|          |          |                         |          |
|----------|----------|-------------------------|----------|
| <b>3</b> | <b>3</b> | Check/Adjust Idle Speed | <b>3</b> |
|----------|----------|-------------------------|----------|

|          |          |                                 |          |
|----------|----------|---------------------------------|----------|
| <b>3</b> | <b>3</b> | <b>Perform Compression Test</b> | <b>3</b> |
|----------|----------|---------------------------------|----------|

|          |          |                                           |          |
|----------|----------|-------------------------------------------|----------|
| <b>3</b> | <b>3</b> | <b>Check Crankcase Ventilation System</b> | <b>3</b> |
|----------|----------|-------------------------------------------|----------|

|   |   |                               |   |
|---|---|-------------------------------|---|
| 3 | 3 | Check Fuel Evaporation System | 3 |
|---|---|-------------------------------|---|

|   |   |                                                          |   |
|---|---|----------------------------------------------------------|---|
| 3 | 3 | Check EGR System (Reset Mileage Counter - If Applicable) | 3 |
|---|---|----------------------------------------------------------|---|

|   |   |                    |   |
|---|---|--------------------|---|
| 3 | 3 | Check Fluid Levels | 3 |
|---|---|--------------------|---|

|   |   |                                  |   |
|---|---|----------------------------------|---|
| 3 | 3 | Inspect Coolant Hoses and Clamps | 3 |
|---|---|----------------------------------|---|

|   |   |                          |   |
|---|---|--------------------------|---|
| 3 | 3 | Cooling & Heating System | 3 |
|---|---|--------------------------|---|

3 3 Crankcase Ventilation System 3

|   |   |                        |   |
|---|---|------------------------|---|
| 3 | 3 | Check Coolant Strength | 3 |
|---|---|------------------------|---|

|   |   |                                                            |   |
|---|---|------------------------------------------------------------|---|
| 3 | 3 | Inspect/Adjust Accessory Drive Belts (Replace if Required) | 3 |
|---|---|------------------------------------------------------------|---|

3 3 Windshield Washer System 3

---

3 3 Clean Battery and Battery Terminals 3

3 3 Throttle linkage 3

```

3      3  Eye] System

```

3 3 Intake Air System 3

3 3 Clutch Hydraulic System 3

3 3 Inspect CV Joint Boots 3

3 3 Drive Shafts For Leaks & Damage 3

### 3 3 Drive Shafts For Leaks & Damage 3

## SCHEDULED SERVICES - GASOLINE

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AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Check Operation of Horn, Wipers/Washers & All Exterior Lights 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Inspect Condition of Wiper Blades 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Check Headlight Alignment 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Check Seat Belt Webbing and Release Mechanisms 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Check Parking Brake Operation 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Check Shift/Clutch Interlock Operation 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Inspect Brake System Hoses & Lines 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Brake Discs & Calipers 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Inspect Front Brake Pads & Rotors 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Inspect Rear Brake Linings & Drums 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Lubricate Chassis 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Inspect Steering Linkage/Front Suspension 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Suspension & Wheel Bearings 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Steering Operation, Tie Rods, Gear Box & Boots 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Lubricate Weatherstripping with Silicone 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Lubricate Door Hinges 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Lubricate Door Locks 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Check Body Drain Holes 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Inspect Shocks/Struts for Leakage 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Inspect Tire Wear Pattern 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Rotate Tires and Adjust Air Pressure (Including Spare) 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 Replace 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Engine Oil 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Oil Filter 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Clean Air Filter Element (Replace if Required) 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Spark Plugs (Except California Models) 3

```

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Service Labor Times

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| Application                                                                                                          | (1)(2)(3) Hours |
|----------------------------------------------------------------------------------------------------------------------|-----------------|
| 4-Cylinder                                                                                                           |                 |
| Automatic Transmission                                                                                               | 1.5             |
| Manual Transmission                                                                                                  | 1.7             |
| 5-Cylinder                                                                                                           |                 |
| Automatic Transmission                                                                                               | 1.5             |
| Manual Transmission                                                                                                  | 1.7             |
| (1) - When replacing camshaft timing belt, add 1.6 hrs. for 4-cylinder and 2.1 hrs. for 5-cylinder gasoline engines. |                 |
| (2) - Add .2 hr. if equipped with A/C.                                                                               |                 |
| (3) - Add .1 hr. if equipped with cruise control.                                                                    |                 |

### 82,500 MILE (132,000 KM) SERVICE

#### 82,500 MILE (132,000 KM) SERVICE

|                                         |                                     |
|-----------------------------------------|-------------------------------------|
| Service Or Inspect                      |                                     |
| Verify Last Major Service Was Performed |                                     |
| Check Fluid Levels                      |                                     |
| Inspect Coolant Hoses and Clamps        |                                     |
| Inspect Brake System                    |                                     |
| Inspect Exhaust System                  |                                     |
| Inspect CV Joint Boots                  |                                     |
| Lubricate Chassis                       |                                     |
| Replace                                 |                                     |
| Engine Oil                              |                                     |
| Oil Filter                              |                                     |
| Lubrication Specifications              |                                     |
| Application                             | Specification                       |
| Engine Oil                              |                                     |
| Ambient Temperatures                    |                                     |
| Greater Than 140 F (-10C)               | .. SAE 15W-40 Or 20W-50 API SG/CD   |
| 140-500F (-100 To +100C)                | .... SAE 10W-30 Or 10W-40 API SG/CD |
| Less Than 500F (100C)                   | ..... SAE 5W-30 Or 5W-40 API SG/CD  |
| Fluid Capacities                        |                                     |

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|   |   |                                                               |   |
|---|---|---------------------------------------------------------------|---|
| 3 | 3 | Throttle Linkage                                              | 3 |
| 3 | 3 | Fuel System                                                   | 3 |
| 3 | 3 | Intake Air System                                             | 3 |
| 3 | 3 | Clutch Hydraulic System                                       | 3 |
| 3 | 3 | Inspect CV Joint Boots                                        | 3 |
| 3 | 3 | Drive Shafts For Leaks & Damage                               | 3 |
| 3 | 3 | Check Operation of Horn, Wipers/Washers & All Exterior Lights | 3 |
| 3 | 3 | Inspect Condition of Wiper Blades                             | 3 |
| 3 | 3 | Check Headlight Alignment                                     | 3 |
| 3 | 3 | Check Seat Belt Webbing and Release Mechanisms                | 3 |
| 3 | 3 | Check Parking Brake Operation                                 | 3 |
| 3 | 3 | Check Shift/Clutch Interlock Operation                        | 3 |
| 3 | 3 | Inspect Brake System Hoses & Lines                            | 3 |
| 3 | 3 | Brake Discs & Calipers                                        | 3 |
| 3 | 3 | Inspect Front Brake Pads & Rotors                             | 3 |
| 3 | 3 | Inspect Rear Brake Linings & Drums                            | 3 |
| 3 | 3 | Lubricate Chassis                                             | 3 |
| 3 | 3 | Inspect Steering Linkage/Front Suspension                     | 3 |
| 3 | 3 | Suspension & Wheel Bearings                                   | 3 |
| 3 | 3 | Steering Operation, Tie Rods, Gear Box & Boots                | 3 |
| 3 | 3 | Lubricate Weatherstripping with Silicone                      | 3 |
| 3 | 3 | Lubricate Door Hinges                                         | 3 |
| 3 | 3 | Lubricate Door Locks                                          | 3 |
| 3 | 3 | Check Body Drain Holes                                        | 3 |
| 3 | 3 | Inspect Shocks/Struts for Leakage                             | 3 |
| 3 | 3 | Inspect Tire Wear Pattern                                     | 3 |

## SCHEDULED SERVICES - GASOLINE

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|   |                                                                  |                                                        |   |
|---|------------------------------------------------------------------|--------------------------------------------------------|---|
| 3 | 3                                                                | Rotate Tires and Adjust Air Pressure (Including Spare) | 3 |
| 3 |                                                                  | Replace                                                | 3 |
| 3 | 3                                                                | Engine Oil                                             | 3 |
| 3 | 3                                                                | Oil Filter                                             | 3 |
| 3 | 3                                                                | Spark Plugs                                            | 3 |
| 3 | 3                                                                | Oxygen Sensor (Reset Mileage Counter - If Applicable)  | 3 |
| 3 | 3                                                                | Air Filter Element                                     | 3 |
| 3 | 3                                                                | Fuel Filter                                            | 3 |
| 3 | 3                                                                | Change Automatic Transaxle Fluid & Clean Strainer      | 3 |
| 3 | 3                                                                | A/T Differential Oil Level (Replace if Required)       | 3 |
| 3 | 3                                                                | Manual Transaxle Fluid Level (Replace if Required)     | 3 |
| 3 | 3                                                                | Drain, Flush and Refill Engine Coolant                 | 3 |
| 3 | 3                                                                | Drain, Refill and Bleed Brake System Fluid             | 3 |
| 3 |                                                                  | Lubrication Specifications                             | 3 |
| 3 | Application                                                      | Specification                                          | 3 |
| 3 |                                                                  |                                                        | 3 |
| 3 | Automatic Transaxle                                              | Dexron-II E ATF                                        | 3 |
| 3 | Brake Fluid                                                      | DOT 4 Brake Fluid (SAE J1703)                          | 3 |
| 3 | Coolant                                                          | 50/50 Mix Water & Ethylene Glycol                      | 3 |
| 3 | Engine Oil (1)                                                   |                                                        | 3 |
| 3 | Ambient Temperatures                                             |                                                        | 3 |
| 3 | Greater Than 140 F (-10C)                                        | SAE 15W-40 Or 20W-50 API SG/CD                         | 3 |
| 3 | 140-500F (-10 To +10C)                                           | SAE 10W-30 Or 10W-40 API SG/CD                         | 3 |
| 3 | Less Than 500F (10C)                                             | SAE 5W-30 Or 5W-40 API SG/CD                           | 3 |
| 3 | Power Steering Fluid                                             | VW Hydraulic Oil G-002-000                             | 3 |
| 3 | Manual Transaxle                                                 | Hypoid Gear Oil SAE 75W-90 API GL-4                    | 3 |
| 3 |                                                                  | Or SAE 75W-90 (G50 Synthetic)                          | 3 |
| 3 | Final Drive (A/T & M/T)                                          |                                                        | 3 |
| 3 | (Differential)                                                   | SAE 75W-90 (G50 Synthetic Gear Oil)                    | 3 |
| 3 | Wheel Bearings                                                   | NLGI Grade 2 Category GC-LB                            | 3 |
| 3 | Steering Linkage (2)(3)                                          | NLGI Grade 2 Category GC-LB                            | 3 |
| 3 | Ball Joints (2)(4)                                               | NLGI Grade 2 Category GC-LB                            | 3 |
| 3 | Weatherstrip                                                     | Dielectric Silicone Grease                             | 3 |
| 3 |                                                                  |                                                        | 3 |
| 3 | (1) - SAE 15W-40 or 20W-40 engine oil is recommended for extreme |                                                        | 3 |
| 3 | conditions or extended highway operation.                        |                                                        | 3 |
| 3 | (2) - Use low pressure grease gun to prevent seal damage.        |                                                        | 3 |
| 3 | (3) - Fill until lubricant squeezes out from the base of seals.  |                                                        | 3 |

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|   |                                                                   |                   |
|---|-------------------------------------------------------------------|-------------------|
| 3 | (4) - Fill ball joint until seal starts to swell.                 | 3                 |
| 3 | Fluid Capacities                                                  | 3                 |
| 3 | Application                                                       | (1) Quantity 3    |
| 3 | Cooling System                                                    | 5.2 Qts. (5.0L) 3 |
| 3 | Engine Oil (2)                                                    | 4.7 Qts. (4.5L) 3 |
| 3 | Automatic Transaxle                                               | 3                 |
| 3 | Fluid Change                                                      | 3.2 Qts. (3.0L) 3 |
| 3 | Dry Fill                                                          | 5.9 Qts. (5.6L) 3 |
| 3 | Final Drive (Differential)                                        | 3                 |
| 3 | A/T (3)                                                           | 0.8 Qt. (.75L) 3  |
| 3 | Manual Transaxle (4)                                              | 2.0 Qts. (1.9L) 3 |
| 3 | (1) - Capacities are recommended or calculated levels. Always use | 3                 |
| 3 | dipstick (if available) to measure level.                         | 3                 |
| 3 | (2) - Includes filter change.                                     | 3                 |
| 3 | (3) - Lifetime fill.                                              | 3                 |
| 3 | (4) - Single case includes manual transaxle & differential.       | 3                 |
| 3 | Service Labor Times                                               | 3                 |
| 3 | Application                                                       | (1)(2)(3) Hours 3 |
| 3 | 4-Cylinder                                                        | 3                 |
| 3 | Automatic Transmission                                            | 3.2 3             |
| 3 | Manual Transmission                                               | 2.6 3             |
| 3 | 5-Cylinder                                                        | 3                 |
| 3 | Automatic Transmission                                            | 3.2 3             |
| 3 | Manual Transmission                                               | 2.6 3             |
| 3 | (1) - When replacing camshaft timing belt, add 1.6 hrs. for       | 3                 |
| 3 | 4-cylinder and 2.1 hrs. for 5-cylinder gasoline engines.          | 3                 |
| 3 | (2) - Add .2 hr. if equipped with A/C.                            | 3                 |
| 3 | (3) - Add .1 hr. if equipped with cruise control.                 | 3                 |

## 97,500 MILE (156,000 KM) SERVICE

|   |                                         |   |
|---|-----------------------------------------|---|
| 3 | 97,500 MILE (156,000 KM) SERVICE        | 3 |
| 3 | Service Or Inspect                      | 3 |
| 3 | Verify Last Major Service Was Performed | 3 |
| 3 | Check Fluid Levels                      | 3 |
| 3 | Inspect Coolant Hoses and Clamps        | 3 |
| 3 | Inspect Brake System                    | 3 |

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```
3 3 Inspect Exhaust System 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Inspect CV Joint Boots 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Lubricate Chassis 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 Replace 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Engine Oil 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Oil Filter 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 Lubrication Specifications 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 Application Specification 3
3 3
3 Engine Oil 3
3 Ambient Temperatures 3
3 Greater Than 140 F (-10C) .. SAE 15W-40 Or 20W-50 API SG/CD 3
3 140-500F (-10 To +10C) .... SAE 10W-30 Or 10W-40 API SG/CD 3
3 Less Than 500F (10C) ..... SAE 5W-30 Or 5W-40 API SG/CD 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 Fluid Capacities 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 Application (1) Quantity 3
3 3
3 Engine Oil (2) ..... 4.7 Qts. (4.5L) 3
3 3
3 (1) - Capacities are recommended or calculated levels. Always use 3
3 dipstick (if available) to measure level. 3
3 (2) - Includes filter change. 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
```

### 105,000 MILE (168,000 KM) SERVICE

```
105,000 MILE (168,000 KM) SERVICE
UAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 Service Or Inspect 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Verify Last Major Service Was Performed 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Diagnostic System Read Out 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Inspect For Fluid Leaks 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Check/Adjust Valve Clearance 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Check/Adjust Idle Speed 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Perform Compression Test 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Check Crankcase Ventilation System 3
```

## SCHEDULED SERVICES - GASOLINE

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```

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Check Fuel Evaporation System 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Check EGR System (Reset Mileage Counter - If Applicable) 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Check Fluid Levels 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Inspect Coolant Hoses and Clamps 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Cooling & Heating System 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Crankcase Ventilation System 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Check Coolant Strength 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Inspect/Adjust Accessory Drive Belts (Replace if Required) 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Windshield Washer System 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Clean Battery and Battery Terminals 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Throttle Linkage 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Fuel System 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Intake Air System 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Clutch Hydraulic System 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Inspect CV Joint Boots 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Drive Shafts For Leaks & Damage 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Check Operation of Horn, Wipers/Washers & All Exterior Lights 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Inspect Condition of Wiper Blades 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Check Headlight Alignment 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Check Seat Belt Webbing and Release Mechanisms 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Check Parking Brake Operation 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Check Shift/Clutch Interlock Operation 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Inspect Brake System Hoses & Lines 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Brake Discs & Calipers 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Inspect Front Brake Pads & Rotors 3
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3 3 Inspect Rear Brake Linings & Drums 3

```

## SCHEDULED SERVICES - GASOLINE

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|                                                                                  |                            |                                                        |   |
|----------------------------------------------------------------------------------|----------------------------|--------------------------------------------------------|---|
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |                            |                                                        |   |
| 3                                                                                | 3                          | Lubricate Chassis                                      | 3 |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |                            |                                                        |   |
| 3                                                                                | 3                          | Inspect Steering Linkage/Front Suspension              | 3 |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |                            |                                                        |   |
| 3                                                                                | 3                          | Suspension & Wheel Bearings                            | 3 |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |                            |                                                        |   |
| 3                                                                                | 3                          | Steering Operation, Tie Rods, Gear Box & Boots         | 3 |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |                            |                                                        |   |
| 3                                                                                | 3                          | Lubricate Weatherstripping with Silicone               | 3 |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |                            |                                                        |   |
| 3                                                                                | 3                          | Lubricate Door Hinges                                  | 3 |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |                            |                                                        |   |
| 3                                                                                | 3                          | Lubricate Door Locks                                   | 3 |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |                            |                                                        |   |
| 3                                                                                | 3                          | Check Body Drain Holes                                 | 3 |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |                            |                                                        |   |
| 3                                                                                | 3                          | Inspect Shocks/Struts for Leakage                      | 3 |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |                            |                                                        |   |
| 3                                                                                | 3                          | Inspect Tire Wear Pattern                              | 3 |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |                            |                                                        |   |
| 3                                                                                | 3                          | Rotate Tires and Adjust Air Pressure (Including Spare) | 3 |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |                            |                                                        |   |
| 3                                                                                |                            | Replace                                                | 3 |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |                            |                                                        |   |
| 3                                                                                | 3                          | Engine Oil                                             | 3 |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |                            |                                                        |   |
| 3                                                                                | 3                          | Oil Filter                                             | 3 |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |                            |                                                        |   |
| 3                                                                                | 3                          | Clean Air Filter Element (Replace if Required)         | 3 |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |                            |                                                        |   |
| 3                                                                                | 3                          | Spark Plugs (Except California Models)                 | 3 |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |                            |                                                        |   |
| 3                                                                                | 3                          | Fuel Filter                                            | 3 |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |                            |                                                        |   |
| 3                                                                                |                            | Lubrication Specifications                             | 3 |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |                            |                                                        |   |
| 3                                                                                | Application                | Specification                                          | 3 |
| 3                                                                                |                            |                                                        | 3 |
| 3                                                                                | Automatic Transaxle        | Dexron-II E ATF                                        | 3 |
| 3                                                                                | Brake Fluid                | DOT 4 Brake Fluid (SAE J1703)                          | 3 |
| 3                                                                                | Coolant                    | 50/50 Mix Water & Ethylene Glycol                      | 3 |
| 3                                                                                | Engine Oil (1)             |                                                        | 3 |
| 3                                                                                | Ambient Temperatures       |                                                        | 3 |
| 3                                                                                | Greater Than 140 F (-100C) | SAE 15W-40 Or 20W-50 API SG/CD                         | 3 |
| 3                                                                                | 140-500F (-100 To +100C)   | SAE 10W-30 Or 10W-40 API SG/CD                         | 3 |
| 3                                                                                | Less Than 500F (100C)      | SAE 5W-30 Or 5W-40 API SG/CD                           | 3 |
| 3                                                                                | Power Steering Fluid       | VW Hydraulic Oil G-002-000                             | 3 |
| 3                                                                                | Manual Transaxle           | Hypoid Gear Oil SAE 75W-90 API GL-4                    | 3 |
| 3                                                                                |                            | Or SAE 75W-90 (G50 Synthetic)                          | 3 |
| 3                                                                                | Final Drive (A/T & M/T)    |                                                        | 3 |
| 3                                                                                | (Differential)             | SAE 75W-90 (G50 Synthetic Gear Oil)                    | 3 |

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```

3 (1) - SAE 15W-40 or 20W-40 engine oil is recommended for extreme 3
3 conditions or extended highway operation. 3
3 (2) - Use low pressure grease gun to prevent seal damage. 3
3 (3) - Fill until lubricant squeezes out from the base of seals. 3
3 (4) - Fill ball joint until seal starts to swell. 3

```

|   |                                  |                 |   |
|---|----------------------------------|-----------------|---|
| 3 | Cooling System .....             | 5.2 Qts. (5.0L) | 3 |
| 3 | Engine Oil (2) .....             | 4.7 Qts. (4.5L) | 3 |
| 3 | Automatic Transaxle .....        |                 | 3 |
| 3 | Fluid Change .....               | 3.2 Qts. (3.0L) | 3 |
| 3 | Dry Fill .....                   | 5.9 Qts. (5.6L) | 3 |
| 3 | Final Drive (Differential) ..... |                 | 3 |
| 3 | A/T (3) .....                    | 0.8 Qt. (.75L)  | 3 |
| 3 | Manual Transaxle (4) .....       | 2.0 Qts. (1.9L) | 3 |

- ```

3 (1) - Capacities are recommended or calculated levels. Always use 3
3 dipstick (if available) to measure level. 3
3 (2) - Includes filter change. 3
3 (3) - Lifetime fill. 3
3 (4) - Single case includes manual transaxle & differential. 3

```

|   |                        |     |   |
|---|------------------------|-----|---|
| 3 | 4-Cylinder             |     | 3 |
| 3 | Automatic Transmission | 1.5 | 3 |
| 3 | Manual Transmission    | 1.7 | 3 |
| 3 | 5-Cylinder             |     | 3 |
| 3 | Automatic Transmission | 1.5 | 3 |
| 3 | Manual Transmission    | 1.7 | 3 |

- |   |                                                             |   |
|---|-------------------------------------------------------------|---|
| 3 | (1) - When replacing camshaft timing belt, add 1.6 hrs. for | 3 |
| 3 | 4-cylinder and 2.1 hrs. for 5-cylinder gasoline engines.    | 3 |
| 3 | (2) - Add .2 hr. if equipped with A/C.                      | 3 |
| 3 | (3) - Add .1 hr. if equipped with cruise control.           | 3 |

```
0AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
3      Service Or Inspect                                             3
```

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## 120,000 MILE (192,000 KM) SERVICE

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|   |   |                                                               |   |
|---|---|---------------------------------------------------------------|---|
| 3 | 3 | Diagnostic System Read Out                                    | 3 |
| 3 | 3 | Inspect For Fluid Leaks                                       | 3 |
| 3 | 3 | Check/Adjust Valve Clearance                                  | 3 |
| 3 | 3 | Check/Adjust Idle Speed                                       | 3 |
| 3 | 3 | Perform Compression Test                                      | 3 |
| 3 | 3 | Check Crankcase Ventilation System                            | 3 |
| 3 | 3 | Check Fuel Evaporation System                                 | 3 |
| 3 | 3 | Check EGR System (Reset Mileage Counter - If Applicable)      | 3 |
| 3 | 3 | Check Fluid Levels                                            | 3 |
| 3 | 3 | Inspect Coolant Hoses and Clamps                              | 3 |
| 3 | 3 | Cooling & Heating System                                      | 3 |
| 3 | 3 | Crankcase Ventilation System                                  | 3 |
| 3 | 3 | Check Coolant Strength                                        | 3 |
| 3 | 3 | Inspect/Adjust Accessory Drive Belts (Replace if Required)    | 3 |
| 3 | 3 | Windshield Washer System                                      | 3 |
| 3 | 3 | Clean Battery and Battery Terminals                           | 3 |
| 3 | 3 | Throttle Linkage                                              | 3 |
| 3 | 3 | Fuel System                                                   | 3 |
| 3 | 3 | Intake Air System                                             | 3 |
| 3 | 3 | Clutch Hydraulic System                                       | 3 |
| 3 | 3 | Suspension & Wheel Bearings                                   | 3 |
| 3 | 3 | Inspect CV Joint Boots                                        | 3 |
| 3 | 3 | Drive Shafts For Leaks & Damage                               | 3 |
| 3 | 3 | Check Operation of Horn, Wipers/Washers & All Exterior Lights | 3 |
| 3 | 3 | Inspect Condition of Wiper Blades                             | 3 |
| 3 | 3 | Check Headlight Alignment                                     | 3 |

## SCHEDULED SERVICES - GASOLINE

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|                                                                                  |   |                                                        |   |
|----------------------------------------------------------------------------------|---|--------------------------------------------------------|---|
| 3                                                                                | 3 | Check Seat Belt Webbing and Release Mechanisms         | 3 |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |   |                                                        |   |
| 3                                                                                | 3 | Check Parking Brake Operation                          | 3 |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |   |                                                        |   |
| 3                                                                                | 3 | Check Shift/Clutch Interlock Operation                 | 3 |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |   |                                                        |   |
| 3                                                                                | 3 | Inspect Brake System Hoses & Lines                     | 3 |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |   |                                                        |   |
| 3                                                                                | 3 | Brake Discs & Calipers                                 | 3 |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |   |                                                        |   |
| 3                                                                                | 3 | Inspect Front Brake Pads & Rotors                      | 3 |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |   |                                                        |   |
| 3                                                                                | 3 | Inspect Rear Brake Linings & Drums                     | 3 |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |   |                                                        |   |
| 3                                                                                | 3 | Lubricate Chassis                                      | 3 |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |   |                                                        |   |
| 3                                                                                | 3 | Inspect Steering Linkage/Front Suspension              | 3 |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |   |                                                        |   |
| 3                                                                                | 3 | Suspension & Wheel Bearings                            | 3 |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |   |                                                        |   |
| 3                                                                                | 3 | Steering Operation, Tie Rods, Gear Box & Boots         | 3 |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |   |                                                        |   |
| 3                                                                                | 3 | Lubricate Weatherstripping with Silicone               | 3 |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |   |                                                        |   |
| 3                                                                                | 3 | Lubricate Door Hinges                                  | 3 |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |   |                                                        |   |
| 3                                                                                | 3 | Lubricate Door Locks                                   | 3 |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |   |                                                        |   |
| 3                                                                                | 3 | Check Body Drain Holes                                 | 3 |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |   |                                                        |   |
| 3                                                                                | 3 | Inspect Shocks/Struts for Leakage                      | 3 |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |   |                                                        |   |
| 3                                                                                | 3 | Inspect Tire Wear Pattern                              | 3 |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |   |                                                        |   |
| 3                                                                                | 3 | Rotate Tires and Adjust Air Pressure (Including Spare) | 3 |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |   |                                                        |   |
| 3                                                                                |   | Replace                                                | 3 |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |   |                                                        |   |
| 3                                                                                | 3 | Engine Oil                                             | 3 |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |   |                                                        |   |
| 3                                                                                | 3 | Oil Filter                                             | 3 |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |   |                                                        |   |
| 3                                                                                | 3 | Spark Plugs                                            | 3 |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |   |                                                        |   |
| 3                                                                                | 3 | Oxygen Sensor (Reset Mileage Counter - If Applicable)  | 3 |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |   |                                                        |   |
| 3                                                                                | 3 | Air Filter Element                                     | 3 |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |   |                                                        |   |
| 3                                                                                | 3 | Fuel Filter                                            | 3 |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |   |                                                        |   |
| 3                                                                                | 3 | Change Automatic Transaxle Fluid & Clean Strainer      | 3 |
| AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA |   |                                                        |   |

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|   |   |                                                                                                             |                                     |
|---|---|-------------------------------------------------------------------------------------------------------------|-------------------------------------|
| 3 | 3 | A/T Differential Oil Level (Replace if Required)                                                            | 3                                   |
| 3 | 3 | Manual Transaxle Fluid Level (Replace if Required)                                                          | 3                                   |
| 3 | 3 | Drain, Flush and Refill Engine Coolant                                                                      | 3                                   |
| 3 | 3 | Drain, Refill and Bleed Brake System Fluid                                                                  | 3                                   |
| 3 | 3 | Lubrication Specifications                                                                                  | 3                                   |
| 3 | 3 | Application                                                                                                 | Specification                       |
| 3 | 3 | Automatic Transaxle                                                                                         | Dexron-II E ATF                     |
| 3 | 3 | Brake Fluid                                                                                                 | DOT 4 Brake Fluid (SAE J1703)       |
| 3 | 3 | Coolant                                                                                                     | 50/50 Mix Water & Ethylene Glycol   |
| 3 | 3 | Engine Oil (1)                                                                                              |                                     |
| 3 | 3 | Ambient Temperatures                                                                                        |                                     |
| 3 | 3 | Greater Than 140°F (-10°C)                                                                                  | SAE 15W-40 Or 20W-50 API SG/CD      |
| 3 | 3 | 140-50°F (-10 To +10°C)                                                                                     | SAE 10W-30 Or 10W-40 API SG/CD      |
| 3 | 3 | Less Than 50°F (10°C)                                                                                       | SAE 5W-30 Or 5W-40 API SG/CD        |
| 3 | 3 | Power Steering Fluid                                                                                        | VW Hydraulic Oil G-002-000          |
| 3 | 3 | Manual Transaxle                                                                                            | Hypoid Gear Oil SAE 75W-90 API GL-4 |
| 3 | 3 |                                                                                                             | Or SAE 75W-90 (G50 Synthetic)       |
| 3 | 3 | Final Drive (A/T & M/T)                                                                                     |                                     |
| 3 | 3 | (Differential)                                                                                              | SAE 75W-90 (G50 Synthetic Gear Oil) |
| 3 | 3 | Wheel Bearings                                                                                              | NLGI Grade 2 Category GC-LB         |
| 3 | 3 | Steering Linkage (2)(3)                                                                                     | NLGI Grade 2 Category GC-LB         |
| 3 | 3 | Ball Joints (2)(4)                                                                                          | NLGI Grade 2 Category GC-LB         |
| 3 | 3 | Weatherstrip                                                                                                | Dielectric Silicone Grease          |
| 3 | 3 | (1) - SAE 15W-40 or 20W-40 engine oil is recommended for extreme conditions or extended highway operation.  |                                     |
| 3 | 3 | (2) - Use low pressure grease gun to prevent seal damage.                                                   |                                     |
| 3 | 3 | (3) - Fill until lubricant squeezes out from the base of seals.                                             |                                     |
| 3 | 3 | (4) - Fill ball joint until seal starts to swell.                                                           |                                     |
| 3 | 3 | Fluid Capacities                                                                                            |                                     |
| 3 | 3 | Application                                                                                                 | (1) Quantity                        |
| 3 | 3 | Cooling System                                                                                              | 5.2 Qts. (5.0L)                     |
| 3 | 3 | Engine Oil (2)                                                                                              | 4.7 Qts. (4.5L)                     |
| 3 | 3 | Automatic Transaxle                                                                                         |                                     |
| 3 | 3 | Fluid Change                                                                                                | 3.2 Qts. (3.0L)                     |
| 3 | 3 | Dry Fill                                                                                                    | 5.9 Qts. (5.6L)                     |
| 3 | 3 | Final Drive (Differential)                                                                                  |                                     |
| 3 | 3 | A/T (3)                                                                                                     | 0.8 Qt. (.75L)                      |
| 3 | 3 | Manual Transaxle (4)                                                                                        | 2.0 Qts. (1.9L)                     |
| 3 | 3 | (1) - Capacities are recommended or calculated levels. Always use dipstick (if available) to measure level. |                                     |
| 3 | 3 | (2) - Includes filter change.                                                                               |                                     |

## SCHEDULED SERVICES - GASOLINE

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|       |                                                             |                      |
|-------|-------------------------------------------------------------|----------------------|
| 3     | (3) - Lifetime fill.                                        | 3                    |
| 3     | (4) - Single case includes manual transaxle & differential. | 3                    |
| ~~~~~ |                                                             |                      |
| 3     | Service Labor Times                                         | 3                    |
| ~~~~~ |                                                             |                      |
| 3     | Application                                                 | (1)(2)(3)(4) Hours 3 |
| 3     |                                                             | 3                    |
| 3     | 4-Cylinder                                                  | 3                    |
| 3     | Automatic Transmission                                      | 3.6 3                |
| 3     | Manual Transmission                                         | 3.0 3                |
| 3     | 5-Cylinder                                                  | 3                    |
| 3     | Automatic Transmission                                      | 3.6 (4) 3            |
| 3     | Manual Transmission                                         | 3.0 (4) 3            |
| 3     |                                                             | 3                    |
| 3     | (1) - When replacing camshaft timing belt, add 1.6 hrs. for | 3                    |
| 3     | 4-cylinder and 2.1 hrs. for 5-cylinder gasoline engines.    | 3                    |
| 3     | (2) - Add .2 hr. if equipped with A/C.                      | 3                    |
| 3     | (3) - Add .1 hr. if equipped with cruise control.           | 3                    |
| 3     | (4) - Add .2 hr. for Quattro models.                        | 3                    |
| ~~~~~ |                                                             |                      |

## LUBRICATION SPECIFICATIONS

### LUBRICATION SPECIFICATIONS TABLE

|             |                      |
|-------------|----------------------|
| ~~~~~       | ~~~~~                |
| Application | Fluid Specifications |

|                            |                                     |
|----------------------------|-------------------------------------|
| Automatic Transaxle        | Dexron-II E ATF                     |
| Brake Fluid                | DOT 4 Brake Fluid (SAE J1703)       |
| Coolant                    | 50/50 Mix Water & Ethylene Glycol   |
| Engine Oil (1)             |                                     |
| Ambient Temperatures       |                                     |
| Greater Than 140 F (-100C) | SAE 15W-40 Or 20W-50 API SG/CD      |
| 140-500F (-100 To +100C)   | SAE 10W-30 Or 10W-40 API SG/CD      |
| Less Than 500F (100C)      | SAE 5W-30 Or 5W-40 API SG/CD        |
| Power Steering Fluid       | VW Hydraulic Oil G-002-000          |
| Manual Transaxle           | Hypoid Gear Oil SAE 75W-90 API GL-4 |
|                            | Or SAE 75W-90 (G50 Synthetic)       |
| Final Drive (A/T & M/T)    |                                     |
| (Differential)             | SAE 75W-90 (G50 Synthetic Gear Oil) |
| Wheel Bearings             | NLGI Grade 2 Category GC-LB         |
| Drive Shaft U-Joints       | NLGI Grade 2 Category GC-LB         |
| Steering Linkage (2)(3)    | NLGI Grade 2 Category GC-LB         |
| Ball Joints (2)(4)         | NLGI Grade 2 Category GC-LB         |
| Weatherstrip               | Dielectric Silicone Grease          |

- (1) - SAE 15W-40 or 20W-40 engine oil is recommended for extreme conditions or extended highway operation.
- (2) - Use low pressure grease gun to prevent seal damage.
- (3) - Fill until lubricant squeezes out from the base of seals.
- (4) - Fill ball joint until seal starts to swell.

~~~~~

SCHEDULED SERVICES - GASOLINE

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FLUID CAPACITIES

FLUID CAPACITIES TABLE

AA

Application	Quantity (1)
-------------	--------------

A/C System R-12 Refrigerant	29-35 Ozs.
-----------------------------------	------------

Cooling System

Diesel	6.9 Qts. (6.5L)
--------------	-----------------

Gasoline	5.2 Qts. (5.0L)
----------------	-----------------

Engine Oil (2)	4.7 Qts. (4.5L)
----------------------	-----------------

Fuel Tank

Diesel

Jetta	10.5 Gals. (40.0L)
-------------	--------------------

Pickup	15 Gals. (56.8L)
--------------	------------------

Rabbit	11 Gals. (41.5L)
--------------	------------------

Gasoline

Convertible	10.5 Gals. (40.0L)
-------------------	--------------------

Jetta	10.5 Gals. (40.0L)
-------------	--------------------

Pickup	15 Gals. (56.8L)
--------------	------------------

Rabbit	10 Gals. (38.0L)
--------------	------------------

Automatic Transaxle

Fluid Change	3.2 Qts. (3.0L)
--------------------	-----------------

Dry Fill	5.9 Qts. (5.6L)
----------------	-----------------

Final Drive (Differential)

A/T (3)	0.8 Qt. (.75L)
---------------	----------------

Manual Transaxle (4)	2.0 Qts. (1.9L)
----------------------------	-----------------

(1) - Capacities are recommended or calculated levels. Always use dipstick (if available) to measure level.

(2) - Includes filter change.

(3) - Lifetime fill.

(4) - Single case includes manual transaxle & differential.

AA

END OF ARTICLE

SERVICE INDICATOR & WARNING LIGHTS

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ARTICLE BEGINNING

1983-88 MAINTENANCE

Volkswagen Service Indicator & Warning Lights

Quantum, Quantum Syncro, Quattro

SERVICE INDICATOR & WARNING LIGHTS

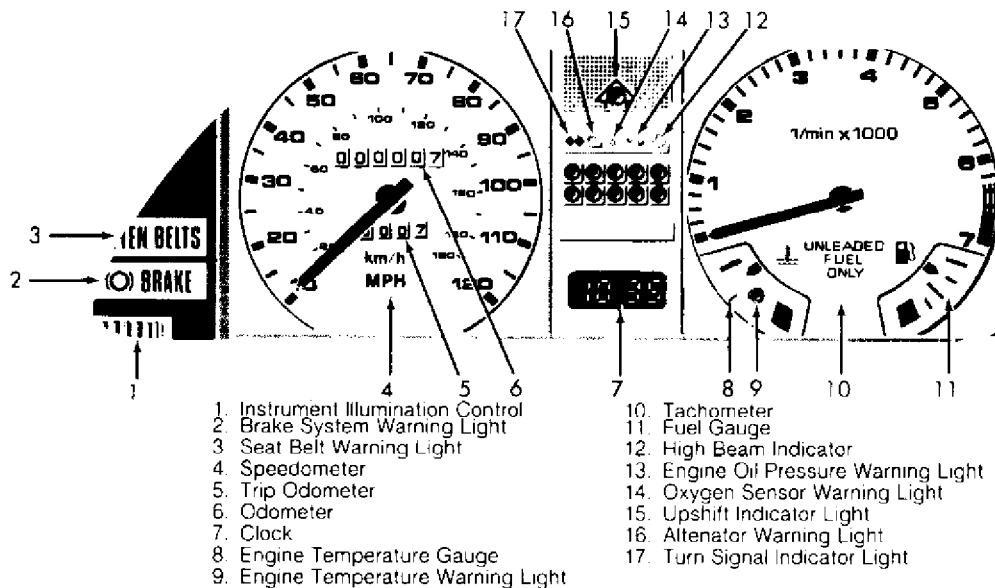


Fig. 1: Dash Gauges & Warning Lights
Courtesy of Volkswagen United States, Inc.

The warning lights come on for a function test when the ignition is switched on and should go out once the engine has started.

"BRAKE" INDICATOR LIGHT

Indicates the brake fluid level is low in the reservoir or the parking brake is still on.

HIGH BEAM INDICATOR LIGHT

Light indicates that the head light high beam is on.

TURN SIGNAL INDICATOR LIGHTS

Indicate signal operation and direction.

SEAT BELT WARNING LIGHT

The warning light stays on until the driver's seat belt is fastened.

SERVICE INDICATOR & WARNING LIGHTS

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ALTERNATOR WARNING LIGHT

Light comes on if alternator is not charging.

REAR WINDOW DEFOGGER INDICATOR

Indicates the rear defogger is on.

EMERGENCY FLASHER INDICATOR

Indicates the emergency flashers are in operation.

"ECS" MALFUNCTION WARNING (IF EQUIPPED)

Warns of a malfunction in the emission control system.

OIL PRESSURE WARNING LIGHT

Indicates no, or low, oil pressure.

COOLANT TEMPERATURE & LEVEL WARNING (IF EQUIPPED)

Warns of excessive engine coolant temperature or low coolant level in system.

"ABS" WARNING LIGHT

Warns of a malfunction in the anti-lock brake system.

GLOW PLUG/WATER SEPARATOR WARNING (DIESEL)

Indicates glow plug function and, when flashing, the need to drain the water separator.

"OXS" OXYGEN SENSOR LIGHT

Indicates service due on emission control system.

END OF ARTICLE

STARTER - BOSCH

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ARTICLE BEGINNING

1987 Starters
BOSCH

Volkswagen

DESCRIPTION

Starter is a brush type, series wound electric motor with an overrunning clutch. Field frame is enclosed by commutator end frame and drive bushing and carries pole shoes and field coils. A spline armature shaft drive end carries drive assembly. Armature shaft is supported at both ends by sintered bronze bushings.

TROUBLE SHOOTING

STARTER DOES NOT CRANK ENGINE

1) Ensure battery is fully charged. Make sure electrical and ground connections are clean and tight. With ignition switch in crank position, measure voltage at spade terminal of starter solenoid. If reading is at least 8 volts (9.5 on Fox), go to step 3).

2) If not, measure voltage at ignition switch. If reading is at least 8 (9.5 on Fox) volts, check wiring between ignition switch and starter solenoid. If not, replace ignition switch.

3) Measure voltage at field (starter) terminal of starter solenoid. If reading is at least 8 volts, repair or replace starter. If not, replace starter solenoid.

NOTE: On vehicles with automatic transmissions, also check park/neutral switch.

STARTER TURNS TOO SLOWLY

Ensure engine crankcase is filled with recommended viscosity oil. Check charging system to ensure battery is fully charged. Make sure electrical and ground connections are clean and tight. If starter still turns slowly, repair or replace starter.

TESTING

STARTER LOAD (LOCK) TEST

With starter on test bench, lock starter drive pinion. Voltmeter and ammeter readings should be within specification.

STARTER NO LOAD TEST

With starter on test bench, operate starter and check ammeter, voltage, and RPM. Readings should be within specification.

STARTER - BOSCH

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REMOVAL & INSTALLATION

NOTE: Only difficult starter removal and installation procedures are covered in this article.

VOLKSWAGEN

Fox

Disconnect negative battery cable. Support engine/transmission assembly with Support Beam (VW 10-222). Remove engine mount bolts, nut, and clamp screw (next to exhaust manifold flange). Remove engine mount. Disconnect wiring and remove starter. To install, reverse removal procedure.

OVERHAUL

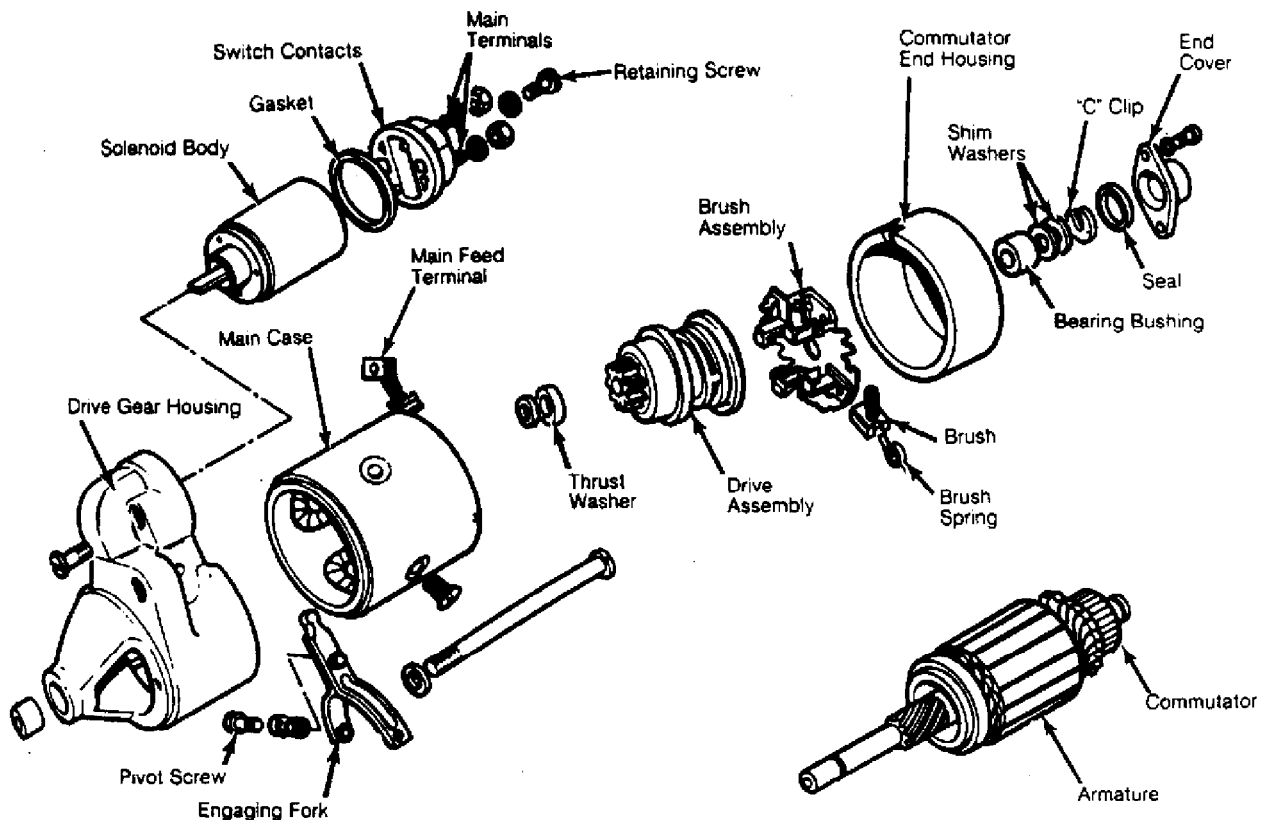


Fig. 1: Exploded View of Typical Bosch Starter

END OF ARTICLE

STEERING COLUMN

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ARTICLE BEGINNING

1987 STEERING
Volkswagen - Steering Columns

Quantum

DESCRIPTION

The Quantum uses a 2-piece collapsible steering column. A flange connects lower and upper column.

REMOVAL & INSTALLATION

STEERING COLUMN

CAUTION: Steering column is designed to be collapsible upon frontal impact. Applying excessive pressure, or causing impact to mainshaft during service, may cause the column to collapse.

Removal

1) Disconnect battery ground cable. Remove steering wheel and combination switch. From inside engine compartment, remove clamp bolt retaining steering shaft clamp to steering gear pinion shaft. Remove column cover bolts and steering column covers. See Fig. 1.

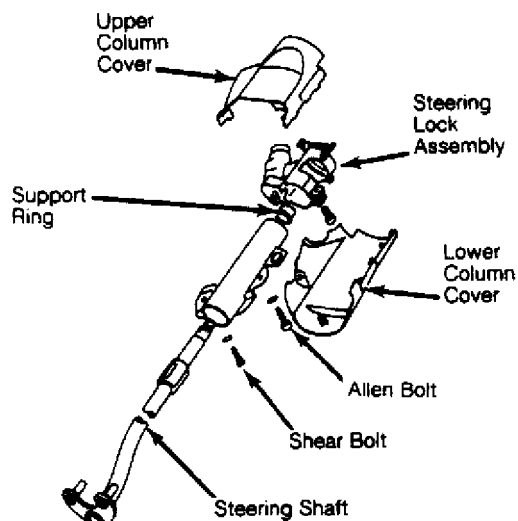


Fig. 1: Exploded View of Upper Steering Column

2) Pry lock washer from steering shaft. Remove spring. Remove contact ring and steering lock assembly. Remove support ring from column tube. See Fig. 1.

3) Punch and drill out shear bolt retaining column tube to dash. Remove Allen bolt. Remove dust boot from floorboard. Remove steering column tube and shaft as an assembly.

STEERING COLUMN

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Installation

1) Install assembled steering column into vehicle. Install shear bolt and Allen bolt finger tight. Fit dust boot into floorboard. Place clamp onto steering gear pinion shaft.

2) Place support ring into column tube. Install steering lock assembly onto steering column. Install contact ring, spring and new lock washer. Tighten Allen bolt. Tighten shear bolt until head snaps off.

3) Install upper and lower column covers. Install column switches and steering wheel.

OVERHAUL

STEERING COLUMN

Disassembly

1) Remove lower flange tube clamp bolt from lower steering shaft. Separate flange tubes and remove bearing flange, bearing, support ring, spring and washer. See Fig. 2.

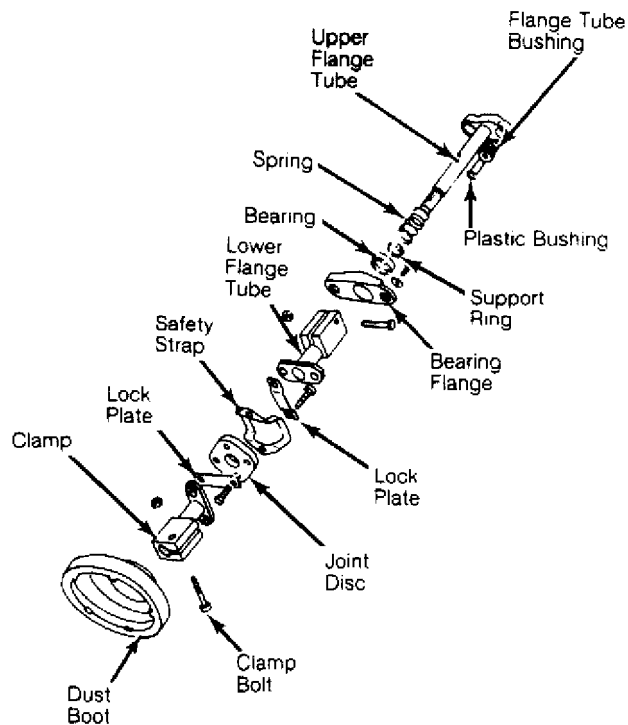


Fig. 2: Exploded View of Lower Steering Column

2) Push upper flange tube toward steering shaft until components can be separated. Remove flange tube bushings with plastic bushings. See Fig. 2. Remove joint disc bolts and pinion clamp bolt. Slide column tube from steering shaft. See Fig. 1.

Inspection

Check joint disc, safety strap and lock plates for damage

STEERING COLUMN

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or wear. Check steering shaft, support ring and steering lock assembly for wear or damage. Replace components as necessary.

Reassembly

To reassemble steering column, reverse disassembly procedure. Press flange tube bushing and plastic bushing in by hand.

TORQUE SPECIFICATIONS TABLE

Application		Ft. Lbs. (N.m)
Allen Bolt		15 (20)
Clamp Bolt		22 (30)
Lock Plate Bolts		18 (24)
Lower Flange Tube Bolt		22 (30)
Steering Wheel Retaining Nut		29 (39)

END OF ARTICLE

STEERING COLUMN SWITCHES

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ARTICLE BEGINNING

1987 STEERING

Volkswagen - Steering Wheel & Column Switches

All Models

REMOVAL & INSTALLATION

* PLEASE READ THIS FIRST *

CAUTION: When performing work on vehicles equipped with Supplemental Restraint System (SRS), exercise extreme caution when working around steering wheel or column. DO NOT apply electrical power to any component on steering column without disconnecting SRS control unit (air bag system may be activated).

STEERING WHEEL & HORN

Removal

1) Disconnect battery ground cable. Remove screws attaching horn button assembly/center pad to steering wheel from behind steering wheel (if equipped).

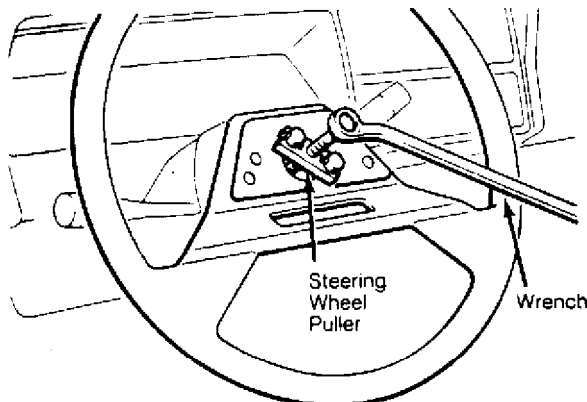


Fig. 1: Removing Steering Wheel

2) Pull horn button assembly/center pad from steering wheel. Use a cloth covered screwdriver to pry off horn button assembly/center pad (if necessary). Disassemble horn button assembly (if necessary).

3) Place springs, contacts, horn or cruise control harness connectors and screws in order for reassembly reference. Place wheels in a straight-ahead position.

STEERING COLUMN SWITCHES

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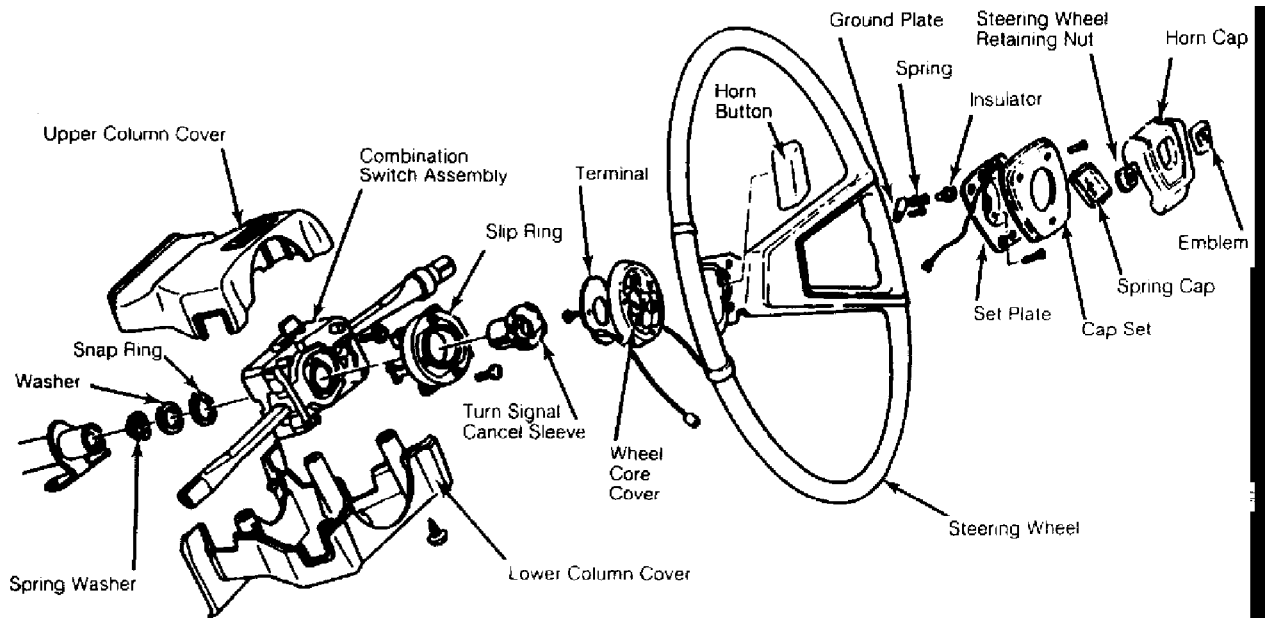


Fig. 2: Exploded View of Typical Steering Wheel Assembly

4) Remove steering wheel retaining nut and washer. Mark steering wheel and shaft for reassembly reference. Using a steering wheel puller, remove steering wheel. See Fig. 1.

5) Place steering wheel, cruise control set/resume switch (if equipped), canceling cams, springs and slip rings in order for reassembly reference.

Installation

1) Coat slip ring contact surfaces with a light electrical grease. Assemble horn button assembly (if disassembled). Ensure wheels are in a straight-ahead position.

2) Aligning marks made during removal, place slip ring, springs, canceling cams, steering wheel, washer and steering wheel retaining nut on shaft.

3) Tighten nut to specification. See STEERING WHEEL TORQUE SPECIFICATIONS table at the end of this article. To complete reassembly, reverse removal procedure.

COMBINATION SWITCH

Removal

Remove steering wheel. Remove upper and lower steering column covers. Disconnect combination switch harness connectors. remove snap ring and washer from steering shaft (if equipped). Remove combination switch attaching screws. Remove combination switch.

Installation

To install, reverse removal procedure. Ensure all electrical connections are tight. Check canceling operation of turn signal switch.

STEERING COLUMN SWITCHES

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STEERING LOCK & IGNITION SWITCH

Removal

1) Remove steering wheel, upper and lower steering column covers and combination switch. Disconnect ignition switch harness connectors.

2) If the shear bolt studs are accessible, use a hacksaw to cut a slot into the exposed studs. Using a screwdriver, remove the studs.

3) If the shear bolt studs are recessed or hard to reach with a hacksaw, center punch studs. Using a drill bit and a screw extractor, remove studs. Remove steering lock and ignition switch.

Installation

1) To install, reverse removal procedure. Install new shear bolts. Tighten shear bolts finger tight. Ensure proper operation of steering lock and ignition switch.

2) Tighten shear bolts until heads break off. Install combination switch, upper and lower steering column covers and steering wheel.

TORQUE SPECIFICATIONS

STEERING WHEEL TORQUE SPECIFICATIONS TABLE

Application		Ft. Lbs (N.m)
All Except Quantum		37 (50)
Quantum		29 (39)

END OF ARTICLE

STEERING GEAR - MANUAL

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ARTICLE BEGINNING

1987 STEERING

Volkswagen - Steering Gears & Linkage - Rack & Pinion

Cabriolet, Fox, Golf, Jetta, Quantum/Syncro, Scirocco

DESCRIPTION

Steering gear is a rack and pinion type. Tie rods connect steering knuckles to ends of rack. Racks are mounted with "U" bolts and rubber bushings.

ADJUSTMENTS

RACK & TIE RODS

- 1) Center rack in housing so rack protrudes an equal amount from each end of rack housing.
- 2) If replacing the non-adjustable left tie rod with an adjustable type, adjust tie rod length "D" to 14.92" (379 mm). Screw tie rods onto rack.
- 3) Adjust to specified dimensions without moving rack from center position. Dimensions "B" and "C" should be 2.77" (70.5 mm) for all models.
- 4) When measurements are correct, secure tie rods with lock nuts. Install rubber boots. See Fig. 1.

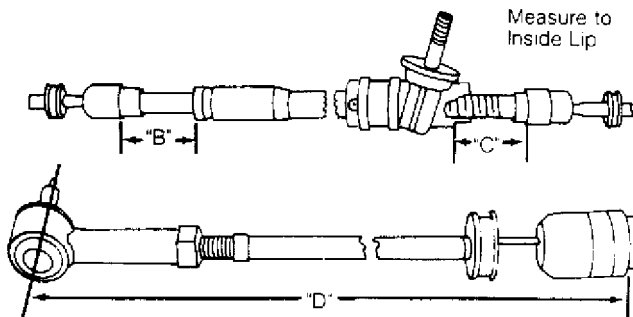


Fig. 1: Installation Adjustment of Tie Rods on Rack

STEERING DRIVE

Loosen pinion shaft adjusting screw lock nut. Turn adjusting bolt until it just contacts thrust washer. Tighten lock nut. Test drive vehicle. Readjust if steering is too heavy or too loose.

REMOVAL & INSTALLATION

STEERING GEAR

STEERING GEAR - MANUAL

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Removal

1) Disconnect shift linkage bearing plate from steering gear housing. Loosen lower "U" joint pinch bolt. Separate steering shaft with lower "U" joint from pinion.

2) Remove tie rod end cotter pins and castle nuts. Using a tie rod end puller, separate tie rod ends from steering knuckles. Remove steering gear clamp bolts. Remove steering gear with tie rods attached.

Installation

1) To install, reverse removal procedure. Correctly align and insert pinion shaft with steering shaft lower "U" joint before tightening steering gear clamp bolts.

2) Connect tie rod outer ends to steering knuckles. Tighten upper and lower universal joint pinch bolts. Connect and adjust shift linkage bearing plate to housing.

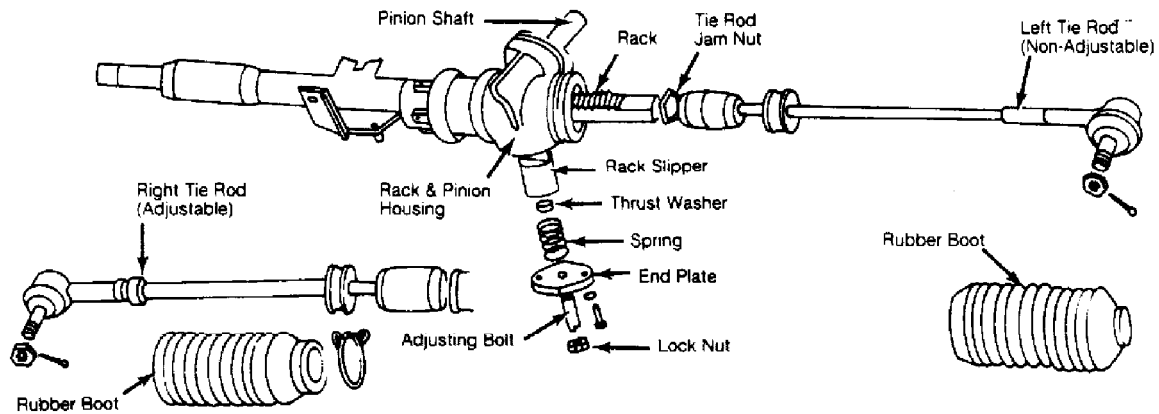


Fig. 2: Exploded View of Rack & Pinion Steering Gear Assembly

OVERHAUL

STEERING GEAR

Overhaul procedures for steering gear are not available from manufacturer. Replace as an assembly if damaged or worn.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS TABLE

Application Ft. Lbs. (N.m)

Gear Box Housing-to-Frame Nuts	22 (30)
Tie Rod End Lock Nut	37 (50)
Tie Rod End Castle Nuts	26 (35)
Tie Rod-to-Rack	52 (70)
"U" Joint-to-Pinion Shaft Clamp Bolts	22 (30)

AAAAA

STEERING GEAR - MANUAL

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STEERING SYSTEM - POWER

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ARTICLE BEGINNING

1987-88 STEERING

Volkswagen - Power-Assisted Rack & Pinion

1987; Cabriolet, GTI, Jetta GLI, Quantum, Quantum Syncro,
Scirocco, Vanagon

1987-88; Jetta, Golf

DESCRIPTION

The system consists of a vane pump, rotary piston pinion gear assembly and an oil reservoir. The vane pump draws fluid from the reservoir and supplies it to the flow control valve. The control valve supplies fluid to the proper side of the rack-piston.

LUBRICATION

CAPACITY

Fluid capacity is 1 qt. (.95L).

FLUID TYPE

Recommended fluid type is ATF Dexron II.

FLUID LEVEL CHECK

Remove reservoir cover. Start engine and let idle. Fluid level should be at mark on upper inside of reservoir.

HYDRAULIC SYSTEM BLEEDING

1) Start engine and let idle. Ensure fluid is at proper level. Turn steering wheel lock-to-lock several times quickly.

2) Continue until fluid level remains at reservoir mark. Ensure no bubbles appear in reservoir when steering wheel is turned. Shut off engine. Ensure oil level does not rise more than 3/8" above mark.

OIL FILTER REPLACEMENT

Remove outer cover, gasket and spring from reservoir. Remove inner filter cover and filter insert. Install new filter, replace filter cover, spring, gasket, and top cover. Check fluid level.

NOTE: Oil filter insert must be replaced whenever repairs are made to power steering system.

STEERING SYSTEM - POWER

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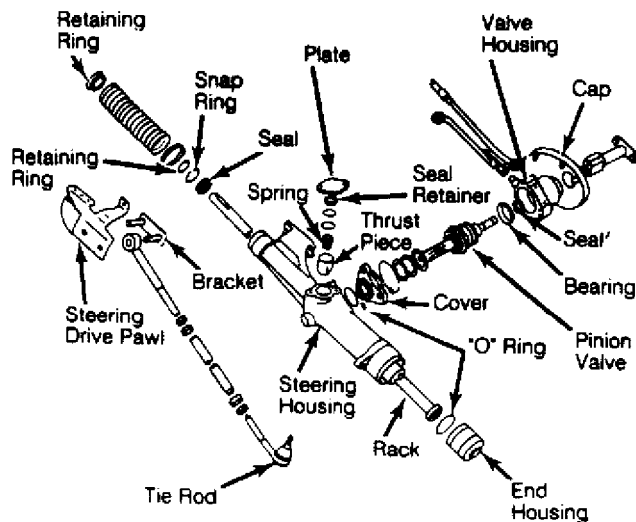


Fig. 1: Exploded View of Power Steering Gear
Courtesy of Volkswagen United States, Inc.

ADJUSTMENTS

BELT TENSION

Loosen nuts on pump mounting bracket. Turn adjusting bolt on bracket until belt deflection is 3/8" at center of belt. Tighten nuts to specification.

STEERING GEAR

With steering gear removed from vehicle, loosen lock nut on steering gear. Finger tighten adjusting screw until it just touches thrust plate. Hold adjusting screw while tightening lock nut. Rack should be able to be moved by hand without binding. Readjust if necessary.

TESTING

SYSTEM PRESSURE TEST

1) Install Pressure Gauge (US1074 B) between pressure hose and pressure pipe of valve housing. Open pressure gauge valve. Run engine at idle. Turn steering wheel lock-to-lock several times.

2) On Quantum, pressure is 986-1189 psi (69-84 kg/cm²). On all others, pressure is 1100-1200 psi (77.83-84.36 kg/cm²). If pressure is not within limits, check pump pressure. If pump is good, replace steering gear.

PUMP PRESSURE TEST

1) Install pressure gauge. Start engine and let idle. Close valve (for no longer than 5 seconds). On Quantum, pressure is 986-1189

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psi (69-84 kg/cm²). On all others, pressure is 1100-1200 psi (77.83-84.36 kg/cm²).

2) If pressure is not to specification, check limiting valve by inspecting bores in valve and piston for obstructions. Ensure piston moves freely in housing. Install new valve if necessary.

LEAK TEST

1) With engine idling, turn steering wheel to full lock and hold in position. Inspect all connections and tighten if necessary. If leak shows at steering pinion, replace housing seal and both intermediate cover seals.

2) If pinion shaft seal is leaking, fluid has entered gear housing. Check for fluid by loosening outer clamp on right steering boot and pushing boot in. If seal is leaking, disassemble steering gear and replace all seals.

REMOVAL & INSTALLATION

STEERING GEAR

Removal

1) Drain fluid from system. Disconnect hydraulic pipes from valve housing. Disconnect lower steering shaft from pinion shaft. Disconnect tie rods from bracket.

2) Remove steering gear-to-body bolts. On all except Quantum, remove rear motor/transmission mount and exhaust pipe. Remove steering gear.

Installation

To install, reverse removal procedure. To install tie rods, install one tie rod to steering gear and tighten before installing the other tie rod.

POWER STEERING PUMP

Removal

Remove alternator and pump belts. Disconnect hydraulic lines from pump. Cap lines to prevent contamination. Remove bracket bolts. Remove pump.

Installation

To install, reverse removal procedure. Adjust belt tension. Start engine and check for leaks.

OVERHAUL

Before disassembling steering gear, check output and system pressure. When overhauling steering gear, always use all parts in Repair Kit (811 498 020). Always use new self-locking nuts and "O" rings.

On all models except Quantum and Quantum Syncro,

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manufacturer recommends replacement of steering gear if pinion or piston-rod seals are leaking.

PINION HOUSING SEAL

Disassembly (Quantum & Quantum Syncro)

1) Remove retaining bolts from pinion valve housing. Remove housing. Mark position of pinion gear for reassembly reference.

2) Remove pinion gear and intermediate cover. Remove "O" rings from intermediate cover. Place housing in padded vise. Drive out oil seal from back.

Inspection

Inspect seal mating surfaces for pitting or scoring. Check pinion and pinion valve surfaces for scratching or pitting. Discard old seals. Replace worn parts as necessary.

Reassembly

Install new seals. Ensure seal lip on housing seal faces intermediate cover. Replace both intermediate cover "O" rings. To complete reassembly, reverse disassembly procedure. Protect pinion teeth on shaft when replacing intermediate cover. Do not damage "O" rings during installation.

STEERING GEAR

Disassembly (Quantum & Quantum Syncro)

1) With steering gear removed from vehicle, remove pinion valve housing. Remove pinion valve assembly. Remove plate, seal retainer, spring, and thrust piece from steering gear housing.

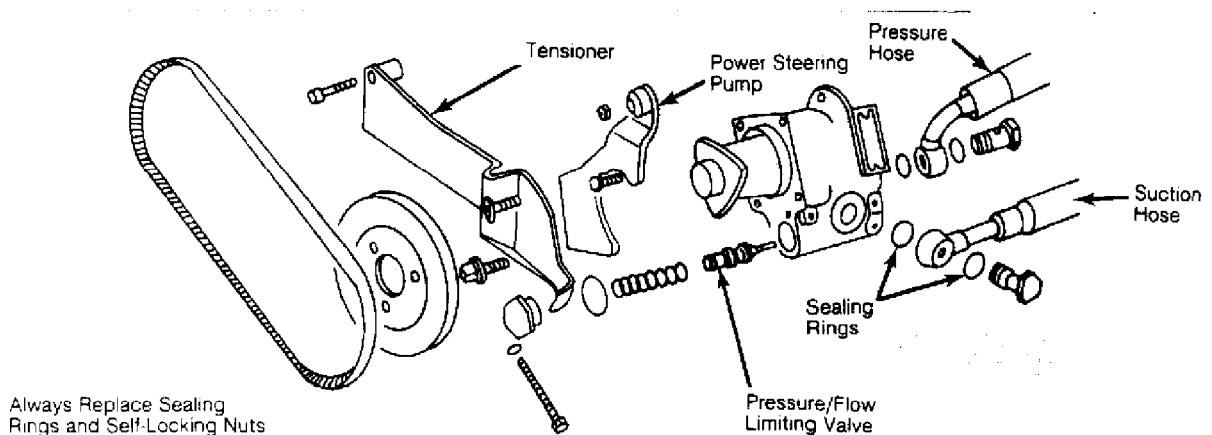


Fig. 2: Vane Pump Assembly
Courtesy of Volkswagen United States, Inc.

2) Remove retaining ring, clamp and boot from steering housing. Remove retaining ring and snap ring from steering gear housing.

3) Remove end housing and "O" ring from steering gear

STEERING SYSTEM - POWER

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housing. Pull rack out of housing. Using oil seal puller, remove oil seal from housing.

Reassembly

1) To install oil seal on housing, place oil seal on flat surface. Push sleeve (available in repair kit 811 498 020) into oil seal. Slide rack into housing.

2) Using Seal Installers (VW 426 and VW 4166), slide oil seal with sleeve over rack and into housing. Remove sleeve. Install snap ring and retaining ring.

3) Install end housing with new "O" ring. Lock in place with 2 punch marks 180 degrees apart. Install thrust piece, spring, "O" ring, seal retainer and plate. Install clamp, boot and retaining ring. Install pinion valve assembly as previously described.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS TABLE

AA

Application	Ft. Lbs. (N.m)
-------------	----------------

End Housing Bolt	37 (50)
------------------------	---------

Pressure-Flow Limiting Valve Cap	42 (57)
--	---------

Pressure Pipe Fitting	29 (39)
-----------------------------	---------

Return Pipe Fitting

On Pump	29 (39)
---------------	---------

On Valve Housing	22 (30)
------------------------	---------

Tie Rod-to-Steering Arm	32 (44)
-------------------------------	---------

Valve Housing Bolt	15 (20)
--------------------------	---------

AA

END OF ARTICLE

SUSPENSION - FRONT

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ARTICLE BEGINNING

1987 SUSPENSION
Volkswagen Front Suspension

Fox, Quantum & Scirocco

DESCRIPTION

Vehicles are equipped with front wheel drive and MacPherson strut independent front suspension. Wheel bearing housings and lower strut tubes are a one piece unit, and are supported by lower control arms. Tie rods are connected to lower strut tube, and stabilizer bar are connected to lower control arm. See Fig. 1.

ADJUSTMENTS & INSPECTION

WHEEL ALIGNMENT SPECIFICATIONS & PROCEDURES

See WHEEL ALIGNMENT SPECIFICATIONS & PROCEDURES in WHEEL ALIGNMENT section.

WHEEL BEARING

Wheel bearings are pressed into wheel bearing housing and no adjustment is required.

BALL JOINT CHECKING

Raise vehicle and support with safety stands. Inspect ball joints for damaged rubber boots and play. Maximum tolerance for ball joint play not available from manufacturer.

SUSPENSION - FRONT

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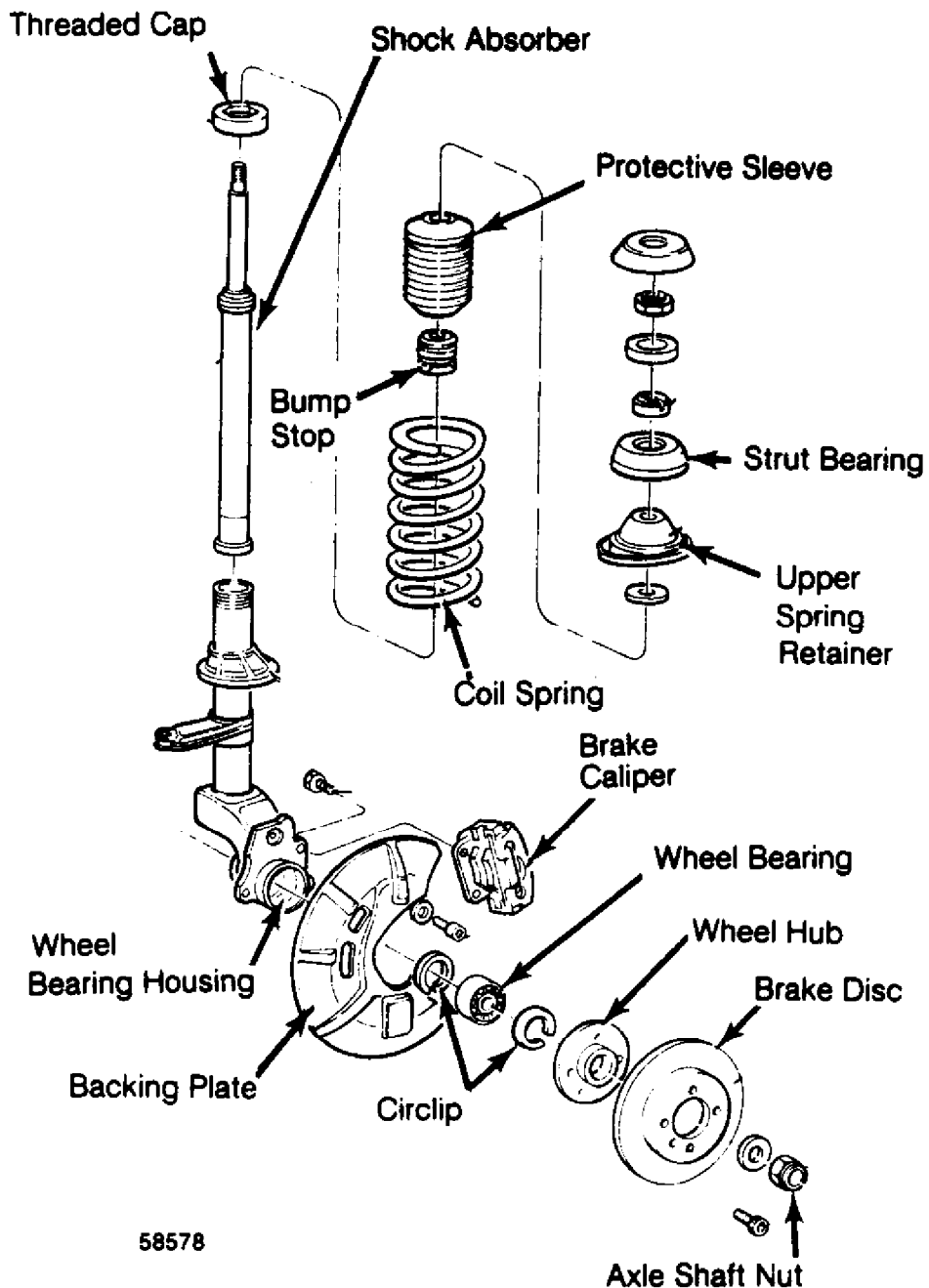


Fig. 1: Exploded View of Front Suspension
Courtesy of Volkswagen United States, Inc.

REMOVAL & INSTALLATION

WHEEL BEARING

NOTE: The wheel bearing is destroyed when pressed out of the housing. Once either the wheel hub or bearing has been removed from housing, a new bearing must be installed.

SUSPENSION - FRONT

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Removal

1) Remove axle shaft nut. Raise and support vehicle with safety stands and allow suspension to hang free. Remove wheel assembly. Remove brake caliper attaching bolts and brake hose bracket, remove caliper and hang out of way. Remove brake disc retaining screw and remove disc.

2) Remove tie rod ball joint from strut tube. Remove nut and clamp bolt from control arm ball joint. Remove stabilizer bracket nut from lower control arm. Remove control arm ball joint from wheel bearing housing and press out axle shaft from hub.

3) Support strut assembly to prevent it from falling. Remove upper strut mounting nut and remove wheel bearing housing and strut assembly.

4) Using Hub Remover (VW 295a), press wheel hub from bearing housing. Using a bearing puller, remove wheel bearing inner race from hub assembly. Remove circlips retaining bearing in hub. Using Bearing Remover (VW519), press wheel bearing out of outboard end of bearing housing.

Installation

1) Using Bearing Installer (40-20) and Housing Support (VW402), press new bearing into bearing housing from outboard side. Using same Housing Support and Hub Installer (VW519), press wheel hub into bearing housing. Apply a small bead approximately 1/4" of D6 locking compound to the axle splines before installing in hub. See Fig. 2.

NOTE: When installing hub, be sure that press adapter contacts ONLY the inner bearing race.

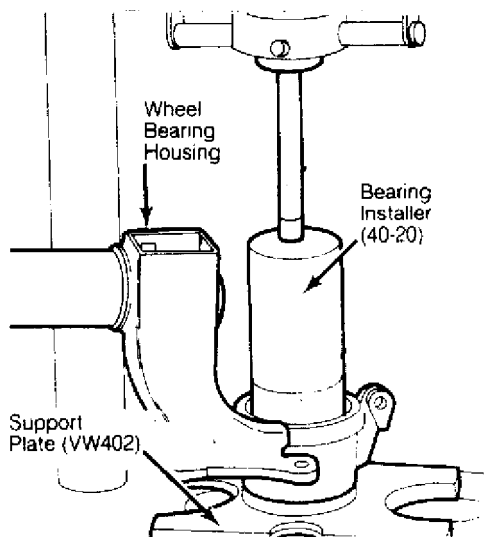


Fig. 2: Pressing Wheel Bearing
Courtesy of Volkswagen United States, Inc.

2) To complete installation, reverse removal procedure. Always replace self-locking axle shaft nut. Tighten all bolts and nuts to specification. See TORQUE SPECIFICATIONS table in this

SUSPENSION - FRONT

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article. Check wheel alignment.

LOWER CONTROL ARM & BALL JOINT

Removal

1) Raise vehicle and support with safety stands. Remove clamp bolt retaining ball joint to wheel bearing housing. Force ball joint out of housing, (ball joint can be replaced while control arm is in vehicle). Leave control arm hanging in mounts at subframe.

2) If control arm is not being removed, remove ball joint clamp bolt and nut and remove ball joint from wheel bearing housing by pressing down on lower control arm. Remove ball joint-to-control arm nuts and remove ball joint.

3) If control arm is being removed, remove stabilizer bar link rod nut, washers and bushings. Remove control arm pivot bolts and nuts and remove lower control arm

Installation

Slide new ball joint into slot in control arm. Install and tighten ball joint retaining bolts. Install lower control arm to subframe. Install ball joint into wheel bearing housing. To complete installation, reverse removal procedure. Tighten control arm pivot bolts with vehicle resting on ground. Tighten all bolts and nuts to specification. See TORQUE SPECIFICATIONS table in this article. Check wheel alignment.

STRUT ASSEMBLY & SHOCK ABSORBER

Removal

1) Remove axle shaft nut. Raise vehicle and support with safety stands allowing suspension to hang free. Remove wheel assembly. Remove caliper mounting bolts and brake hose bracket. Remove caliper and hang out of way. Remove brake disc retaining screw and remove disc.

2) Remove ball joint clamp bolt and nut from wheel bearing housing and press down on control arm to separate ball joint from housing. Press out axle shaft from hub. Support strut assembly to prevent from falling. Remove strut upper mount nut and remove strut.

Disassembly

1) Install strut to spring compressor. Slightly collapse coil spring. Remove shock absorber piston rod nut. Slowly release spring pressure. Remove upper retaining hardware and coil spring.

2) Place strut assembly in a holding fixture. Remove shock absorber threaded cap and remove shock absorber from strut tube. Drain any oil that may be in strut tube.

Reassembly

1) Install shock absorber in strut tube and install and tighten threaded cap. Install protective sleeve and bump stop over piston rod. Both coil springs must be of same class. If set cannot be matched, both springs will have to be replaced. Springs are color

SUSPENSION - FRONT

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coded.

2) Position coil spring into lower spring seat. Install the upper spring retainer. Fit entire assembly into spring compressor and collapse coil spring until all the threaded portion of piston rod is exposed.

3) Install bearing, rubber bumper and remaining upper retaining components. Hold piston rod and tighten piston and lock nut.

Installation

To install, reverse removal procedure. Tighten all bolts and nuts to specification. Check wheel alignment.

FRONT SUSPENSION ASSEMBLY

Removal

1) Raise vehicle and support at center with safety stands. Disconnect brake line, leave flex line in place, and plug openings. Remove stabilizer link rod nut, bushings and washers.

2) Remove tie rod nut. Separate tie rod from wheel bearing housing. Remove bolts retaining inner portion of constant velocity joint to transaxle drive flange.

3) Remove lower control arm front pivot bolts. Support suspension assembly being removed. Remove upper strut retaining nuts, (located in engine compartment). Remove suspension assembly from vehicle.

Installation

To install, reverse removal procedure. Tighten control arm pivot bolts with vehicle resting on ground. Tighten all bolts and nuts to specification.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS TABLE

XX

Application	Ft. Lbs. (N.m)
-------------	----------------

Axle Nut	170 (230)
----------------	-----------

Axle Shaft-to-Transaxle Bolt	32 (44)
------------------------------------	---------

Ball Joint Clamp Bolt	48 (65)
-----------------------------	---------

Ball Joint-to-Control Arm Bolt	48 (65)
--------------------------------------	---------

Caliper Pin Bolts	18 (24)
-------------------------	---------

Control Arm Pivot Bolts	44 (60)
-------------------------------	---------

Strut Upper Mount Nut	44 (60)
-----------------------------	---------

Tie Rod Castle Nut	22 (30)
--------------------------	---------

Wheel Lug Bolt	81 (110)
----------------------	----------

XX

END OF ARTICLE

SUSPENSION - REAR (4WD)

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ARTICLE BEGINNING

1987 Rear Suspension
VOLKSWAGEN

Quantum/Quantum Syncro

DESCRIPTION

Suspension is an independent system using lower control arms, strut assemblies, and a stabilizer bar. See Fig. 1.

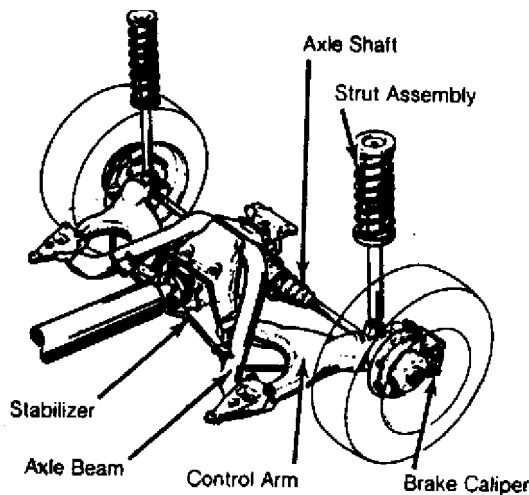


Fig. 1: Quantum Syncro Rear Suspension
Courtesy of Volkswagen United States, Inc.

ADJUSTMENTS & INSPECTION

WHEEL ALIGNMENT SPECIFICATIONS & PROCEDURES

See WHEEL ALIGNMENT SPECIFICATIONS & PROCEDURES in WHEEL ALIGNMENT section.

WHEEL BEARING

Wheel bearings are not adjustable.

REMOVAL & INSTALLATION

WHEEL BEARING

Removal

- 1) Remove control arm. See CONTROL ARM section in this article.
- 2) Remove splash shield screws and shield. Press out wheel hub using Housing Support (3110) and Press Adapters (VW-295) and

SUSPENSION - REAR (4WD)

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(VW-295a). Using snap ring pliers, remove 2 snap rings. Press out wheel bearing using housing support and Press Adapter (40-20).

Installation

1) Install new snap ring in hub and coat bearing surface with grease. Press in new bearing using same tools as pressing out. Install snap ring. Press wheel hub into bearing using Support Plate (VW-402), Bearing Support (VW-519), and Press Adapters (VW-411) and (VW-432).

2) To complete installation, reverse removal procedure. Always replace axle shaft self-locking nut. Tighten all bolts to specification. See TIGHTENING SPECIFICATIONS table.

STRUT ASSEMBLY

Removal

1) With vehicle on floor, remove upper strut plastic cap and remove strut attaching nuts.

2) Slowly raise vehicle until weight is off spring. Remove lower strut mounting bolt. Remove strut.

Disassembly

Place strut assembly in vice. Hold piston rod and remove nut and take off components, spacer and coil spring.

Reassembly

To assemble, reverse disassembly procedure.

Installation

To install, reverse removal procedure. Tighten all bolts to specification.

CONTROL ARM

Removal

1) Remove hub cover and axle nut. Raise and support vehicle. Remove wheel assembly, brake caliper mounting bolts and caliper. Remove brake disc.

2) Support control arm with floor jack and remove lower strut mounting bolt. Remove stabilizer bracket and 2 control arm pivot bolts. Support axle shaft and lower control arm slightly to allow control arm to be pulled off axle shaft.

Installation

To install, reverse removal procedure. Tighten axle shaft nut and control arm pivot bolts to specification with vehicle on ground. Always replace axle shaft self-locking nut.

END OF ARTICLE

SUSPENSION - REAR (FWD)

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ARTICLE BEGINNING

1987 Rear Suspension
VOLKSWAGEN

Quantum, Quantum Syncro

DESCRIPTION

Rear suspension is link type with MacPherson type suspension struts. Suspension uses control arms and axle beam for stabilization. Control arms and axle beam are combined as one unit. Brake drums or discs ride on stub axles bolted to control arms. See Fig. 1.

ADJUSTMENTS & INSPECTION

WHEEL ALIGNMENT SPECIFICATIONS & PROCEDURES

See WHEEL ALIGNMENT SPECIFICATIONS & PROCEDURES in WHEEL ALIGNMENT section.

WHEEL BEARING

Tighten hub nut to 7.5 ft. lbs. (10 N.m), while rotating brake drum by hand. Determine the bearing play by testing the force needed to move thrust washer. Light pressure should move thrust washer. Turn hub nut until correct pressure is obtained.

REMOVAL & INSTALLATION

STRUT ASSEMBLY

NOTE: DO NOT remove both suspension struts at same time as this would overload bushings in axle beam.

Removal

1) With vehicle on floor, take off plastic cap covering strut upper retaining nuts and remove nuts.

2) Slowly raise vehicle until weight is off spring. Remove bolt retaining lower end of strut shock absorber to axle beam mount. Raise vehicle until strut can be removed.

Disassembly

Place strut assembly in vise. Hold piston rod and remove strut retaining nut. Take off components down to slotted nut. Remove slotted nut. Take off spacer and coil spring.

NOTE: Some models do not have the slotted nut on shock absorber shaft.

Inspection

SUSPENSION - REAR (FWD)

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Hand check shock absorbers for even resistance through entire piston stroke. Worn shock absorbers cannot be overhauled. If coil spring is being replaced, ensure that paint stripe color code on replacement spring matches original spring code.

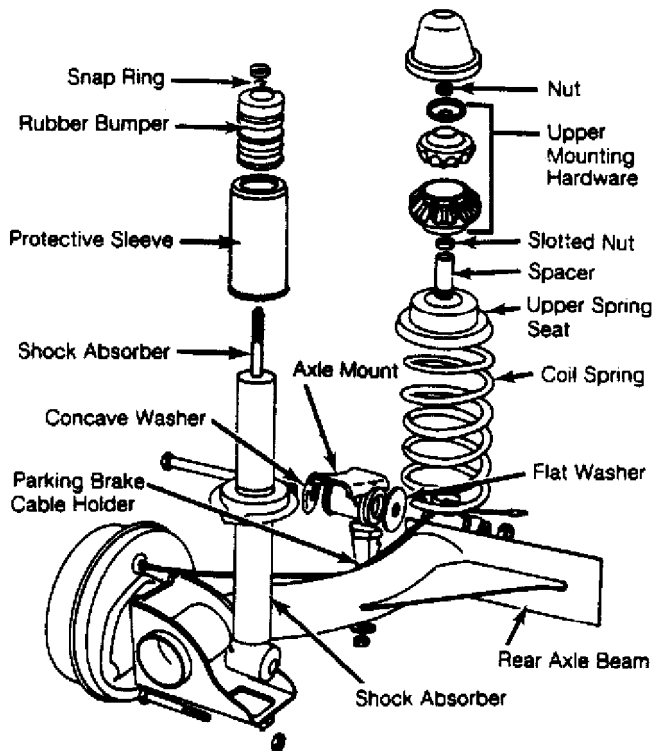


Fig. 1: Exploded View of Rear Suspension Components
Courtesy of Volkswagen United States, Inc.

Reassembly

1) Fit protective cap and tube on shock absorber. Install rubber buffer, with small diameter end downward. Insert snap ring and washer.

2) Place spring into lower seat. Fit upper retainer with spacer sleeve. Tighten slotted nut retaining piston rod. Put on upper mounting hardware and tighten piston rod.

Installation

To install, reverse removal procedure. Tighten all bolts and nuts to specification. See TIGHTENING SPECIFICATIONS table in this article.

SUSPENSION ASSEMBLY

Removal

1) With vehicle on floor, disconnect upper strut mount. Raise vehicle and support with safety stands.

2) Disconnect parking brake at holder near axle mount. Disconnect and plug brake lines. Leave flex hose attached to suspension.

SUSPENSION - REAR (FWD)

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3) Separate brake pressure regulator spring from axle beam (if equipped). Remove both nuts retaining axle beam on each side to body.

NOTE: Do not install bolts and nuts coated with undercoating wax. With waxy coating on threads, true torque tightening cannot be reached. Clean or replace bolts and nuts.

Installation

1) If axle beam mounting has been removed, adjust mounting pad. See Fig. 2. If pad is not correctly aligned, torsional preload of mounting bushings will be incorrect.

2) Position rear suspension on body. Install nuts retaining axle beam to body. Raise wheel and guide upper end of strut into body mount.

3) Connect parking brake cables. Connect brake lines. Lower vehicle and tighten upper strut retaining nuts. Tighten all bolts and nuts to specification. Bleed brake system.

AXLE BEAM PIVOT BUSHING

Removal

1) This procedure is for replacing bushing with axle beam installed in vehicle. Raise vehicle and support with safety stands under vehicle body.

2) With no pressure on beam, remove nuts retaining axle beam to body and tap out pivot bolt.

3) Using Bushing Remover (VW 3111), press out bushing. Select new bushing and press bushing into place.

Installation

1) Loosely install mounting pad on axle beam. On Quantum models, use Bushing Installer (VW 3111) to install bushing (with power tool if possible). Install bushing to a depth of 2.42-2.44" (61.5-62.0 mm). Concave washer and bolt head must face toward outside of vehicle. Bolt head must recess into washer.

2) Using Mounting Bracket Aligner (VW 261 or 3021), align mount. See Fig. 2. Tighten pivot bolt nut to specification with vehicle on ground.

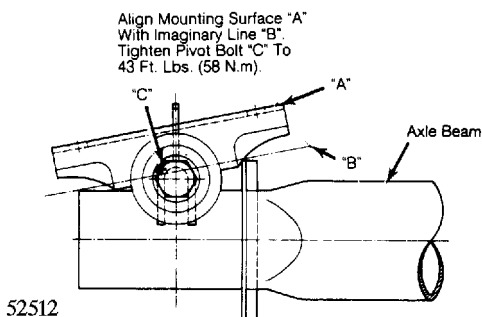


Fig. 2: Correct Alignment of Axle Beam Mounting Pad
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TORQUE SPECIFICATIONS

TIGHTENING SPECIFICATIONS TABLE

Application Ft. Lbs. (N.m)

Brake Caliper Bolts	48 (65)
Coil Spring Retainer-to-Piston Rod Nut	11 (15)
Rear Axle Beam Pivot Bushing Bolt	43 (58)
Rear Axle Mounting Pad-to-Body Bolts	63 (85)
Shock Absorber-to-Axle Beam Nut	52 (70)
Shock Absorber-to-Body Bolt	26 (35)
Shock Absorber Slot Nut	15 (20)
Stub Axle-to-Control Arm Bolts	44 (60)
Wheel Lug Bolts	81 (110)

END OF ARTICLE

SYSTEM WIRING DIAGRAMS

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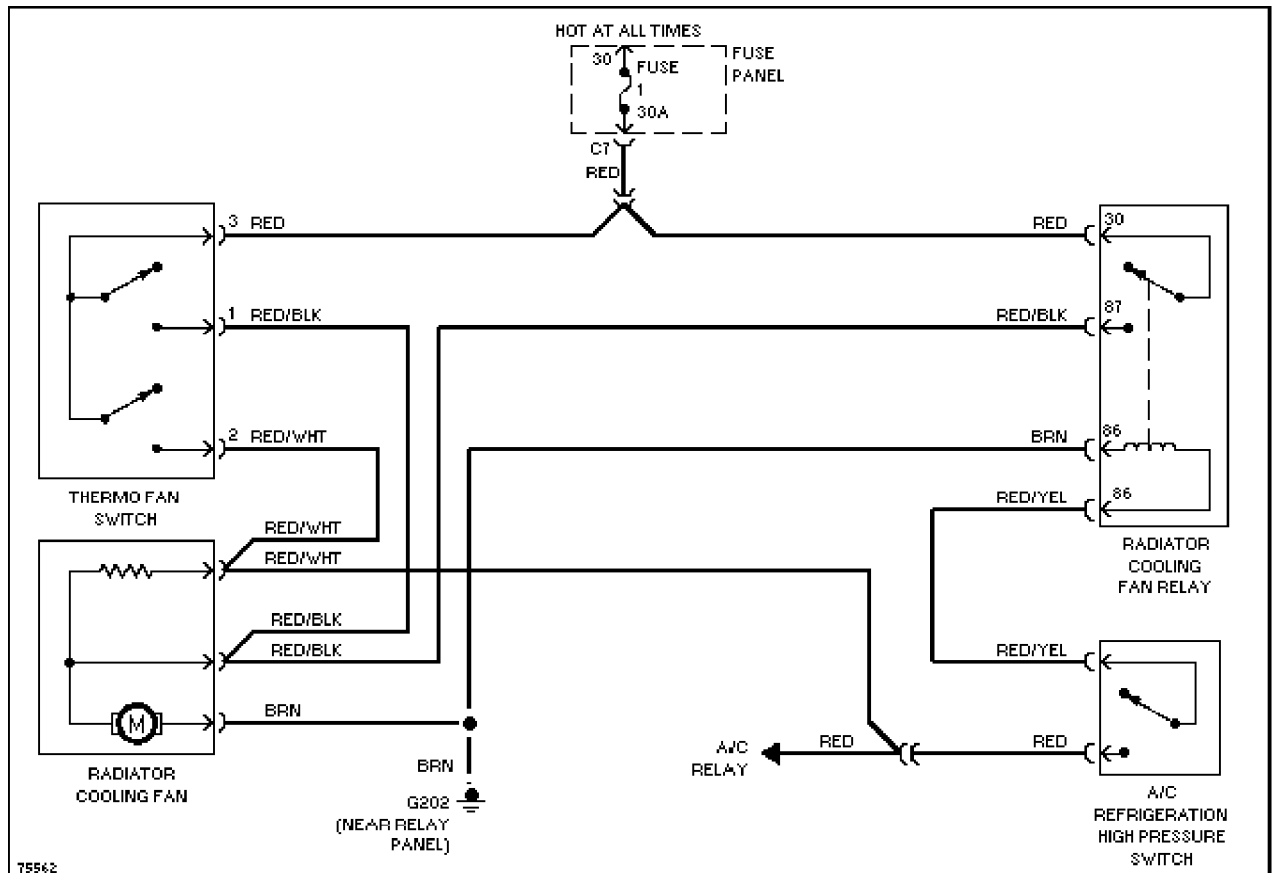
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ARTICLE BEGINNING

1987 System Wiring Diagrams

Volkswagen - Quantum/Quantum Syncro

COOLING FAN



Cooling Fan Circuit, W/ A/C

SYSTEM WIRING DIAGRAMS

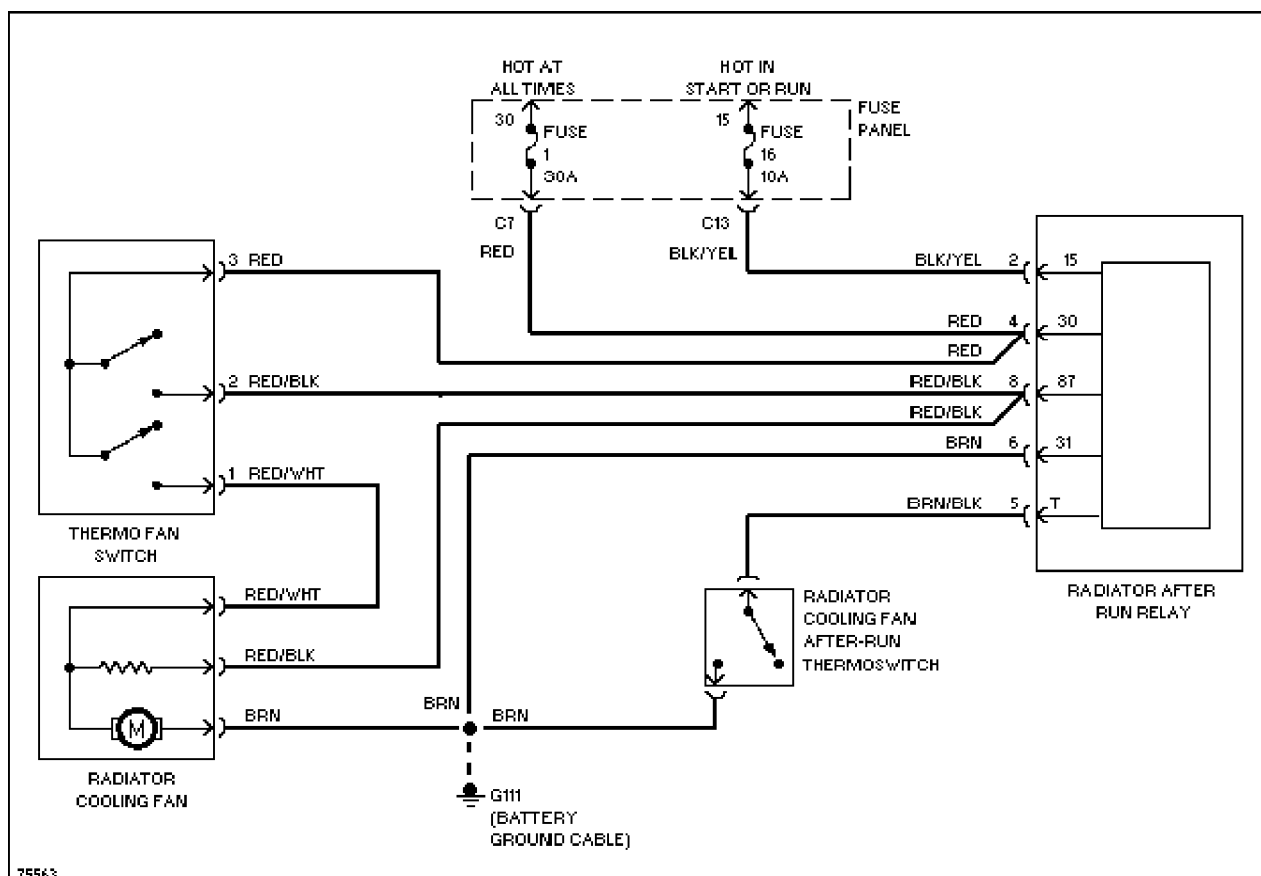
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Cooling Fan Circuit, W/O A/C

DEFOGGERS

SYSTEM WIRING DIAGRAMS

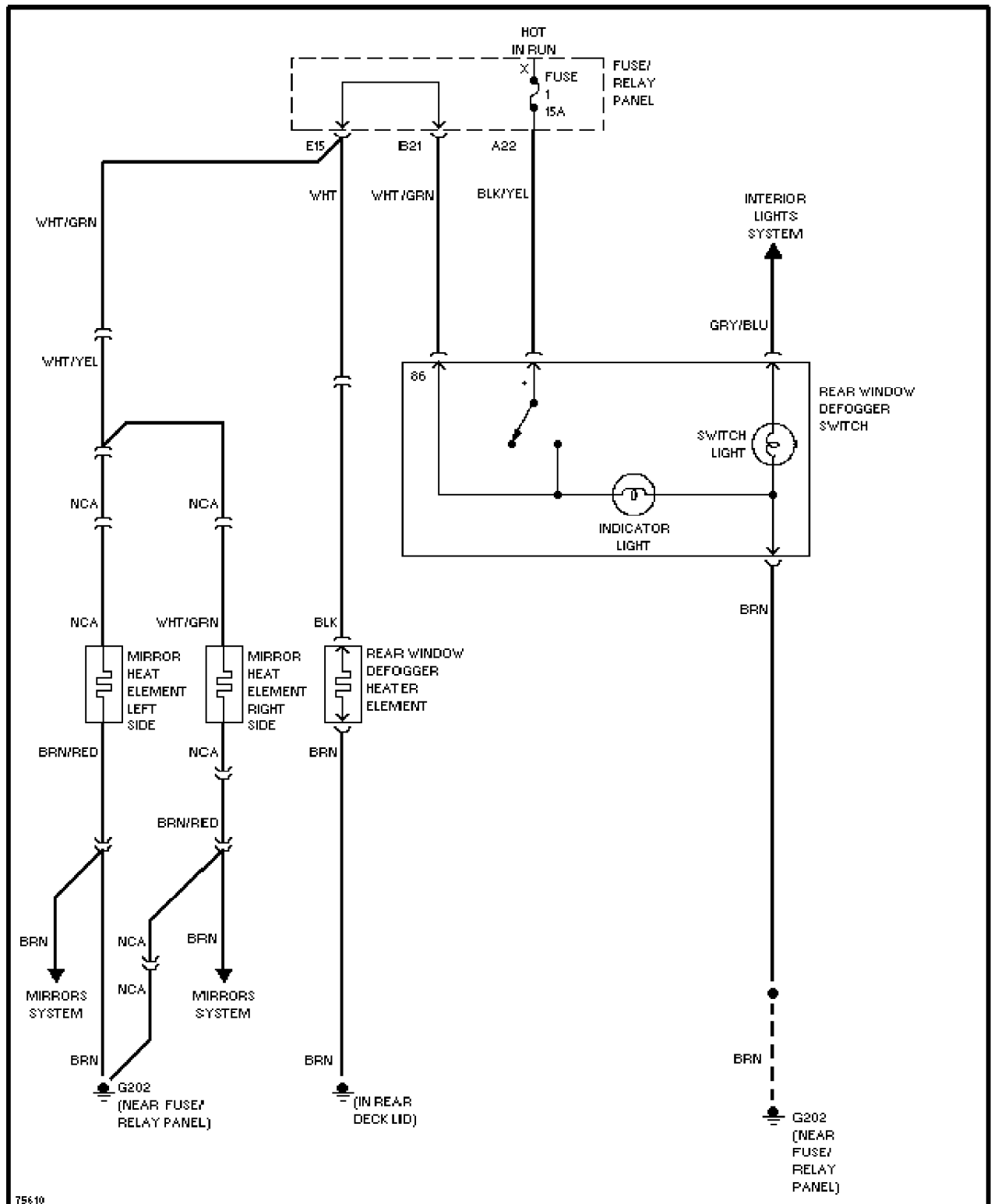
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Defogger Circuit

HORN

SYSTEM WIRING DIAGRAMS

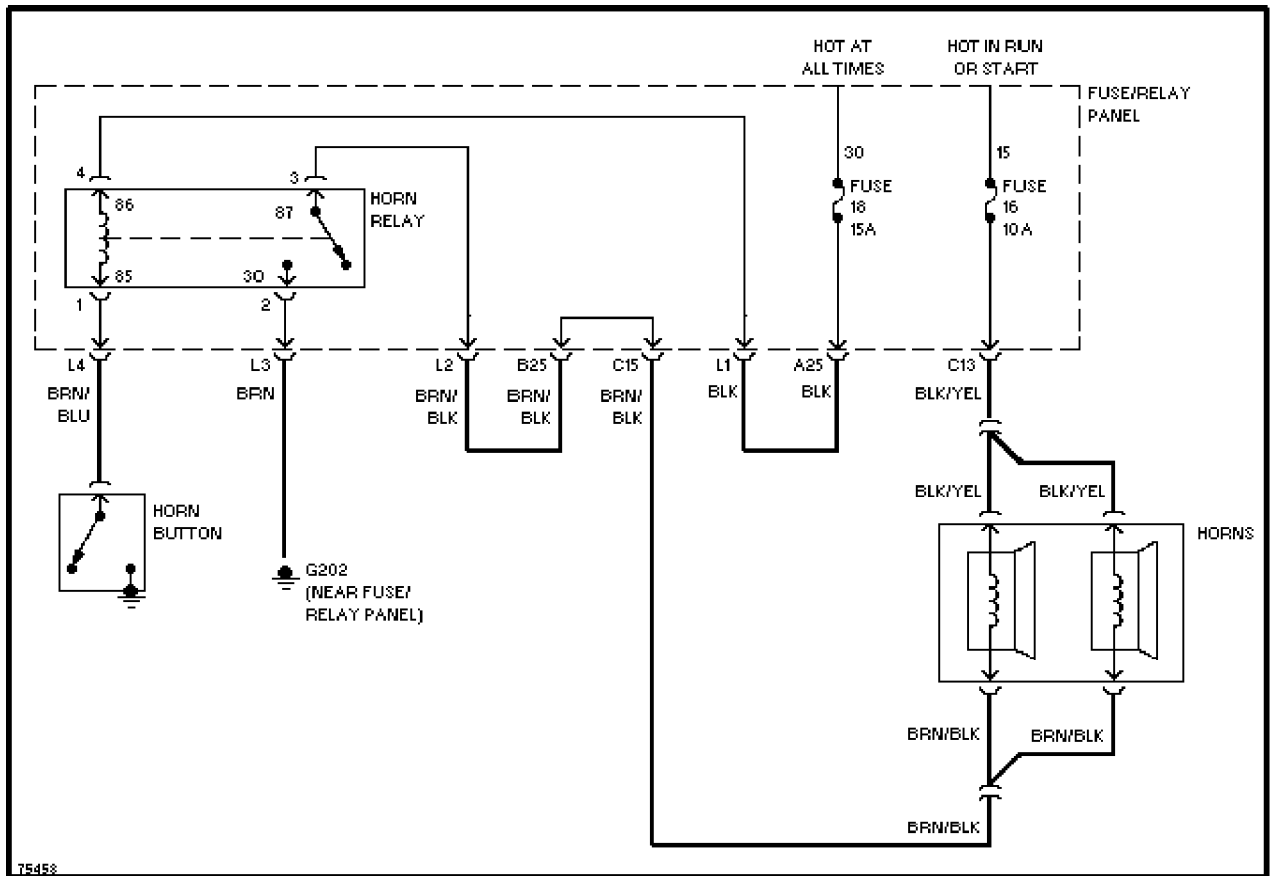
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Horn Circuit

POWER ANTENNA

SYSTEM WIRING DIAGRAMS

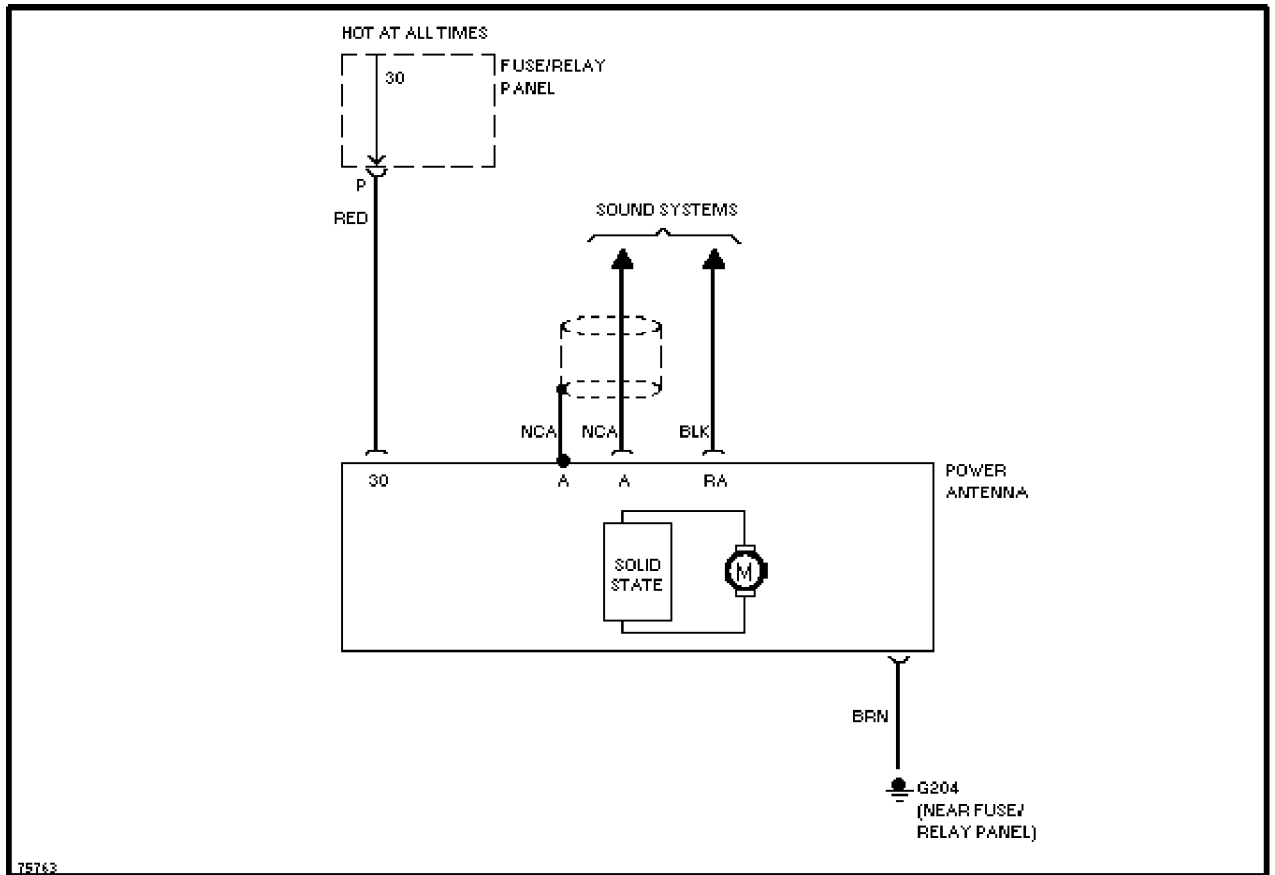
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Power Antenna Circuit

POWER DOOR LOCKS

SYSTEM WIRING DIAGRAMS

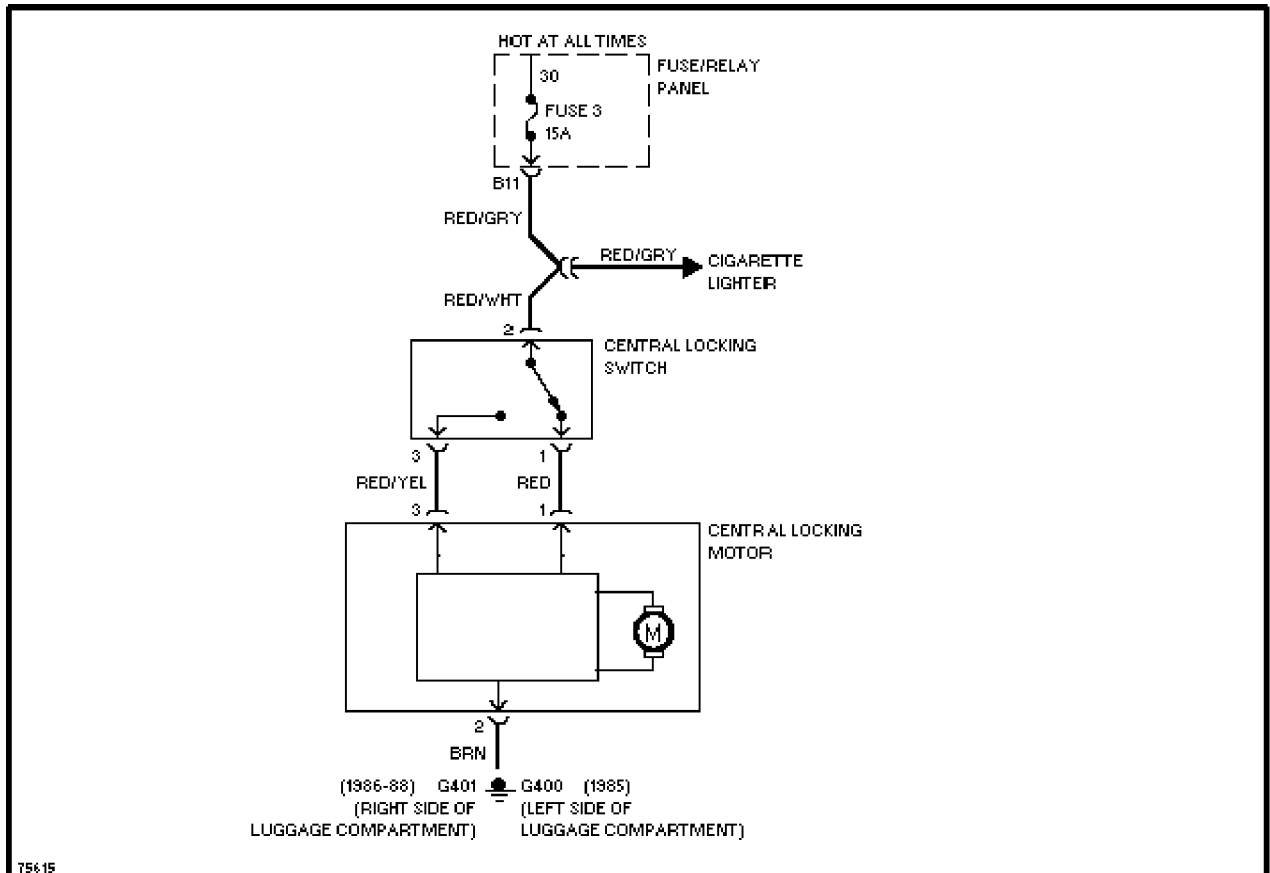
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Power Door Lock Circuit

POWER MIRRORS

SYSTEM WIRING DIAGRAMS

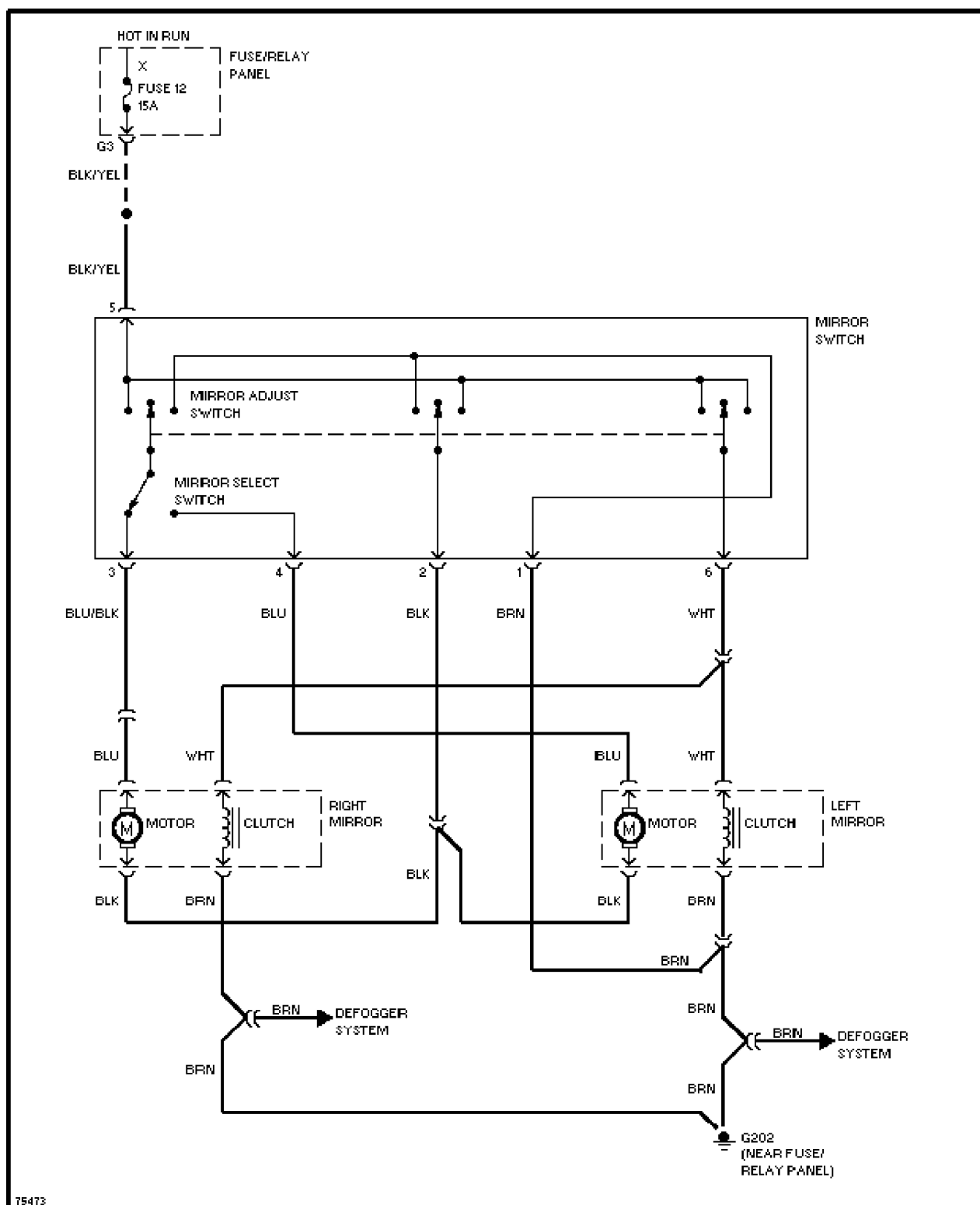
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Power Mirror Circuit

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Power Window Circuit

RADIO

SYSTEM WIRING DIAGRAMS

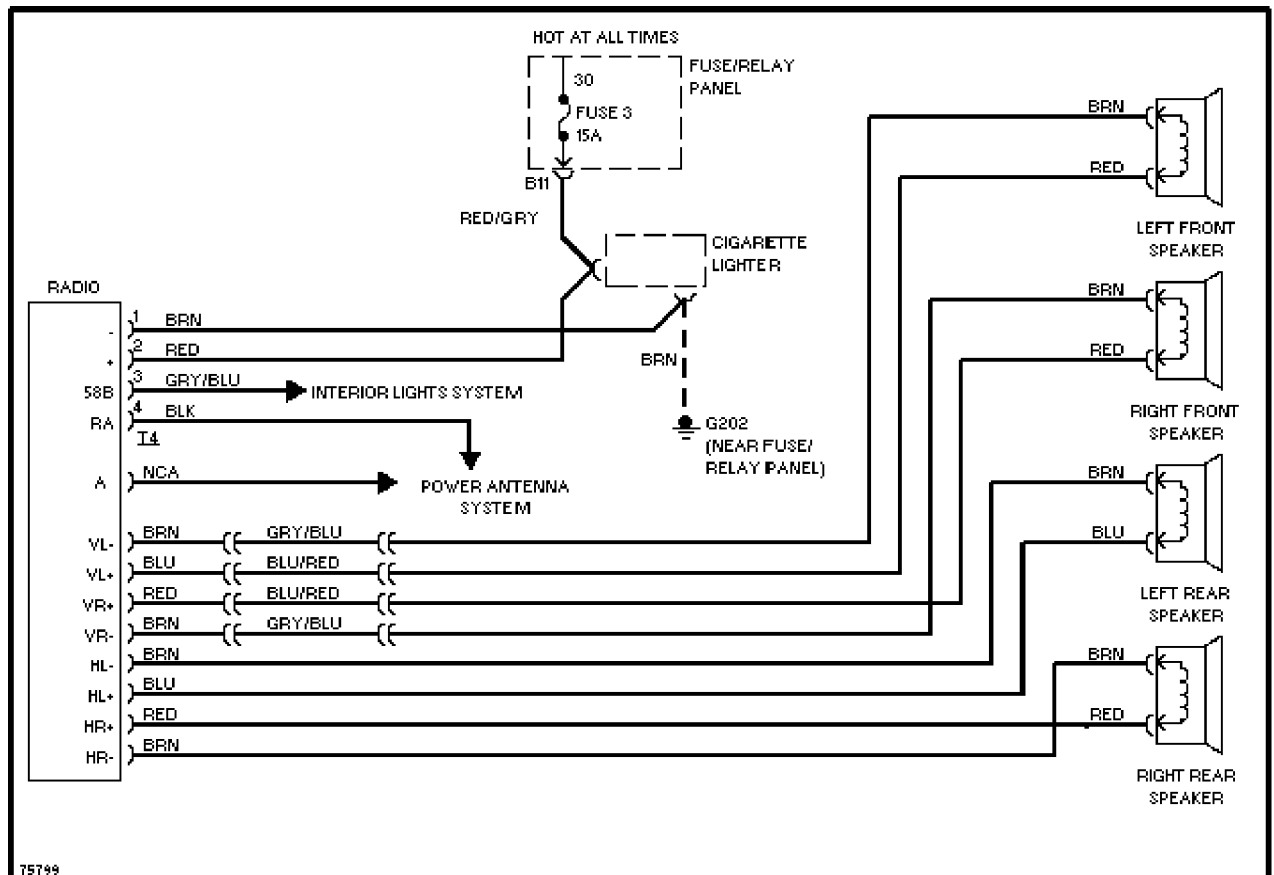
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Radio Circuits

STARTING/CHARGING

SYSTEM WIRING DIAGRAMS

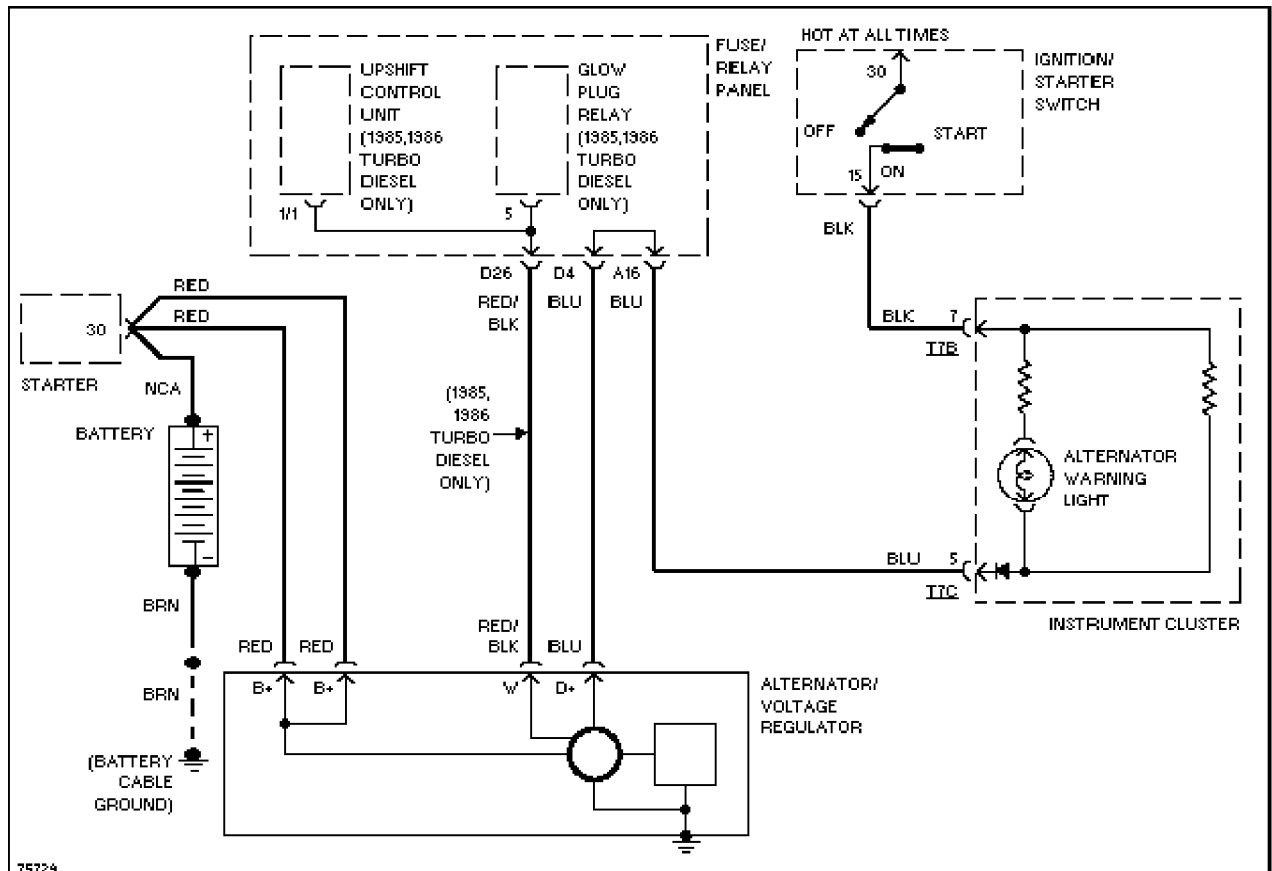
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Charging Circuit

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TRANSMISSION REMOVAL & INSTALLATION - M/T

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ARTICLE BEGINNING

MANUAL TRANSMISSION REMOVAL

1987 Volkswagen

Cabriolet, Golf, GTI, Jetta, Scirocco, Quantum, Vanagon

CABRIOLET, GOLF, GTI, JETTA & SCIROCCO R & I

REMOVAL

NOTE: Transaxle is lowered out of vehicle. Engine remains installed.

1) Disconnect battery ground. Attach an engine support assembly. Remove left transaxle mount bolts and mount. Disconnect back-up light wires, speedometer drive cable (plug hole) and clutch cable.

2) Remove upper clutch housing-to-transaxle bolts. Remove starter. On models equipped with flywheel which has cut-outs, align flywheel lug with boss on bellhousing. On all models, disconnect shift linkage at rod lever and relay lever and remove front selector rod.

NOTE: Vehicles with cut-outs in flywheel can be identified by a stud/nut at right engine-to-transaxle mounting position. Flywheel on this type vehicle MUST be aligned before separating engine/transaxle.

3) Remove exhaust pipe bracket. Remove transaxle rear mount and support transaxle on jack. Disconnect left and right drive shafts at transaxle and wire up out of way. Remove large plate cover bolts (plate remains on engine). Remove small cover bolts and cover.

4) Remove the right engine-to-transaxle bolt (stud/nut). On vehicles with cut-outs in flywheel, pull transaxle away from engine to clear dowels and lower and remove transaxle. On all other vehicles, pull transaxle away from engine, while cocking engine so right drive flange clears flywheel. Lower and remove transaxle.

5) With transaxle removed from engine, install Holder (VW558) to ring gear or pressure plate. Remove bolts in a diagonal manner until flywheel can be removed. Pry retaining ring from release plate and lift release plate from pressure plate. Remove pressure plate bolts in a diagonal manner and separate clutch disc.

INSTALLATION

NOTE: When replacing clutch components, it is recommended that 190 mm parts be upgraded to latest 200 mm version.

1) To install, coat pressure plate bolts with Loctite 270 or 271 and reverse removal procedure. Align cut-out in flywheel to allow right drive shaft flange passing clearance (if equipped).

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2) Ensure large cover plate is properly seated. Retaining ring ends must be between 2 slots in release plate. Use Clutch Aligner (VW547) to center clutch disc on flywheel. If new flywheel is to be installed, a new timing mark must be cut into flywheel 1/4" (6 mm) to right of TDC mark.

QUANTUM R & I

REMOVAL

1) Disconnect battery ground. Remove upper engine-to-transaxle bolts. Detach speedometer cable. Unhook clutch cable. Disconnect exhaust pipe at manifold. Remove engine support bolts. Remove front muffler and exhaust pipe.

2) Remove drive shafts at transaxle. Disconnect back-up light wiring. Remove cover plate bolts. Remove starter bolt. Remove shift rod coupling bolt. Pry off shift rod coupling ball. Pull off shift rod coupling from shift rod.

3) Position transmission lift under transaxle and lift up slightly. Loosen bolt "A" and remove bolt "B" from rear transaxle mount. Remove rubber mount. Remove 3 front transaxle support bolts. Remove lower engine-to-transaxle bolts.

4) Pry transaxle away from engine. Remove transaxle by lowering transaxle support 2071 or US 618 with US 618/1. Lock flywheel to prevent rotation and index mark pressure plate and flywheel. Loosen pressure plate bolts 1/4 turn at a time, working in a diagonal pattern. Slide pressure plate off dowels on flywheel.

INSTALLATION

1) Using a clutch alignment tool, fit pressure plate with clutch. Make sure alignment marks are observed. Loosely attach assembly with 6 bolts.

2) Tighten pressure plate bolts in a criss-cross pattern about 2 turns at a time. Position transaxle to engine. Make sure mainshaft splines are clean and lubricated lightly with molybdenum disulphide grease.

3) Reverse removal procedure to install remaining components. Make sure all engine-to-transaxle mounts are aligned and free of tension before tightening bolts and nuts.

VANAGON R & I

REMOVAL

1) Disconnect negative battery cable. Remove bolts attaching top of engine to transmission. Remove bracket for accelerator cable. Remove left drive shaft from transmission and support with a wire.

2) Remove clutch cable bracket from transmission. Remove clutch slave cylinder from mounting bracket and hang on a wire (DO NOT disconnect hydraulic line).

3) Disconnect back-up light wires. Disconnect starter wires

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and remove starter. Remove right drive shaft from transmission and support with a wire. Support engine using VW Engine Support (VW 785/1B). Remove rubber plugs from left wheel housing to hook in support chain.

4) Remove shift rod support and shift linkage from transmission. Support transmission using transmission jack. Disconnect ground strap from body. Remove front transmission mount from body.

5) Lower front part of transmission by loosening spindle of Engine Support (VW 785/1B) until there is enough room to remove transmission. Remove lower bolts attaching engine to transmission. Pull transmission off of engine guide bolts and remove from vehicle.

6) Lock flywheel with flywheel retainer tool. Mark position of pressure plate on flywheel for reassembly reference. Loosen pressure plate-to-flywheel bolts evenly in a diagonal fashion and remove clutch assembly.

INSTALLATION

1) Apply molybdenum disulfide grease to release bearing. Clean splines of transmission input shaft and lubricate lightly with molybdenum disulfide powder. Position clutch disc against flywheel and align using a centering tool.

2) Install pressure plate and tighten bolts evenly in a diagonal fashion. Install transmission by reversing removal procedure. Tighten front transmission mounts. Insert rear bolt for slave cylinder before installing. Position air deflector plates correctly.

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ARTICLE BEGINNING

AUTOMATIC TRANSMISSION SERVICING
1987 Volkswagen

IDENTIFICATION

TRANSMISSION CODES TABLE

Application		Code
Cabriolet, Golf, GTI, Jetta & Scirocco		010
Quantum		087 & 089
Vanagon		090

LUBRICATION

SERVICE INTERVALS

Check fluid level every 15,000 miles. Change fluid every 30,000 miles under severe driving conditions.

CHECKING FLUID LEVEL

Transmission

With transmission at normal operating temperature, park vehicle on level surface. Place selector lever in "P" or "N" position and apply parking brake. Allow engine to idle. Remove dipstick, wipe clean and insert. Remove dipstick and check that fluid level is between marks on dipstick.

Final Drive

Place vehicle on level surface. Fluid level must be up to edge of fill hole on side of case. If level is too high, this may indicate fluid transfer between transmission and final drive caused by leaking seals.

NOTE: Normal fluid color on late production vehicles is Red/Brown. This is normal.

RECOMMENDED FLUID

Transmission

Use Dexron II ATF.

Final Drive

Use API GL-5, SAE 90.

FLUID CAPACITY

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TRANSMISSION REFILL CAPACITIES TABLE

Application	Refill Qts. (L)	Dry Fill Qts. (L)
-------------	--------------------	----------------------

All Models 3.2 (3.0L) 6.4 (6.0)

FINAL DRIVE REFILL CAPACITIES TABLE

Model	Qts. (L)
-------	----------

All Except Vanagon8 (.76)

Vanagon 1.3 (1.23)

DRAINING & REFILLING

1) Remove transaxle protection plate. Remove rear pan bolts and loosen front pan bolts. Carefully lower pan and drain as much fluid as possible. Remove oil pan and pour out remaining fluid. Remove filter. Clean oil pan in solvent and dry, using compressed air.

2) Install new filter and tighten screws to 27 INCH lbs. (3 N.m). Install oil pan, using new gasket. Tighten oil pan bolts to 15 ft. lbs. (20 N.m). Install protection plate, tighten bolts to 18 ft. lbs. (25 N.m). Add 3.2 qts. (3.0L) of transmission fluid and check fluid level.

ADJUSTMENTS

SECOND BRAKE BAND

1) Adjust brake band with transmission in a horizontal position only. Loosen adjustment screw lock nut. Tighten brake band adjustment screw to 90 INCH lbs. (10 N.m). See Fig. 1.

2) Loosen adjustment screw, then tighten to 45 INCH lbs. (5 N.m). Back off 2 turns on 5-cylinder engines or 2 1/2 turns on 4-cylinder engines. Tighten lock nut to 178 INCH lbs. (20 N.m).

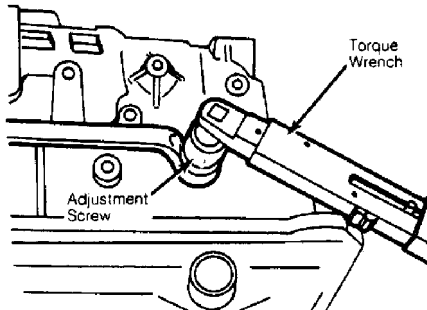


Fig. 1: Adjusting Second Brake Band
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SELECTOR LEVER CABLE

Vanagon

Place transmission lever in "P" position. Loosen bolt which retains shift rod to operating lever on transaxle. See Fig. 2. Ensure selector lever and transaxle operating lever are in "P" position. Push shift rod to rear and tighten bolt.

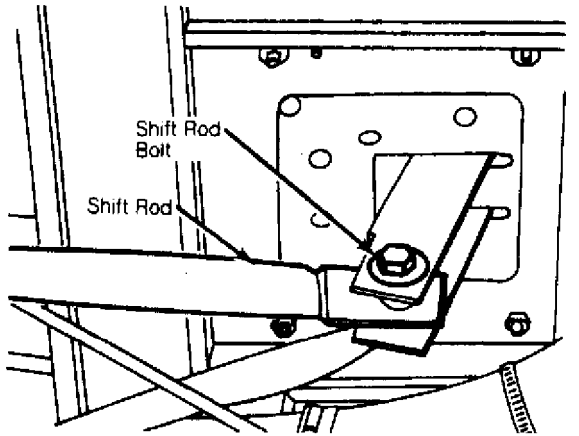


Fig. 2: Adjusting Vanagon Shift Lever
Courtesy of Volkswagen United States, Inc.

All Others

Place transmission in "P" position. Loosen nut for clamping pin which retains selector cable to operating lever on transaxle. Ensure selector lever and transaxle operating lever are in "P" position. Tighten cable clamping nut to 72 INCH lbs. (8 N.m).

THROTTLE CABLE

NOTE: Accelerator linkage must be adjusted so that the operating lever on transmission is against stop when throttle valve is closed.

Cabriolet, Golf, GTI, Jetta & Scirocco

1) Engine must be at operating temperature and turned off. Place gear selector in "P" position. Loosen adjusting nut and lock nut on throttle cable at transaxle. Disconnect throttle cable from transaxle. See Fig. 3.



Fig. 3: Transaxle Throttle Cable (All Except Quantum & Vanagon)
Courtesy of Volkswagen United States, Inc.

2) Loosen lock nuts on throttle cable support bracket. Push throttle cable sleeve in direction of arrow until there is no play. See Fig. 4.

3) Throttle valve must remain closed and

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accelerator/transaxle linkage must be in closed position.

4) Turn lock nut No. 1 against support bracket. Tighten lock nut No. 2. Install accelerator cable on transaxle.

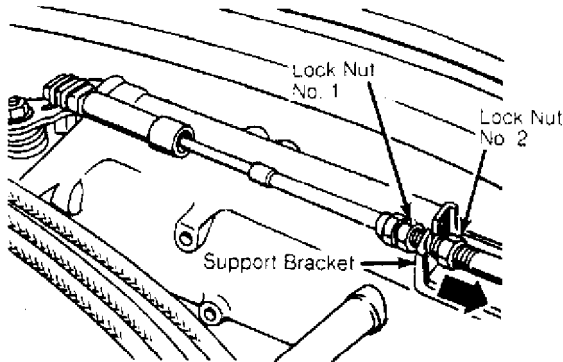


Fig. 4: Adjusting Throttle Cable (All Except Quantum & Vanagon)
Courtesy of Volkswagen United States, Inc.

5) Depress accelerator pedal completely and hold there. Working at transaxle, push transaxle operating lever against kickdown adjusting nuts.

6) Turn adjusting nut until all slack is removed from cable. Release accelerator pedal. Ensure transaxle operating lever rests against kickdown stop. Tighten lock nut.

Quantum (087 Transaxle)

1) Engine must be at operating temperature and turned off. Place accelerator in idle position. Place selector lever in "P" position. Apply parking brake.

2) Loosen adjusting nut on throttle cable at transaxle. Remove retaining clips for ball sockets of push and pull rods. Pry ball sockets from relay bracket levers. See Fig. 5.

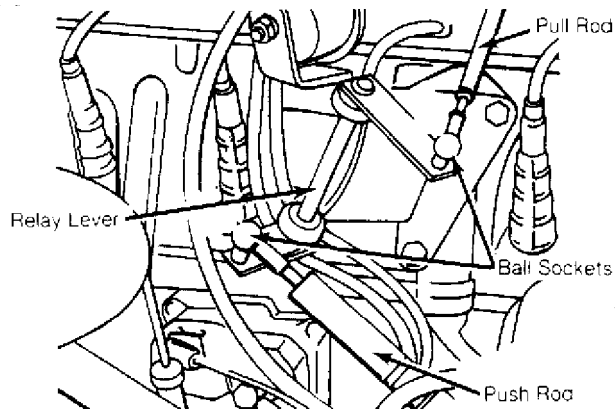


Fig. 5: Quantum Push & Pull Rods
Courtesy of Volkswagen United States, Inc.

3) Rotate pull rod relay lever counterclockwise to stop. With relay lever against stop, loosen pull rod lock nut and turn ball socket until it fits easily on relay lever ball stud.

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4) Tighten lock nut. Install push rod socket on relay lever. Install both ball socket retaining clips.

5) Loosen nut on push rod. See Fig. 6. Slide push rod apart so transaxle operating lever is in closed-throttle position and throttle body lever is against idle stop. Tighten nut on push rod.

NOTE: Ensure push rod fits easily on transmission operating lever.

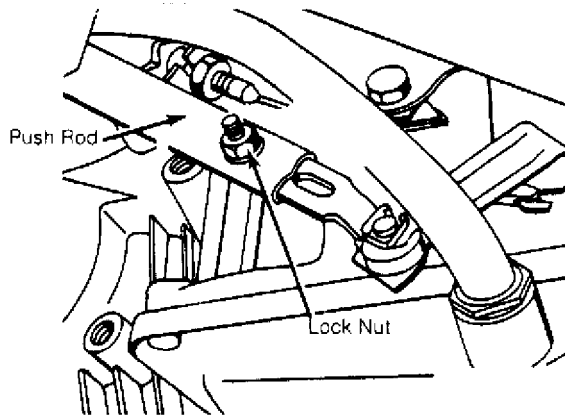


Fig. 6: Adjusting Quantum Transaxle Push Rod
Courtesy of Volkswagen United States, Inc.

6) Loosen lock nut located below adjusting nut on throttle cable. See Fig. 7. Depress accelerator pedal to stop on floor and hold.

7) Turn adjusting nut until transaxle operating lever moves, in direction of arrow, to stop. Tighten lock nut.

8) To check adjustment, push throttle lever against idle stop. Transaxle operating lever must be in closed-throttle position. Place accelerator pedal in full-throttle position, WITHOUT engaging kickdown. Throttle valve lever must contact full-throttle stop and kickdown spring in push rod must NOT be compressed.

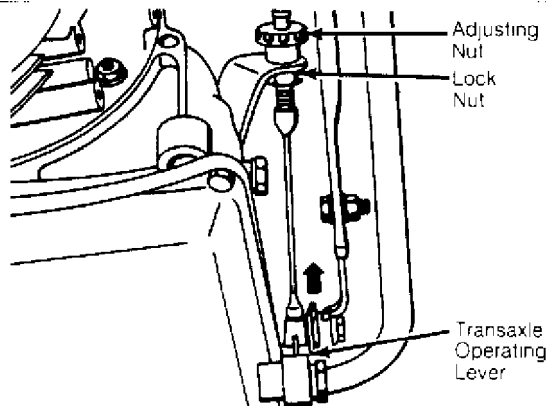


Fig. 7: Quantum Throttle Cable
Courtesy of Volkswagen United States, Inc.

9) Press accelerator pedal to stop (kickdown position).

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Transaxle operating lever must contact stop and kickdown spring in push rod must be compressed. Distance "A" on push rod must be $13/32$ " (10.5 mm). See Fig. 8.

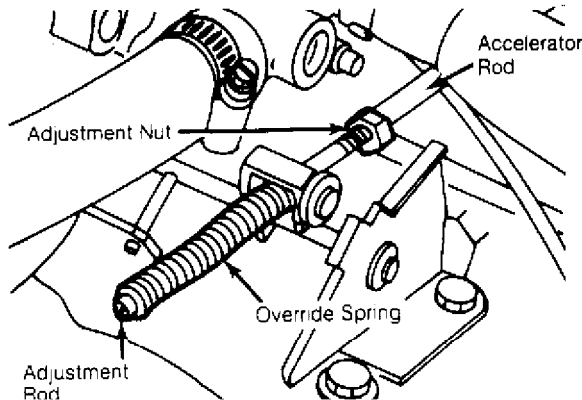


Fig. 8: Checking Quantum Push Rod Adjustment
Courtesy of Volkswagen United States, Inc.

Vanagon

1) To check adjustment, place accelerator pedal in full throttle position. Throttle lever must contact stop, but kickdown lever on transaxle must NOT be in kickdown position.

2) Press accelerator pedal beyond full throttle position to floor. Override spring must be compressed and kickdown lever on transaxle must be in kickdown position. If not, readjust.

3) Loosen adjustment nut and remove override spring. See Fig. 9. Start engine and readjust idle speed, if necessary. Turn engine off.

4) Push accelerator rod to closed throttle position (against stop). Using a screwdriver, turn adjustment rod until it just contacts throttle lever pivot.

5) Install override spring, start engine and check idle speed. If necessary, adjust idle speed by turning rod. Tighten lock nut on adjustment rod.

6) Depress accelerator pedal to floor. Kickdown lever on transaxle must be in kickdown position on stop.

7) Release accelerator pedal. Kickdown lever on transaxle must return to idle position. If necessary, adjust throttle cable at clamping bolt. Clamping bolt is located at accelerator pedal end of accelerator cable.

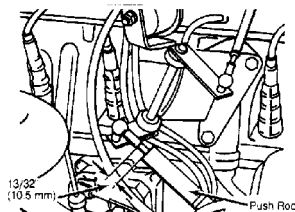


Fig. 9: Adjusting Vanagon Accelerator Rod
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NEUTRAL SAFETY SWITCH

Neutral safety switch is located in shift console. Remove console cover and adjust switch so that engine starts in "P" and "N" positions only.

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ARTICLE BEGINNING

MANUAL TRANSMISSION SERVICING

1987 Volkswagen

Cabriolet, Fox, Golf, GTI, Jetta, Quantum, Scirocco,
Vanagon

LUBRICATION SERVICE INTERVALS

No oil changes are required. Check oil every 15,000 miles.

FLUID LEVEL

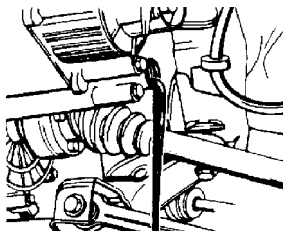
FOX, QUANTUM, SCIROCCO, VANAGON

Check lubricant level at fill hole. Lubricant should be level with bottom of fill hole.

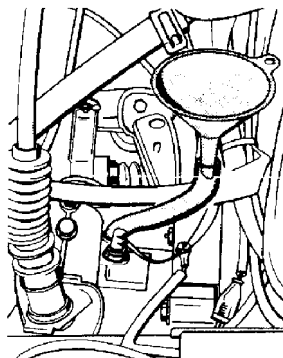
CABRIOLET, GOLF, GTI & JETTA

1) Because of transaxle mounting angle, oil will run out of checking hole even though transaxle is filled to capacity. To check oil level, place vehicle on level surface.

2) Remove oil filler plug. Allow oil to drain off until level with edge of hole. See Fig. 1. Remove speedometer cable at transaxle. Pour in .5 qt. (.5L) of fluid.



CHECKING



ADDING

Fig. 1: Checking & Adding Fluid to Cabriolet, Golf, GTI & Jetta
Courtesy of Volkswagen United States, Inc.

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RECOMMENDED FLUID

Use API GL-4, SAE 80W or 80W-90.

FLUID CAPACITY

TRANSMISSION REFILL CAPACITIES TABLE

Application Qts. (L)

Cabriolet, Golf, GTI, Jetta,
Quantum & Scirocco

5-Speed 2.1 (2.0)

Fox 1.8 (1.7)

Vanagon

091/1 (2WD) 3.2 (3.0)

094 (4WD) 4.7 (4.5)

GEARSHIFT LINKAGE ADJUSTMENTS

CABRIOLET, GOLF, GTI & JETTA

1) Place shift lever in Neutral. Loosen shifter rod clamp.
See Fig. 2. Selector lever must move freely on shifter rod.

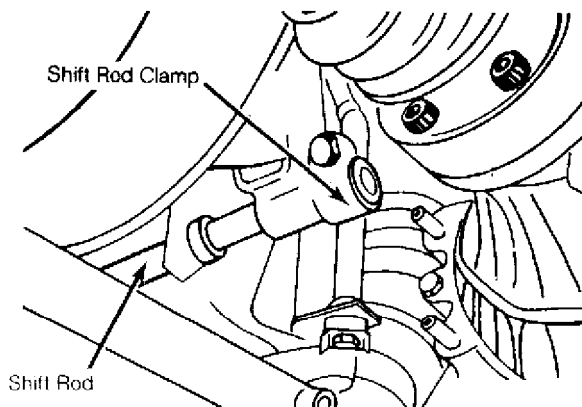


Fig. 2: Shift Rod Clamp Location (Cabriolet, Golf, GTI & Jetta
Courtesy of Volkswagen United States, Inc.

2) Remove gearshift knob and boot. Position Adjustment Gauge (3104) over shift rod. See Fig. 3. With transaxle in Neutral, align shift rod with selector lever. Tighten shifter rod clamp to 19 ft. lbs. (26 N.m).

3) Move gearshift lever through entire range of gear selection, including Reverse. Gears must engage smoothly and without jamming. Reinstall gearshift knob and boot.

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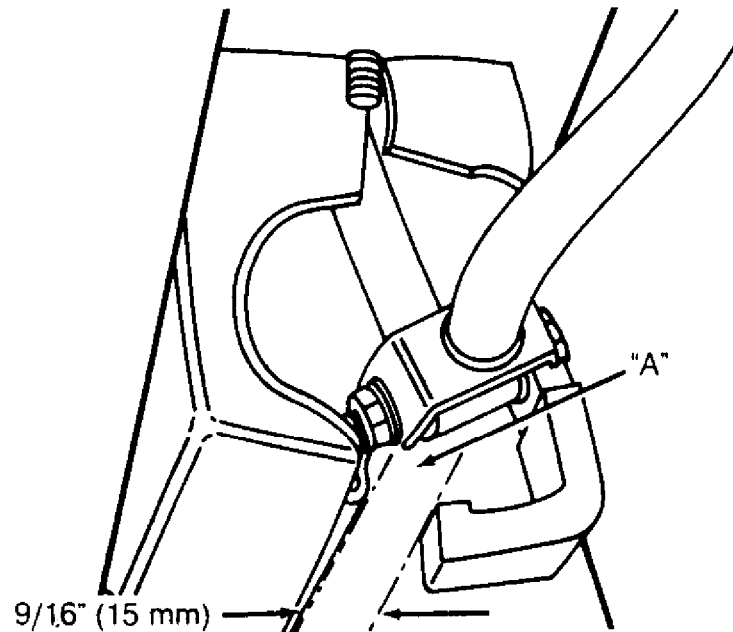


Fig. 3: Adjustment Gauge Location
Courtesy of Volkswagen United States, Inc.

FOX

1) Shift transaxle into 1st gear. Push gearshift lever to left stop. Release lever. If lever does not spring back 1/4-3/8" (5-10 mm) to right, move gearshift lever in slots. If adjustment does not correct hard shifting, go to step 2).

2) Place gearshift lever in Neutral. Remove gearshift lever and shift boot. Loosen shift rod clamp nut. See Fig. 4.

3) Ensure shift finger slides freely on shift rod. Move gearshift lever to right side, between 3rd and 4th gear positions. Gearshift lever should remain perpendicular to ball housing.

4) With inner shift lever in Neutral, and gearshift lever between 3rd and 4th gear, tighten clamp nut. Ensure transaxle shifts smoothly. If necessary, adjust gearshift lever bearing housing.

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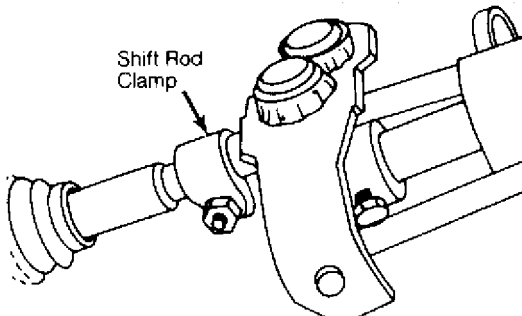


Fig. 4: Shift Rod Clamp Nut For Fox
Courtesy of Volkswagen United States, Inc.

SCIROCCO

1) Pull boot off housing. Loosen shift rod clamp bolt so lever moves freely on shift rod. Adjust shift finger in center of lock-out plate so that an equal distance is obtained on both sides of shift finger. See Fig. 5.

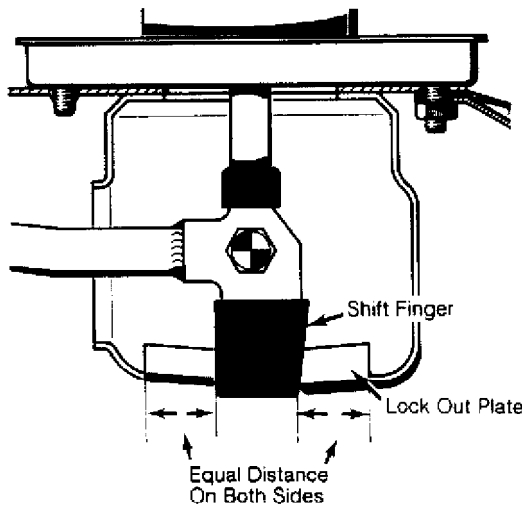


Fig. 5: Adjusting Scirocco Shift Finger
Courtesy of Volkswagen United States, Inc.

2) Adjust shift rod end so distance "A" is 9/16" (15 mm). See Fig. 6. Tighten shift rod clamp to 14 ft. lbs. (20 N.m). If shift linkage is spongy or jamming after adjustment, change distance "A" to 1/2" (13 mm). If shift linkage will not stay adjusted, install a new clamp bolt and lock nut.

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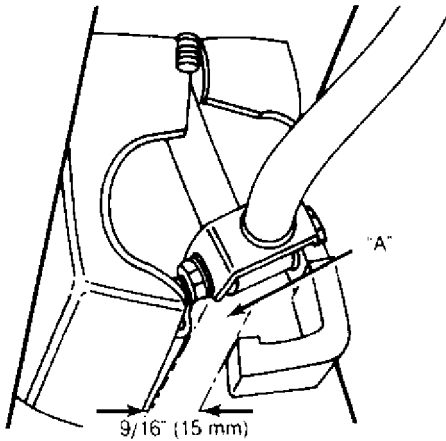


Fig. 6: Adjusting Scirocco Shift Rod End
Courtesy of Volkswagen United States, Inc.

QUANTUM

1) Shift transaxle into 1st gear. Push gearshift lever to left stop. Release lever. Lever must spring back 1/4-3/8" (5-10 mm) to right.

2) Shift into 5th gear. Push gearshift lever to right stop. Release lever. Lever must spring back 1/4-3/8" (5-10 mm) to left.

3) If lever does not react as described, remove center console. Loosen retaining bolts, move gearshift lever housing slightly sideways in slots. Tighten bolts. If this adjustment does not correct hard shifting, proceed to step 4).

4) Place gearshift lever in Neutral. From under vehicle, loosen shift rod clamp nut so shift finger slides freely on shift rod. See Fig. 4. Remove shift lever knob and rubber boot.

5) Loosen gearshift lever housing bolts, align round centering holes and tighten bolts. Install Linkage Adjustment Gauge (3057) with locating pin toward front. See Fig. 7. Push shift lever to "5/R" gear position of gauge. Tighten lower knurled knob on gauge.

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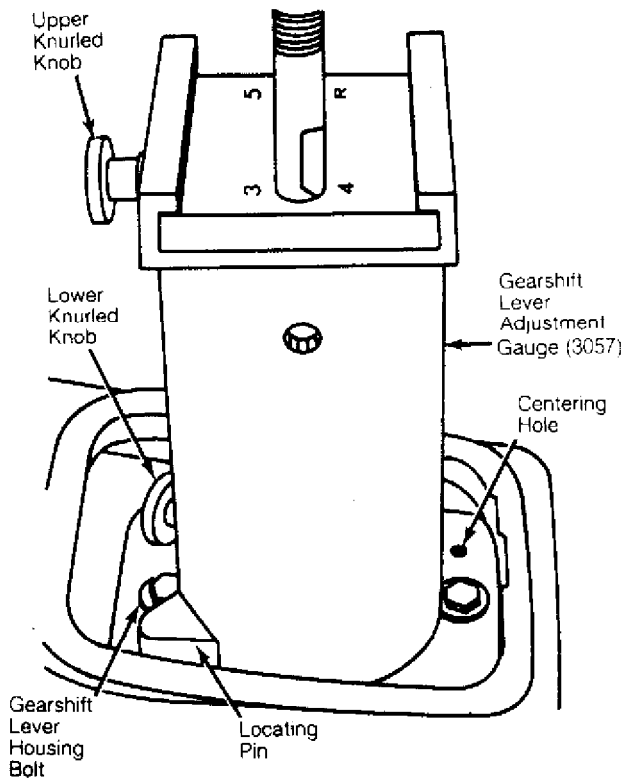


Fig. 7: Adjusting Quantum Gearshift Linkage
Courtesy of Volkswagen United States, Inc.

6) Move shift lever and slide to right stop. Tighten upper knurled knob on gauge. Push shift lever into "3/4" gear position of gauge. Adjust shift rod and finger with transaxle in Neutral. Tighten shift rod clamp nut and remove gauge.

7) Place gearshift lever in 1st gear, press to left stop and release. Shift lever must spring back to right. Place lever in 5th gear, push shift lever to right stop and release. Shift lever must spring back to left.

8) If gearshift lever does not spring back as indicated, move gearshift lever housing slightly sideways in slots. Ensure all gears engage easily and without jamming, particularly reverse gear stop. Install shift boot and lever knob.

NOTE: All 4WD transaxle linkage adjustment should be performed only when gearshift lever adjustment cannot be corrected or after a repair which involved loosening shift rod clamp.

QUANTUM SYNCRO

1) Shift transaxle into 1st gear. Push gearshift lever to left stop. Release lever. Lever should spring back 1/4-3/8" (5-10 mm) to right.

2) Shift transaxle into 5th gear. Push gearshift lever to right stop. Release lever. Lever should spring back 1/4-3/8" (5-10 mm) to left.

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3) If gearshift lever does not respond as described in steps 1) and 2), remove shift knob. Remove lower center console.

4) Loosen 4 housing retaining bolts. See Fig. 8. Move gearshift lever slightly in slots. Tighten bolts.

5) If still not adjusted, place transaxle in Neutral. Loosen 4 bolts. Align centering holes of stop plate and bearing support. Tighten bolts. Install Adjusting Gauge (3048).

6) Loosen clamp between front and rear shift rods under vehicle. Allow rear rod to center itself. Tighten clamp nut to 11 ft. lbs. (15 N.m). Remove adjusting gauge. Ensure transaxle shifts correctly. Install console and boot.

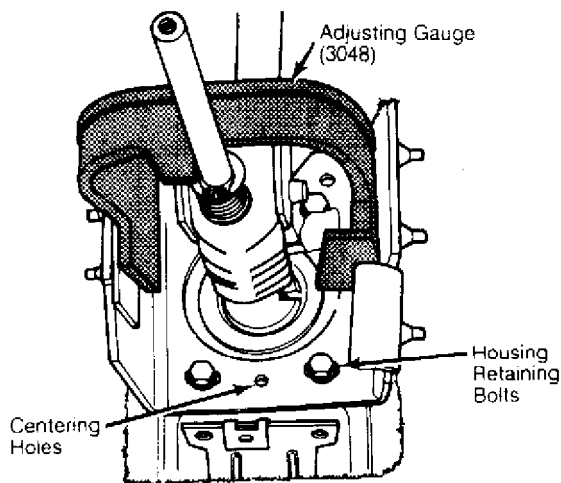


Fig. 8: Adjusting Quantum Syncro Gearshift Linkage
Courtesy of Volkswagen United States, Inc.

VANAGON

1) Place gearshift lever in Neutral position. Align round centering holes of upper gearshift lever housing plate with holes in lower lever bearing plate.

2) Loosen nut on clamp that connects front and rear shift rods. Ensure joints of shift rods slide freely. Remove spare tire. Set shift lever on transaxle in vertical (Neutral) position.

3) At gearshift lever end of front shift rod, ensure stop finger of front shift rod is in center of shift mechanism housing.

4) Adjust front shift rod end so there is 29/32" (23 mm) clearance between front shift rod end and stop plate. Tighten shift rod clamp.

5) Check for proper operation. Ensure shift lever does not rub against heater pipe insulation.

VANAGON SYNCRO (4WD)

1) Place gearshift lever in Neutral position. Align round centering holes of upper gearshift lever housing plate with holes in lower lever bearing plate.

2) Loosen nut on clamp that connects front and rear shift

TRANSMISSION SERVICING - M/T

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rods. Ensure joints of shift rods slide freely. Remove spare tire. Set shift lever on transaxle in vertical (Neutral) position.

3) Push shift rod into transaxle until spring tension is felt (shift position for 2nd-3rd gear). Hold in this position.

4) Push shift rod to right (shift position for 1st-Reverse). Clearance between reverse gear lock and shift rod stop should be .12" (3 mm).

5) Allow shift to spring back to left to 2nd-3rd gear shift position. Push rod slightly to right. Boot must touch inside of shift mechanism housing.

6) Making sure transaxle and gearshift lever are in Neutral positions, tighten clamp nut between front and rear shift rods. Tighten to 18 ft. lbs. (25 N.m).

7) Place gearshift lever in 2nd gear position inside passenger compartment. Distance between gearshift lever and upper edge of gearshift lever opening in console must be at least 5/8" (15 mm). If not, adjust gearshift lever bearing by sliding back in slotted holes. Ensure all gears engage smoothly.

END OF ARTICLE

Article Text

ARTICLE BEGINNING

AIR CONDITIONING TROUBLE SHOOTING

BASIC AIR CONDITIONING TROUBLE SHOOTING CHART

[illegible]

CONDITION	POSSIBLE CAUSE
-----------	----------------

CONDITION POSSIBLE CASE

Compressor Not Working

- ␣ Compressor clutch circuit open.
- ␣ Compressor clutch coil inoperative.
- ␣ Poor clutch ground connection.
- ␣ Fan belts loose.
- ␣ Thermostatic switch inoperative.
- ␣ Thermostatic switch not adjusted.
- ␣ Ambient temperature switch open.
- ␣ Superheat fuse blown.

[illegible]

Excessive Noise or Vibration

- Missing or loose mounting bolts.
- Bad idler pulley bearings.
- Fan belts not tightened correctly.
- Compressor clutch contacting body.
- Excessive system pressure.
- Compressor oil level low.
- Damaged clutch bearings.
- Damaged reed valves.
- Damaged compressor.

[illegible]

Insufficient or No Cooling;
Compressor Working

- ū Expansion valve inoperative.
- ū Heater control valve stuck open.
- ū Low system pressure.
- ū Blocked condenser fins.
- ū Blocked evaporator fins.
- ū Vacuum system leak.
- ū Vacuum motors inoperative.
- ū Control cables improperly adjusted.
- ū Restricted air inlet.
- ū Mode doors binding.
- ū Blower motor inoperative.
- ū Temperature above system capacity.

[illegible]

TROUBLE SHOOTING - BASIC PROCEDURES

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BRAKE SYSTEM TROUBLE SHOOTING

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BRAKE SYSTEM TROUBLE SHOOTING CHART

AA

CONDITION	POSSIBLE CAUSE	CORRECTION
-----------	----------------	------------

AA

Brakes Pull Left or Right	Incorrect tire pressure	Inflate tires to proper pressure
------------------------------	-------------------------	----------------------------------

Front end out of alignment	See WHEEL ALIGNMENT
----------------------------	---------------------

Mismatched tires	Check tires sizes
------------------	-------------------

Restricted brake lines or hoses	Check hose routing
------------------------------------	--------------------

Loose or malfunctioning caliper	See DISC BRAKES or BRAKE SYSTEM
------------------------------------	------------------------------------

Bent shoe or oily linings	See DRUM BRAKES or BRAKE SYSTEM
---------------------------	------------------------------------

Malfunctioning rear brakes	See DRUM, DISC BRAKES or BRAKE SYSTEM
----------------------------	--

Loose suspension parts	See SUSPENSION
------------------------	----------------

AA

Noises Without Brakes Applied	Front linings worn out	Replace linings
----------------------------------	------------------------	-----------------

Dust or oil on drums or rotors	See DRUM, DISC BRAKES or BRAKE SYSTEM
-----------------------------------	--

AA

Noises With Brakes Applied	Insulator on outboard shoe damaged	See DISC BRAKES or BRAKE SYSTEM
-------------------------------	---------------------------------------	------------------------------------

Incorrect pads or linings	Replace pads or linings
---------------------------	-------------------------

AA

Brake Rough, Chatters or Pulsates	Excessive lateral runout	Check rotor runout
--------------------------------------	--------------------------	--------------------

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Parallelism not to specifications	Reface or replace rotor
-----------------------------------	-------------------------

Wheel bearings not adjusted	See SUSPENSION
-----------------------------	----------------

Rear drums out-of-round	Reface or replace drums
-------------------------	-------------------------

Disc pad reversed, steel against rotor	Remove and reinstall pad
--	--------------------------

AA

Excessive Pedal
Effort

Malfunctioning power unit	See POWER BRAKES or BRAKE SYSTEM
---------------------------	----------------------------------

Partial system failure	Check fluid and pipes
------------------------	-----------------------

Worn disc pad or lining	Replace pad or lining
-------------------------	-----------------------

Caliper piston stuck or sluggish	See DISC BRAKES or BRAKE SYSTEM
----------------------------------	---------------------------------

Master cylinder piston stuck	See MASTER CYLINDERS or BRAKE SYSTEM
------------------------------	--------------------------------------

Brake fade due to incorrect pads for linings	Replace pads or linings
--	-------------------------

Linings or pads glazed	Replace pads or linings
------------------------	-------------------------

Worn drums	Reface or replace drums
------------	-------------------------

AA

Excessive Pedal
Travel

Partial brake system failure	Check fluid and pipes
------------------------------	-----------------------

Insufficient fluid in master cylinder	See MASTER CYLINDERS or BRAKE SYSTEM
---------------------------------------	--------------------------------------

Air trapped in system	See BRAKE BLEEDING or BRAKE SYSTEM
-----------------------	------------------------------------

Rear brakes not adjusted	See Adjustments in DRUM BRAKES or BRAKE SYSTEM
--------------------------	--

Bent shoe or lining	See DRUM BRAKES or BRAKE SYSTEM
---------------------	---------------------------------

Plugged master cylinder cap	See MASTER CYLINDERS or BRAKE SYSTEM
-----------------------------	--------------------------------------

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Improper brake fluid

Replace brake fluid

AA

Pedal Travel

Decreasing

Compensating port plugged

See MASTER CYLINDERS
or BRAKE SYSTEM

Swollen cup in master
cylinder

See MASTER CYLINDERS
or BRAKE SYSTEM

Master cylinder piston
not returning

See MASTER CYLINDERS
or BRAKE SYSTEM

Weak shoe retracting springs

See DRUM BRAKES
BRAKE SYSTEM

Wheel cylinder piston
sticking

See DRUM BRAKES or
BRAKE SYSTEM

AA

Dragging

Brakes

Master cylinder pistons
not returning

See MASTER CYLINDERS
BRAKE SYSTEM

Restricted brake lines
or hoses
Incorrect parking brake
adjustment

Check line routing

See DRUM BRAKES
BRAKE SYSTEM

Parking Brake cables frozen

See DRUM BRAKES
BRAKE SYSTEM

Incorrect installation of
inboard disc pad

Remove and replace
correctly

Power booster output
rod too long

See POWER BRAKE UNITS
BRAKE SYSTEM

Brake pedal not returning
freely

See DISC, DRUM BRAKES
BRAKE SYSTEM

AA

Brakes Grab or
Uneven Braking
Action

Malfunction of combination
valve

See CONTROL VALVE or
BRAKE SYSTEM

Malfunction of power brake
unit

See POWER BRAKE UNITS
or BRAKE SYSTEM

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Binding brake pedal

See DISC, DRUM BRAKES
or BRAKE SYSTEM

AA

Pulsation or
Roughness

Uneven pad wear caused by
caliper

See DISC BRAKES or
BRAKE SYSTEM

Uneven rotor wear

See DISC BRAKES or
BRAKE SYSTEM

Drums out-of-round

Reface or replace drums

AA

CARBURETOR TROUBLE SHOOTING:

READ THIS FIRST:

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COLD START SYMPTOMS

BASIC COLD START SYMPTOMS TROUBLE SHOOTING CHART

AA

CONDITION

POSSIBLE CAUSE

CORRECTION

AA

Engine Won't
Start

Choke not closing

Check choke
operation, see
FUEL SYSTEMS

Choke linkage bent

Check linkage, see
FUEL SYSTEM

AA

Engine Starts,
Then Dies

Choke vacuum kick setting
too wide

Check setting and
adjust see, FUEL
SYSTEMS

Fast idle RPM too low

Reset RPM to specifi-
cation, see TUNE-UP

Fast idle cam index
incorrect

Reset fast idle cam
index, see FUEL
SYSTEMS

Vacuum leak

Inspect vacuum
system for leaks

TROUBLE SHOOTING - BASIC PROCEDURES

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Low fuel pump outlet

Repair or replace
pump, see FUEL
SYSTEMS

Low carburetor fuel level

Check float setting
see FUEL SYSTEM

AA

Engine Quits
Under Load

Choke vacuum kick setting
incorrect

Reset vacuum kick
setting, see FUEL
SYSTEMS

Fast idle cam index
incorrect

Reset fast idle cam
index, see FUEL
SYSTEM

Incorrect hot fast idle
speed RPM

Reset fast idle RPM,
see TUNE-UP

AA

Engine Starts,
Runs Up, Then
Idles, Slowly
With Black Smoke

Choke vacuum kick set too
narrow

Reset vacuum kick,
see FUEL SYSTEMS

Fast idle cam index
incorrect

Reset fast idle cam
index, see FUEL
SYSTEMS

Hot fast idle RPM too low

Reset fast idle RPM,
see TUNE-UP

AA

HOT STARTING SYMPTOMS

BASIC HOT START SYMPTOMS TROUBLE SHOOTING CHART

AA

CONDITION

POSSIBLE CAUSE

CORRECTION

AA

Engine Won't
Start

Engine flooded

Allow fuel to
evaporate

AA

COLD ENGINE DRIVEABILITY SYMPTOMS

BASIC COLD ENGINE DRIVEABILITY SYMPTOMS TROUBLE SHOOTING CHART

AA

CONDITION

POSSIBLE CAUSE

CORRECTION

AA

Engine Stalls in
Gear

Choke vacuum kick setting
incorrect

Reset choke vacuum
kick, see FUEL
SYSTEMS

Fast idle RPM incorrect

Reset fast idle RPM,
see TUNE-UP

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Fast idle cam index
incorrect

Reset fast idle cam
see FUEL SYSTEMS

AA

Acceleration Sag
or Stall

Defective choke control
switch

Replace choke
control switch

Choke vacuum kick setting
incorrect

Reset choke vacuum
kick see, FUEL
SYSTEMS

Float level incorrect
(too low)

Adjust float level,
FUEL SYSTEMS

Accelerator pump defective

Repair or replace
pump see FUEL
SYSTEMS

Secondary throttles not
closed

Inspect lockout
adjustment, see FUEL
SYSTEMS

AA

Sag or Stall
After Warmup

Defective choke control
switch

Replace choke
control switch, see
FUEL SYSTEMS

Defective accelerator pump

Replace pump, see
FUEL SYSTEMS

Float level incorrect
(too low)

Adjust float level,
see FUEL SYSTEMS

AA

Backfiring &
Black Smoke

Plugged heat crossover
system

Remove restriction

AA

WARM ENGINE DRIVEABILITY SYMPTOM

BASIC WARM ENGINE DRIVEABILITY SYMPTOMS TROUBLE SHOOTING CHART

AA

CONDITION

POSSIBLE CAUSE

CORRECTION

AA

Hesitation With
Small Amount of
Gas Pedal Movement

Vacuum leak

Inspect vacuum lines

Accelerator pump weak or
inoperable

Replace pump, see
FUEL SYSTEMS

Float level setting too low

Reset float level,
see, FUEL SYSTEMS

Metering rods sticking or
binding

Inspect and/or
replace rods, see

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FUEL SYSTEMS

Carburetor idle or transfer system plugged	Inspect system and remove restriction
--	---------------------------------------

Frozen or binding heated air inlet	Inspect heated air door for binding
------------------------------------	-------------------------------------

AA

Hesitation With Heavy Gas Pedal Movement	Defective accelerator pump	Replace pump, see FUEL SYSTEMS
--	----------------------------	--------------------------------

Metering rod carrier sticking or binding	Remove restriction
--	--------------------

Large vacuum leak	Inspect vacuum system and repair leak
-------------------	---------------------------------------

Float level setting too low	Reset float level, see FUEL SYSTEMS
-----------------------------	-------------------------------------

Defective fuel pump, lines or filter	Inspect pump, lines and filter
--------------------------------------	--------------------------------

Air door setting incorrect	Adjust air door setting, see FUEL
----------------------------	-----------------------------------

AA

CHARGING SYSTEM TROUBLE SHOOTING

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BASIC CHARGING SYSTEM TROUBLE SHOOTING CHART

AA

CONDITION	POSSIBLE CAUSE	CORRECTION
-----------	----------------	------------

AA

Vehicle Will Not Start	Dead battery	Check battery cells, alternator belt tension and alternator output
------------------------	--------------	--

Loose or corroded battery connections	Check all charging system connections
---------------------------------------	---------------------------------------

Ignition circuit or switch	Check and replace as
----------------------------	----------------------

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malfunction

necessary

AA

Alternator Light Stays On With Engine Running	Loose or worn alternator drive belt	Check alternator drive tension and condition, See Belt Adjustment in TUNE-UP article in the TUNE-UP section
---	--	--

Loose alternator wiring connections	Check all charging system connections
--	--

Short in alternator light wiring	See Indicator Warning Lights in STANDARD INSTRUMENTS in the ACCESSORIES & EQUIPMENT section
-------------------------------------	---

Defective alternator stator or diodes	See Bench Tests in ALTERNATOR article
--	--

Defective regulator	See Regulator Check in ALTERNATOR article
---------------------	--

AA

Alternator Light Stays Off With Ignition Switch ON	Blown fuse	See WIRING DIAGRAMS
---	------------	---------------------

Defective alternator	See Testing in ALTERNATOR article
----------------------	--------------------------------------

Defective indicator light bulb or socket	See Indicator Warning Lights in STANDARD INSTRUMENTS in the ACCESSORIES & EQUIPMENT section
---	---

AA

Alternator Light Stays OFF With Ignition Switch ON	Short in alternator wiring	See On-Vehicle Tests in ALTERNATOR article
---	----------------------------	---

Defective rectifier bridge	See Bench Tests in ALTERNATOR article
----------------------------	--

AA

Lights or Fuses Burn Out Frequently	Defective alternator wiring	See On-Vehicle Tests in ALTERNATOR article
---	-----------------------------	---

Defective regulator	See Regulator Check in ALTERNATOR article
---------------------	--

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Defective battery

Check and replace as necessary

AA

Ammeter Gauge Loose or worn drive belt
Shows Discharge

Check alternator drive belt tension and condition. See Belt Adjustment in TUNE-UP article in the TUNE-UP section

Defective wiring

Check all wires and wire connections

Defective alternator or regulator

See Bench Tests and On-Vehicle Tests in ALTERNATOR article

Defective ammeter, or improper ammeter wiring connection

See Testing in STANDARD INSTRUMENTS in the ACCESSORIES & EQUIPMENT section

AA

Noisy Loose drive pulley
Alternator

Tighten drive pulley attaching nut

Loose mounting bolts

Tighten all alternator mounting bolts

Worn or dirty bearings

See Bearing Replacement ALTERNATOR article

Defective diodes or stator

See Bench Test in ALTERNATOR article

AA

Battery Does Loose or worn drive belt
Stay Charged

Check alternator drive belt tension and condition. See Belt Adjustment in appropriate TUNE-UP article in the TUNE-UP section

Loose or corroded battery connections

Check all charging system connections

Loose alternator connections

Check all charging system connections

Defective alternator or battery

See On-Vehicle Tests and Bench Tests in

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ALTERNATOR article

Add-on electrical accessories Install larger
exceeding alternator capacity alternator

AA

Battery	Defective battery	Check alternator
Overcharged-		output and repair as
Uses Too Much		necessary
Water		

Defective alternator	See On-Vehicle Test and Bench Tests in ALTERNATOR article
----------------------	---

Excessive alternator voltage	Check alternator output and repair as necessary
------------------------------	--

AA

CLUTCH TROUBLE SHOOTING

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BASIC CLUTCH TROUBLE SHOOTING CHART

AA

CONDITION	POSSIBLE CAUSE	CORRECTION
-----------	----------------	------------

AA

Chattering or Grabbing	Incorrect clutch adjustment	Adjust clutch
	Oil, grease or glaze on facings	Disassemble and clean or replace
	Loose "U" joint flange	See DRIVE AXLES article
	Worn input shaft spline	Replace input shaft
	Binding pressure plate	Replace pressure plate
	Binding release lever	See CLUTCH article
	Binding clutch disc hub	Replace clutch disc
	Unequal pressure plate contact	Replace worn/misaligned components
	Loose/bent clutch disc	Replace clutch disc

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Incorrect transmission alignment	Realign transmission
Worn pressure plate, disc or flywheel	Replace damaged components
Broken or weak pressure springs	Replace pressure plate
Sticking clutch pedal	Lubricate clutch pedal & linkage
Incorrect clutch disc facing	Replace clutch disc
Engine loose in chassis	Tighten all mounting bolts

AA

Failure to Release	Oil or grease on clutch facings	Clean or replace clutch clutch disc
	Incorrect release lever or pedal adjustment	See CLUTCH article
	Worn or broken clutch facings	Replace clutch disc
	Bent clutch disc or pressure plate	Replace damaged components
	Clutch disc hub binding on input shaft	Clean or replace clutch disc and/or input shaft
	Binding pilot bearing	Replace pilot bearing
	Sticking release bearing sleeve	Replace release bearing and/or sleeve
	Binding clutch cable	See CLUTCH article
	Defective clutch master	Replace master cylinder
	Defective clutch slave	Replace slave cylinder
	Air in hydraulic system	Bleed hydraulic system
Rattling	Weak or broken release lever spring	Replace spring and check alignment
	Damaged pressure plate	Replace pressure plate

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Broken clutch return spring Replace return spring

Worn splines on clutch disc
or input shaft Replace clutch disc
and/or input shaft

Worn clutch release bearing Replace release bearing

Dry or worn pilot bearing Lubricate or replace
pilot bearing

Unequal release lever
contact Align or replace
release lever

Incorrect pedal free play Adjust free play

Warped or damaged clutch
disc Replace damaged
components

AA

Slipping Pressure springs worn or Release pressure plate

Oily, greasy or worn
facings Clean or replace clutch
disc

Incorrect clutch alignment Realign clutch assembly

Warped clutch disc or
pressure plate Replace damaged
components

Binding release levers or
clutch pedal Lubricate and/or
replace release
components

AA

Squeaking Worn or damaged release Replace release bearing

Dry or worn pilot or
release bearing Lubricate or replace
assembly

Pilot bearing turning in
crankshaft Replace pilot bearing
and/or crankshaft

Worn input shaft bearing Replace bearing and
seal

Incorrect transmission
alignment Realign transmission

Dry release fork between
pivot Lubricate release fork
and pivot

AA

Heavy and/or
Stiff Pedal Sticking release bearing
sleeve Replace release bearing
and/or sleeve

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Dry or binding clutch
pedal hub

Lubricate and align
components

Floor mat interference
with pedal

Lay mat flat in proper
area

Dry or binding ball/fork
pivots

Lubricate and align
components

Faulty clutch cable

Replace clutch cable

AA

Noisy Clutch
Pedal

Faulty interlock switch

Replace interlock
switch

Self-adjuster ratchet
noise

Lubricate or replace
self-adjuster

Speed control interlock
switch

Lubricate or replace
interlock switch

AA

Clutch Pedal
Sticks Down

Binding clutch cable

See CLUTCH article

Springs weak in pressure
plate

Replace pressure plate

Binding in clutch linkage

Lubricate and free
linkage

AA

Noisy

Dry release bearing

Lubricate or replace
release bearing

Dry or worn pilot bearing

Lubricate or replace
bearing

Worn input shaft bearing

Replace bearing

AA

Transmission
Click

Weak springs in pressure
plate

Replace pressure plate

Release fork loose on ball
stud

Replace release fork
and/or ball stud

Oil on clutch disc damper

Replace clutch disc

Broken spring in slave
cylinder

Replace slave cylinder

AA

COOLING SYSTEM TROUBLE SHOOTING

TROUBLE SHOOTING - BASIC PROCEDURES

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COOLING SYSTEM TROUBLE SHOOTING

AA

CONDITION	POSSIBLE CAUSE	CORRECTION
-----------	----------------	------------

AA

Overheating	Coolant Leak	Fill/Pressure Test System
	A/C Condenser Fins Clogged	Remove/Clean Condenser
	Radiator Fins Clogged	Remove/Clean Radiator
	Thermostat Stuck Closed	Replace Thermostat
	Clogged Cooling System Passages	Clean/Flush Cooling System
	Water Pump Malfunction	Replace Water Pump
	Fan Clutch Malfunction	Replace Fan Clutch
	Retarded Ignition Timing	Reset Ignition Timing
	Cooling Fan Malfunction	Test Cooling Fan/Circuit
	Cooling Fan Motor Malfunction	Test Fan Motor
	Cooling Fan Relay Malfunction	Test Fan Relay
	Faulty Radiator Cap	Replace Radiator Cap
	Broken/Slipping Fan Belt	Replace Fan Belt
	Restricted Exhaust	Repair Exhaust System
Corrosion	Impurities In Coolant	Clean/Flush System
Coolant Leakage	Damaged hose	Replace Hose
	Leaky Water Pump	Replace Water Pump
	Damaged Radiator Seam	Replace/Repair Radiator

TROUBLE SHOOTING - BASIC PROCEDURES

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Leaky Thermostat Cover

Replace Thermostat
Cover

Cylinder Head Problem

Check Head/Head Gasket

Leaky Freeze Plugs

Replace Freeze Plugs

AA

Recovery System Inoperative

Loose and/or Defective
Radiator Cap

Replace Radiator Cap

Overflow Tube Clogged
and/or Leaking

Repair Tube

Recovery Bottle Vent
Restricted

Clean Vent

AA

No Heater Core Flow

Collapsed Heater Hose

Replace Heater Hose

Plugged Heater Core

Clean/Replace Heater
Core

Faulty Heater Valve

Replace Heater Valve

AA

DIESEL ENGINE TROUBLE SHOOTING

WARNING: This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.

NOTE: Diesel engines mechanical diagnosis is the same as gasoline engines for items such as noisy valves, bearings, pistons, etc. The following trouble shooting covers only items pertaining to diesel engines.

BASIC DIESEL ENGINE TROUBLE SHOOTING CHART

AA

CONDITION

POSSIBLE CAUSE

CORRECTION

AA

Engine Won't
Crank

Bad battery connections
or dead batteries

Check connections
and/or replace
batteries

Bad starter connections
or bad starter

Check connections
and/or replace
batteries

TROUBLE SHOOTING - BASIC PROCEDURES

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AA

Engine Cranks Slowly, Won't Start	Bad battery connections or dead batteries	Check connections and/or replace batteries
	Engine oil too heavy	Replace engine oil

AA

Engine Cranks Normally, But Will Not Start	Glow plugs not functioning	Check glow plug system, see FUEL SYSTEMS
	Glow plug control not functioning	Check controller, see FUEL SYSTEMS
	Fuel not injected into cylinders	Check fuel injectors, see FUEL SYSTEMS
	No fuel to injection pump	Check fuel delivery system
	Fuel filter blocked	Replace fuel filter
	Fuel tank filter blocked	Replace fuel tank filter
	Fuel pump not operating	Check pump operation and/or replace pump
	Fuel return system blocked	Inspect system and remove restriction
	No voltage to fuel solenoid	Check solenoid and connections
	Incorrect or contaminated fuel	Replace fuel
	Incorrect injection pump timing	Re-adjust pump timing, see FUEL SYSTEMS
	Low compression	Check valves, pistons, rings, see ENGINES
	Injection pump malfunction	Inspect and/or replace injection pump

AA

Engine Starts, Won't Idle	Incorrect slow idle adjustment	Reset idle adjustment, see TUNE-UP
	Fast idle solenoid malfunctioning	Check solenoid and connections
	Fuel return system blocked	Check system and remove restrictions
	Glow plugs go off too soon	See glow plug diagnosis in FUEL SYSTEMS
	Injection pump timing incorrect	Reset pump timing, see FUEL SYSTEMS
	No fuel to injection pump	Check fuel delivery system
	Incorrect or contaminated fuel	Replace fuel
	Low compression	Check valves, piston, rings, see ENGINES
	Injection pump malfunction	Replace injection pump, see FUEL SYSTEMS
	Fuel solenoid closes in RUN position	Check solenoid and connections

TROUBLE SHOOTING - BASIC PROCEDURES

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AA

Engines Starts/	Incorrect slow idle	Reset slow idle, see
Idles Rough W/out	adjustment	TUNE-UP
Smoke or Noise	Injection line fuel leaks	Check lines and
		connections
	Fuel return system blocked	Check lines and
		connections
	Air in fuel system	Bleed air from system
	Incorrect or contaminated	Replace fuel
	fuel	
	Injector nozzle malfunction	Check nozzles, see
		FUEL SYSTEMS

AA

Engines Starts	Injection pump timing	Reset pump timing, see
and Idles Rough	incorrect	FUEL SYSTEMS
W/out Smoke or	Engine not fully broken in	Put more miles on
Noise, But Clears		engine
After Warm-Up	Air in system	Bleed air from system
	Injector nozzle malfunction	Check nozzles, see
		FUEL SYSTEMS

AA

Engine Idles	Blocked fuel filter	Replace fuel filter
Correctly,	Injection pump timing	Reset pump timing, see
Misfires Above	incorrect	FUEL SYSTEMS
Idle	Incorrect or contaminated	Replace fuel
	fuel	

AA

Engine Won't	Fast idle adjustment	Reset fast idle, see
Return To Idle	incorrect	TUNE-UP
	Internal injection pump	Replace injection pump,
	malfunction	see FUEL SYSTEMS
	External linkage binding	Check linkage and
		remove binding

AA

Fuel Leaks On	Loose or broken fuel line	Check lines and
Ground		connections
	Internal injection pump	Replace injection pump,
	seal leak	see FUEL SYSTEMS

AA

Cylinder	Injector nozzles sticking	Test injectors, see
Knocking Noise	open	FUEL SYSTEMS
	Very low nozzle opening	Test injectors and/or
	pressure	replace

AA

Loss of Engine	Restricted air intake	Remove restriction
Power	EGR valve malfunction	Replace EGR valve
	Blocked or damaged exhaust	Remove restriction
	system	and/or replace
		components
	Blocked fuel tank filter	Replace filter
	Restricted fuel filter	Remove restriction
		and/or replace filter

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Remove restriction
and/or replace cap

Check fuel lines and connections

Remove restriction

Replace fuel

Check nozzle for blockage, see FUEL SYSTEMS

Check valves, rings,
pistons, see ENGINES

Loud Engine

Reset timing, see
FUEL SYSTEMS

EGR valve malfunction

Replace EGR valve
Replace injection pump,
see FUEL SYSTEMS

Check pressure, see
FUEL SYSTEMS

Engine

Check cooling system
and repair leaks

Belt slipping or damaged

Check tension and/or
replace belt

Remove and replace
thermostat, see
ENGINE COOLING

Replace head gasket

Oil Light on at

Check oil pump
operation, see ENGINES

Remove restriction
and/or replace cooler

Engine Won't

Remove and check
solenoid and replace
if needed

VACUUM PUMP DIAGNOSIS

Loose pump-to-drive
assembly screws

Tighten screws

Tighten tube

Replace valves

Loose end plug

Bad seal crimp

Tighten end plug

Remove and re-crimp seal

[illegible]

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DRIVE AXLE - NOISE DIAGNOSIS

UNRELATED NOISES

Some driveline trouble symptoms are also common to the engine, transmission, wheel bearings, tires, and other parts of the vehicle. Ensure cause of trouble actually is in the drive axle before adjusting, repairing, or replacing any of its parts.

NON-DRIVE AXLE NOISES

A few conditions can sound just like drive axle noise and have to be considered in pre-diagnosis. The 4 most common noises are exhaust, tires, CV/universal joints and wheel trim rings.

In certain conditions, the pitch of the exhaust gases may sound like gear whine. At other times, it may be mistaken for a wheel bearing rumble.

Tires, especially radial and snow, can have a high-pitched tread whine or roar, similar to gear noise. Also, some non-standard tires with an unusual tread construction may emit a roar or whine.

Defective CV/universal joints may cause clicking noises or excessive driveline play that can be improperly diagnosed as drive axle problems.

Trim and moldings also can cause a whistling or whining noise. Ensure none of these components are causing the noise before disassembling the drive axle.

GEAR NOISE

A "howling" or "whining" noise from the ring and pinion gear can be caused by an improper gear pattern, gear damage, or improper bearing preload. It can occur at various speeds and driving conditions, or it can be continuous.

Before disassembling axle to diagnose and correct gear noise, make sure that tires, exhaust, and vehicle trim have been checked as possible causes.

CHUCKLE

This is a particular rattling noise that sounds like a stick against the spokes of a spinning bicycle wheel. It occurs while decelerating from 40 MPH and usually can be heard until vehicle comes to a complete stop. The frequency varies with the speed of the vehicle.

A chuckle that occurs on the driving phase is usually caused by excessive clearance due to differential gear wear, or by a damaged tooth on the coast side of the pinion or ring gear. Even a very small tooth nick or a ridge on the edge of a gear tooth is enough the cause the noise.

This condition can be corrected simply by cleaning the gear tooth nick or ridge with a small grinding wheel. If either gear is damaged or scored badly, the gear set must be replaced. If metal has

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broken loose, the carrier and housing must be cleaned to remove particles that could cause damage.

KNOCK

This is very similar to a chuckle, though it may be louder, and occur on acceleration or deceleration. Knock can be caused by a gear tooth that is damaged on the drive side of the ring and pinion gears. Ring gear bolts that are hitting the carrier casting can cause knock. Knock can also be due to excessive end play in the axle shafts.

CLUNK

Clunk is a metallic noise heard when an automatic transmission is engaged in Reverse or Drive, or when throttle is applied or released. It is caused by backlash somewhere in the driveline, but not necessarily in the axle. To determine whether driveline clunk is caused by the axle, check the total axle backlash as follows:

1) Raise vehicle on a frame or twinpost hoist so that drive wheels are free. Clamp a bar between axle companion flange and a part of the frame or body so that flange cannot move.

2) On conventional drive axles, lock the left wheel to keep it from turning. On all models, turn the right wheel slowly until it is felt to be in Drive condition. Hold a chalk marker on side of tire about 12" from center of wheel. Turn wheel in the opposite direction until it is again felt to be in Drive condition.

3) Measure the length of the chalk mark, which is the total axle backlash. If backlash is one inch or less, drive axle is not the source of clunk noise.

BEARING WHINE

Bearing whine is a high-pitched sound similar to a whistle. It is usually caused by malfunctioning pinion bearings. Pinion bearings operate at drive shaft speed. Roller wheel bearings may whine in a similar manner if they run completely dry of lubricant. Bearing noise will occur at all driving speeds. This distinguishes it from gear whine, which usually comes and goes as speed changes.

BEARING RUMBLE

Bearing rumble sounds like marbles being tumbled. It is usually caused by a malfunctioning wheel bearing. The lower pitch is because the wheel bearing turns at only about 1/3 of drive shaft speed.

CHATTER ON TURNS

This is a condition where the entire front or rear of vehicle vibrates when vehicle is moving. The vibration is plainly felt as well

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as heard. Extra differential thrust washers installed during axle repair can cause a condition of partial lock-up that creates this chatter.

AXLE SHAFT NOISE

Axle shaft noise is similar to gear noise and pinion bearing whine. Axle shaft bearing noise will normally distinguish itself from gear noise by occurring in all driving modes (Drive, cruise, coast and float), and will persist with transmission in Neutral while vehicle is moving at problem speed.

If vehicle displays this noise condition, remove suspect axle shafts, replace wheel seals and install a new set of bearings. Re-evaluate vehicle for noise before removing any internal components.

VIBRATION

Vibration is a high-frequency trembling, shaking or grinding condition (felt or heard) that may be constant or variable in level and can occur during the total operating speed range of the vehicle.

The types of vibrations that can be felt in the vehicle can be divided into 3 main groups:

- * Vibrations of various unbalanced rotating parts of the vehicle.
- * Resonance vibrations of the body and frame structures caused by rotating of unbalanced parts.
- * Tip-in moans of resonance vibrations from stressed engine or exhaust system mounts or driveline flexing modes.

DRIVE AXLE - RWD TROUBLE SHOOTING

WARNING: This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing. For definitions of listed noises or sounds, see DRIVE AXLE - NOISE DIAGNOSIS.

DRIVE AXLE (RWD) TROUBLE SHOOTING

CONDITION	POSSIBLE CAUSE	CORRECTION
Knocking or Clunking	Differential Side Gear Clearance	Check Clearance
	Worn Pinion Shaft	Replace Pinion Shaft
	Axle Shaft End Play	Check End Play

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Missing Gear Teeth	Check Differential/ Replace Gear
--------------------	-------------------------------------

Wrong Axle Backlash	Check Backlash
---------------------	----------------

Misaligned Driveline	Realign Driveline
----------------------	-------------------

AA

Clinking During Engagement

Side Gear Clearance	Check Clearance
---------------------	-----------------

Ring and Pinion Backlash	Check Backlash
--------------------------	----------------

Worn/Loose Pinion Shaft	Replace Shaft/Bearing
-------------------------	-----------------------

Bad "U" Joint	Replace "U" Joint
---------------	-------------------

Sticking Slip Yoke	Lube Slip Yoke
--------------------	----------------

Broken Rear Axle Mount	Replace Mount
------------------------	---------------

Loose Drive Shaft Flange	Check Flange
--------------------------	--------------

AA

Click/Chatter On Turns

Differential Side Gear Clearance	Check Clearance
-------------------------------------	-----------------

Wrong Turn On Plates (1)	Replace Clutch Plates
--------------------------	-----------------------

Wrong Differential Lubricant (1)	Change Lubricant
-------------------------------------	------------------

AA

Knock Or Click

Flat Spot on Rear Wheel Bearing	Replace Wheel Bearing
------------------------------------	-----------------------

AA

Low Vibration At All Speeds

Faulty Wheel Bearing	Replace Wheel Bearing
----------------------	-----------------------

Faulty "U" Joint	Replace "U" Joint
------------------	-------------------

Faulty Drive Shaft	Balance Drive Shaft
--------------------	---------------------

Faulty Companion Flange	Replace Flange
-------------------------	----------------

Faulty Slip Yoke Flange	Replace Flange
-------------------------	----------------

(1) - Limited slip differential only.

AA

FWD AXLE SHAFTS & CV JOINTS TROUBLE SHOOTING

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to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.

BASIC FWD AXLE SHAFTS & CV JOINTS TROUBLE SHOOTING CHART

AA	
CONDITION	POSSIBLE CAUSE
AA	
Grease Leaks	CV boot torn or cracked
AA	
Clicking Noise on Cornering	Damaged outer CV
AA	
Clunk Noise on Acceleration	Damaged inner CV
AA	
Vibration or Shudder on Acceleration	Sticking, damaged or worn CV Misalignment or spring height
AA	

FUEL INJECTION TROUBLE SHOOTING

WARNING: This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.

BASIC FUEL INJECTION TROUBLE SHOOTING CHART

AA		
CONDITION	POSSIBLE CAUSE	CORRECTION
AA		
Engine Won't Start (Cranks Normally)	Cold start valve inoperative	Test valve and circuit
	Poor connection;vacuum or wiring	Check vacuum and electrical connections
	Contaminated fuel	Test fuel for water or alcohol
	Defective fuel pump relay or circuit	Test relay and wiring
	Battery too low	Charge and test battery
Low fuel pressure		Test pressure regul-

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ator and fuel pump,
check for restricted
lines and filters

No distributor reference
pulses

Repair ignition
system as necessary

Open coolant temperature
sensor circuit

Test sensor and
wiring

Shorted W.O.T. switch in
T.P.S.

Disconnect W.O.T.
switch, engine
should start

Defective ECM

Replace ECM

Fuel tank residual pressure
valve leaks

Test for fuel
pressure drop after
shut down

AA

Hard Starting

Disconnected hot air tube
to air cleaner

Reconnect tube and
test control valve

Defective Idle Air Control
(IAC) valve

Test valve operation
and circuit

Shorted, open or misadjusted
T.P.S.

Test and adjust or
replace T.P.S.

EGR valve open

Test EGR valve and
control circuit

Poor Oxygen sensor signal

Test for shorted or
circuit

Incorrect mixture from PCV
system

Test PCV for flow,
check sealing of oil
filter cap

AA

Poor High Speed
Operation

Low fuel pump volume

Faulty pump or
restricted fuel
lines or filters

Poor MAP sensor signal

Test MAP sensor,
vacuum hose and
wiring

Poor Oxygen sensor signal

Test for shorted or
open sensor or
circuit

Open coolant temperature

Test sensor and

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sensor circuit	wiring
Faulty ignition operation	Check wires for cracks or poor connections, test secondary voltage with oscilloscope
Contaminated fuel	Test fuel for water or alcohol
Intermittent ECM ground	Test ECM ground connection for resistance
Restricted air cleaner	Replace air cleaner
Restricted exhaust system	Test for exhaust manifold back pressure
Poor MAF sensor signal	Check leakage between sensor and manifold
Poor VSS signal	If tester for ALCL hook-up is available check that VSS reading matches speedometer
AA	
Ping or Knock on Acceleration	Poor Knock sensor signal Test for shorted or open sensor or circuit
Poor Baro sensor signal	Test for shorted or open sensor or circuit
Improper ignition timing	See VEHICLE EMISSION CONTROL LABEL (where applicable)
Check for engine overheating problems	Low coolant, loose belts or electric cooling fan inoperative
AA	

NOTE: For additional electronic fuel injection trouble shooting information, see the appropriate article in the ENGINE PERFORMANCE section (not all vehicles have Computer Engine

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Control articles). Information is provided there for diagnosing fuel system problems on vehicles with electronic fuel injection.

GASOLINE ENGINE - MECHANICAL TROUBLE SHOOTING

WARNING: This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.

BASIC GASOLINE ENGINE - MECHANICAL TROUBLE SHOOTING CHART

AA		
CONDITION	POSSIBLE CAUSE	CORRECTION
AA		
Engine Lops At Idle	Intake manifold-to-head leaks	Replace manifold gasket, See ENGINES
	Blown head gasket	Replace head gasket, See ENGINES
	Worn timing gears, chain or sprocket	Replace gears, chain or sprocket
	Worn camshaft lobes	Replace camshaft, See ENGINES
	Overheated engine	Check cooling system, See COOLING
	Blocked crankcase vent valve	Remove restriction
	Leaking EGR valve	Repair leak and/or replace valve
	Faulty fuel pump	Replace fuel pump
	AA	
	Leaking fuel pump	Repair leak and/or replace fuel pump
Engine Has Low Power	Excessive piston-to-bore clearance	Install larger pistons, See ENGINES
	Sticking valves or weak valve springs	Check valve train components, See ENGINES
	Incorrect valve timing	Reset valve timing, See ENGINES
	Worn camshaft lobes	Replace camshaft, See ENGINES
	Blown head gasket	Replace camshaft, See ENGINES
	Clutch slipping	Adjust pedal and/or replace components, See ENGINES
	Engine overheating	Check cooling system, See COOLING
	Auto. Trans. pressure	

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regulator valve faulty	Replace pressure regulator valve
Auto. Trans. fluid level too low	Add fluid as necessary
Improper vacuum diverter valve operation	Replace vacuum diverter valve
Vacuum leaks	Inspect vacuum system and repair as required
Leaking piston rings	Replace piston rings, See ENGINES

AA

Faulty High Speed Operation	Low fuel pump volume	Replace fuel pump
	Leaking valves or worn	Replace valves and/or springs, See ENGINES
	Incorrect valve timing	Reset valve timing, See ENGINES
	Intake manifold restricted	Remove restriction
	Worn distributor shaft	Replace distributor

AA

Faulty Acceleration	Improper fuel pump stroke	Remove pump and reset pump stroke
	Incorrect ignition timing	Reset ignition timing, See TUNE-UP
	Leaking valves	Replace valves, See ENGINES
	Worn fuel pump diaphragm or piston	Replace diaphragm or piston

AA

Intake Backfire	Improper ignition timing	Reset ignition timing, See TUNE-UP
	Faulty accelerator pump discharge	Replace accelerator pump
	Improper choke operation	Check choke and adjust as required
	Defective EGR valve	Replace EGR valve
	Fuel mixture too lean	Reset air/fuel mixture, See TUNE-UP
	Choke valve initial clearance too large	Reset choke valve initial clearance

AA

Exhaust Backfire	Vacuum leak	Inspect and repair vacuum system
	Faulty vacuum diverter valve	Replace vacuum diverter valve
	Faulty choke operation	Check choke and adjust as required
	Exhaust system leak	repair exhaust system leak

AA

Engine	Ignition timing too far	Reset ignition timing,
--------	-------------------------	------------------------

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Detonation	advanced	See TUNE-UP
	Faulty ignition system	Check ignition timing, See TUNE-UP
	Spark plugs loose or faulty	Retighten or replace plugs
	Fuel delivery system clogged	Inspect lines, pump and filter for clog
	EGR valve inoperative	Replace EGR valve
	PCV system inoperative	Inspect and/or replace hoses or valve
	Vacuum leaks	Check vacuum system and repair leaks
	Excessive combustion chamber deposits	Remove built-up deposits
	Leaking, sticking or broken valves	Inspect and/or replace valves
AA		
External Oil Leakage	Fuel pump improperly seated or worn gasket	Remove pump, replace gasket and seat properly
	Oil pan gasket broken or pan bent	Straighten pan and replace gasket
	Timing chain cover gasket broken	Replace timing chain cover gasket
	Rear main oil seal worn	Replace rear main oil seal
	Oil pan drain plug not seated properly	Remove and reinstall drain plug
	Camshaft bearing drain hole blocked	Remove restriction
	Oil pressure sending switch leaking	Remove and reinstall sending switch
	AA	
	Worn valve stems or guides	Replace stems or guides, See ENGINES
	Valve "O" ring seals damaged	Replace "O" ring seals, See ENGINES
Excessive Oil Consumption	Plugged oil drain back holes	Remove restrictions
	Improper PCV valve operation	Replace PCV valve
	Engine oil level too high	Remove excess oil
	Engine oil too thin	Replace thicker oil
	Valve stem oil deflectors damaged	Replace oil deflectors
	Incorrect piston rings	Replace piston rings, See ENGINES
	Piston ring gaps not staggered	Reinstall piston rings, See ENGINES
	Insufficient piston ring tension	Replace rings, See ENGINES
	Piston ring grooves or oil	Replace piston rings,

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return slots clogged	See ENGINES
Piston rings sticking in grooves	Replace piston rings, See ENGINES
Piston ring grooves excessively worn	Replace piston and rings, See ENGINES
Compression rings installed upside down	Replace compression rings correctly, See ENGINES
Worn or scored cylinder walls	Rebore cylinders or replace block
Mismatched oil ring expander and rail	Replace oil ring expander and rail, See ENGINES
Intake gasket dowels too long	Replace intake gasket dowels
Excessive main or connecting rod bearing clearance	Replace main or connecting rod bearings, See ENGINES

AA

No Oil Pressure	Low oil level	Add oil to proper level
	Oil pressure sender or gauge broken	Replace sender or gauge
	Oil pump malfunction	Remove and overhaul oil pump, See ENGINES
	Oil pressure relief valve sticking	Remove and reinstall valve
	Oil pump passages blocked	Overhaul oil pump, See ENGINES
	Oil pickup screen or tube blocked	remove restriction
	Loose oil inlet tube	Tighten oil inlet tube
	Loose camshaft bearings	Replace camshaft bearings, See ENGINES
	Internal leakage at oil passages	Replace block or cylinder head

AA

Low Oil Pressure	Low engine oil level	Add oil to proper level
	Engine oil too thin	Remove and replace with thicker oil
	Excessive oil pump clearance	Reduce oil pump clearance, See ENGINES
	Oil pickup tube or screen blocked	Remove restrictions
	Main, rod or cam bearing clearance excessive	Replace bearing to reduce clearance, See ENGINES

AA

High Oil Pressure	Improper grade of oil	Replace with proper oil
	Oil pressure relief valve stuck closed	Eliminate binding
	Oil pressure sender or gauge faulty	Replace sender or gauge

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AA

Noisy Main Bearings	Inadequate oil supply	Check oil delivery to main bearings
	Excessive main bearing clearance	Replace main bearings, See ENGINES
	Excessive crankshaft end play	Replace crankshaft, See ENGINES
	Loose flywheel or torque converter	Tighten attaching bolts
	Loose or damaged vibration damper	Tighten or replace vibration damper
	Crankshaft journals out-of-round	Re-grind crankshaft journals
	Excessive belt tension	Loosen belt tension

AA

Noisy Connecting Rods	Excessive bearing clearance or missing bearing	Replace bearing, See ENGINES
	Crankshaft rod journal out-of-round	Re-grind crankshaft journal
	Misaligned connecting rod or cap	Remove rod or cap and realign
	Incorrectly tightened rod bolts	Remove and re-tighten rod bolts

AA

Noisy Pistons and Rings	Excessive piston-to-bore clearance	Install larger pistons, See ENGINES
	Bore tapered or out-of-round	Rebore block
	Piston ring broken	Replace piston rings, See ENGINES
	Piston pin loose or seized	Replace piston pin, See ENGINES
	Connecting rods misaligned	Realign connecting rods
	Ring side clearance too loose or tight	Replace with larger or smaller rings
	Carbon build-up on piston	Remove carbon

AA

Noisy Valve Train	Worn or bent push rods	Replace push rods, See ENGINES
	Worn rocker arms or bridged pivots	Replace push rods, See ENGINES
	Dirt or chips in valve lifters	Remove lifters and remove dirt/chips
	Excessive valve lifter leak-down	Replace valve lifters, See ENGINES
	Valve lifter face worn	Replace valve lifters, See ENGINES
	Broken or cocked valve springs	replace or reposition springs
	Too much valve stem-to-guide clearance	Replace valve guides, See ENGINES
	Valve bent	Replace valve, See ENGINES

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Loose rocker arms	Retighten rocker arms, See ENGINES
Excessive valve seat run-out	Reface valve seats, See ENGINES
Missing valve lock	Install new valve lock
Excessively worn camshaft lobes	Replace camshaft, See ENGINES
Plugged valve lifter oil holes	Eliminate restriction or replace lifter
Faulty valve lifter check ball	Replace lifter check ball, See ENGINES
Rocker arm nut installed upside down	Remove and reinstall correctly
Valve lifter incorrect for engine	Remove and replace valve lifters
Faulty push rod seat or lifter plunger	Replace plunger or push rod

AA

Noisy Valves	Improper valve lash	Re-adjust valve lash, See ENGINES
	Worn or dirty valve lifters	Clean and/or replace lifters
	Worn valve guides	Replace valve guides, See ENGINES
	Excessive valve seat or face run-out	Reface seats or valve face
	Worn camshaft lobes	Replace camshaft, See ENGINES
	Loose rocker arm studs	Re-tighten rocker arm studs, See ENGINES
	Bent push rods	Replace push rods, See ENGINES
	Broken valve springs	Replace valve springs, See ENGINES

AA

Burned, Sticking or Broken Valves	Weak valve springs or warped valves	Replace valves and/or springs, See ENGINES
	Improper lifter clearance	Re-adjust clearance or replace lifters
	Worn guides or improper guide clearance	Replace valve guides, See ENGINES
	Out-of-round valve seats or improper seat width	Re-grind valve seats
	Gum deposits on valve stems, seats or guides	Remove deposits
	Improper spark timing	Re-adjust spark timing

AA

Broken Pistons/Rings	Undersize pistons	Replace with larger pistons, See ENGINES
	Wrong piston rings	Replace with correct rings, See ENGINES
	Out-of-round cylinder bore	Re-bore cylinder bore

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Improper connecting rod alignment	Remove and realign connecting rods
Excessively worn ring grooves	Replace pistons, See ENGINES
Improperly assembled piston pins	Re-assemble pin-to-piston, See ENGINES
Insufficient ring gap clearance	Install new rings, See ENGINES
Engine overheating	Check cooling system
Incorrect ignition timing	Re-adjust ignition timing, See TUNE-UP

AA

Excessive Exhaust Noise	Leaks at manifold to head, or to pipe	Replace manifold or pipe gasket
	Exhaust manifold cracked or broken	Replace exhaust manifold, See ENGINES

AA

HEATER SYSTEM TROUBLE SHOOTING

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BASIC HEATER SYSTEM TROUBLE SHOOTING CHART

AA

CONDITION	POSSIBLE CAUSE
-----------	----------------

AA

Insufficient, Erratic,
or No Heat

- ù Low Coolant Level
- ù Incorrect thermostat.
- ù Restricted coolant flow through heater core.
- ù Heater hoses plugged.
- ù Misadjusted control cable.
- ù Sticking heater control valve.
- ù Vacuum hose leaking.
- ù Vacuum hose blocked.
- ù Vacuum motors inoperative.
- ù Blocked air inlet.
- ù Inoperative heater blower motor.
- ù Oil residue on heater core fins.
- ù Dirt on heater core fins.

AA

Too Much Heat

- ù Improperly adjusted cables.
- ù Sticking heater control valve.
- ù No vacuum to heater control valve.
- ù Temperature door stuck open.

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AA

Air Flow Changes During
Acceleration

- ù Vacuum system leak.
- ù Bad check valve or reservoir.

AA

Air From Defroster At All
Times

- ù Vacuum system leak.
- ù Improperly adjusted control cables.
- ù Inoperative vacuum motor.

AA

Blower Does Not Operate
Correctly

- ù Blown fuse.
- ù Blower motor windings open.
- ù Resistors burned out.
- ù Motor ground connection loose.
- ù Wiring harness connections loose.
- ù Blower motor switch inoperative.
- ù Blower relay inoperative.
- ù Fan binding or foreign object in housing.
- ù Fan blades broken or bent.

AA

IGNITION SYSTEM TROUBLE SHOOTING

PLEASE READ THIS FIRST:

WARNING: This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.

IGNITION SECONDARY TROUBLE SHOOTING CHART

ÜAA¿

3 START: Visually inspect Spark Plug Wires, Coil Wires, 3
3 Plug Wire Boots, Rotor, and Distributor Cap for 3
3 signs of damage. 3

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ÜAA¿

ÜAAA¿

3 OK 3

AAAAAU

ÜAAAAAA¿

3 NOT OK 3

AAAAAAU

ÜAA¿

3 * To test secondary ignition 3
3 system, modify a Spark Plug 3
3 by attaching a ground wire 3
3 to the body of the plug and 3
3 widening the gap to 1/4-3/8". 3

ÜAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA¿

3 * Repair or replace 3
3 damaged components 3
3 as necessary 3

AAAAAAAAAAAAAAAAAAAAAAAAAU

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3 Disconnect spark plug wire 3
3 and insert test plug. Ground 3
3 plug, crank engine, and 3
3 check for spark. 3

AA

UAAA

UAAAAAAAAAAZ

3 GOOD SPARK 3

AAAAAAAAAAU

UAAAAAAAAAAZ

3 NO SPARK 3

AAAAAAAAAAU

UAAA

3 * If plug sparks, driveability 3
3 problem is most likely NOT 3
3 in the ignition system. 3

AA

UAAA

3 * Remove coil wire from the 3
3 distributor and attach the 3
3 modified spark plug. Ground 3
3 the plug and crank engine 3
3 while checking for spark. 3

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3 GOOD SPARK 3

AAAAAAAAAAU

UAAAAAAAAAAZ

3 NO SPARK 3

AAAAAAAAAAU

UAAA

3 * If plug has a good spark, 3
3 the problem is in the plug 3
3 wires, distributor cap, or 3
3 rotor. Replace components 3
3 as necessary. 3

AA

UAAA

3 * Proceed to the IGNITION 3
3 PRIMARY TROUBLE SHOOTING 3
3 CHECK CHART below in this 3
3 article. 3

AA

IGNITION PRIMARY TROUBLE SHOOTING CHART

UAAA

3 START: Visually inspect primary ignition wires for 3
3 broken, frayed, split, or cut wires. Also check 3
3 for loose, corroded, or disconnected connectors. 3

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3 OK 3

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UAAAAAAAAAZ

3 NOT OK 3

AAAAAU

UAAA

3 * Check that battery voltage 3
3 is at least 11.5 volts. 3

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3 * Repair or replace damaged 3
3 components as necessary. 3

AA

UAAA

UAAAAZ

3 NOT OK 3

AAAAAU

UAAAAZ

3 OK 3

AAAAAU

UAAA

3 * Replace or recharge the 3
3 battery. 3

AA

UAAA

3 * Check for battery voltage 3
3 at the positive terminal of 3
3 the coil. 3

AA

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BASIC MANUAL STEERING GEAR TROUBLE SHOOTING CHART

AA

CONDITION	POSSIBLE CAUSE	CORRECTION
-----------	----------------	------------

AA

Rattle or Chuckling Noise in Rack and Pinion	Rack and pinion mounting bracket loose	Tighten all mounting bolts
	Lack of/or incorrect lubricant	Correct as necessary

	Steering gear mounting bolts loose	Tighten all mounting bolts
--	---------------------------------------	-------------------------------

AA

Excessive Play	Front wheel bearing improperly adjusted	See FRONT SUSPENSION article
----------------	--	---------------------------------

	Loose or worn steering linkage	See STEERING LINKAGE article
--	-----------------------------------	---------------------------------

	Loose or worn steering gear shift	See MANUAL STEERING GEAR article
--	--------------------------------------	-------------------------------------

	Steering arm loose on gear shaft	See MANUAL STEERING GEAR article
--	-------------------------------------	-------------------------------------

	Steering gear housing bolts loose	Tighten all mounting bolts
--	--------------------------------------	-------------------------------

	Steering gear adjustment too loose	See MANUAL STEERING GEAR article
--	---------------------------------------	-------------------------------------

	Steering arms loose on knuckles	Tighten and check steering linkage
--	------------------------------------	---------------------------------------

	Rack and pinion mounting loose	Tighten all mounting bolts
--	-----------------------------------	-------------------------------

	Rack and pinion out of adjustment	See adjustment in STEERING article
--	--------------------------------------	---------------------------------------

	Tie rod end loose	Tighten and check steering linkage
--	-------------------	---------------------------------------

	Excessive Pitman shaft-to- ball nut lash	Repair as necessary
--	---	---------------------

AA

Poor Returnability	Lack of lubricant in ball joint or linkage	Lubricate and service systems
-----------------------	---	----------------------------------

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Binding in linkage or ball joints	See STEERING LINKAGE and SUSPENSION article
-----------------------------------	---

Improper front end alignment	See WHEEL ALIGNMENT article
------------------------------	-----------------------------

Improper tire pressure	Inflate to proper pressure
------------------------	----------------------------

Tie rod binding	Inflate to proper pressure
-----------------	----------------------------

Shaft seal rubbing shaft	See STEERING COLUMN article
--------------------------	-----------------------------

AA

Excessive Vertical Motion	Improper tire pressure	Inflate to proper pressure
---------------------------	------------------------	----------------------------

Tires, wheels or rotors out of balance	Balance tires then check wheels and rotors
--	--

Worn or faulty shock absorbers	Check and replace if necessary
--------------------------------	--------------------------------

Loose tie rod ends or steering	Tighten or replace if necessary
--------------------------------	---------------------------------

Loose or worn wheel bearings	See SUSPENSION article
------------------------------	------------------------

AA

Steering Pulls to One Side	Improper tire pressure	Inflate to proper pressure
----------------------------	------------------------	----------------------------

Front tires are different sizes	Rotate or replace if necessary
---------------------------------	--------------------------------

Wheel bearings not adjusted properly	See FRONT SUSPENSION article
--------------------------------------	------------------------------

Bent or broken suspension components	See FRONT SUSPENSION article
--------------------------------------	------------------------------

Improper wheel alignment	See WHEEL ALIGNMENT article
--------------------------	-----------------------------

Brakes dragging	See BRAKES article
-----------------	--------------------

AA

Instability	Low or uneven tire pressure	Inflate to proper pressure
-------------	-----------------------------	----------------------------

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Loose or worn wheel bearings	See FRONT SUSPENSION article
Loose or worn idler arm bushing	See FRONT SUSPENSION article
Loose or worn strut bushings	See FRONT SUSPENSION article
Incorrect front wheel alignment	See WHEEL ALIGNMENT article
Steering gear not centered	See MANUAL STEERING GEARS article
Springs or shock	Check and replace if necessary
Improper cross shaft	See MANUAL STEERING GEARS article

AA

POWER STEERING TROUBLE SHOOTING

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BASIC POWER STEERING TROUBLE SHOOTING CHART

AA

CONDITION	POSSIBLE CAUSE	CORRECTION
AA		
Rattle or Chucking Noise	Pressure hoses touching engine parts	Adjust to proper clearance
	Loose Pitman shaft	Adjust or replace if necessary
	Tie rods ends or Pitman arm loose	Tighten and check system
	Rack and pinion mounts loose	Tighten all mounting bolts
	Free play in worm and	See POWER STEERING GEAR article
	Loose sector shaft or	See POWER STEERING GEAR

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thrust bearing adjustment

Free play in pot coupling See STEERING COLUMN
article

Worn shaft serrations See STEERING COLUMN
article

AA

Growl in Excessive pressure in Restricted hoses, see
Steering Pump hoses POWER STEERING GEAR
article

Scored pressure plates See POWER STEERING GEAR
article

Scored thrust plates or See POWER STEERING GEAR
rotor article

Extreme wear of cam ring See POWER STEERING GEAR
article

AA

Rattle in Vanes not installed See POWER STEERING PUMP
Steering Pump article

Vanes sticking in rotor See POWER STEERING PUMP
article

AA

Swish noise in Defective flow control See POWER STEERING PUMP
Pump valve article

AA

Groan in Air in fluid See POWER STEERING PUMP
Steering Pump article

Poor pressure hose Tighten and check,
connection replace if necessary

AA

Squawk When Damper "O" ring on valve See POWER STEERING PUMP
Turning spool cut article

AA

Moan or Whine Pump shaft bearing scored Replace bearing and
in Pump fluid

Air in fluid or fluid See POWER STEERING PUMP
level low article

Hose or column grounded Check and replace if
necessary

Cover "O" ring missing See POWER STEERING PUMP
or damaged article

Valve cover baffle See POWER STEERING PUMP

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missing or damaged

article

Interference of
components in pump

See POWER STEERING PUMP
article

Loose or poor bracket
alignment

Correct or replace if
necessary

AA

Hissing When
Parking

Internal leakage in
steering gear

Check valved assembly
first

AA

Chirp in
Steering Pump

Loose or worn power
steering belt

Adjust or replace if
necessary

AA

Buzzing When
Not Steering

Noisy pump

See POWER STEERING PUMP
article

Free play in steering
shaft bearing

See STEERING COLUMN
article

Bearing loose on shaft
serrations

See STEERING COLUMN
article

AA

Clicking Noise
in Pump

Pump slippers too long

See POWER STEERING PUMP
article

Broken slipper springs

See POWER STEERING PUMP
article

Excessive wear or nicked
rotors

See POWER STEERING PUMP
article

Damaged cam contour

See POWER STEERING PUMP
article

AA

Poor Return of
Wheel

Wheel rubbing against
turn signal

See STEERING COLUMN
SWITCHES article

Flange rubbing steering
gear adjuster

See STEERING COLUMN
article

Tight or frozen steering
shaft bearing

See STEERING COLUMN
article

Steering gear out of
adjustment

See POWER STEERING GEAR
article

Sticking or plugged
spool valve

See POWER STEERING PUMP
article

Improper front end
alignment

See WHEEL ALIGNMENT
article

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Wheel bearings worn or loose	See FRONT SUSPENSION article
Ties rods or ball joints binding	Check and replace if necessary
Intermediate shaft joints binding	See STEERING COLUMN article
Kinked pressure hoses	Correct or replace if necessary
Loose housing head spanner nut	See POWER STEERING GEAR article
Damaged valve lever	See POWER STEERING GEAR article
Sector shaft adjusted too tight	See ADJUSTMENTS in POWER STEERING GEAR article
Worm thrust bearing adjusted too tight	See ADJUSTMENTS in POWER STEERING GEAR article
Reaction ring sticking in cylinder	See POWER STEERING GEAR article
Reaction ring sticking in housing head	See POWER STEERING GEAR article
Steering pump internal leakage	See POWER STEERING PUMP article
Steering gear-to-column misalignment	See STEERING COLUMN article
Lack of lubrication in linkage	Service front suspension
Lack of lubrication in ball joints	Service front suspension
AA	
High internal pump leakage	See POWER STEERING PUMP article
Power steering pump belt slipping	Adjust or replace if necessary
Low fluid level	Check and fill to proper level
Engine idle speed to low	Adjust to correct

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		setting
	Air in pump fluid system	See POWER STEERING PUMP article
	Pump output low	See POWER STEERING PUMP article
	Steering gear malfunctioning	See POWER STEERING GEAR article
AA		
Wheel Surges or Jerks	Low fluid level	Check and fill to proper level
	Loose fan belt	Adjust or replace if necessary
	Insufficient pump pressure	See POWER STEERING PUMP article
	Sticky flow control valve	See POWER STEERING PUMP article
	Linkage hitting oil pan at full turn	Replace bent components
AA		
Kick Back or Free Play	Air in pump fluid system	See POWER STEERING PUMP article
	Worn poppet valve in steering gear	See POWER STEERING PUMP article
	Excessive over center lash	See POWER STEERING GEAR article
	Thrust bearing out of adjustment	See POWER STEERING GEAR article
	Free play in pot coupling	See POWER STEERING PUMP article
	Steering gear coupling loose on shaft	See POWER STEERING PUMP article
	Steering disc mounting bolts loose	Tighten or replace if necessary
	Coupling loose on worm shaft	Tighten or replace if necessary
	Improper sector shaft adjustment	See POWER STEERING GEAR article

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Excessive worm piston side play	See POWER STEERING GEAR article
---------------------------------	---------------------------------

Damaged valve lever	See POWER STEERING GEAR article
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Universal joint loose	Tighten or replace if necessary
-----------------------	---------------------------------

Defective rotary valve	See POWER STEERING GEAR article
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AA

No Power When Parking	Sticking flow control valve	See POWER STEERING PUMP article
-----------------------	-----------------------------	---------------------------------

Insufficient pump pressure output	See POWER STEERING PUMP article
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Excessive internal pump leakage	See POWER STEERING PUMP article
---------------------------------	---------------------------------

Excessive internal gear leakage	See POWER STEERING PUMP article
---------------------------------	---------------------------------

Flange rubs against gear adjust plug	See STEERING COLUMN article
--------------------------------------	-----------------------------

Loose pump belt	Adjust or replace if necessary
-----------------	--------------------------------

Low fluid level	Check and add proper amount of fluid
-----------------	--------------------------------------

Engine idle too low	Adjust to correct setting
---------------------	---------------------------

Steering gear-to-column misaligned	See STEERING COLUMN article
------------------------------------	-----------------------------

AA

No Power, Left Turn	Left turn reaction seal "O" ring worn	See POWER STEERING GEAR article
---------------------	---------------------------------------	---------------------------------

Left turn reaction seal damaged/missing	See POWER STEERING GEAR article
---	---------------------------------

Cylinder head "O" ring damaged	See POWER STEERING PUMP article
--------------------------------	---------------------------------

AA

No Power, Right Turns	Column pot coupling bottomed	See STEERING COLUMN article
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Right turn reaction seal "O" ring worn	See POWER STEERING GEAR article
---	------------------------------------

Right turn reaction seal damaged	See POWER STEERING GEAR article
-------------------------------------	------------------------------------

Internal leakage through piston end plug	See POWER STEERING GEAR article
---	------------------------------------

Internal leakage through side plugs	See POWER STEERING GEAR article
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AA

Lack of Effort in Turning	Left and/or right reaction seal sticking in cylinder head	Replace, see POWER STEERING GEAR article
------------------------------	---	---

AA

Wanders to One Side	Front end alignment incorrect	See WHEEL ALIGNMENT article
------------------------	----------------------------------	--------------------------------

Unbalanced steering gear valve	See POWER STEERING GEAR article
-----------------------------------	------------------------------------

AA

Low Pressure Due to Steering Pump	Flow control valve stuck or inoperative	See POWER STEERING PUMP article
--------------------------------------	--	------------------------------------

Pressure plate not flat against cam ring	See POWER STEERING PUMP article
---	------------------------------------

Extreme wear of cam ring	Replace and check adjustments
--------------------------	----------------------------------

Scored plate, thrust plate or rotor	See POWER STEERING PUMP article
--	------------------------------------

Vanes not installed properly	See POWER STEERING PUMP article
---------------------------------	------------------------------------

Vanes sticking in rotor slots	See POWER STEERING PUMP article
----------------------------------	------------------------------------

Cracked/broken thrust or pressure plate	See POWER STEERING PUMP article
--	------------------------------------

AA

STARTER TROUBLE SHOOTING

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BASIC STARTER TROUBLE SHOOTING CHART

AA

CONDITION	POSSIBLE CAUSE	CORRECTION
-----------	----------------	------------

AA

Starter Fails to Operate	Dead battery or bad connections between starter and battery	Check battery charge and all wires and connections to starter
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Ignition switch faulty or misadjusted	Adjust or replace ignition switch
--	--------------------------------------

Open circuit between starter switch ignition terminal on starter relay	Check and repair wires and connections as necessary
--	---

Starter relay or starter defective	See Testing in STARTER article
---------------------------------------	-----------------------------------

Open solenoid pull-in wire	See Testing in STARTER article
-------------------------------	-----------------------------------

AA

Starter Does Not Operate and Headlights Dim	Weak battery or dead cell	Charge or replace battery as necessary
---	------------------------------	---

Loose or corroded battery connections	Check that battery connections are clean and tight
--	--

Internal ground in starter windings	See Testing in STARTER article
--	-----------------------------------

Grounded starter fields	See Testing in STARTERS
-------------------------	-------------------------

Armature rubbing on pole shoes	See STARTER article
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AA

Starter Turns but Engine Does Not Rotate	Starter clutch slipping	See STARTER article
--	-------------------------	---------------------

Broken clutch housing	See STARTER article
-----------------------	---------------------

Pinion shaft rusted or dry	See STARTER article
-------------------------------	---------------------

Engine basic timing incorrect	See Ignition Timing in TUNE-UP article
----------------------------------	---

Broken teeth on engine flywheel	Replace flywheel and check for starter pinion gear damage
------------------------------------	---

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AA

Starter Will Not Crank Engine	Faulty overrunning clutch	See STARTER article
	Broken clutch housing	See STARTER article
	Broken flywheel teeth	Replace flywheel and check for starter pinion gear damage
	Armature shaft sheared or reduction gear teeth stripped	See STARTER article
	Weak battery	Charge or replace battery as necessary
	Faulty solenoid	See On-Vehicle Tests in STARTER article
	Poor grounds	Check all ground connections for tight and clean connections
	Ignition switch faulty or misadjusted	Adjust or replace ignition switch as necessary

AA

Starter Cranks Engine Slowly	Battery weak or defective	Charge or replace battery as necessary
	Engine overheated	See ENGINE COOLING SYSTEM article
	Engine oil too heavy	Check that proper viscosity oil is used
	Poor battery-to-starter connections	Check that all between battery and starter are clean and tight
	Current draw too low or too high	See Bench Tests in STARTER article
	Bent armature, loose pole shoes screws or worn bearings	See STARTER article
	Burned solenoid contacts	Replace solenoid

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	Faulty starter	Replace starter
Starter Engages Engine Only Momentarily	Engine timing too far advanced	See Ignition Timing in TUNE-UP article
	Overrunning clutch not engaging properly	Replace overrunning clutch. See STARTER article
	Broken starter clutch	See STARTER article
	Broken teeth on engine flywheel	Replace flywheel and check starter pinion gear for damage
	Weak drive assembly thrust spring	See STARTER article
	Weak hold-in coil	See Bench Tests in STARTER article
Starter Drive Will Not Engage	Defective point assembly	See Testing in STARTER article
	Poor point assembly ground	See Testing in STARTER article
	Defective pull-in coil	Replace starter solenoid
Starter Relay Does Not Close	Dead battery	Charge or replace battery as necessary
	Faulty wiring	Check all wiring and connections leading to relay
	Neutral safety switch faulty	Replace neutral safety switch
Starter Drive Will Not Disengage	Starter relay faulty	Replace starter relay
	Starter motor loose on mountings	Tighten starter attach bolts
	Worn drive end bushing	See STARTER article
	Damaged engine flywheel teeth	Replace flywheel and starter pinion gear for damage

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Drive yolk return spring broken or missing	Replace return spring
Faulty ignition switch	Replace ignition switch
Insufficient clearance between winding leads to solenoid terminal and main contact in solenoid	Replace starter solenoid
Starter clutch not disengaging	Replace starter clutch
Ignition starter switch contacts sticking	Replace ignition switch

AA

Starter Relay Operates but Solenoid Does Not	Faulty solenoid switch, switch connections or	Check all wiring between relay and solenoid or replace relay or solenoid as necessary
--	---	---

Broken lead or loose soldered connections	Repair wire or wire connections as necessary
---	--

AA

Solenoid Plunger Vibrates When Switch is Engaged	Weak battery	Charge or replace battery as necessary
--	--------------	--

Solenoid contacts corroded	Clean contacts or replace solenoid
----------------------------	------------------------------------

Faulty wiring	Check all wiring leading to solenoid
---------------	--------------------------------------

Broken connections inside switch cover	Repair connections or replace solenoid
--	--

Open hold-in wire	Replace solenoid
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AA

Low Current Draw	Worn brushes or weak	Replace brushes or brush springs as necessary
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AA

High Pitched Whine During Cranking Before Engine Fires but Engine Fires and Cranks Normally	Distance too great between starter pinion and flywheel	Align starter or check that correct starter and flywheel are being used
---	--	---

AA

High Pitched	Distance too small between
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Whine After Engine starter pinion and flywheel
Fires With Key Flywheel runout contributes
released. Engine to the intermittent nature
Fires and Cranks
Normally

AA

STEERING COLUMN TROUBLE SHOOTING

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BASIC STEERING COLUMN TROUBLE SHOOTING CHART

AA

CONDITION	POSSIBLE CAUSE	CORRECTION
-----------	----------------	------------

AA

Noise in Steering	Coupling pulled apart	See STEERING COLUMNS article
	Column not correctly aligned	See STEERING COLUMNS article
	Broken lower joint	Replace joint
	Horn contact ring not	See STEERING COLUMN article
	Bearing not lubricated	See STEERING COLUMN article
	Shaft snap ring not properly seated	Reseat or replace snap ring
	Plastic spherical joint not lubricated	See STEERING COLUMN article
	Shroud or housing loose	Tighten holding screws
	Lock plate retaining ring not seated	See STEERING COLUMN article
	Loose sight shield	Tighten holding screws
High Steering Shaft Effort	Column assembly misaligned	See STEERING COLUMN article
	Improperly installed dust	Adjust or replace

TROUBLE SHOOTING - BASIC PROCEDURES

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shield

Tight steering universal joint	See STEERING COLUMN article
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AA

High Shift Effort	Column is out of alignment	See STEERING COLUMN article
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Improperly installed dust shield	Adjust or replace
----------------------------------	-------------------

Seals or bearings not lubricated	See STEERING COLUMNS article
----------------------------------	------------------------------

Mounting bracket screws too long	Replace with new shorter screws
----------------------------------	---------------------------------

Burrs on shift tube	Remove burrs or replace tube
---------------------	------------------------------

Lower bowl bearing assembled wrong	See STEERING COLUMN article
------------------------------------	-----------------------------

Shift tube bent or broken	Replace as necessary
---------------------------	----------------------

Improper adjustment of shift levers	See STEERING COLUMN article
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AA

Improper Trans. Shifting	Sheared shift tube joint	Replace as necessary
--------------------------	--------------------------	----------------------

Sheared lower shaft lever	Replace as necessary
---------------------------	----------------------

Improper shift lever adjustment	See STEERING COLUMN article
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Improper gate plate adjustment	See STEERING COLUMN article
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AA

Excess Play in Column	Instrument panel bracket bolts loose	Tighten bolts and check bracket
-----------------------	--------------------------------------	---------------------------------

Broken weld nut on jacket	See STEERING COLUMN article
---------------------------	-----------------------------

Instrument bracket capsule sheared	See STEERING COLUMN article
------------------------------------	-----------------------------

Column bracket/jacket bolts loose	Tighten bolts and check bracket
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AA

Steering Locks in Gear	Release lever mechanism	See STEERING COLUMN article
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AA

SUSPENSION TROUBLE SHOOTING

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BASIC SUSPENSION TROUBLE SHOOTING CHART

AA

CONDITION	POSSIBLE CAUSE	CORRECTION
-----------	----------------	------------

AA

Front End Noise	Loose or worn wheel	See Wheel Bearing Adjustment in SUSPENSION
-----------------	---------------------	--

Worn shocks or shock mountings	Replace struts or strut mountings
--------------------------------	-----------------------------------

Worn struts or strut mountings	Replace struts or strut mountings
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Loose or worn lower control arm	See SUSPENSION
---------------------------------	----------------

Loose steering gear-to-frame bolts	See STEERING
------------------------------------	--------------

Worn control arm bushings	See SUSPENSION
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Ball joints not lubricated	Lubricate ball joints & see Ball Joint Checking in SUSPENSION
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AA

Front Wheel Shake, Shimmy, or Vibration	Tires or wheels out of balance	Check tire balance
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Incorrect wheel alignment	See WHEEL ALIGNMENT
---------------------------	---------------------

Drive shaft unbalanced	Check drive shaft balance
------------------------	---------------------------

Loose or worn wheel bearings	See WHEEL ALIGNMENT
------------------------------	---------------------

Loose or worn tie rod ends	See SUSPENSION
----------------------------	----------------

Worn upper ball joints	See Ball Joint Checking
------------------------	-------------------------

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	in SUSPENSION	
Worn shock absorbers	Replace shock absorbers	
Worn strut bushings	Replace strut bushings	
AA		
Car Pulls to One Side	Mismatched or uneven tires	Check tire condition
	Broken or sagging springs	See SUSPENSION
	Loose or worn strut bushings	See SUSPENSION
	Improper wheel alignment	See WHEEL ALIGNMENT
	Improper rear axle alignment	Check rear axle alignment
	Power steering gear unbalanced	See STEERING
	Front brakes dragging	See BRAKES
AA		
Abnormal Tire Wear	Unbalanced tires	Check tire balance & rotation
	Sagging or broken springs	See SUSPENSION
	Incorrect front end alignment	See WHEEL ALIGNMENT
	Faulty shock absorbers	Replace shock absorbers
AA		
Scuffed Tires	Toe-In incorrect	See WHEEL ALIGNMENT
	Suspension arm bent or twisted	See appropriate SUSPENSION article
AA		
Springs Bottom or Sag	Bent or broken springs	See SUSPENSION
	Leaking or worn shock absorbers	Replace shock absorbers
	Frame misalignment	Check frame for damage
AA		
Spring Noises	Loose "U" Bolts	See SUSPENSION
	Loose or worn bushings	See SUSPENSION
	Worn or missing interliners	See SUSPENSION
AA		
Shock Absorber	Loose shock mountings	Check & tighten

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Noise		mountings
	Worn bushings	Replace bushings
	Air in system	Bleed air from system
	Undercoating on shocks	Remove undercoating
AA		
Car Leans or	Loose stabilizer bar	See SUSPENSION
Sways on Corners		
	Faulty shocks or mountings	Replace shocks or mountings
	Broken or sagging springs	See SUSPENSION
AA		
Shock Absorbers	Worn seals or reservoir	See SUSPENSION
Leaking	tube crimped	
AA		
Broken Springs	Loose "U" bolts	See SUSPENSION
	Inoperative shock absorbers	Replace shock absorbers
AA		

TUNE-UP TROUBLE SHOOTING - GAS ENGINE VEHICLES

PLEASE READ THIS FIRST:

WARNING: This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.

SPARK PLUG DIAGNOSIS

BASIC SPARK PLUG TROUBLE SHOOTING CHARTS

AA		
CONDITION	POSSIBLE CAUSE	CORRECTION
AA		
Normal Spark	Light Tan or Gray deposits	No Action
Plug Condition		
	Electrode not burned or fouled	No Action
	Gap tolerance not changed	No Action
AA		
Cold Fouling or	Overrich air/fuel mixture	Adjust air/fuel
Carbon Deposits		mixture, see ENGINE PERFORMANCE section

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Faulty choke	Replace choke assembly, see ENGINE PERFORMANCE section
Clogged air filter	Clean and/or replace air filter
Incorrect idle speed or dirty carburetor	Reset idle speed and/or clean carburetor
Faulty ignition wires	Replace ignition wiring
Prolonged operation at idle	Shut engine off during long idle
Sticking valves or worn valve guide seals	Check valve train
AA	

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Wrong type of spark plug,
too hot

Replace with correct
spark plug, see
ENGINE PERFORMANCE

AA

Chipped
Insulators

Severe detonation

Check for over-
advanced timing or
combustion

Improper gapping
procedure

Re-gap spark plugs

AA

Rust Colored
Deposits

Additives in unleaded
fuel

Try different fuel
brand

AA

Water In Combustion
Chamber

Blown head gasket or
cracked head

Repair or replace
head or head gasket

AA

ELECTRONIC IGNITION DIAGNOSIS

NOTE: Before diagnosing an electronic ignition system, ensure that all wiring is connected properly between distributor, wiring connector and spark plugs. Ignition problem will show up either as: Engine Will Not Start or Engine Runs Rough.

BASIC ELECTRONIC IGNITION TROUBLE SHOOTING CHARTS

AA

CONDITION

POSSIBLE CAUSE

CORRECTION

AA

Engine Won't
Start

Open circuit between
distributor and bulkhead
connector

Repair circuit

Open circuit between
bulkhead connector and
ignition switch

Repair circuit

Open circuit between
ignition switch and
starter solenoid

Repair circuit

AA

Engine Runs
Rough

Fuel lines leaking or
clogged

Tighten fitting,
remove restriction

Initial timing incorrect

Reset ignition timing
see ENGINE PERFORMANCE

Centrifugal advance
malfunction

Repair distributor
advance

Defective spark plugs or

Replace plugs or plug

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wiring		wiring
AA		
Component Failure	Spark arc-over on cap, rotor or coil	Replace cap, rotor or coil
	Defective pick-up coil	Replace pick-up coil
	Defective ignition coil	Replace ignition coil
	Defective vacuum unit	Replace vacuum unit
	Defective control module	Replace control module
AA		

ELECTRONIC IGNITION DIAGNOSIS BY OSCILLOSCOPE PATTERN

BASIC ELECTRONIC IGNITION TROUBLE SHOOTING

CHARTS - USING OSCILLOSCOPE PATTERNS

AA		
CONDITION	POSSIBLE CAUSE	CORRECTION
AA		
Firing Voltage Lines are the Same, but Abnormally High	Retarded ignition timing	Reset ignition timing, see ENGINE PERFORMANCE section
	Fuel mixture too lean	Readjust carburetor, see ENGINE PERFORMANCE
	High resistance in coil wire	Replace coil wire
	Corrosion in coil tower terminal	Clean and/or replace coil
	Corrosion in distributor coil terminal	Clean and/or replace distributor cap
AA		
Firing Voltage Lines are the Same but Abnormally Low	Fuel mixture too rich	Readjust carburetor, see ENGINE PERFORMANCE
	Breaks in coil wire causing arcing	Replace coil wire
	Cracked coil tower causing arcing	Replace coil
	Low coil output	Replace coil
	Low engine compression	Determine cause and repair
AA		
One or More, But	Carburetor idle mixture	Readjust carburetor,

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Not All Firing not balanced see ENGINE PERFORMANCE

Voltage Lines are Higher Than Others	EGR valve stuck open	Clean and/or replace valve
--------------------------------------	----------------------	----------------------------

High resistance in spark plug wires	Replace spark plug wires
-------------------------------------	--------------------------

Cracked or broken spark plug insulator	Replace spark plugs
--	---------------------

Intake vacuum leak	Repair leak
1. Check for leaks at the intake manifold gasket, throttle body gasket, and PCV valve. 2. Use a vacuum gauge to check for leaks at the intake manifold. 3. Check for leaks at the throttle body gasket. 4. Check for leaks at the PCV valve.	1. Check for leaks at the intake manifold gasket, throttle body gasket, and PCV valve. 2. Use a vacuum gauge to check for leaks at the intake manifold. 3. Check for leaks at the throttle body gasket. 4. Check for leaks at the PCV valve.

Defective spark plugs	Replace spark plugs
-----------------------	---------------------

Corroded spark plug terminals	Replace spark plugs
-------------------------------	---------------------

[illegible]

One or More, But Not All Firing	Curb idle mixture not balanced	Readjust carburetor, see ENGINE PERFORMANCE
---------------------------------	--------------------------------	---

Voltage Lines Are Lower Than Others	Breaks in plug wires causing arcing	Replace plug wires
-------------------------------------	-------------------------------------	--------------------

Cracked coil tower causing arcing	Replace coil
-----------------------------------	--------------

Low compression Determine cause and repair

Defective spark plugs	Replace spark plugs
-----------------------	---------------------

Corroded spark plugs	Replace spark plugs
----------------------	---------------------

[illegible]

Cylinders Not Firing	Cracked distributor cap terminals	Replace distributor cap
----------------------	-----------------------------------	-------------------------

Shorted spark plug wire	Determine cause and repair
-------------------------	----------------------------

Mechanical problem in engine	Determine cause and repair
------------------------------	----------------------------

Defective spark plugs	Replace spark plugs
-----------------------	---------------------

Spark plugs fouled	Replace spark plugs
--------------------	---------------------

[illegible]

DRIVEABILITY PROBLEMS TROUBLE SHOOTING

BASIC DRIVEABILITY PROBLEMS TROUBLE SHOOTING TABLE

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CONDITION	POSSIBLE CAUSE	CORRECTION
AA		
Hard Starting	Binding carburetor linkage	Eliminate binding
	Binding choke linkage	Eliminate binding
	Binding choke piston	Eliminate binding
	Restricted choke vacuum	Check vacuum lines for blockage
	Worn or dirty needle valve and seat	Clean carburetor, see ENGINE PERFORMANCE
	Float sticking	Readjust or replace float see the ENGINE PERFORMANCE section
	Incorrect choke adjustment	Reset choke adjustment see ENGINE PERFORMANCE
	Defective coil	Replace coil
	Improper spark plug gap	Regap spark plugs
Detonation	Incorrect ignition timing	Reset ignition timing see ENGINE PERFORMANCE
	Over-advanced ignition timing	Reset ignition timing see ENGINE PERFORMANCE
	Defective spark plugs	Replace spark plugs
	Fuel lines clogged	Clean fuel lines
	EGR system malfunction	Check and repair EGR system
	PCV system malfunction	Repair PCV system
	Vacuum leaks	Check and repair vacuum system
	Loose fan belts	Tighten or replace fan belts, see ENGINE PERFORMANCE
	Restricted airflow	Remove restriction
	Vacuum advance malfunction	Check distributor operation
AA		

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Dieseling	Binding carburetor linkage	Eliminate binding
	Binding throttle linkage	Eliminate binding
	Binding choke linkage or fast idle cam	Eliminate binding
	Defective idle solenoid	Replace idle solenoid see ENGINE PERFORMANCE
	Improper base idle speed	Reset idle speed, see see ENGINE PERFORMANCE
	Incorrect ignition timing	Reset ignition timing see ENGINE PERFORMANCE
Faulty Acceleration	Incorrect idle mixture setting	Reset idle mixture, see ENGINE PERFORMANCE
	Incorrect ignition timing	Reset ignition timing see ENGINE PERFORMANCE
	Engine cold and choke too lean	Adjust choke and allow engine to warm-up
	Defective spark plugs	Replace spark plugs
	Defective coil	Replace coil
	Clogged idle transfer slots	Clean idle transfer slots, see FUEL
Faulty Low Speed Operation	Restricted idle air bleeds and passages	Disassemble and clean carburetor, see FUEL
	Clogged air cleaner	Replace air filter
	Defective spark plugs	Replace spark plugs
	Defective ignition wires	Replace ignition wire see ENGINE PERFORMANCE
	Defective distributor cap	Replace distributor cap
Faulty High Speed Operation	Incorrect ignition timing	Reset ignition timing see ENGINE PERFORMANCE
	Defective distributor centrifugal advance	Replace advance mechanism

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Defective distributor vacuum advance	Replace advance unit
Incorrect spark plugs or plug gap	Check gap and/or replace spark plugs
Faulty choke operation	Check choke and repair as required
Clogged vacuum passages	Remove restrictions
Improper size or clogged main jet	Check jet size and clean, see FUEL
Restricted air cleaner	Check filter and replace as necessary
Defective distributor cap, rotor or coil	Replace cap, rotor or coil

[illegible]

Misfire at All Speeds

Defective spark plugs	Replace spark plugs
Defective spark plug wires	Replace spark plug wires
Defective distributor cap, rotor, or coil	Replace cap, rotor, or coil
Cracked or broken vacuum hoses	Replace vacuum hoses
Vacuum leaks	Repair vacuum leaks
Fuel lines clogged	Remove restriction

[illegible]

Hesitation

Cracked or broken vacuum hoses	Replace vacuum hoses
Vacuum leaks	Repair Vacuum leaks
Binding carburetor linkage	Eliminate binding
Binding throttle linkage	Eliminate binding
Binding choke linkage or fast idle cam	Eliminate binding
Improper float setting	Readjust float setting, see FUEL
Cracked or broken ignition	Replace ignition

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	wires	wires
AA		
Rough idle, Missing or Stalling	Incorrect curb idle or fast idle speed	Reset idle speed, see see ENGINE PERFORMANCE
	Incorrect basic timing	Reset ignition timing see ENGINE PERFORMANCE
	Improper idle mixture adjustment	Reset idle mixture, see ENGINE PERFORMANCE
	Improper feedback system operation	Check feedback system see ENGINE PERFORMANCE
	Incorrect spark plug gap	Reset spark plug gap, see ENGINE PERFORMANCE
	Moisture in ignition components	Dry components
	Loose or broken ignition wires	Replace ignition wires
	Damaged distributor cap or or rotor	Replace distributor cap or rotor
	Faulty ignition coil	Replace ignition coil
	Fuel filter clogged or worn	Replace fuel filter
	Damaged idle mixture screw	Replace idle mixture screw, see FUEL
	Improper fast idle cam adjustment	Reset fast idle cam adjustment, see TUNE- see ENGINE PERFORMANCE
	Improper EGR valve operation	Replace EGR valve
	Faulty PCV valve air flow	Replace PCV valve
	Choke binding or improper choke setting	Reset choke or eliminate binding
	Vacuum leak	Repair vacuum leak
	Improper float bowl fuel level	Reset float adjustment, see FUEL
	Clogged air bleed or idle passages	Clean carburetor passages, see FUEL

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Clogged or worn air cleaner filter	Replace air filter
Faulty choke vacuum diaphragm	Replace diaphragm, see ENGINE PERFORMANCE
Exhaust manifold heat valve inoperative	Replace heat valve
Improper distributor spark advance	Check distributor operation
Leaking valves or valve components	Check and repair valvetrain
Improper carburetor mounting	Remove and remount carburetor
Excessive play in distributor shaft	Replace distributor
Loose or corroded wiring connections	Repair or replace as required

AA

Engine Surges	Improper PCV valve airflow	Replace PCV valve
	Vacuum leaks	Repair vacuum leaks
	Clogged air bleeds	Remove restriction
	EGR valve malfunction	Replace EGR valve
	Restricted air cleaner filter	Replace air filter
	Cracked or broken vacuum hoses	Replace vacuum hoses
	Cracked or broken ignition wires	Replace ignition wires
	Vacuum advance malfunction	Check unit and replace as necessary
	Defective or fouled spark plugs	Replace spark plugs

AA

Ping or Spark Knock	Incorrect ignition timing	Reset ignition timing see ENGINE PERFORMANCE
	Distributor centrifugal or vacuum advance malfunction	Check operation and replace as necessary

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Carburetor setting too lean	Readjust mixture setting, see ENGINE PERFORMANCE
-----------------------------	--

Vacuum leak	Eliminate vacuum leak
-------------	-----------------------

EGR valve malfunction	Replace EGR valve
-----------------------	-------------------

AA

Poor Gasoline Mileage	Cracked or broken vacuum hoses	Replace vacuum hoses
-----------------------	--------------------------------	----------------------

Vacuum leaks	Repair vacuum leaks
--------------	---------------------

Defective ignition wires	Replace wires
--------------------------	---------------

Incorrect choke setting	Readjust setting, see ENGINE PERFORMANCE
-------------------------	--

Defective vacuum advance	Replace vacuum advance
--------------------------	------------------------

Defective spark plugs	Replace spark plugs
-----------------------	---------------------

Binding carburetor power piston	Eliminate binding
---------------------------------	-------------------

Dirt in carburetor jets	Clean and/or replace jets
-------------------------	---------------------------

Incorrect float adjustment	Readjust float setting, see FUEL
----------------------------	----------------------------------

Defective power valve	Replace power valve, see ENGINE PERFORMANCE
-----------------------	---

Incorrect idle speed	Readjust idle speed
----------------------	---------------------

AA

Engine Stalls	Improper float level	Readjust float level
---------------	----------------------	----------------------

Leaking needle valve and seat	Replace needle valve and seat
-------------------------------	-------------------------------

Vacuum leaks	Eliminate vacuum leaks
--------------	------------------------

AA

VACUUM PUMP - DIESEL TROUBLE SHOOTING

WARNING: This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to

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problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.

NOTE: Diesel engines mechanical diagnosis is the same as gasoline engines for items such as noisy valves, bearings, pistons, etc. The following trouble shooting covers only items pertaining to diesel engines.

VACUUM PUMP (DIESEL) TROUBLE SHOOTING CHART

AA		
CONDITION	POSSIBLE CAUSE	CORRECTION
AA		
Excessive Noise	Loose pump-to-drive assembly screws	Tighten screws
	Loose tube on pump assembly	Tighten tube
	Valves not functioning properly	Replace valves
AA		
Oil Leakage	Loose end plug	Tighten end plug
	Bad seal crimp	Remove and re-crimp seal
AA		

WHEEL ALIGNMENT TROUBLE SHOOTING

WARNING: This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.

BASIC WHEEL ALIGNMENT TROUBLE SHOOTING CHART

AA		
CONDITION	POSSIBLE CAUSE	CORRECTION
AA		
Premature Tire Wear	Improper tire inflation	Check tire pressure
	Front alignment out of tolerance	See ALIGNMENT SPECS in WHEEL ALIGNMENT section
	Suspension components worn	See SUSPENSION section
	Steering system components worn	See STEERING section
	Improper standing height	See WHEEL ALIGNMENT
	Uneven or sagging springs	See SUSPENSION section

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Bent wheel	See WHEEL ALIGNMENT
Improper torsion bar adjustment	See SUSPENSION section
Loose or worn wheel bearings	See WHEEL BEARING ADJ. in SUSPENSION section
Worn or defective shock	Replace shock absorbers
Tires out of balance	Check tire balance
Pulls to One Side	Improper tire inflation
	Check tire pressure
Brake dragging	See BRAKE section
Mismatched tires	See WHEEL ALIGNMENT
Broken or sagging spring	See SUSPENSION section
Broken torsion bar	See SUSPENSION section
Power steering valve not centered	See STEERING section
Front alignment out of tolerance	See WHEEL ALIGNMENT section
Defective wheel bearing	See WHEEL BEARINGS in SUSPENSION section
Uneven sway bar links	See SUSPENSION section
Frame bent	Check for frame damage
Steering system bushing worn	See STEERING section
Hard Steering	Idler arm bushing too tight
	See STEERING LINKAGE in STEERING section
Ball joint tight or seized	See SUSPENSION section
Steering linkage too tight	See STEERING LINKAGE in STEERING section
Power steering fluid low	Add proper amount of fluid
Power steering drive belt loose	See STEERING section

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Power steering pump defective See STEERING section

Steering gear out of adjustment See STEERING section

Incorrect wheel alignment See WHEEL ALIGNMENT

Damaged steering gear See STEERING section

Damaged suspension See SUSPENSION section

Bent steering knuckle or supports See SUSPENSION section

AA

Vehicle "Wanders" Strut rod or control arm bushing worn See SUSPENSION section

Loose or worn wheel bearings See WHEEL BEARINGS in SUSPENSION section

Improper tire inflation Check tire pressure

Stabilizer bar missing or defective See SUSPENSION section

Wheel alignment out of tolerance See Adjustment in WHEEL ALIGNMENT section

Broken spring See SUSPENSION section

Defective shock absorbers Replace shock absorbers

Worn steering & suspension components See SUSPENSION section

AA

Front End Shimmy Tire out of balance/round Check tire balance

Excessive wheel runout See WHEEL ALIGNMENT

Insufficient or improper caster See WHEEL ALIGNMENT section

Worn suspension or steering components See SUSPENSION section

Defective shock absorbers Replace shock absorber

Wheel bearings worn or loose See WHEEL BEARING ADJ. in SUSPENSION section

Power steering reaction See STEERING section

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Bracket loose

Steering gear box (rack) mounting loose See STEERING section

Steering gear adjustment loose See STEERING section

Worn spherical joints See SUSPENSION section

AA

Toe-In Not Adjustable Lower control arm bent See SUSPENSION section

Frame bent Check frame for damage

AA

Camber Not Adjustable Control arm bent See SUSPENSION section

Frame bent Check frame for damage

Hub & bearing not seated properly See SUSPENSION section

AA

END OF ARTICLE

TUNE-UP - 5-CYL

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ARTICLE BEGINNING

1987 Volkswagen 5 Tune-Up
TUNE-UP

Quantum, Quantum Syncro

ENGINE IDENTIFICATION

Engine number is stamped on left side of engine just below cylinder head.

ENGINE CODE

Application Code

Quantum

2.22L KX

Quantum Syncro

2.22L JT

ENGINE COMPRESSION

Check compression with engine warm, all spark plugs removed and throttle wide open. Crank engine through at least 6 compression strokes per cylinder to determine engine compression.

COMPRESSION SPECIFICATIONS

Application Specification

Compression Ratio

2.22L 8.5:1

Compression Pressure (1)

2.22L

Normal (New Engine) 130-174 psi (9-12 kg/cm²)

Minimum 100 psi (7 kg/cm²)

Max. Variation Between Cylinders

2.22L 29 psi (2 kg/cm²)

VALVE CLEARANCE

All 5-cylinder engines are equipped with hydraulic valve lifters. No adjustment is necessary.

VALVE ARRANGEMENT

E-I-E-I-I-E-I-E-I-E (Front-to-rear).

TUNE-UP - 5-CYL

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SPARK PLUGS

SPARK PLUG TYPE

Application Bosch Champion

2.22L

Quantum W7DTC N8GY
Quantum Syncro WR7DS N8GY

SPARK PLUG SPECIFICATIONS

Application Gap In. (mm) Torque Ft. Lbs. (N.m)
All Models .028-.032 (.7-.8) 14 (20)

HIGH TENSION WIRE RESISTANCE

Carefully remove ends of wire from spark plug and distributor. Using an ohmmeter, check resistance of wire while gently twisting wire. If resistance is incorrect or fluctuates from infinity to any value, replace wire.

HIGH TENSION WIRE RESISTANCE

Application Ohms
Coil Wire 1600-2400
Spark Plug Wire With Connectors 4600-7400
Spark Plug Connector 4000-6000
Spark Plug Suppressor 600-1400

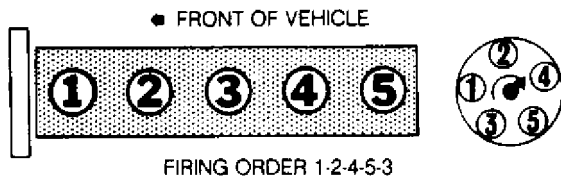


Fig. 1: Firing Order & Distributor Rotation

DISTRIBUTOR

All models are equipped with Bosch electronic, breakerless ignition system.

TUNE-UP - 5-CYL

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IGNITION TIMING

2.22L

Ensure idle speed is set to specification and all accessories are off. Connect timing light. Adjust ignition timing with vacuum hoses connected. After adjustment ensure idle speed is within specification.

IGNITION TIMING (Degrees BTDC @ RPM)

Application	Degrees @ RPM
-------------	---------------

2.22L

Quantum & Quantum Syncro	6 @ 750-850
--------------------------	-------------

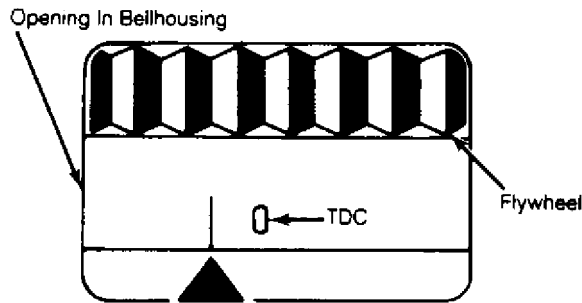


Fig. 2: Typical Ignition Timing Mark Location

IDLE SPEED & MIXTURE

IDLE SPEED

NOTE: Idle speed is electronically controlled and not adjustable on 2.22L engines.

IDLE SPEED & CO LEVEL SPECIFICATION

Application	Idle RPM	CO%
-------------	----------	-----

2.22L	750-850	(1) .3-3.0
-------	---------	------------

(1) - Value given is checking value. Adjustment value is .6-1.0%.

IDLE MIXTURE & CO LEVEL

2.22L

1) With engine at normal operating temperature, turn off all electrical equipment, including A/C and radiator fan. If injection system has been opened or components replaced, run engine several times to 3000 RPM for about 2 minutes.

2) Disconnect crankcase breather hoses and plug openings.

TUNE-UP - 5-CYL

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Vent hoses (from crankcase) to atmosphere. Remove cap from charcoal canister "T" located on right fender apron and vent to atmosphere. Connect Tester (VW 1367) and Cable Adapter (VW 1112). Depress "%" button on tester. Remove CO probe receptacle cap and connect CO meter. Ensure fit is snug to prevent exhaust leaks.

3) Connect multimeter with adapter to differential pressure regulator. Remove connector from regulator and connect Adapter (1315 A/1) to regulator. Connect multimeter to adapter and turn switch to "DCA 200 mA".

NOTE: If engine does not run with wire connected, connections in wire plug may be reversed.

4) Start and run engine at idle speed. With oxygen sensor connected, duty cycle should be 26-30% and idle speed should be 750-850 RPM. If duty cycle is not as specified, turn idle adjusting screw on throttle body. If RPM signal is displayed, check idle stabilizer unit. If duty cycle and RPM values are okay, continue with CO level adjustment.

NOTE: Only duty cycle is adjustable. Idle speed is controlled by an idle stabilizer valve.

5) Unplug oxygen sensor connector CO level should be .3-3.0% (checking value). If CO reading is okay, reconnect oxygen sensor and recheck duty cycle. If CO reading is not as specified, stop engine and remove boot from mixture control unit.

6) Center punch hole in CO adjusting screw plug and drill a 3/32" hole to a depth of 5/32". Do not drill completely through as adjustment screw will be damaged.

7) Install a 1/8" sheet metal screw and remove plug using pliers. Start engine and run at idle. Adjust CO level to .6-1.0% (adjusting value) by turning adjustment screw with Adjusting Wrench (P 377). See Fig. 3. DO NOT accelerate engine with adjusting tool in place or push down on tool. After each adjustment, remove adjusting tool and briefly accelerate engine before measuring current reading.

8) If CO value is not as specified, check oxygen sensor system. If CO value is okay, reconnect oxygen sensor connector and recheck duty cycle. If duty cycle is 26-30%, disconnect oxygen sensor connector. Observe differential pressure reading on multimeter. Current reading must be 8.5-12.5 mA at sea level, 8-12 mA at 1000 feet above sea level, and 5.5-9.5 mA at 4000 feet above sea level.

TUNE-UP - 5-CYL

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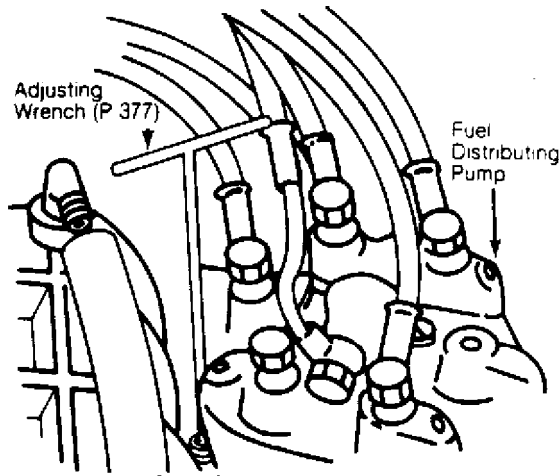


Fig. 3: Adjusting Idle Speed & Mixture

9) If current reading is not as specified, check altitude sensor. If current reading is okay, reconnect oxygen sensor and observe current reading on multimeter. If current does not fluctuate, check oxygen sensor. If current does fluctuate, turn engine off. Install new plug in mixture control unit and seat plug flush with unit. Remove all test equipment and reconnect all hoses and wiring.

COLD (FAST) IDLE RPM

Cold start valve operates on all Volkswagen models with 2.22L engines when engine coolant is less than 50°F (10°C).

FUEL PUMP

FUEL PUMP PERFORMANCE

AA

Application	Pressure psi (kg/cm ²)	Volume in 30 sec. Pints (Liters)
-------------	---------------------------------------	-------------------------------------

2.22L	(1) 75-82 (5.2-5.8)	2.1 (1.0)
-------------	---------------------	-----------

(1) - Minimum pressure after 10 minutes is 38 psi (2.7 kg/cm²).

AA

EMISSION CONTROL SYSTEMS

See EMISSIONS section.

IGNITION

DISTRIBUTOR

All models are equipped with Bosch electronic ignition.

TUNE-UP - 5-CYL

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IGNITION COIL

Ignition coil used on 2.22L engine uses standard coil connections. For specifications see RESISTANCE - OHMS table.

RESISTANCE - OHMS @ 68°F (20°C)

Application			Primary	Secondary
2.22L			.52-.76	2400-3500

FUEL SYSTEM

FUEL INJECTION

All 2.22L models are equipped with Bosch (CIS-E) Continuous Injection System-Electronic.

ELECTRICAL

BATTERY

BATTERY SPECIFICATIONS

Application		Amp Hr. Rating
All Models		63

STARTER

All models are equipped with Bosch starters.

ALTERNATOR

All models use a Bosch alternator.

ALTERNATOR SPECIFICATIONS

Application		Rated Amp Output
All Models		65

ALTERNATOR REGULATOR

All models use Bosch, nonadjustable regulators which are integral with the alternator.

REGULATOR OPERATING VOLTAGE @ 80°F (27°C)

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Article Text (p. 7)

[illegible]

BELT ADJUSTMENT

Application (1) Deflection In. (mm)

All Belts 3/8-9/16 (10-15)

(1) - Measured with 20 lbs. (9 kg) pressure applied at midpoint of longest belt run.

[illegible]

FLUID CAPACITIES	
Application	Quantity
Crankcase (Includes Filter)	
Quantum & Quantum Syncro	4.0 qts. (3.8L)
Cooling System (Includes Heater)	
All Models	8.5 qts. (8.0L)
Auto. Trans. (Dexron II)	3.2 qts. (3.0L)
Auto. Trans. Final Drive (SAE 90)	
Quantum & Quantum Syncro	1.6 qts. (1.5L)

END OF ARTICLE

VACUUM DIAGRAMS

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ARTICLE BEGINNING

1987 Exhaust Emission Systems VOLKSWAGEN VACUUM DIAGRAMS

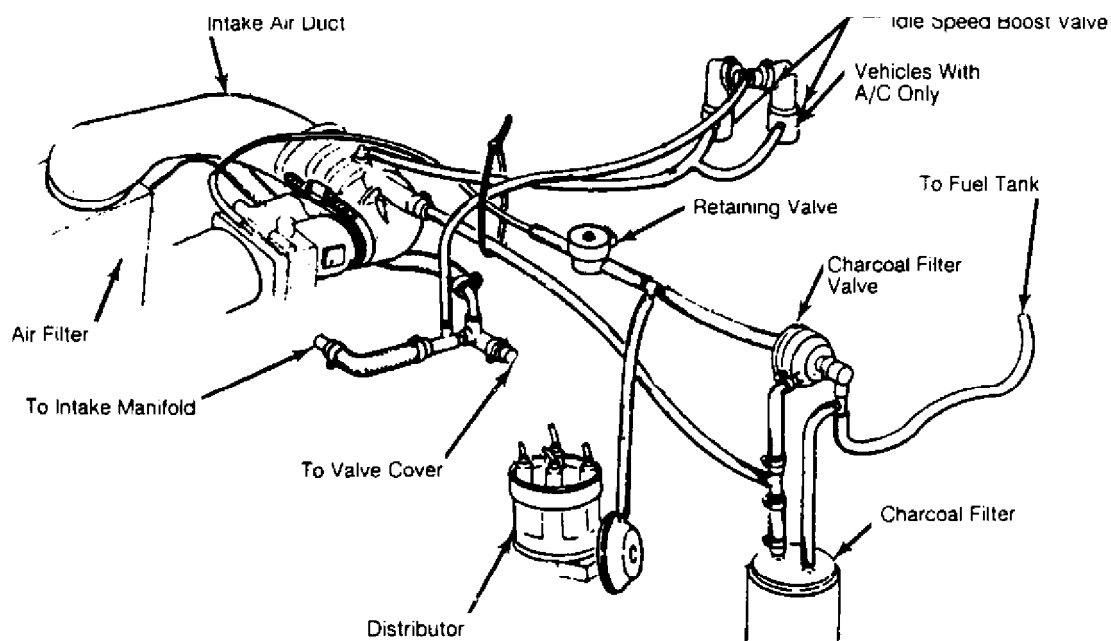


Fig. 1: Fox Vacuum Diagram
Courtesy of Volkswagen United States, Inc.

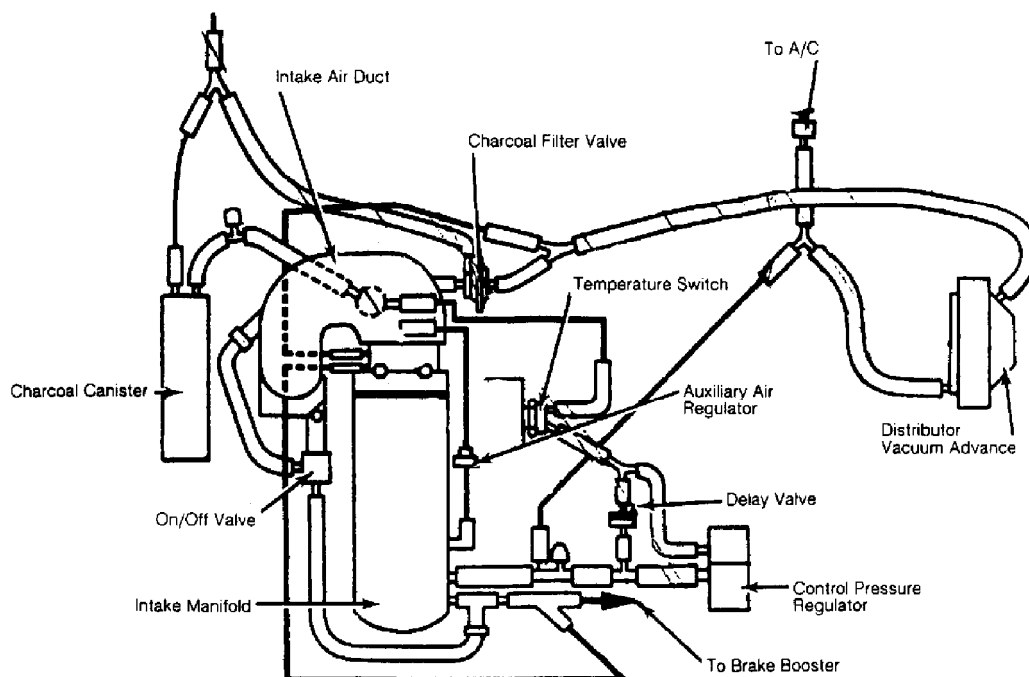


Fig. 2: Quantum Vacuum Diagram
Courtesy of Volkswagen United States, Inc.

VACUUM DIAGRAMS

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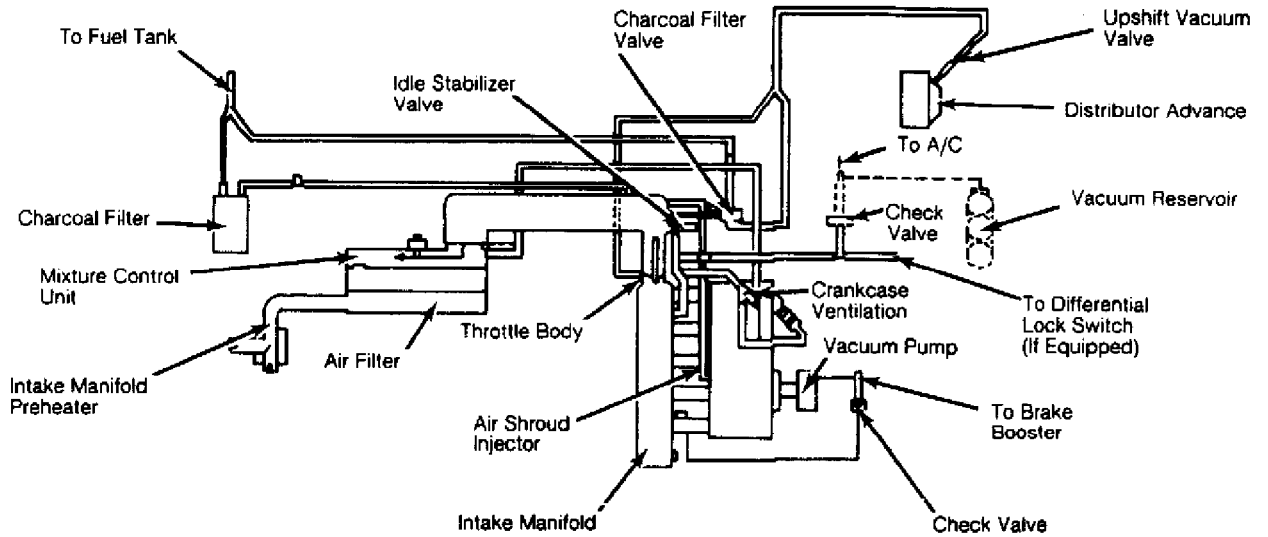


Fig. 3: Quantum Syncro Vacuum Diagram
Courtesy of Volkswagen United States, Inc.

END OF ARTICLE

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ARTICLE BEGINNING

GENERAL INFORMATION

Waveforms - Injector Pattern Tutorial

* PLEASE READ THIS FIRST *

NOTE: This article is intended for general information purposes only. This information may not apply to all makes and models.

PURPOSE OF THIS ARTICLE

Learning how to interpret injector drive patterns from a Lab Scope can be like learning ignition patterns all over again. This article exists to ease you into becoming a skilled injector pattern interpreter.

You will learn:

- * How a DVOM and noid light fall short of a lab scope.
- * The two types of injector driver circuits, voltage controlled & current controlled.
- * The two ways injector circuits can be wired, constant ground/switched power & constant power/switched ground.
- * The two different pattern types you can use to diagnose with, voltage & current.
- * All the valuable details injector patterns can reveal.

SCOPE OF THIS ARTICLE

This is NOT a manufacturer specific article. All different types of systems are covered here, regardless of the specific year/make/model/engine.

The reason for such broad coverage is because there are only a few basic ways to operate a solenoid-type injector. By understanding the fundamental principles, you will understand all the major points of injector patterns you encounter. Of course there are minor differences in each specific system, but that is where a waveform library helps out.

If this is confusing, consider a secondary ignition pattern. Even though there are many different implementations, each still has a primary voltage turn-on, firing line, spark line, etc.

If specific waveforms are available in On Demand for the engine and vehicle you are working on, you will find them in the Engine Performance section under the Engine Performance category.

IS A LAB SCOPE NECESSARY?

INTRODUCTION

You probably have several tools at your disposal to diagnose injector circuits. But you might have questioned "Is a lab scope

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necessary to do a thorough job, or will a set of noid lights and a multifunction DVOM do just as well?"

In the following text, we are going to look at what noid lights and DVOMs do best, do not do very well, and when they can mislead you. As you might suspect, the lab scope, with its ability to look inside an active circuit, comes to the rescue by answering for the deficiencies of these other tools.

OVERVIEW OF NOID LIGHT

The noid light is an excellent "quick and dirty" tool. It can usually be hooked to a fuel injector harness fast and the flashing light is easy to understand. It is a dependable way to identify a no-pulse situation.

However, a noid light can be very deceptive in two cases:

- * If the wrong one is used for the circuit being tested.
Beware: Just because a connector on a noid light fits the harness does not mean it is the right one.
- * If an injector driver is weak or a minor voltage drop is present.

Use the Right Noid Light

In the following text we will look at what can happen if the wrong noid light is used, why there are different types of noid lights (besides differences with connectors), how to identify the types of noid lights, and how to know the right type to use.

First, let's discuss what can happen if the incorrect type of noid light is used. You might see:

- * A dimly flashing light when it should be normal.
- * A normal flashing light when it should be dim.

A noid light will flash dim if used on a lower voltage circuit than it was designed for. A normally operating circuit would appear underpowered, which could be misinterpreted as the cause of a fuel starvation problem.

Here are the two circuit types that could cause this problem:

- * Circuits with external injector resistors. Used predominately on some Asian & European systems, they are used to reduce the available voltage to an injector in order to limit the current flow. This lower voltage can cause a dim flash on a noid light designed for full voltage.
- * Circuits with current controlled injector drivers (e.g. "Peak and Hold"). Basically, this type of driver allows a quick burst of voltage/current to flow and then throttles it back significantly for the remainder of the pulse width duration. If a noid light was designed for the other type of driver (voltage controlled, e.g. "Saturated"), it will appear dim because it is expecting full voltage/current to flow for the entire duration of the pulse width.

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Let's move to the other situation where a noid light flashes normally when it should be dim. This could occur if a more sensitive noid light is used on a higher voltage/amperage circuit that was weakened enough to cause problems (but not outright broken). A circuit with an actual problem would thus appear normal.

Let's look at why. A noid light does not come close to consuming as much amperage as an injector solenoid. If there is a partial driver failure or a minor voltage drop in the injector circuit, there can be adequate amperage to fully operate the noid light BUT NOT ENOUGH TO OPERATE THE INJECTOR.

If this is not clear, picture a battery with a lot of corrosion on the terminals. Say there is enough corrosion that the starter motor will not operate; it only clicks. Now imagine turning on the headlights (with the ignition in the RUN position). You find they light normally and are fully bright. This is the same idea as noid light: There is a problem, but enough amp flow exists to operate the headlights ("noid light"), but not the starter motor ("injector").

How do you identify and avoid all these situations? By using the correct type of noid light. This requires that you understand the types of injector circuits that your noid lights are designed for. There are three. They are:

- * Systems with a voltage controlled injector driver. Another way to say it: The noid light is designed for a circuit with a "high" resistance injector (generally 12 ohms or above).
- * Systems with a current controlled injector driver. Another way to say it: The noid light is designed for a circuit with a low resistance injector (generally less than 12 ohms) without an external injector resistor.
- * Systems with a voltage controlled injector driver and an external injector resistor. Another way of saying it: The noid light is designed for a circuit with a low resistance injector (generally less than 12 ohms) and an external injector resistor.

NOTE: Some noid lights can meet both the second and third categories simultaneously.

If you are not sure which type of circuit your noid light is designed for, plug it into a known good car and check out the results. If it flashes normally during cranking, determine the circuit type by finding out injector resistance and if an external injector resistor is used. You now know enough to identify the type of injector circuit. Label the noid light appropriately.

Next time you need to use a noid light for diagnosis, determine what type of injector circuit you are dealing with and select the appropriate noid light.

Of course, if you suspect a no-pulse condition you could plug in any one whose connector fit without fear of misdiagnosis. This is because it is unimportant if the flashing light is dim or bright. It is only important that it flashes.

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In any cases of doubt regarding the use of a noid light, a lab scope will overcome all inherent weaknesses.

OVERVIEW OF DVOM

A DVOM is typically used to check injector resistance and available voltage at the injector. Some techs also use it check injector on-time either with a built-in feature or by using the dwell/duty function.

There are situations where the DVOM performs these checks dependably, and other situations where it can deceive you. It is important to be aware of these strengths and weaknesses. We will cover the topics above in the following text.

Checking Injector Resistance

If a short in an injector coil winding is constant, an ohmmeter will accurately identify the lower resistance. The same is true with an open winding. Unfortunately, an intermittent short is an exception. A faulty injector with an intermittent short will show "good" if the ohmmeter cannot force the short to occur during testing.

Alcohol in fuel typically causes an intermittent short, happening only when the injector coil is hot and loaded by a current high enough to jump the air gap between two bare windings or to break down any oxides that may have formed between them.

When you measure resistance with an ohmmeter, you are only applying a small current of a few milliamps. This is nowhere near enough to load the coil sufficiently to detect most problems. As a result, most resistance checks identify intermittently shorted injectors as being normal.

There are two methods to get around this limitation. The first is to purchase a tool that checks injector coil windings under full load. The Kent-Moore J-39021 is such a tool, though there are others. The Kent-Moore costs around \$240 at the time of this writing and works on many different manufacturer's systems.

The second method is to use a lab scope. Remember, a lab scope allows you to see the regular operation of a circuit in real time. If an injector is having a short or intermittent short, the lab scope will show it.

Checking Available Voltage At the Injector

Verifying a fuel injector has the proper voltage to operate correctly is good diagnostic technique. Finding an open circuit on the feed circuit like a broken wire or connector is an accurate check with a DVOM. Unfortunately, finding an intermittent or excessive resistance problem with a DVOM is unreliable.

Let's explore this drawback. Remember that a voltage drop due to excessive resistance will only occur when a circuit is operating? Since the injector circuit is only operating for a few milliseconds at a time, a DVOM will only see a potential fault for a few milliseconds. The remaining 90+% of the time the unloaded injector circuit will show normal battery voltage.

Since DVOMs update their display roughly two to five times a

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second, all measurements in between are averaged. Because a potential voltage drop is visible for such a small amount of time, it gets "averaged out", causing you to miss it.

Only a DVOM that has a "min-max" function that checks EVERY MILLISECOND will catch this fault consistently (if used in that mode). The Fluke 87 among others has this capability.

A "min-max" DVOM with a lower frequency of checking (100 millisecond) can miss the fault because it will probably check when the injector is not on. This is especially true with current controlled driver circuits. The Fluke 88, among others fall into this category.

Outside of using a Fluke 87 (or equivalent) in the 1 mS "min-max" mode, the only way to catch a voltage drop fault is with a lab scope. You will be able to see a voltage drop as it happens.

One final note. It is important to be aware that an injector circuit with a solenoid resistor will always show a voltage drop when the circuit is energized. This is somewhat obvious and normal; it is a designed-in voltage drop. What can be unexpected is what we already covered--a voltage drop disappears when the circuit is unloaded. The unloaded injector circuit will show normal battery voltage at the injector. Remember this and do not get confused.

Checking Injector On-Time With Built-In Function

Several DVOMs have a feature that allows them to measure injector on-time (mS pulse width). While they are accurate and fast to hookup, they have three limitations you should be aware of:

- * They only work on voltage controlled injector drivers (e.g. "Saturated Switch"), NOT on current controlled injector drivers (e.g. "Peak & Hold").
- * A few unusual conditions can cause inaccurate readings.
- * Varying engine speeds can result in inaccurate readings.

Regarding the first limitation, DVOMs need a well-defined injector pulse in order to determine when the injector turns ON and OFF. Voltage controlled drivers provide this because of their simple switch-like operation. They completely close the circuit for the entire duration of the pulse. This is easy for the DVOM to interpret.

The other type of driver, the current controlled type, start off well by completely closing the circuit (until the injector pintle opens), but then they throttle back the voltage/current for the duration of the pulse. The DVOM understands the beginning of the pulse but it cannot figure out the throttling action. In other words, it cannot distinguish the throttling from an open circuit (de-energized) condition.

Yet current controlled injectors will still yield a millisecond on-time reading on these DVOMs. You will find it is also always the same, regardless of the operating conditions. This is because it is only measuring the initial completely-closed circuit on-time, which always takes the same amount of time (to lift the injector pintle off its seat). So even though you get a reading, it is useless.

The second limitation is that a few erratic conditions can

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cause inaccurate readings. This is because of a DVOM's slow display rate; roughly two to five times a second. As we covered earlier, measurements in between display updates get averaged. So conditions like skipped injector pulses or intermittent long/short injector pulses tend to get "averaged out", which will cause you to miss important details.

The last limitation is that varying engine speeds can result in inaccurate readings. This is caused by the quickly shifting injector on-time as the engine load varies, or the RPM moves from a state of acceleration to stabilization, or similar situations. It too is caused by the averaging of all measurements in between DVOM display periods. You can avoid this by checking on-time when there are no RPM or load changes.

A lab scope allows you to overcome each one of these limitations.

Checking Injector On-Time With Dwell Or Duty

If no tool is available to directly measure injector millisecond on-time measurement, some techs use a simple DVOM dwell or duty cycle functions as a replacement.

While this is an approach of last resort, it does provide benefits. We will discuss the strengths and weaknesses in a moment, but first we will look at how a duty cycle meter and dwell meter work.

How A Duty Cycle Meter and Dwell Meter Work

All readings are obtained by comparing how long something has been OFF to how long it has been ON in a fixed time period. A dwell meter and duty cycle meter actually come up with the same answers using different scales. You can convert freely between them. See RELATIONSHIP BETWEEN DWELL & DUTY CYCLE READINGS TABLE.

The DVOM display updates roughly one time a second, although some DVOMs can be a little faster or slower. All measurements during this update period are tallied inside the DVOM as ON time or OFF time, and then the total ratio is displayed as either a percentage (duty cycle) or degrees (dwell meter).

For example, let's say a DVOM had an update rate of exactly 1 second (1000 milliseconds). Let's also say that it has been measuring/tallying an injector circuit that had been ON a total of 250 mS out of the 1000 mS. That is a ratio of one-quarter, which would be displayed as 25% duty cycle or 15° dwell (six-cylinder scale). Note that most duty cycle meters can reverse the readings by selecting the positive or negative slope to trigger on. If this reading were reversed, a duty cycle meter would display 75%.

Strengths of Dwell/Duty Meter

The obvious strength of a dwell/duty meter is that you can compare injector on-time against a known-good reading. This is the only practical way to use a dwell/duty meter, but requires you to have known-good values to compare against.

Another strength is that you can roughly convert injector mS on-time into dwell reading with some computations.

A final strength is that because the meter averages

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everything together it does not miss anything (though this is also a severe weakness that we will look at later). If an injector has a fault where it occasionally skips a pulse, the meter registers it and the reading changes accordingly.

Let's go back to figuring out dwell/duty readings by using injector on-time specification. This is not generally practical, but we will cover it for completeness. You NEED to know three things:

- * Injector mS on-time specification.
- * Engine RPM when specification is valid.
- * How many times the injectors fire per crankshaft revolution.

The first two are self-explanatory. The last one may require some research into whether it is a bank-fire type that injects every 360° of crankshaft rotation, a bank-fire that injects every 720°, or an SFI that injects every 720°. Many manufacturers do not release this data so you may have to figure it out yourself with a frequency meter.

Here are the four complete steps to convert millisecond on-time:

1) Determine the injector pulse width and RPM it was obtained at. Let's say the specification is for one millisecond of on-time at a hot idle of 600 RPM.

2) Determine injector firing method for the complete 4 stroke cycle. Let's say this is a 360° bank-fired, meaning an injector fires each and every crankshaft revolution.

3) Determine how many times the injector will fire at the specified engine speed (600 RPM) in a fixed time period. We will use 100 milliseconds because it is easy to use.

Six hundred crankshaft Revolutions Per Minute (RPM) divided by 60 seconds equals 10 revolutions per second.

Multiplying 10 times .100 yields one; the crankshaft turns one time in 100 milliseconds. With exactly one crankshaft rotation in 100 milliseconds, we know that the injector fires exactly one time.

4) Determine the ratio of injector on-time vs. off-time in the fixed time period, then figure duty cycle and/or dwell. The injector fires one time for a total of one millisecond in any given 100 millisecond period.

One hundred minus one equals 99. We have a 99% duty cycle. If we wanted to know the dwell (on 6 cylinder scale), multiple 99% times .6; this equals 59.4° dwell.

Weaknesses of Dwell/Duty Meter

The weaknesses are significant. First, there is no one-to-one correspondence to actual mS on-time. No manufacturer releases dwell/duty data, and it is time-consuming to convert the mS on-time readings. Besides, there can be a large degree of error because the conversion forces you to assume that the injector(s) are always firing at the same rate for the same period of time. This can be a dangerous assumption.

Second, all level of detail is lost in the averaging process. This is the primary weakness. You cannot see the details you need to make a confident diagnosis.

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Here is one example. Imagine a vehicle that has a faulty injector driver that occasionally skips an injector pulse. Every skipped pulse means that that cylinder does not fire, thus unburned O₂ gets pushed into the exhaust and passes the O₂ sensor. The O₂ sensor indicates lean, so the computer fattens up the mixture to compensate for the supposed "lean" condition.

A connected dwell/duty meter would see the fattened pulse width but would also see the skipped pulses. It would tally both and likely come back with a reading that indicated the "pulse width" was within specification because the rich mixture and missing pulses offset each other.

This situation is not a far-fetched scenario. Some early GM 3800 engines were suffering from exactly this. The point is that a lack of detail could cause misdiagnosis.

As you might have guessed, a lab scope would not miss this.

RELATIONSHIP BETWEEN DWELL & DUTY CYCLE READINGS TABLE (1)

AA

Dwell Meter (2)	Duty Cycle Meter
-----------------	------------------

10	1%
15	25%
30	50%
45	75%
60	100%

(1) - These are just some examples for your understanding.

It is okay to fill in the gaps.

(2) - Dwell meter on the six-cylinder scale.

AA

THE TWO TYPES OF INJECTOR DRIVERS

OVERVIEW

There are two types of transistor driver circuits used to operate electric fuel injectors: voltage controlled and current controlled. The voltage controlled type is sometimes called a "saturated switch" driver, while the current controlled type is sometimes known as a "peak and hold" driver.

The basic difference between the two is the total resistance of the injector circuit. Roughly speaking, if a particular leg in an injector circuit has total resistance of 12 or more ohms, a voltage control driver is used. If less than 12 ohms, a current control driver is used.

It is a question of what is going to do the job of limiting the current flow in the injector circuit; the inherent "high" resistance in the injector circuit, or the transistor driver. Without some form of control, the current flow through the injector would cause the solenoid coil to overheat and result in a damaged injector.

VOLTAGE CONTROLLED CIRCUIT ("SATURATED SWITCH")

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The voltage controlled driver inside the computer operates much like a simple switch because it does not need to worry about limiting current flow. Recall, this driver typically requires injector circuits with a total leg resistance of 12 or more ohms.

The driver is either ON, closing/completing the circuit (eliminating the voltage-drop), or OFF, opening the circuit (causing a total voltage drop).

Some manufacturers call it a "saturated switch" driver. This is because when switched ON, the driver allows the magnetic field in the injector to build to saturation. This is the same "saturation" property that you are familiar with for an ignition coil.

There are two ways "high" resistance can be built into an injector circuit to limit current flow. One method uses an external solenoid resistor and a low resistance injector, while the other uses a high resistance injector without the solenoid resistor. See the left side of Fig. 1.

In terms of injection opening time, the external resistor voltage controlled circuit is somewhat faster than the voltage controlled high resistance injector circuit. The trend, however, seems to be moving toward use of this latter type of circuit due to its lower cost and reliability. The ECU can compensate for slower opening times by increasing injector pulse width accordingly.

NOTE: Never apply battery voltage directly across a low resistance injector. This will cause injector damage from solenoid coil overheating.

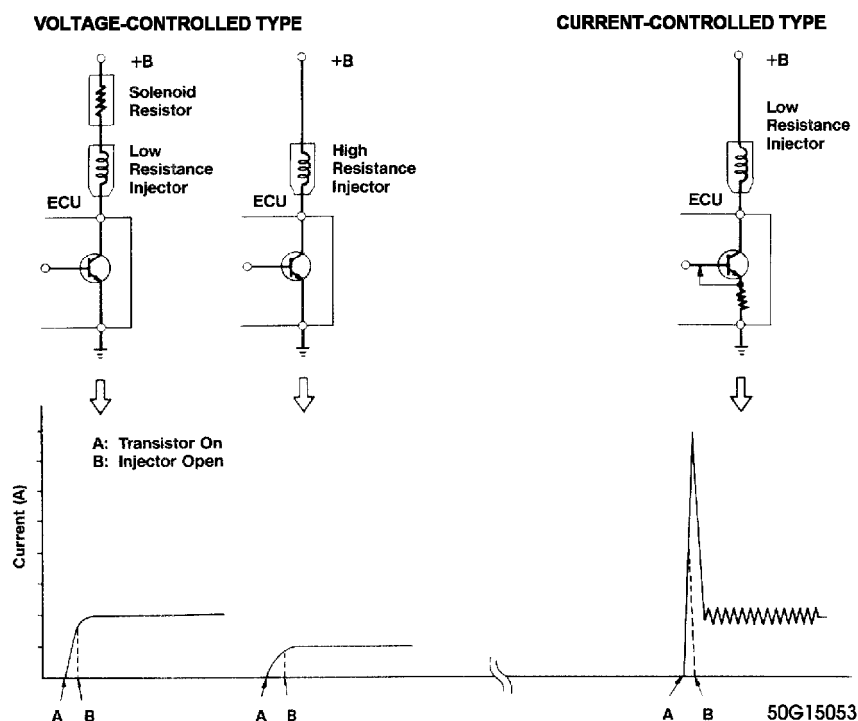


Fig. 1: Injector Driver Types - Current and Voltage

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CURRENT CONTROLLED CIRCUIT ("PEAK & HOLD")

The current controlled driver inside the computer is more complex than a voltage controlled driver because as the name implies, it has to limit current flow in addition to its ON-OFF switching function. Recall, this driver typically requires injector circuits with a total leg resistance of less than 12 ohms.

Once the driver is turned ON, it will not limit current flow until enough time has passed for the injector pintle to open. This period is preset by the particular manufacturer/system based on the amount of current flow needed to open their injector. This is typically between two and six amps. Some manufacturers refer to this as the "peak" time, referring to the fact that current flow is allowed to "peak" (to open the injector).

Once the injector pintle is open, the amp flow is considerably reduced for the rest of the pulse duration to protect the injector from overheating. This is okay because very little amperage is needed to hold the injector open, typically in the area of one amp or less. Some manufacturers refer to this as the "hold" time, meaning that just enough current is allowed through the circuit to "hold" the already-open injector open.

There are a couple methods of reducing the current. The most common trims back the available voltage for the circuit, similar to turning down a light at home with a dimmer.

The other method involves repeatedly cycling the circuit ON-OFF. It does this so fast that the magnetic field never collapses and the pintle stays open, but the current is still significantly reduced. See the right side of Fig. 1 for an illustration.

The advantage to the current controlled driver circuit is the short time period from when the driver transistor goes ON to when the injector actually opens. This is a function of the speed with which current flow reaches its peak due to the low circuit resistance. Also, the injector closes faster when the driver turns OFF because of the lower holding current.

NOTE: Never apply battery voltage directly across a low resistance injector. This will cause injector damage from solenoid coil overheating.

THE TWO WAYS INJECTOR CIRCUITS ARE WIRED

Like other circuits, injector circuits can be wired in one of two fundamental directions. The first method is to steadily power the injectors and have the computer driver switch the ground side of the circuit. Conversely, the injectors can be steadily grounded while the driver switches the power side of the circuit.

There is no performance benefit to either method. Voltage controlled and current controlled drivers have been successfully implemented both ways.

However, 95% percent of the systems are wired so the driver controls the ground side of the circuit. Only a handful of systems use the drivers on the power side of the circuit. Some examples of the

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latter are the 1970's Cadillac EFI system, early Jeep 4.0 EFI (Renix system), and Chrysler 1984-87 TBI.

INTERPRETING INJECTOR WAVEFORMS

INTERPRETING A VOLTAGE CONTROLLED PATTERN

NOTE: Voltage controlled drivers are also known as "Saturated Switch" drivers. They typically require injector circuits with a total leg resistance of 12 ohms or more.

NOTE: This example is based on a constant power/switched ground circuit.

* See Fig. 2 for pattern that the following text describes.

Point "A" is where system voltage is supplied to the injector. A good hot run voltage is usually 13.5 or more volts. This point, commonly known as open circuit voltage, is critical because the injector will not get sufficient current saturation if there is a voltage shortfall. To obtain a good look at this precise point, you will need to shift your Lab Scope to five volts per division.

You will find that some systems have slight voltage fluctuations here. This can occur if the injector feed wire is also used to power up other cycling components, like the ignition coil(s). Slight voltage fluctuations are normal and are no reason for concern. Major voltage fluctuations are a different story, however. Major voltage shifts on the injector feed line will create injector performance problems. Look for excessive resistance problems in the feed circuit if you see big shifts and repair as necessary.

Note that circuits with external injector resistors will not be any different because the resistor does not affect open circuit voltage.

Point "B" is where the driver completes the circuit to ground. This point of the waveform should be a clean square point straight down with no rounded edges. It is during this period that current saturation of the injector windings is taking place and the driver is heavily stressed. Weak drivers will distort this vertical line.

Point "C" represents the voltage drop across the injector windings. Point "C" should come very close to the ground reference point, but not quite touch. This is because the driver has a small amount of inherent resistance. Any significant offset from ground is an indication of a resistance problem on the ground circuit that needs repaired. You might miss this fault if you do not use the negative battery post for your Lab Scope hook-up, so it is HIGHLY recommended that you use the battery as your hook-up.

The points between "B" and "D" represent the time in milliseconds that the injector is being energized or held open. This line at Point "C" should remain flat. Any distortion or upward bend indicates a ground problem, short problem, or a weak driver. Alert readers will catch that this is exactly opposite of the current

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controlled type drivers (explained in the next section), because they bend upwards at this point.

How come the difference? Because of the total circuit resistance. Voltage controlled driver circuits have a high resistance of 12+ ohms that slows the building of the magnetic field in the injector. Hence, no counter voltage is built up and the line remains flat.

On the other hand, the current controlled driver circuit has low resistance which allows for a rapid magnetic field build-up. This causes a slight inductive rise (created by the effects of counter voltage) and hence, the upward bend. You should not see that here with voltage controlled circuits.

Point "D" represents the electrical condition of the injector windings. The height of this voltage spike (inductive kick) is proportional to the number of windings and the current flow through them. The more current flow and greater number of windings, the more potential for a greater inductive kick. The opposite is also true. The less current flow or fewer windings means less inductive kick. Typically you should see a minimum 35 volts at the top of Point "D".

If you do see approximately 35 volts, it is because a zener diode is used with the driver to clamp the voltage. Make sure the beginning top of the spike is squared off, indicating the zener dumped the remainder of the spike. If it is not squared, that indicates the spike is not strong enough to make the zener fully dump, meaning the injector has a weak winding.

If a zener diode is not used in the computer, the spike from a good injector will be 60 or more volts.

Point "E" brings us to a very interesting section. As you can see, the voltage dissipates back to supply value after the peak of the inductive kick. Notice the slight hump? This is actually the mechanical injector pintle closing. Recall that moving an iron core through a magnetic field will create a voltage surge. The pintle is the iron core here.

This pintle hump at Point "E" should occur near the end of the downward slope, and not afterwards. If it does occur after the slope has ended and the voltage has stabilized, it is because the pintle is slightly sticking because of a faulty injector

If you see more than one hump it is because of a distorted pintle or seat. This faulty condition is known as "pintle float".

It is important to realize that it takes a good digital storage oscilloscope or analog lab scope to see this pintle hump clearly. Unfortunately, it cannot always be seen.

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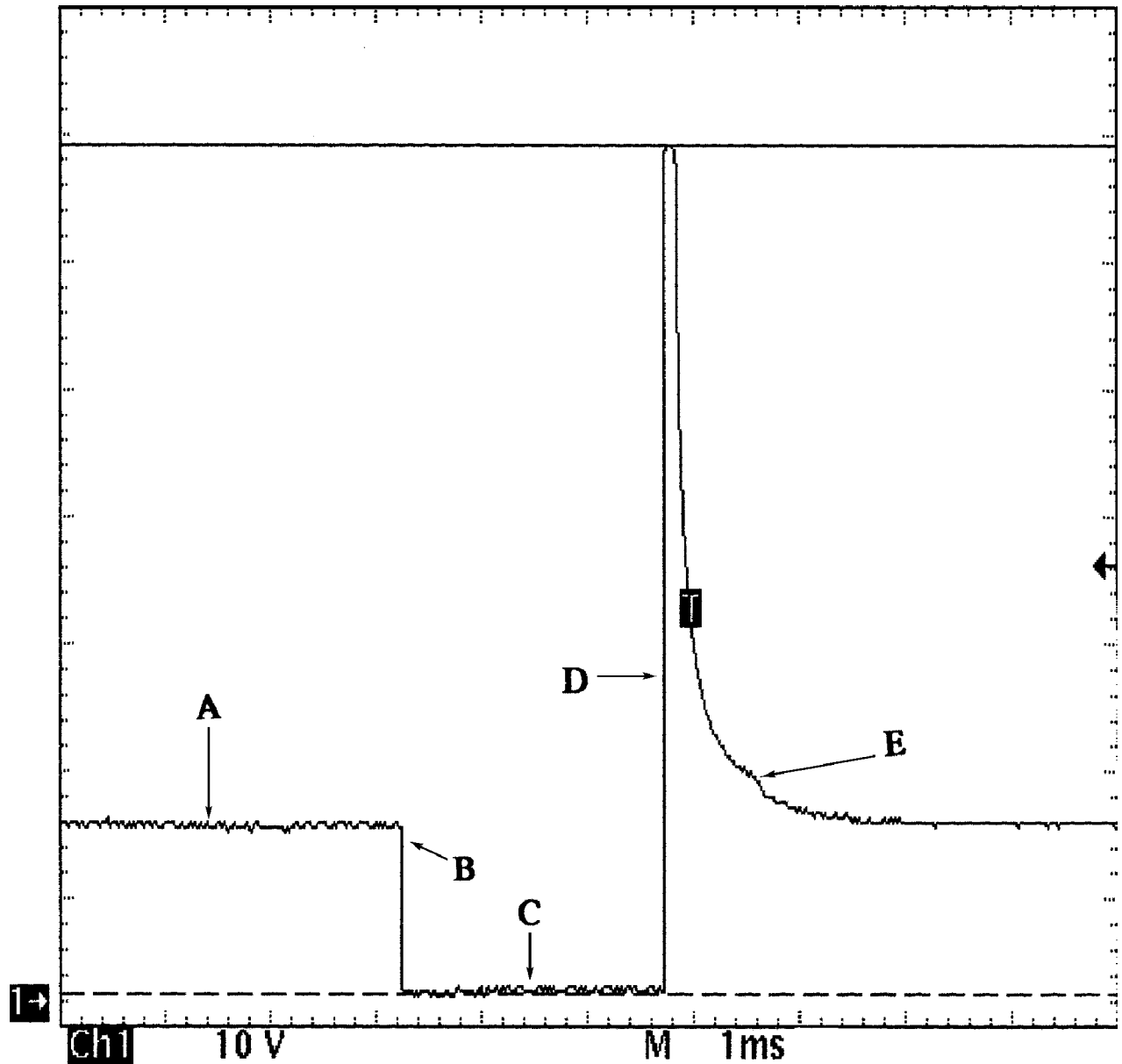


Fig. 2: Identifying Voltage Controlled Type Injector Pattern

INTERPRETING A CURRENT CONTROLLED PATTERN

NOTE: Current controlled drivers are also known as "Peak and Hold" drivers. They typically require injector circuits with a total leg resistance with less than 12 ohm.

NOTE: This example is based on a constant power/switched ground circuit.

* See Fig. 3 for pattern that the following text describes.

Point "A" is where system voltage is supplied to the

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injector. A good hot run voltage is usually 13.5 or more volts. This point, commonly known as open circuit voltage, is critical because the injector will not get sufficient current saturation if there is a voltage shortfall. To obtain a good look at this precise point, you will need to shift your Lab Scope to five volts per division.

You will find that some systems have slight voltage fluctuations here. This could occur if the injector feed wire is also used to power up other cycling components, like the ignition coil(s). Slight voltage fluctuations are normal and are no reason for concern. Major voltage fluctuations are a different story, however. Major voltage shifts on the injector feed line will create injector performance problems. Look for excessive resistance problems in the feed circuit if you see big shifts and repair as necessary.

Point "B" is where the driver completes the circuit to ground. This point of the waveform should be a clean square point straight down with no rounded edges. It is during this period that current saturation of the injector windings is taking place and the driver is heavily stressed. Weak drivers will distort this vertical line.

Point "C" represents the voltage drop across the injector windings. Point "C" should come very close to the ground reference point, but not quite touch. This is because the driver has a small amount of inherent resistance. Any significant offset from ground is an indication of a resistance problem on the ground circuit that needs repaired. You might miss this fault if you do not use the negative battery post for your Lab Scope hook-up, so it is HIGHLY recommended that you use the battery as your hook-up.

Right after Point "C", something interesting happens. Notice the trace starts a normal upward bend. This slight inductive rise is created by the effects of counter voltage and is normal. This is because the low circuit resistance allowed a fast build-up of the magnetic field, which in turn created the counter voltage.

Point "D" is the start of the current limiting, also known as the "Hold" time. Before this point, the driver had allowed the current to free-flow ("Peak") just to get the injector pintle open. By the time point "D" occurs, the injector pintle has already opened and the computer has just significantly throttled the current back. It does this by only allowing a few volts through to maintain the minimum current required to keep the pintle open.

The height of the voltage spike seen at the top of Point "D" represents the electrical condition of the injector windings. The height of this voltage spike (inductive kick) is proportional to the number of windings and the current flow through them. The more current flow and greater number of windings, the more potential for a greater inductive kick. The opposite is also true. The less current flow or fewer windings means less inductive kick. Typically you should see a minimum 35 volts.

If you see approximately 35 volts, it is because a zener diode is used with the driver to clamp the voltage. Make sure the beginning top of the spike is squared off, indicating the zener dumped the remainder of the spike. If it is not squared, that indicates the spike is not strong enough to make the zener fully dump, meaning there

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is a problem with a weak injector winding.

If a zener diode is not used in the computer, the spike from a good injector will be 60 or more volts.

At Point "E", notice that the trace is now just a few volts below system voltage and the injector is in the current limiting, or the "Hold" part of the pattern. This line will either remain flat and stable as shown here, or will cycle up and down rapidly. Both are normal methods to limit current flow. Any distortion may indicate shorted windings.

Point "F" is the actual turn-off point of the driver (and injector). To measure the millisecond on-time of the injector, measure between points "C" and "F". Note that we used cursors to do it for us; they are measuring a 2.56 mS on-time.

The top of Point "F" (second inductive kick) is created by the collapsing magnetic field caused by the final turn-off of the driver. This spike should be like the spike on top of point "D".

Point "G" shows a slight hump. This is actually the mechanical injector pintle closing. Recall that moving an iron core through a magnetic field will create a voltage surge. The pintle is the iron core here.

This pintle hump at Point "E" should occur near the end of the downward slope, and not afterwards. If it does occur after the slope has ended and the voltage has stabilized, it is because the pintle is slightly sticking. Some older Nissan TBI systems suffered from this.

If you see more than one hump it is because of a distorted pintle or seat. This faulty condition is known as "pintle float".

It is important to realize that it takes a good digital storage oscilloscope or analog lab scope to see this pintle hump clearly. Unfortunately, it cannot always be seen.

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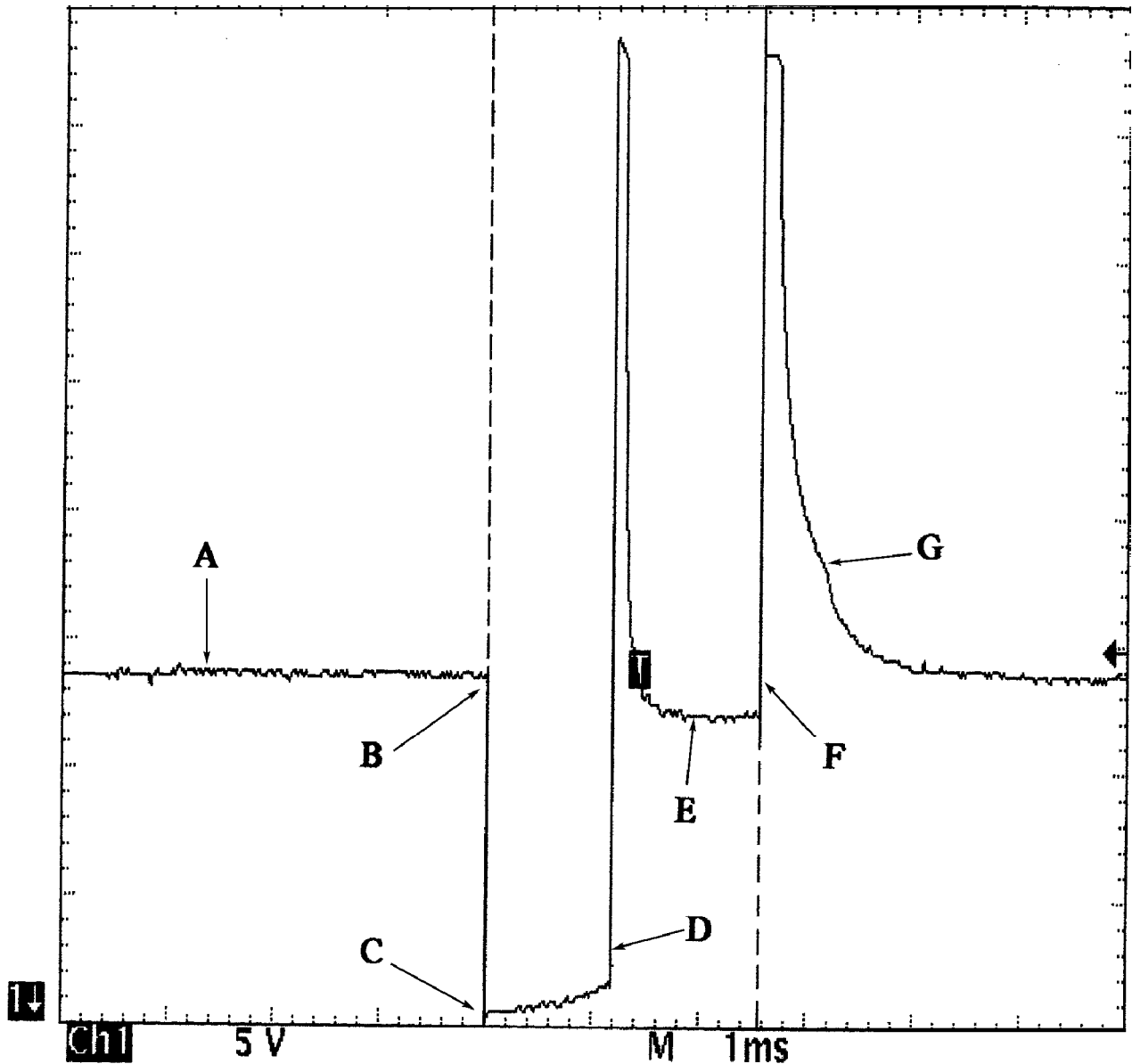


Fig. 3: Identifying Current Controlled Type Injector Pattern

CURRENT WAVEFORM SAMPLES

EXAMPLE #1 - VOLTAGE CONTROLLED DRIVER

The waveform pattern shown in Fig. 4 indicate a normal current waveform from a Ford 3.0L V6 VIN [U] engine. This voltage controlled type circuit pulses the injectors in groups of three injectors. Injectors No. 1, 3, and 5 are pulsed together and cylinders 2, 4, and 6 are pulsed together. The specification for an acceptable bank resistance is 4.4 ohms. Using Ohm's Law and assuming a hot run voltage of 14 volts, we determine that the bank would draw a current of 3.2 amps.

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However this is not the case because as the injector windings become saturated, counter voltage is created which impedes the current flow. This, coupled with the inherent resistance of the driver's transistor, impedes the current flow even more. So, what is a known good value for a dynamic current draw on a voltage controlled bank of injectors? The waveform pattern shown below indicates a good parallel injector current flow of 2 amps. See Fig. 4.

Note that if just one injector has a resistance problem and partially shorts, the entire parallel bank that it belongs to will draw more current. This can damage the injector driver.

The waveform pattern in Fig. 5 indicates this type of problem with too much current flow. This is on other bank of injectors of the same vehicle; the even side. Notice the Lab Scope is set on a one amp per division scale. As you can see, the current is at an unacceptable 2.5 amps.

It is easy to find out which individual injector is at fault. All you need to do is inductively clamp onto each individual injector and compare them. To obtain a known-good value to compare against, we used the good bank to capture the waveform in Fig. 6. Notice that it limits current flow to 750 milliamps.

The waveform shown in Fig. 7 illustrates the problem injector we found. This waveform indicates an unacceptable current draw of just over one amp as compared to the 750 milliamp draw of the known-good injector. A subsequent check with a DVOM found 8.2 ohms, which is under the 12 ohm specification.

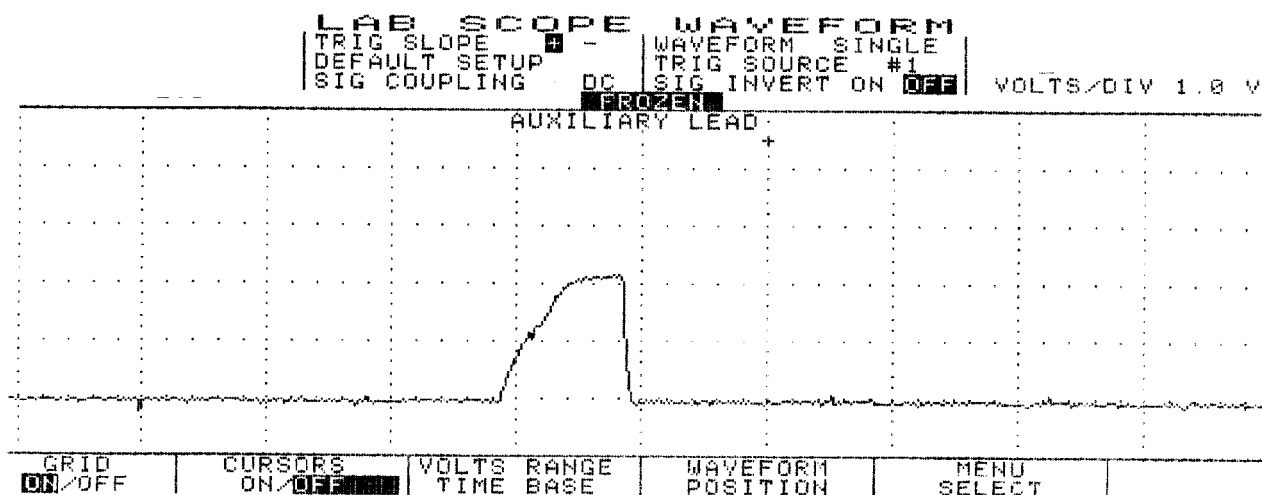


Fig. 4: Injector Bank w/Normal Current Flow - Current Pattern

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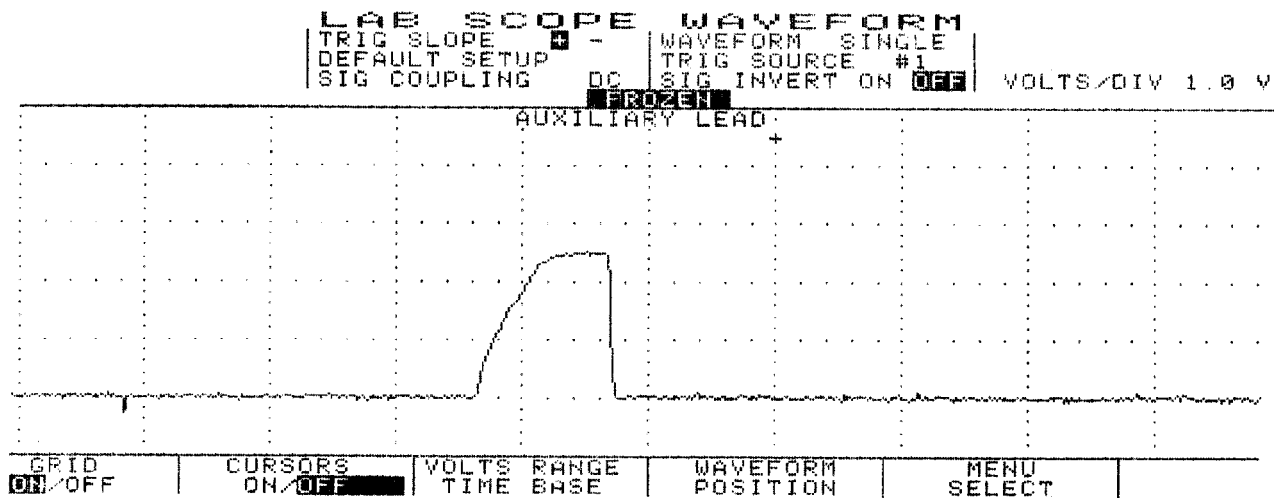


Fig. 5: Injector Bank w/Excessive Current Flow - Current Pattern

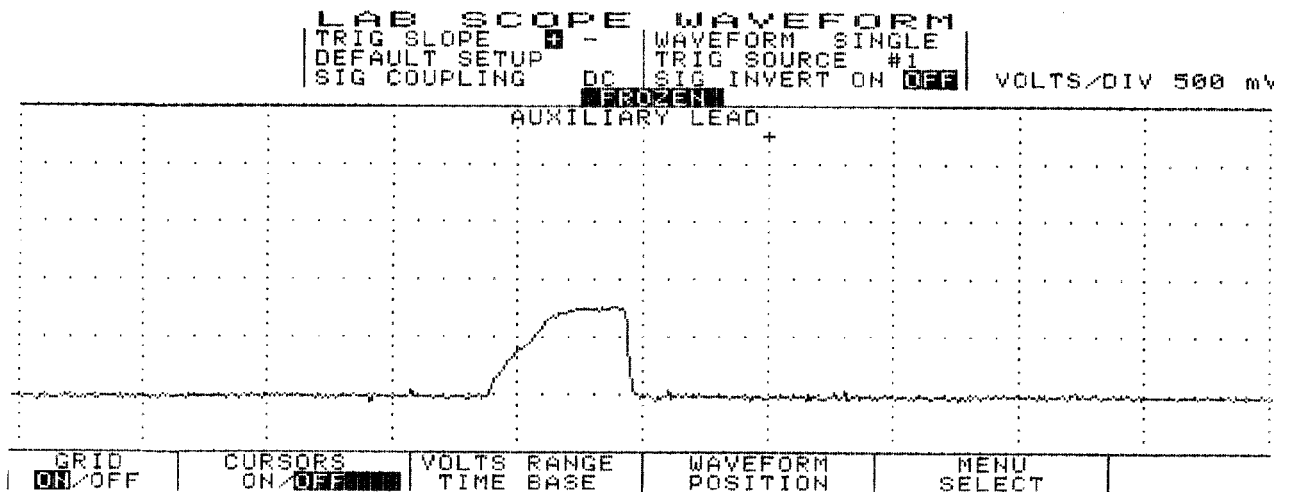


Fig. 6: Single Injector w/Normal Current Flow - Current Pattern

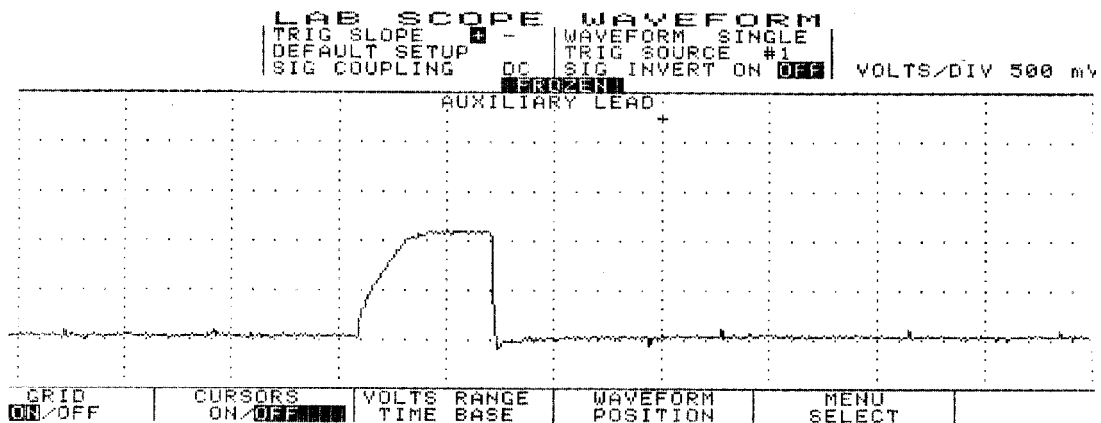


Fig. 7: Single Injector w/Excessive Current Flow - Current Pattern

EXAMPLE #2 - VOLTAGE CONTROLLED DRIVER

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This time we will look at a GM 3.1L V6 VIN [T]. Fig. 8 shows the 1, 3, 5 (odd) injector bank with the current waveform indicating about a 2.6 amp draw at idle. This pattern, taken from a known good vehicle, correctly stays at or below the maximum 2.6 amps current range. Ideally, the current for each bank should be very close in comparison.

Notice the small dimple on the current flow's rising edge. This is the actual injector opening or what engineers refer to as the "set point." For good idle quality, the set point should be uniform between the banks.

When discussing Ohm's Law as it pertains to this parallel circuit, consider that each injector has specified resistance of 12.2 ohms. Since all three injectors are in parallel the total resistance of this parallel circuit drops to 4.1 ohms. Fourteen volts divided by four ohms would pull a maximum of 3.4 amps on this bank of injectors. However, as we discussed in EXAMPLE #1 above, other factors knock this value down to roughly the 2.6 amp neighborhood.

Now we are going to take a look at the even bank of injectors; injectors 2, 4, and 6. See Fig. 9. Notice this bank peaked at 1.7 amps at idle as compared to the 2.6 amps peak of the odd bank (Fig. 8). Current flow between even and odd injectors banks is not uniform, yet it is not causing a driveability problem. That is because it is still under the maximum amperage we figured out earlier. But be aware this vehicle could develop a problem if the amperage flow increases any more.

Checking the resistance of this even injector group with a DVOM yielded 6.2 ohms, while the odd injector group in the previous example read 4.1 ohms.

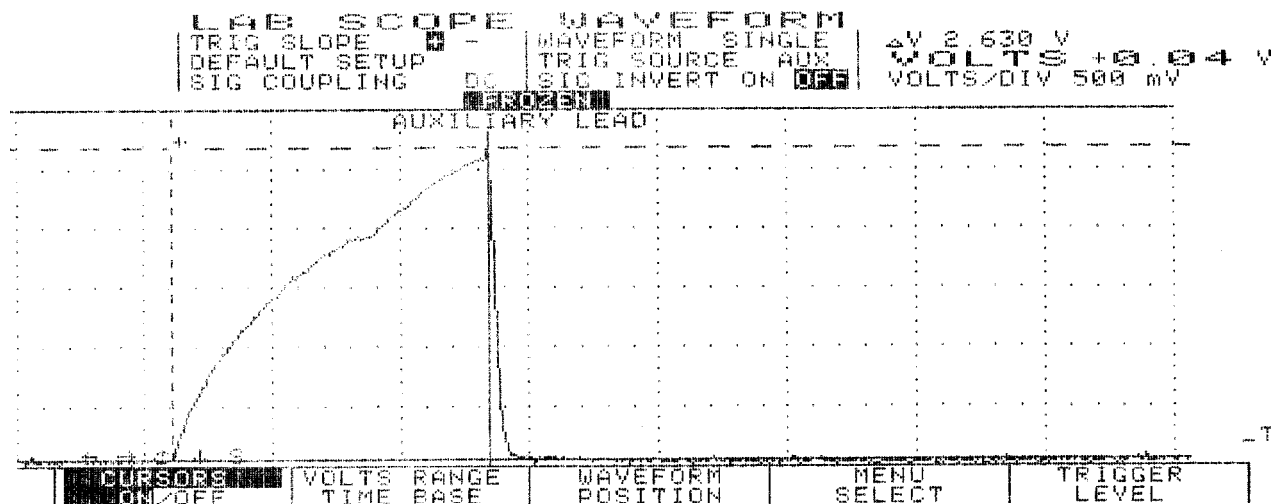


Fig. 8: Injector Odd Bank w/Normal Current Flow - Current Pattern

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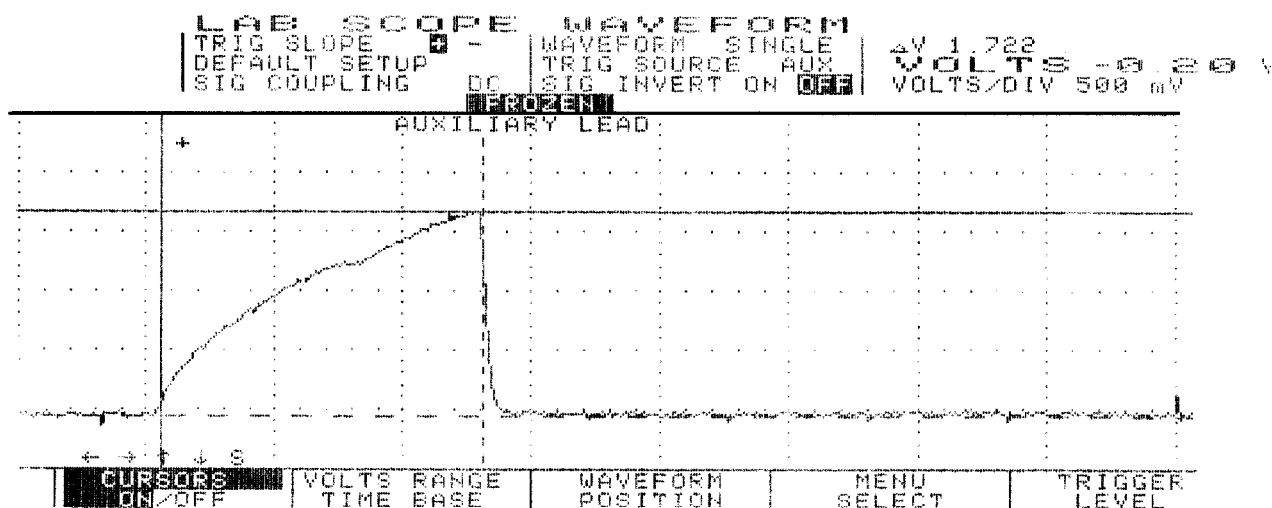


Fig. 9: Injector Even Bank w/Normal Current Flow - Current Pattern

EXAMPLE #3 - VOLTAGE CONTROLLED DRIVER

Example #3 is of a Ford 5.0L V8 SEFI. Fig. 10 shows a waveform of an individual injector at idle with the Lab Scope set on 200 milliamps per division. Notice the dimple in the rising edge. This dimple indicates the actual opening of the injector (set point) occurred at 400 milliamps and current peaked at 750 milliamps. This is a good specification for this engine.

The next waveform pattern in Fig. 11 shows an abnormality with another injector. With the Lab Scope set on 500 milliamps per division, you can see that the current waveform indicates a 1200 milliamp draw. This is a faulty injector.

Abnormally low resistance injectors create excessive current draw, causing rough idle, and possible computer driver damage.

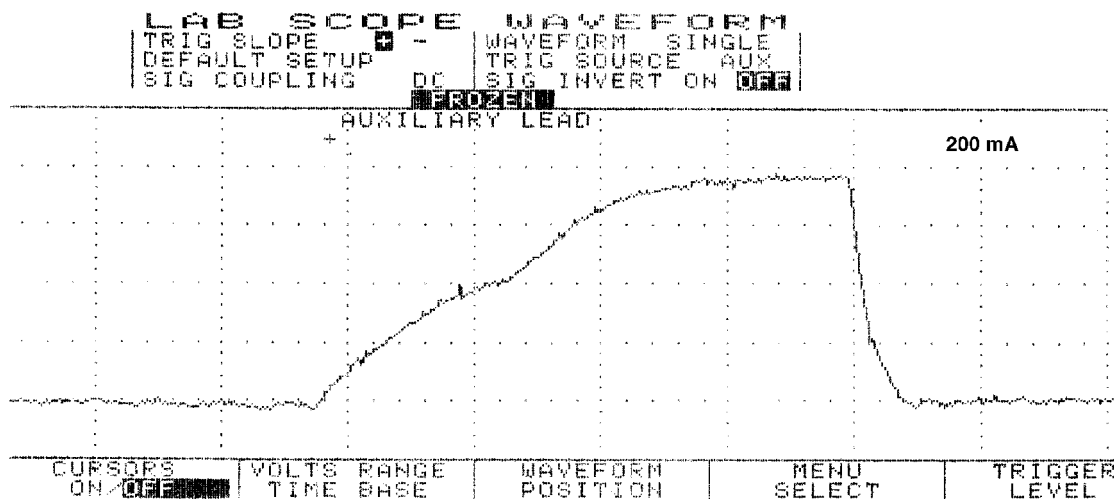


Fig. 10: Single Injector w/Normal Current Flow - Current Pattern

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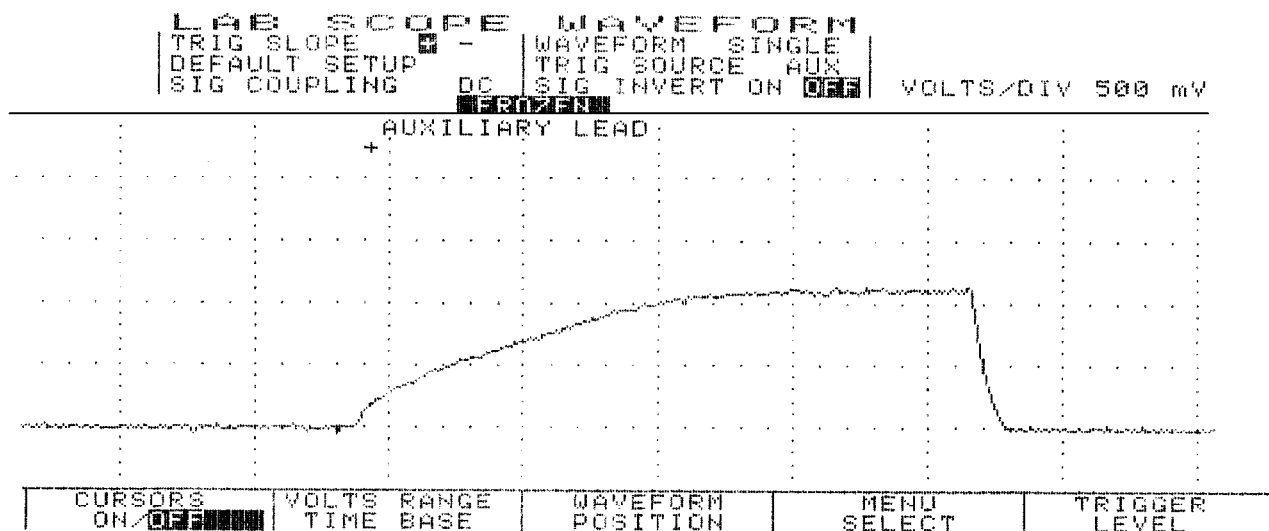


Fig. 11: Single Injector w/Excessive Current Flow - Current Pattern

EXAMPLE #4 - CURRENT CONTROLLED DRIVER

Example #4 is of a Ford 4.6L SEFI VIN [W]. See Fig. 12 for the known-good waveform pattern. This Ford system is different from the one above in EXAMPLE #3 as it peaks at 900 milliamps and the actual opening of the injector (set point) is just below 600 milliamps.

This is offered as a comparison against the Ford pattern listed above, as they are both Ford SEFI injectors but with different operating ranges. The point is that you should not make any broad assumptions for any manufacturer.

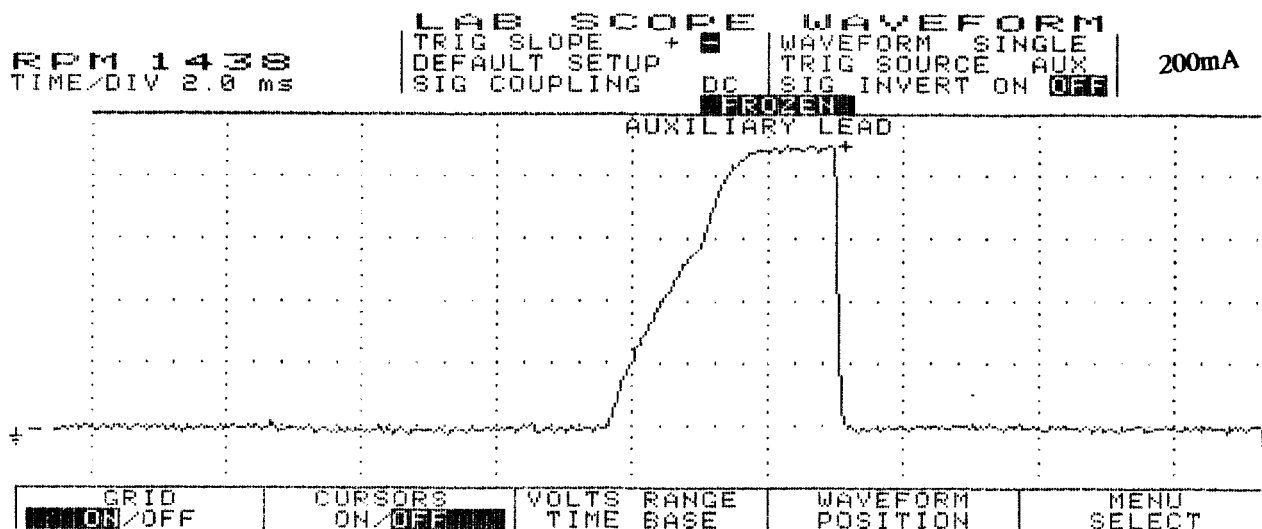


Fig. 12: Single Injector w/Normal Current Flow - Current Pattern

EXAMPLE #5 - CURRENT CONTROLLED DRIVER

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The known-good waveform in Fig. 13 is from a Chrysler 3.0L V6 PFI VIN [3]. It is a perfect example of the peak and hold theory. The waveform shows a 1-amp per division current flow, ramping to 4 amps and then decreasing to 1-amp to hold the injector open.

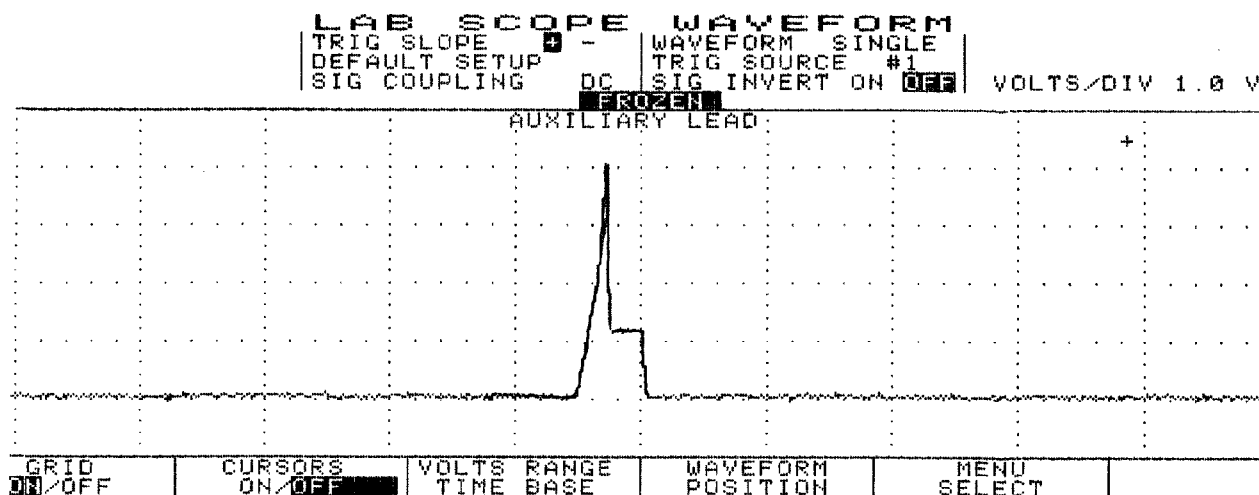


Fig. 13: Injector Bank w/Normal Current Flow - Current Pattern

EXAMPLE #6 - CURRENT CONTROLLED DRIVER

This next known-good waveform is from a Ford 5.0L V8 CFI VIN [F]. See Fig. 14. The pattern, which is set on a 250 milliamps scale, indicates a 1.25 amp peak draw and a hold at 350 milliamps.

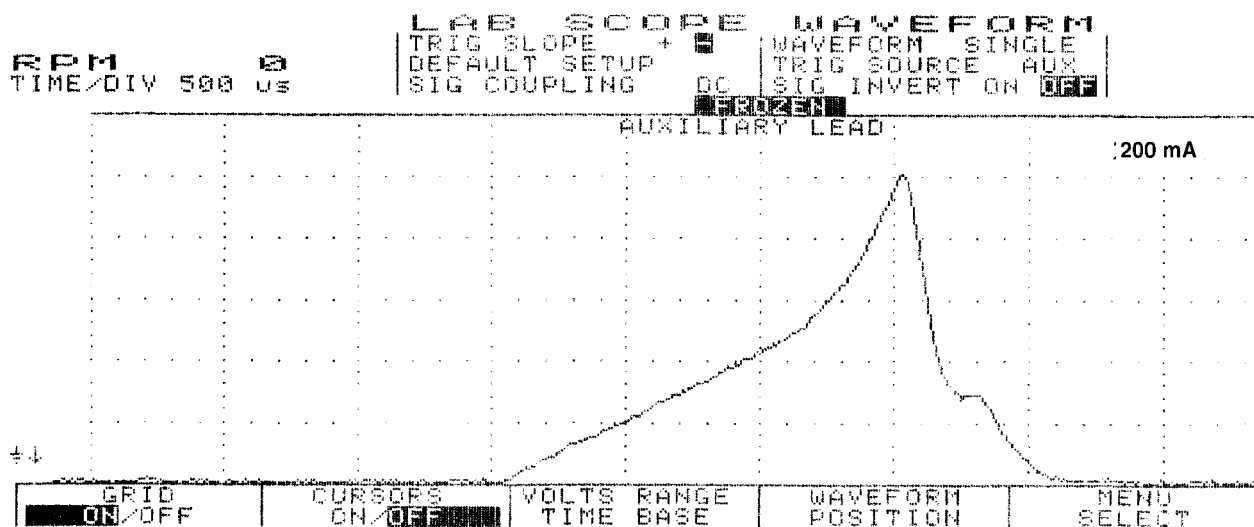


Fig. 14: Single Injector w/Normal Current Flow - Current Pattern

EXAMPLE #7 - CURRENT CONTROLLED DRIVER

The known-good current controlled type waveform in Fig. 15 is from a GM 2.0L TBI VIN [1]. With the lab scope set at 2 amps per division, notice that this system peaks at 4 amps and holds at 1 amp.

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The next waveform is from the same type of engine, except that it shows a faulty injector. See Fig. 16. Notice that the current went to almost 5 amps and stayed at 1 amp during the hold pattern. Excessive amounts of current flow from bad injectors are a common source of intermittent computer shutdown. Using a current waveform pattern is the most accurate method of pinpointing this problem.

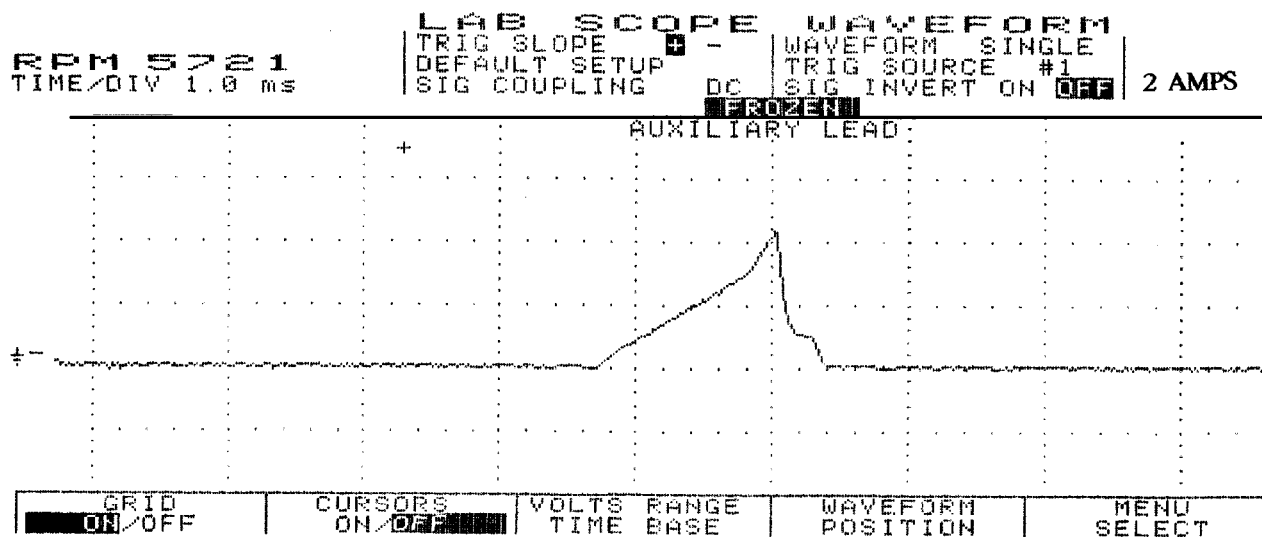


Fig. 15: Single Injector w/Normal Current Flow - Current Pattern

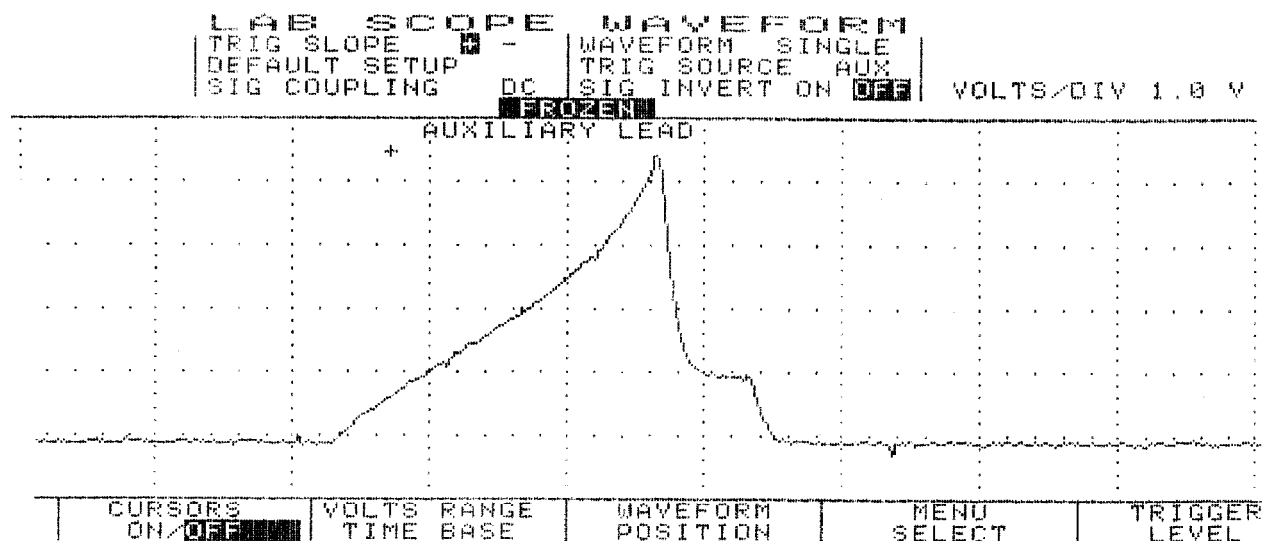


Fig. 16: Single Injector w/Excessive Current Flow - Current Pattern

EXAMPLE #8 - CURRENT CONTROLLED DRIVER

This known-good CPI system waveform from a GM 4.3L V6 CPI VIN [W] peaks at 4 amps and holds at 1-amp. See Fig. 17 for waveform.

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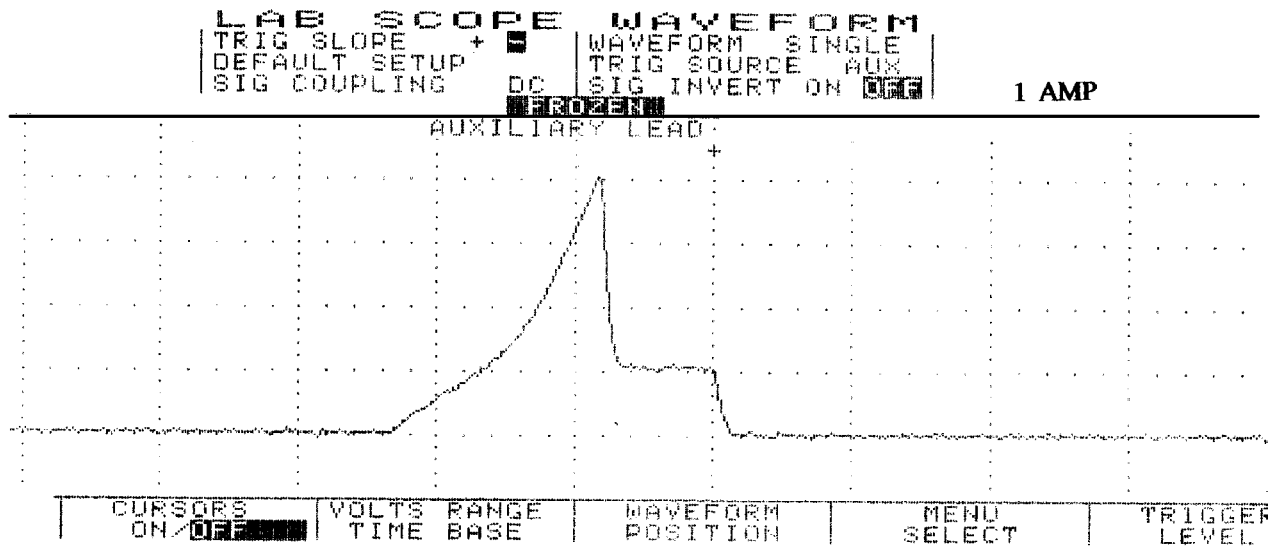
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95B23870
Fig. 17: Single Injector w/Normal Current Flow - Current Pattern

VOLTAGE WAVEFORM SAMPLES

EXAMPLE #1 - VOLTAGE CONTROLLED DRIVER

These two known-good waveform patterns are from a Ford 4.6L V8 VIN [W]. Fig. 18 illustrates the 64 volt inductive kick on this engine, indicating no clamping is occurring. The second pattern, Fig. 19, was taken during hot idle, closed loop, and no load.

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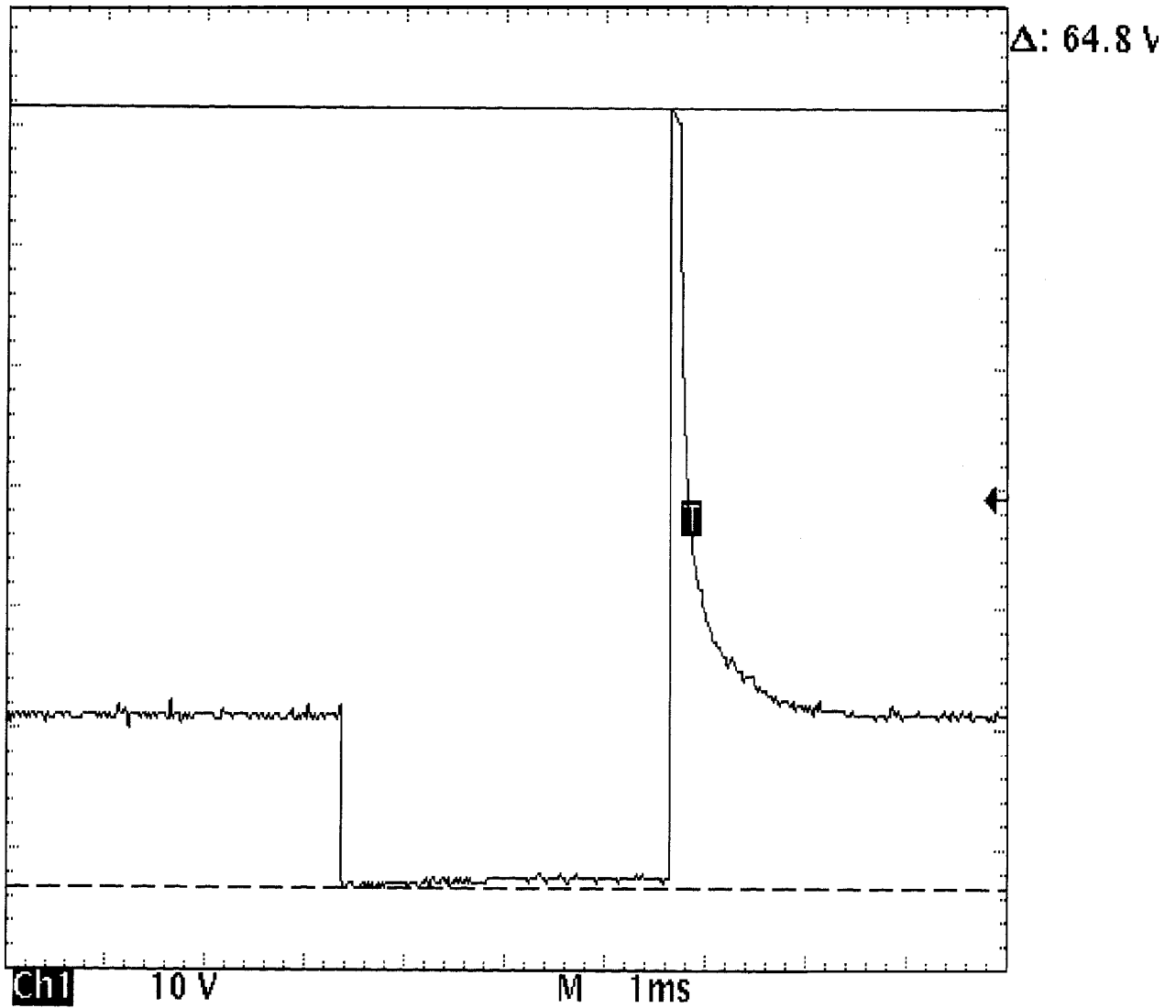


Fig. 18: ^{95E23857}Injector Bank - Known Good - Voltage Pattern

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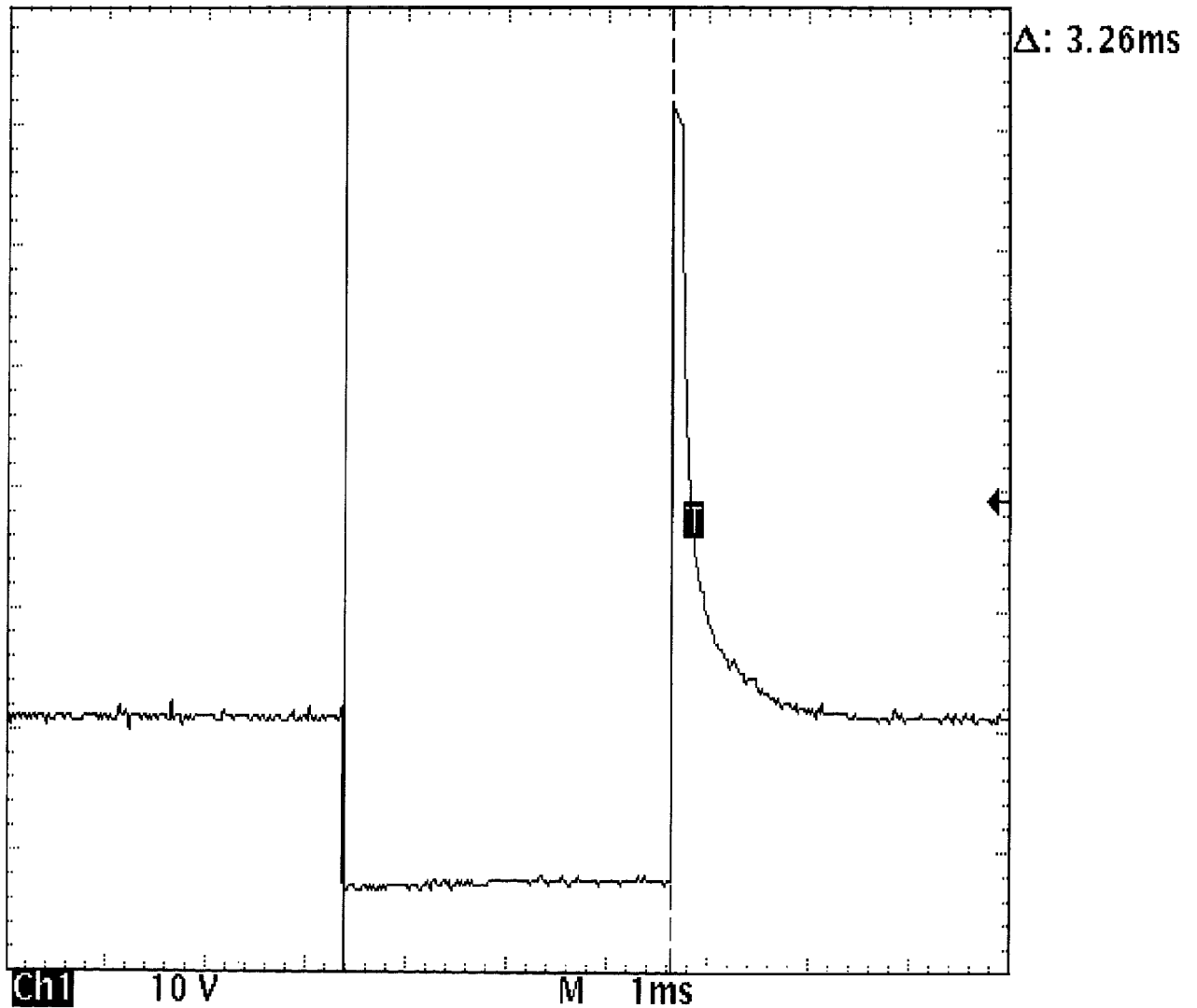


Fig. 19: 95F23858 Injector Bank - Known Good - Voltage Pattern

EXAMPLE #2 - VOLTAGE CONTROLLED DRIVER

The known-good waveform pattern in Fig. 20 is from a GM 3.8L V6 PFI VIN [3]. It was taken during hot idle, closed loop and no load.

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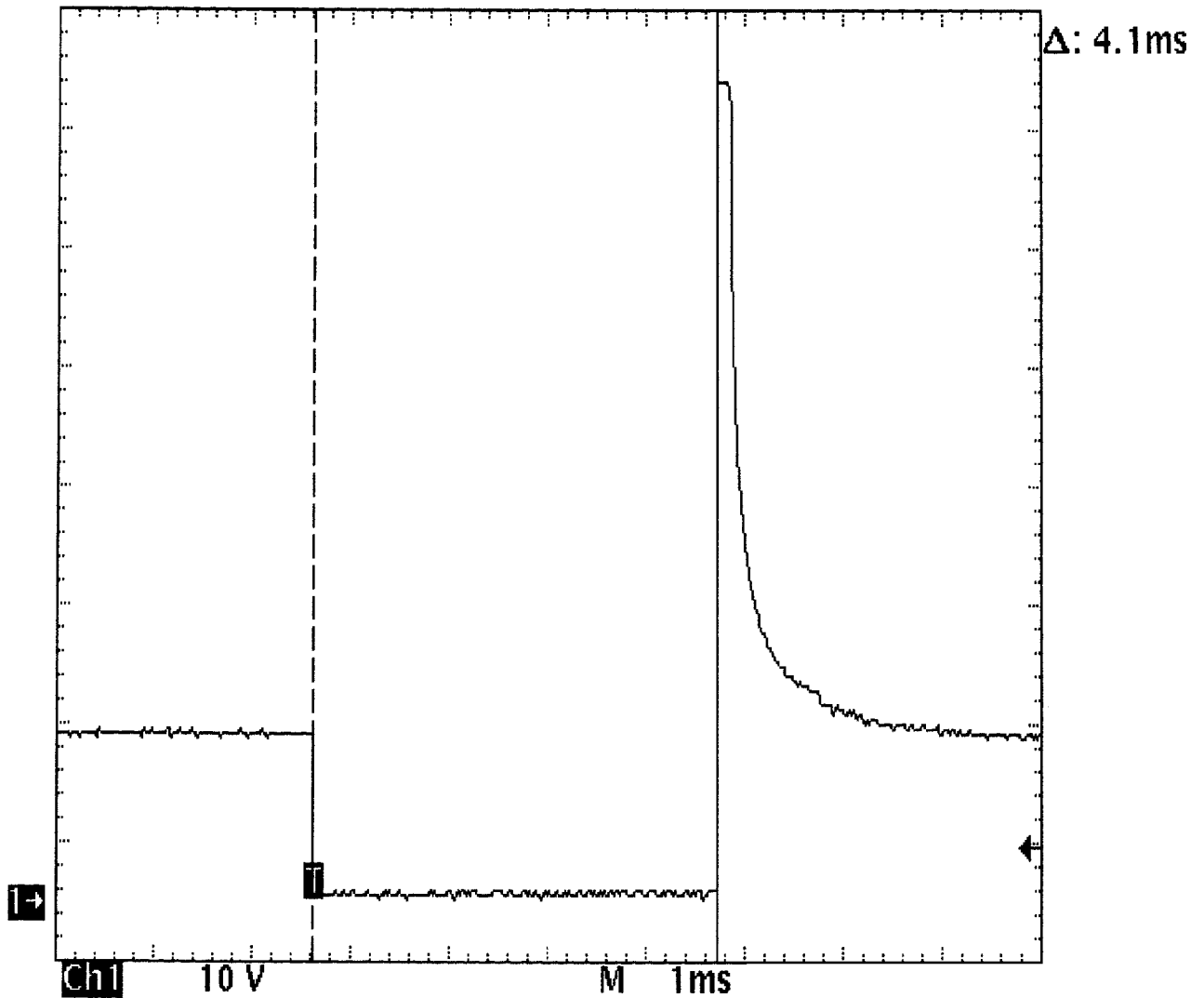


Fig. 20: Injector Bank - Known Good - Voltage Pattern

EXAMPLE #3 - VOLTAGE CONTROLLED DRIVER

This known-good waveform pattern, Fig. 21, is from a GM 5.0L V8 TPI VIN [F]. It was taken during hot idle, closed loop and no load.

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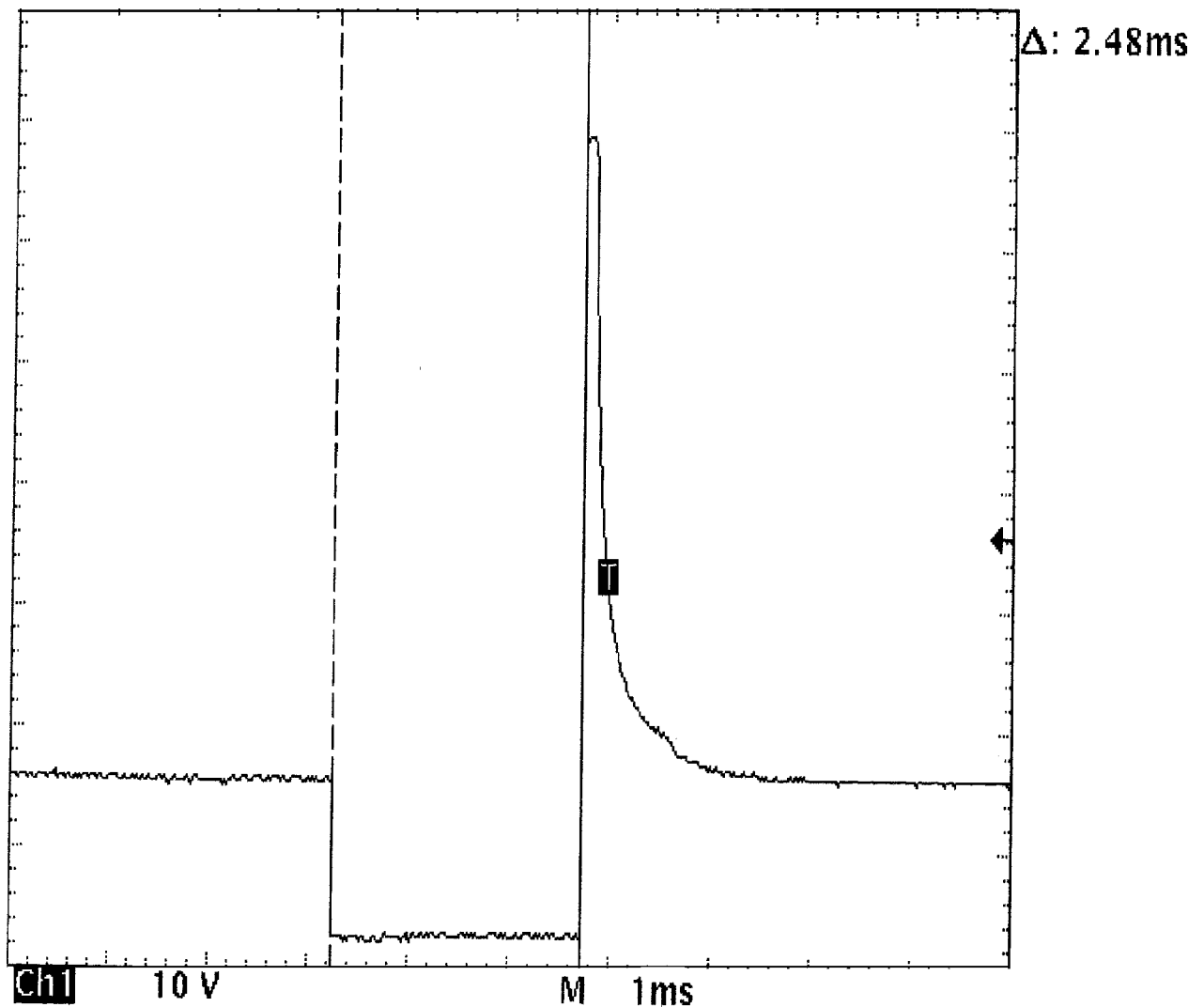


Fig. 21: Injector Bank - Known Good - Voltage Pattern

EXAMPLE #4 - CURRENT CONTROLLED DRIVER

From 1984 to 1987, Chrysler used this type injector drive on their TBI-equipped engines. See Fig. 22 for a known-good pattern. Instead of the ground side controlling the injector, Chrysler permanently grounds out the injector and switches the power feed side. Most systems do not work this way.

These injectors peak at 6 amps of current flow and hold at 1 amp.

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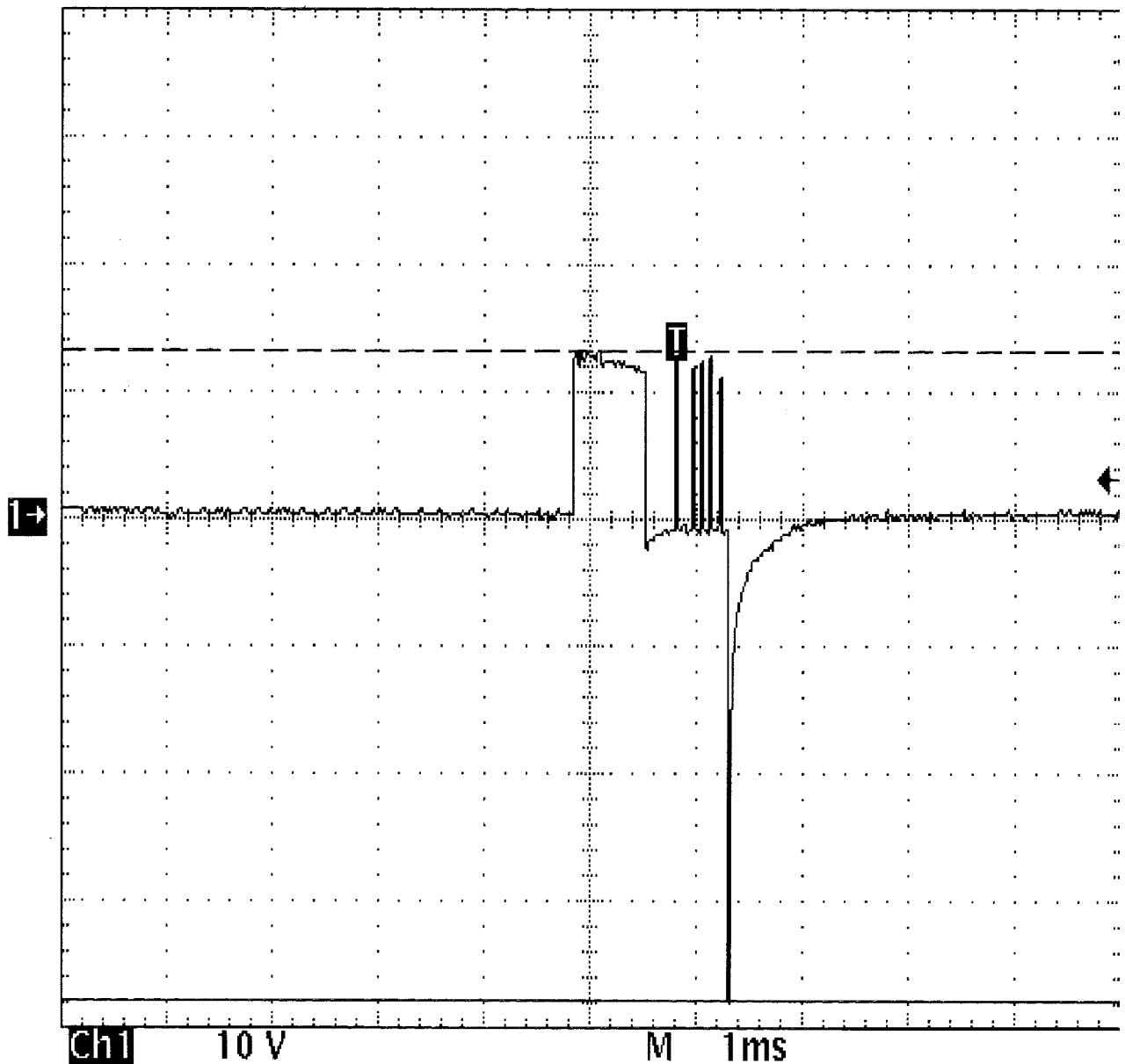
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Fig. 22: Single Injector - Known Good - Voltage Pattern

EXAMPLE #5 - CURRENT CONTROLLED DRIVER

These two known-good waveform patterns are from a Chrysler 3.0L V6 VIN [3]. The first waveform, Fig. 23, is a dual trace pattern that illustrates how Chrysler uses the rising edge of the engine speed signal to trigger the injectors. The second waveform, Fig. 24, was taken during hot idle, closed loop, and no load.

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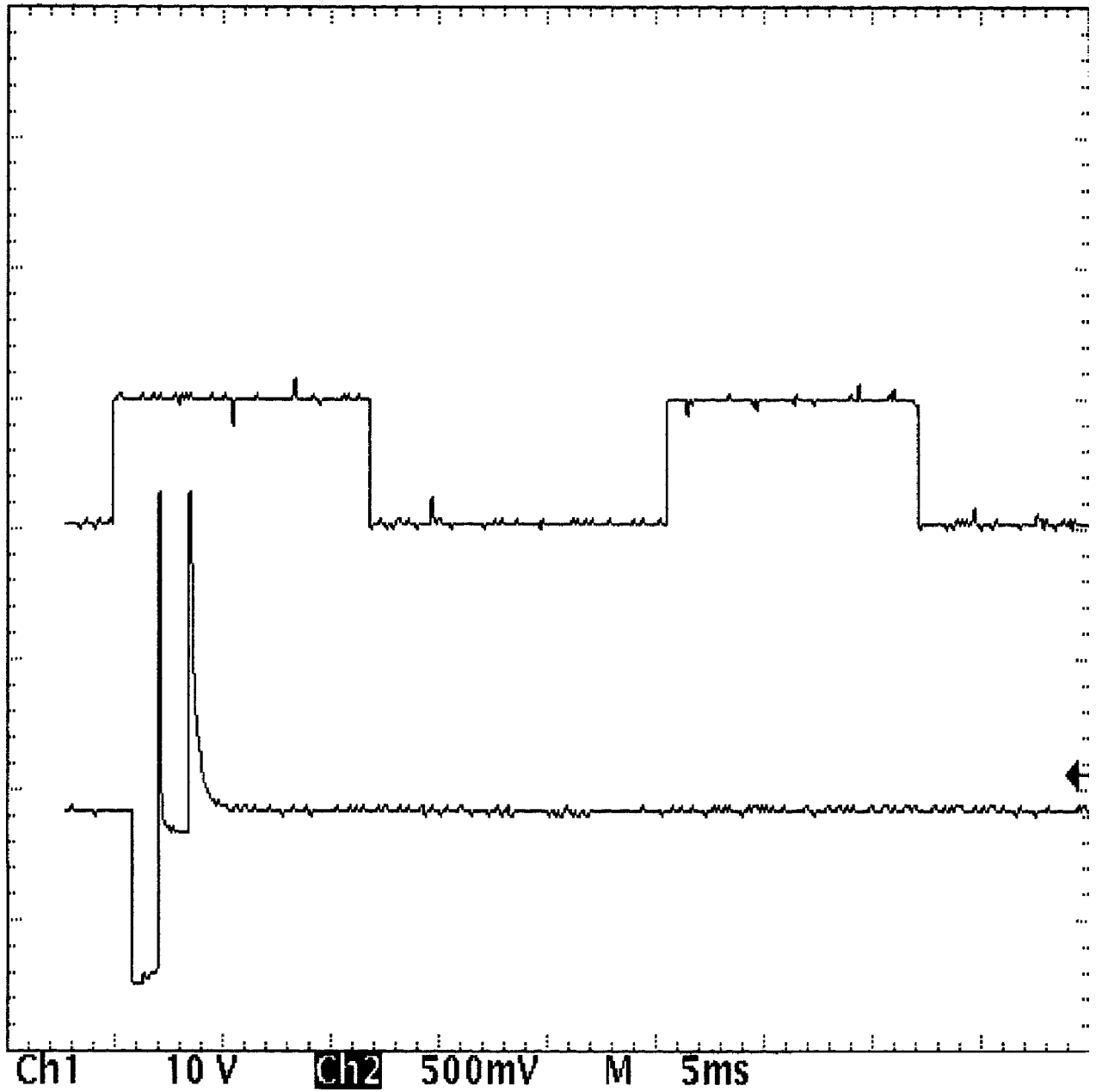


Fig. 23: ^{95A23861}Injector Bank - Known Good - Voltage Pattern

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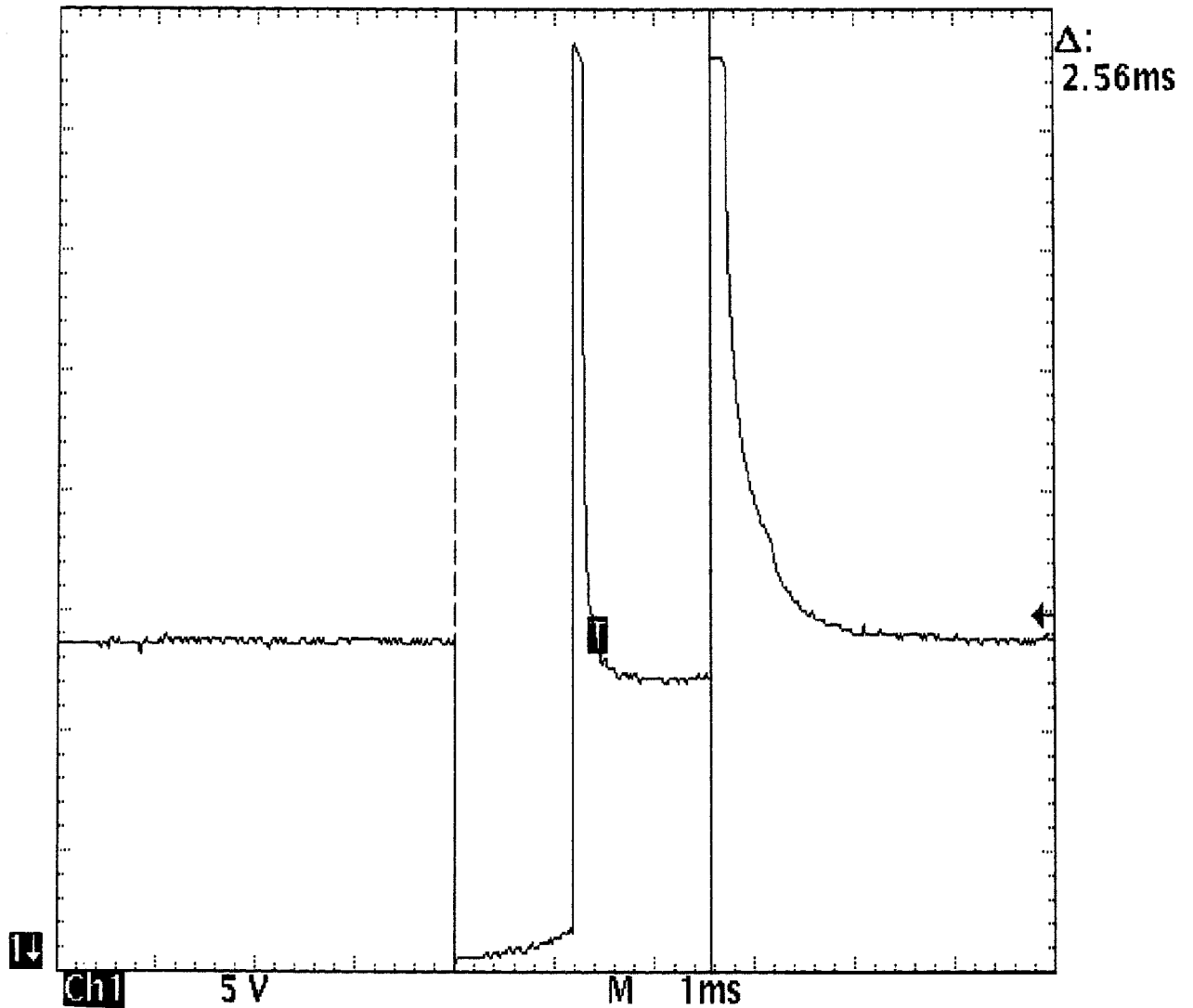


Fig. 24: ^{95B23854}Injector Bank - Known Good - Voltage Pattern

EXAMPLE #6 - CURRENT CONTROLLED DRIVER

This known-good pattern from a Ford 3.0L V6 PFI VIN [U] illustrates that a zener diode inside the computer is used to clamp the injector's inductive kick to 35-volts on this system. See Fig. 25.

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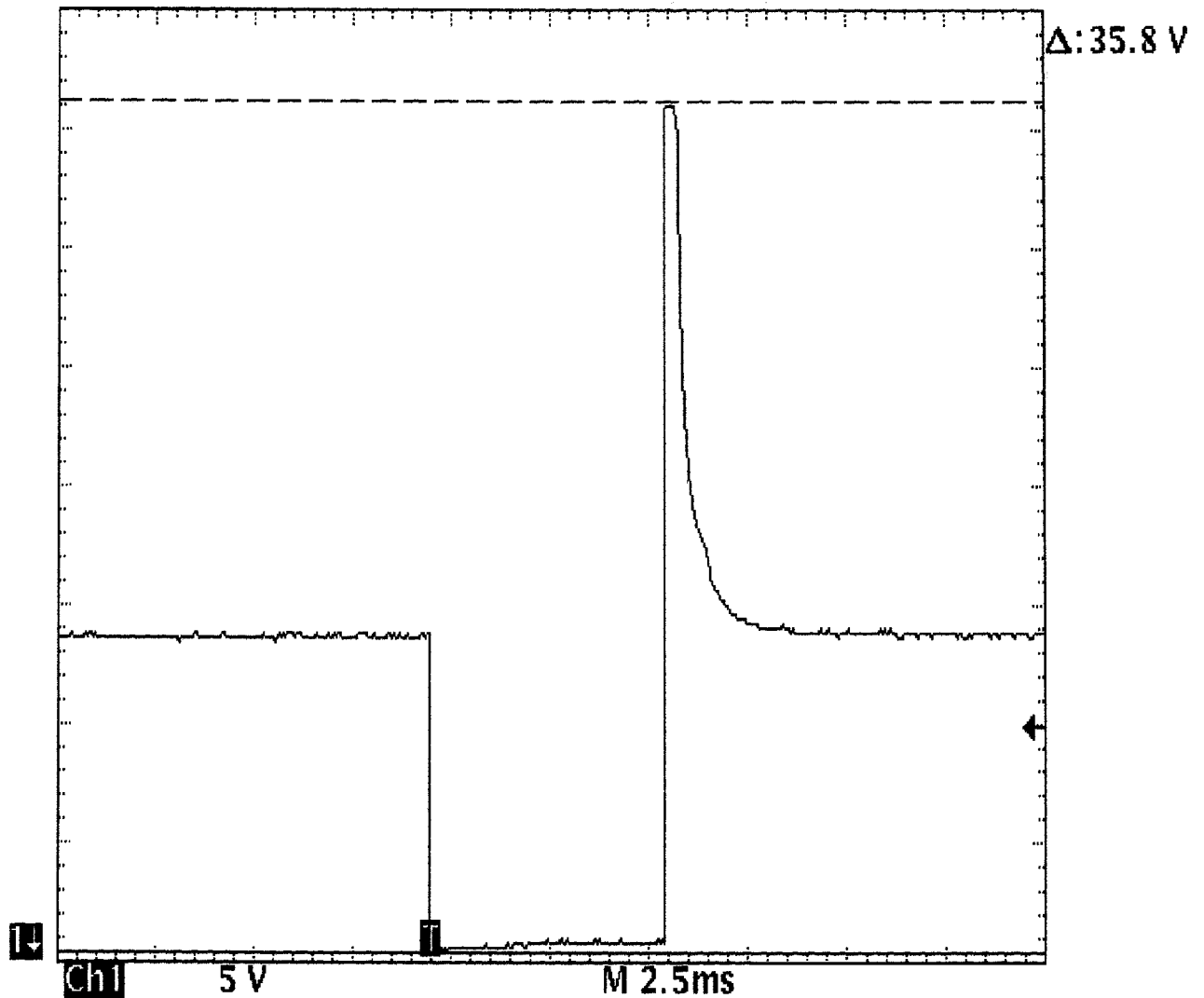


Fig. 25: Injector Bank - Known Good - Voltage Pattern

EXAMPLE #7 - CURRENT CONTROLLED DRIVER

This known-good waveform from a Ford 5.0L V8 CFI VIN [F] was taken during hot idle, closed loop, and no load. See Fig. 26.

WAVEFORMS - INJECTOR PATTERN TUTORIAL

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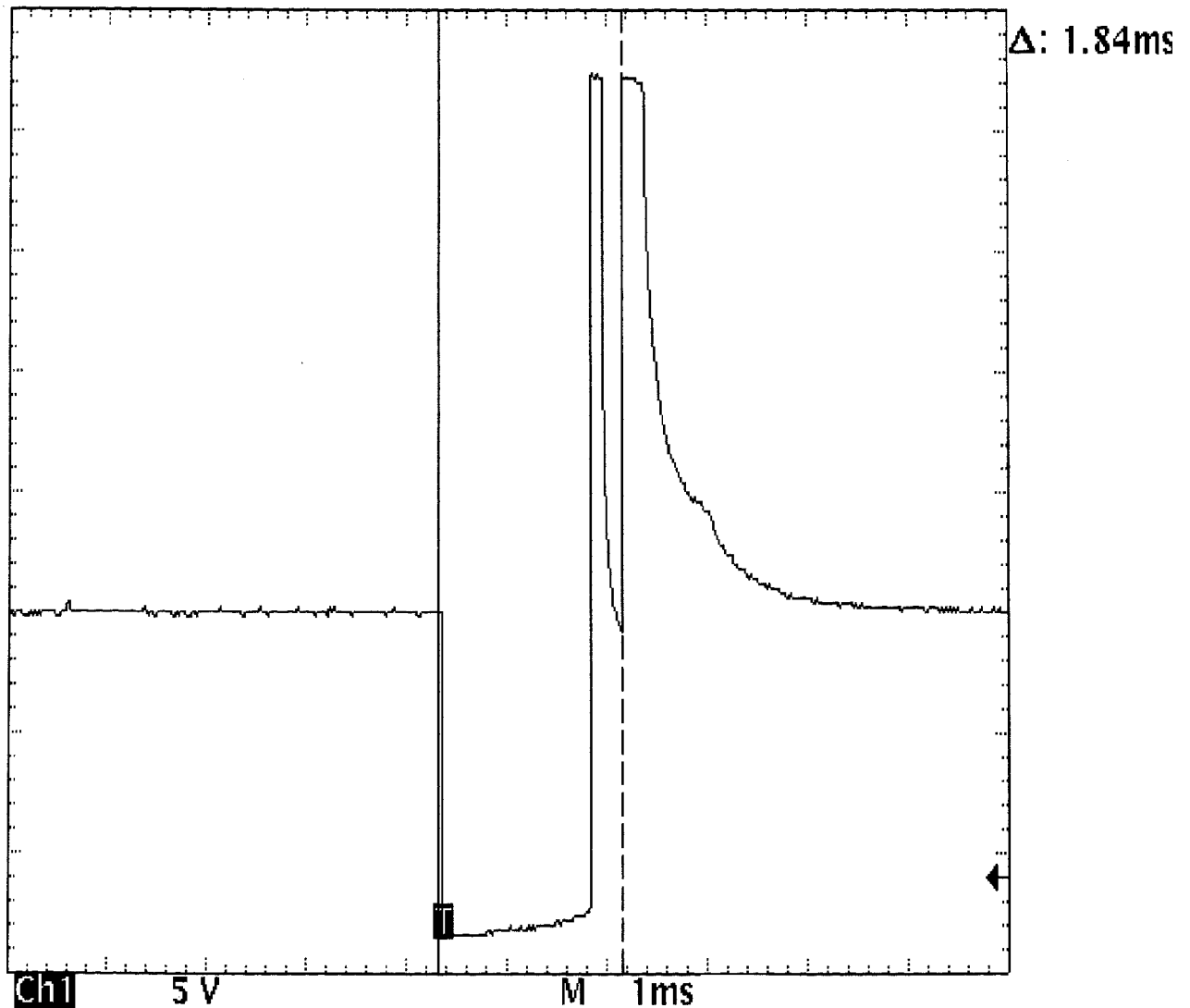


Fig. 26: Single Injector - Known Good - Voltage Pattern

EXAMPLE #8 - CURRENT CONTROLLED DRIVER

These two known-good waveform patterns are from a GM 2.0L In-Line 4 VIN [1]. Fig. 27 illustrates the 78 volt inductive spike that indicates a zener diode is not used. The second waveform, Fig. 28, was taken during hot idle, closed loop, and no load.

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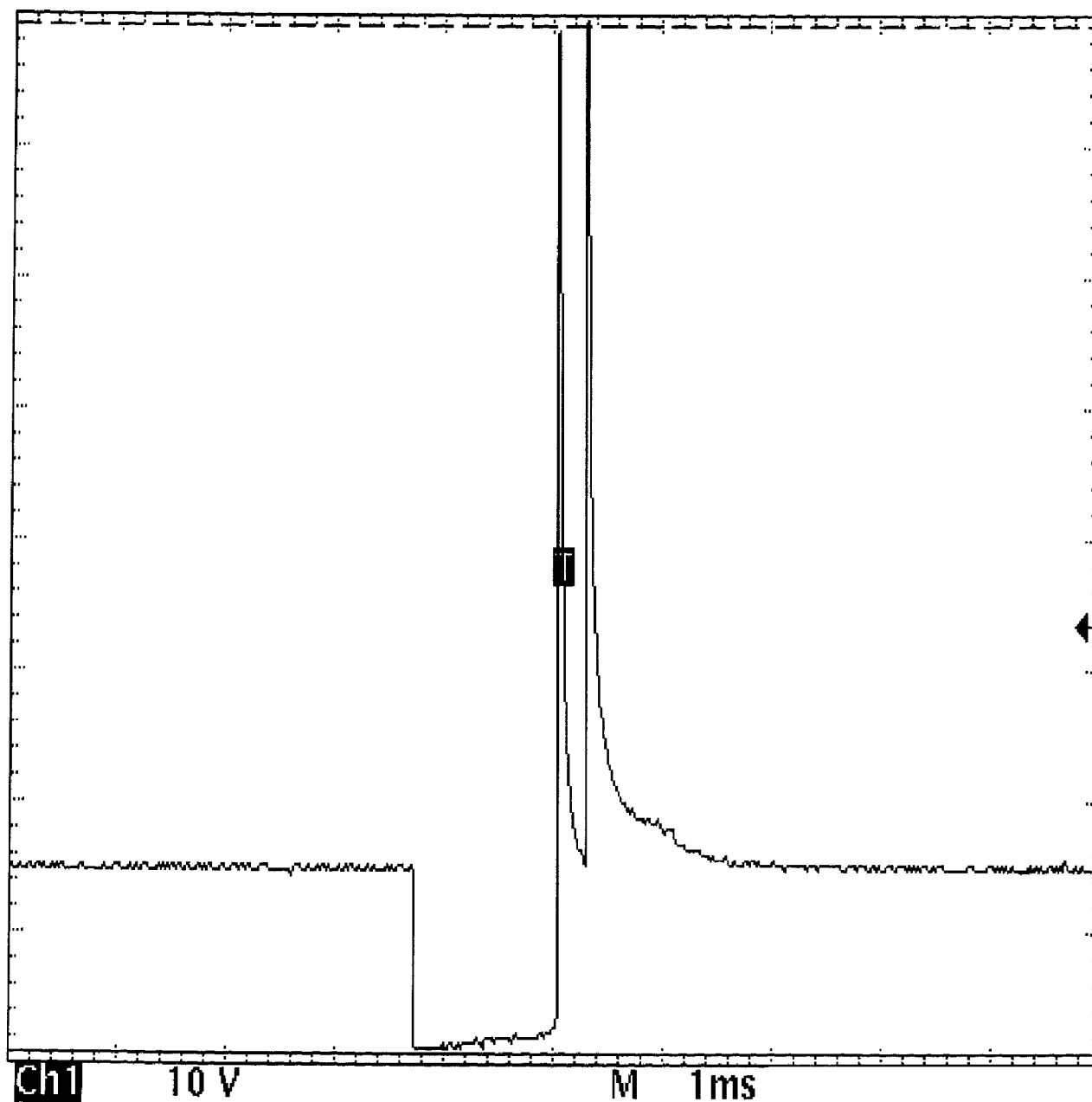


Fig. 27: ^{95D23849}Single Injector - Known Good - Voltage Pattern

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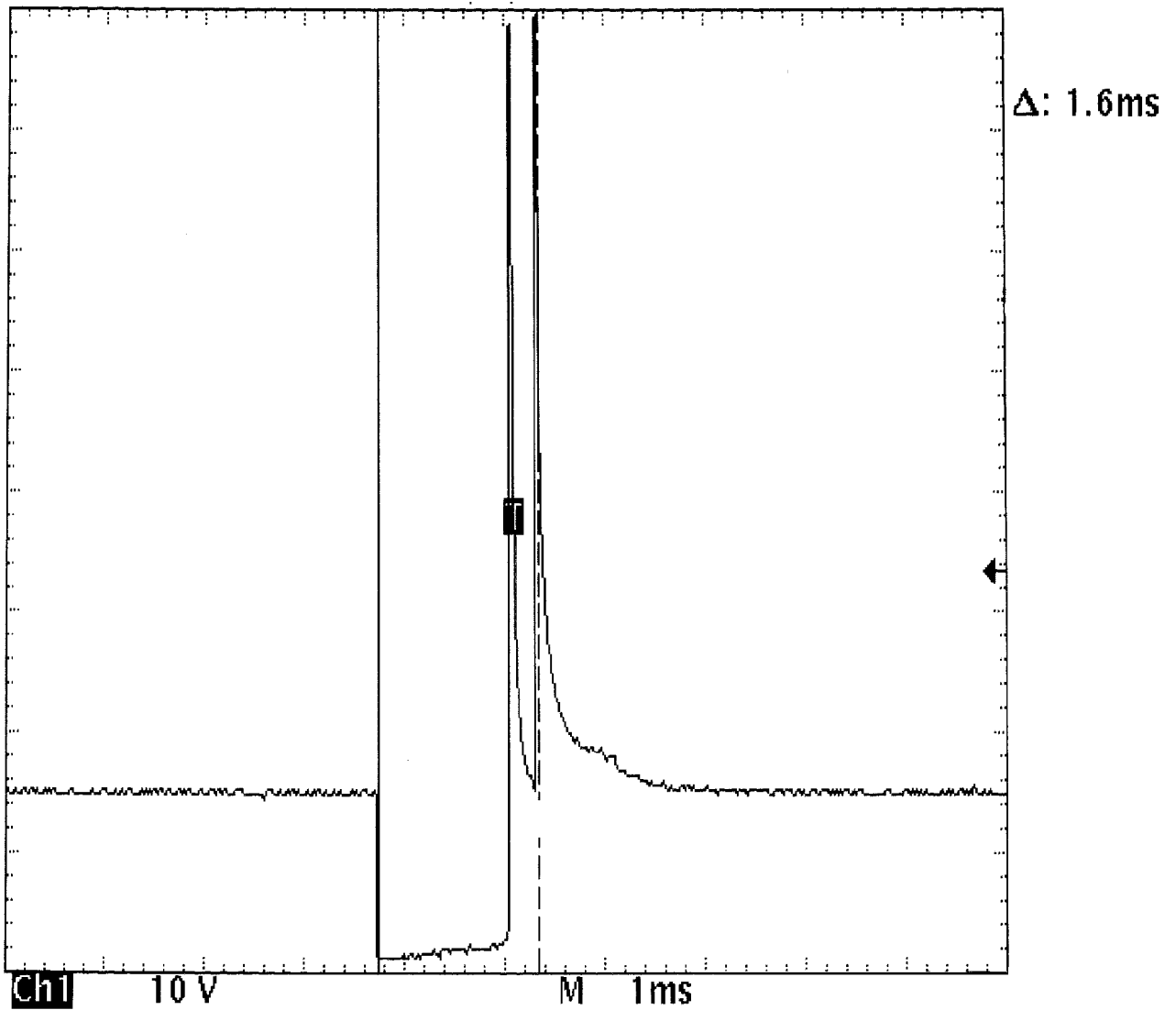


Fig. 28: Single Injector - Known Good - Voltage Pattern

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Decimal500 +/- .333

WHEEL ALIGNMENT SPECIFICATIONS & PROCEDURES

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Caster in Degrees

Fraction 2 +/- 21/64

Decimal 2.0 +/- .333

Toe-In in Inches

Fraction -5/64 +/- 5/64

Decimal -.083 +/- .083

Toe-In in Degrees

Fraction -21/64 +/- 21/64

Decimal -.166 +/- .166

Toe-Out in Turns

Inner NS

Outer NS

Steering Axis Inclination (SAI)

NS

Rear

Camber in Degrees

Fraction 1 1/2 +/- 1/2

Decimal 1.500 +/- .500

Caster in Degrees

Fraction

Decimal

Toe-In in Inches

Fraction 13/64 +/- 5/64

Decimal208 +/- .083

Toe-In in Degrees

Fraction 27/64 +/- 11/64

Decimal416 +/- .166

Toe-Out in Turns

Inner

Outer

Steering Axis Inclination (SAI)

.....

Fox Wagon

Front

Camber in Degrees

Fraction -1/2 +/- 21/64

Decimal500 +/- .333

Caster in Degrees

Fraction 1 5/64 +/- 21/64

Decimal 1.083 +/- .333

Toe-In in Inches

Fraction -5/64 +/- 5/64

Decimal -.083 +/- .083

Toe-In in Degrees

Fraction -21/64 +/- 21/64

Decimal -.166 +/- .166

Toe-Out in Turns

Inner NS

Outer NS

Steering Axis Inclination (SAI)

NS

Rear

Camber in Degrees

Fraction 1 1/2 +/- 1/2

Decimal 1.500 +/- .500

WHEEL ALIGNMENT SPECIFICATIONS & PROCEDURES

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Caster in Degrees		
Fraction		
Decimal		
Toe-In in Inches		
Fraction		13/64 +/- 5/64
Decimal		.208 +/- .083
Toe-In in Degrees		
Fraction		27/64 +/- 11/64
Decimal		.416 +/- .166
Toe-Out in Turns		
Inner		
Outer		
Steering Axis Inclination (SAI)		
Golf & Jetta		
Front		
Camber in Degrees		
Fraction		-1/2 +/- 21/64
Decimal		-.500 +/- .333
Caster in Degrees		
Fraction		1 1/2 +/- 1/2
Decimal		1.500 +/- .500
Toe-In in Inches		
Fraction		0 +/- 5/64
Decimal		0 +/- .083
Toe-In in Degrees		
Fraction		0 +/- 11/64
Decimal		0 +/- .166
Toe-Out in Turns		
Inner		NS
Outer		NS
Steering Axis Inclination (SAI)		NS
Rear		
Camber in Degrees		
Fraction		-1 43/64 +/- 21/64
Decimal		-1.666 +/- .333
Caster in Degrees		
Fraction		
Decimal		
Toe-In in Inches		
Fraction		13/64 +/- 1/8
Decimal		.208 +/- .125
Toe-In in Degrees		
Fraction		27/64 +/- 1/4
Decimal		.416 +/- .250
Toe-Out in Turns		
Inner		
Outer		
Steering Axis Inclination (SAI)		
GTI & GLI		
Front		
Camber in Degrees		
Fraction		-37/64 +/- 21/64

WHEEL ALIGNMENT SPECIFICATIONS & PROCEDURES

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Decimal		-.583 +/- .333
Caster in Degrees		
Fraction		1 37/64 +/- 1/2
Decimal		1.583 +/- .500
Toe-In in Inches		
Fraction		0 +/- 5/64
Decimal		0 +/- .083
Toe-In in Degrees		
Fraction		0 +/- 1/8
Decimal		0 +/- .125
Toe-Out in Turns		
Inner		NS
Outer		NS
Steering Axis Inclination (SAI)		NS
Rear		
Camber in Degrees		
Fraction		-1 43/64 +/- 21/64
Decimal		-1.666 +/- .333
Caster in Degrees		
Fraction		
Decimal		
Toe-In in Inches		
Fraction		
Decimal		
Toe-In in Degrees		
Fraction		
Decimal		
Toe-Out in Turns		
Inner		
Outer		
Steering Axis Inclination (SAI)		
Quantum		
Front (See Fig. 1) (1)		
Camber in Degrees		
Fraction		-43/64 +/- 1/2
Decimal		-.666 +/- .500
Caster in Degrees		
Fraction		1/2 +/- 1/2
Decimal		.500 +/- .500
Toe-In in Inches		
Fraction		5/64 +/- 3/64
Decimal		.083 +/- .042
Toe-In in Degrees		
Fraction		11/64 +/- 1/8
Decimal		.166 +/- .125
Toe-Out in Turns		
Inner		NS
Outer		NS
Steering Axis Inclination (SAI)		NS
Rear		
Camber in Degrees		
Fraction		-1 43/64 +/- 21/64

WHEEL ALIGNMENT SPECIFICATIONS & PROCEDURES

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Decimal	-1.666 +/- .333
Caster in Degrees	
Fraction	
Decimal	
Toe-In in Inches	
Fraction	13/64 +/- 1/8
Decimal	.208 +/- .125
Toe-In in Degrees	
Fraction	27/64 +/- 1/4
Decimal	.416 +/- .250
Toe-Out in Turns	
Inner	
Outer	
Steering Axis Inclination (SAI)	
Quantum Syncro	
Front	
Camber in Degrees	
Fraction	43/64 +/- 1
Decimal	.333 +/- 1.0
Caster in Degrees	
Fraction	1/2 +/- 11/64
Decimal	.500 +/- .166
Toe-In in Inches	
Fraction	5/64 +/- 3/64
Decimal	.083 +/- .042
Toe-In in Degrees	
Fraction	11/64 +/- 5/64
Decimal	.166 +/- .083
Toe-Out in Turns	
Inner	NS
Outer	NS
Steering Axis Inclination (SAI)	NS
Rear	
Camber in Degrees	
Fraction	-37/64 +/- -1/2
Decimal	-.583 +/- -.500
Caster in Degrees	
Fraction	
Decimal	
Toe-In in Inches	
Fraction	11/64 +/- 5/64
Decimal	.166 +/- .083
Toe-In in Degrees	
Fraction	21/64 +/- 11/64
Decimal	.333 +/- .166
Toe-Out in Turns	
Inner	
Outer	
Steering Axis Inclination (SAI)	
Vanagon	
Front (See Fig. 2 & 3)	
Camber in Degrees	

WHEEL ALIGNMENT SPECIFICATIONS & PROCEDURES

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Fraction		0 +/- 1/2
Decimal		0 +/- .500
Caster in Degrees		
Fraction		7 1/4 +/- 1/4
Decimal		7.250 +/- .250
Toe-In in Inches		
Fraction		11/64 +/- 1/4
Decimal		.166 +/- .250
Toe-In in Degrees		
Fraction		21/64 +/- 1/2
Decimal		.333 +/- .500
Toe-Out in Turns		
Inner		NS
Outer		NS
Steering Axis Inclination (SAI)		NS
Rear (See Fig. 4)		
Camber in Degrees		
Fraction		-53/64 +/- 1/2
Decimal		-.833 +/- .500
Caster in Degrees		
Fraction		
Decimal		
Toe-In in Inches		
Fraction		0 +/- 3/32
Decimal		0 +/- .083
Toe-In in Degrees		
Fraction		0 +/- 3/16
Decimal		0 +/- .166
Toe-Out in Turns		
Inner		
Outer		
Steering Axis Inclination (SAI)		
Vanagon Syncro		
Front		
Camber in Degrees		
Fraction		21/64 +/- 21/64
Decimal		.333 +/- .333
Caster in Degrees		
Fraction		4 43/64 +/- 1/4
Decimal		4.666 +/- .250
Toe-In in Inches		
Fraction		0 +/- 11/64
Decimal		0 +/- .166
Toe-In in Degrees		
Fraction		0 +/- 5/16
Decimal		0 +/- .313
Toe-Out in Turns		
Inner		NS
Outer		NS
Steering Axis Inclination (SAI)		NS
Rear		
Camber in Degrees		

WHEEL ALIGNMENT SPECIFICATIONS & PROCEDURES

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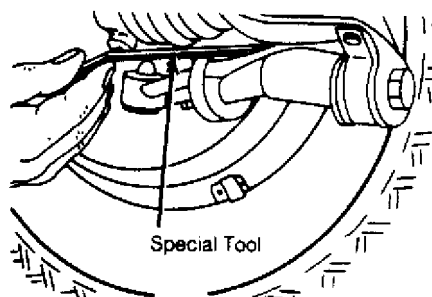
Fraction		-1/4 +/- 11/64
Decimal		-.250 +/- .166
Caster in Degrees		
Fraction		
Decimal		
Toe-In in Inches		
Fraction		5/64 +/- 11/64
Decimal		.083 +/- .166
Toe-In in Degrees		
Fraction		5/32 +/- 5/16
Decimal		.166 +/- .313
Toe-Out in Turns		
Inner		
Outer		
Steering Axis Inclination (SAI)		

(1) - Caster and rear camber are not adjustable.

NS - Information not supplied by manufacturer.

AA

ALIGNMENT PROCEDURES

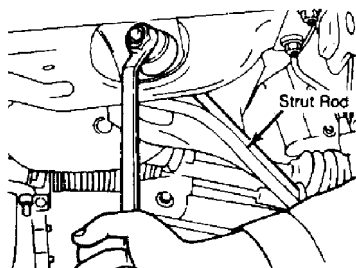


CAMBER ADJUSTMENT
WITH SPECIAL TOOL

To adjust, pry lower ball joint out to increase
camber.

Fig. 1: Camber adjustment with special tool.

To adjust, pry lower ball joint out to increase camber.



CASTER ADJUSTMENT

To adjust caster, lengthen or shorten strut rod
as shown.

Fig. 2: Caster adjustment.

To adjust caster, lengthen or shorten strut rod as shown.

WHEEL ALIGNMENT SPECIFICATIONS & PROCEDURES

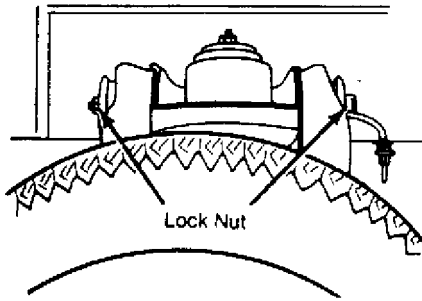
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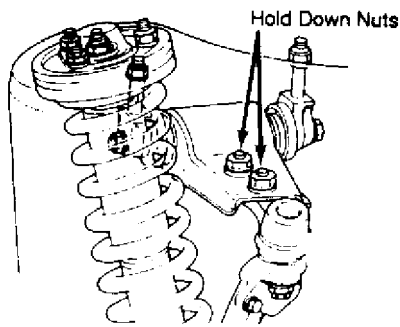


CAMBER ADJUSTMENT

Loosen lock nut on control arm and rotate to obtain correct camber setting.

Fig. 3: Camber adjustment.

Loosen lock nut on control arm and rotate to obtain correct camber setting.



CAMBER ADJUSTMENT

Loosen hold down nuts on the control arm and position in or out to set camber.

Fig. 4: Camber adjustment.

Loosen hold down nuts on the control arm and position in or out to set camber.

END OF ARTICLE

WHEEL ALIGNMENT THEORY/OPERATION

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ARTICLE BEGINNING

GENERAL INFORMATION

Wheel Alignment Theory & Operation

ALL MODELS

* PLEASE READ THIS FIRST *

NOTE: This article is intended for general information purposes only. This information may not apply to all makes and models.

PRE-ALIGNMENT INSTRUCTIONS

GENERAL ALIGNMENT CHECKS

Before adjusting wheel alignment, check the following:

- * Each axle uses tires of same construction and tread style, equal in tread wear and overall diameter. Verify that radial and axial runout is not excessive. Inflation should be at manufacturer's specifications.
- * Steering linkage and suspension must not have excessive play. Check for wear in tie rod ends and ball joints. Springs must not be sagging. Control arm and strut rod bushings must not have excessive play. See Fig. 1.

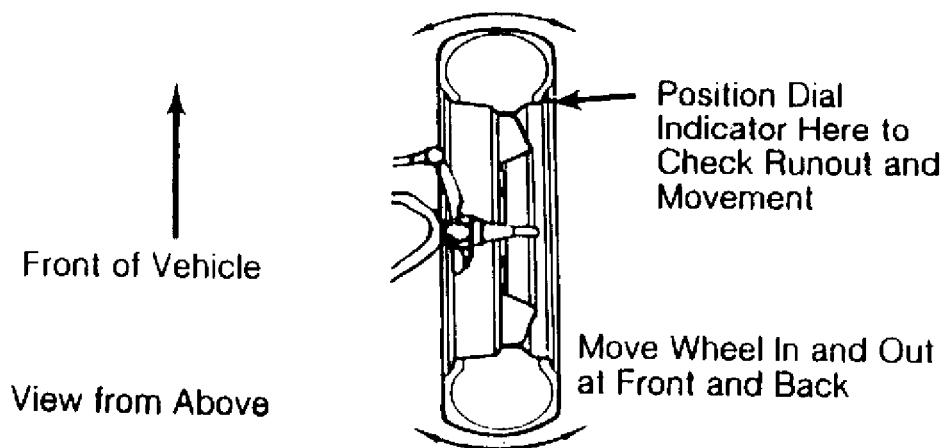


Fig. 1: Checking Steering Linkage

- * Vehicle must be on level floor with full fuel tank, no passenger load, spare tire in place and no load in trunk. Bounce front and rear end of vehicle several times. Confirm vehicle is at normal riding height.

WHEEL ALIGNMENT THEORY/OPERATION

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- * Steering wheel must be centered with wheels in straight ahead position. If required, shorten one tie rod adjusting sleeve and lengthen opposite sleeve (equal amount of turns). See Fig. 2.
- * Wheel bearings should have the correct preload and lug nuts must be tightened to manufacturer's specifications. Adjust camber, caster and toe-in using this sequence. Follow instructions of the alignment equipment manufacturer.

CAUTION: Do not attempt to correct alignment by straightening parts. Damaged parts must be replaced.

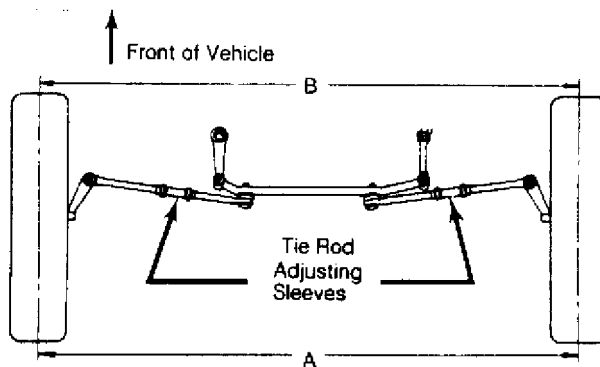


Fig. 2: Adjusting Tie Rod Sleeves (Top View)

CAMBER

1) Camber is the tilting of the wheel, outward at either top or bottom, as viewed from front of vehicle. See Fig. 3.

2) When wheels tilt outward at the top (from centerline of vehicle), camber is positive. When wheels tilt inward at top, camber is negative. Amount of tilt is measured in degrees from vertical.

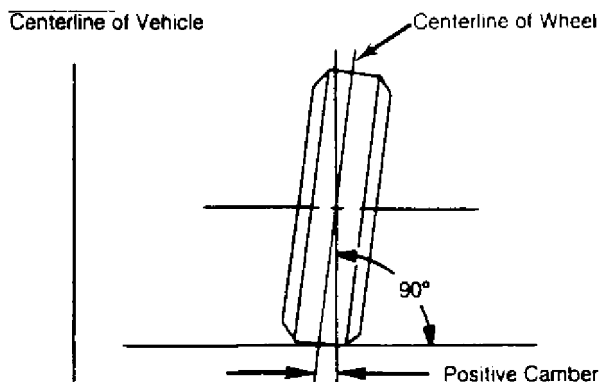


Fig. 3: Determining Camber Angle

CASTER

1) Caster is tilting of front steering axis either forward or backward from vertical, as viewed from side of vehicle. See Fig. 4.

2) When axis is tilted backward from vertical, caster is

WHEEL ALIGNMENT THEORY/OPERATION

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positive. This creates a trailing action on front wheels. When axis is tilted forward, caster is negative, causing a leading action on front wheels.

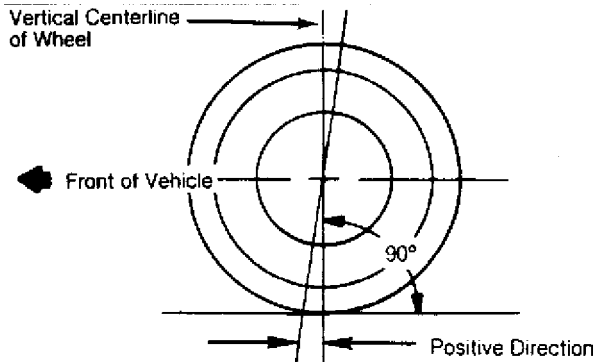


Fig. 4: Determining Caster Angle

TOE-IN ADJUSTMENT

Toe-in is the width measured at the rear of the tires subtracted by the width measured at the front of the tires at about spindle height. A positive figure would indicate toe-in and a negative figure would indicate toe-out. If the distance between the front and rear of the tires is the same, toe measurement would be zero. To adjust:

- 1) Measure toe-in with front wheels in straight ahead position and steering wheel centered. To adjust toe-in, loosen clamps and turn adjusting sleeve or adjustable end on right and left tie rods. See Figs. 2 and 5.
- 2) Turn equally and in opposite directions to maintain steering wheel in centered position. Face of tie rod end must be parallel with machined surface of steering rod end to prevent binding.
- 3) When tightening clamps, make certain that clamp bolts are positioned so there will be no interference with other parts throughout the entire travel of linkage.

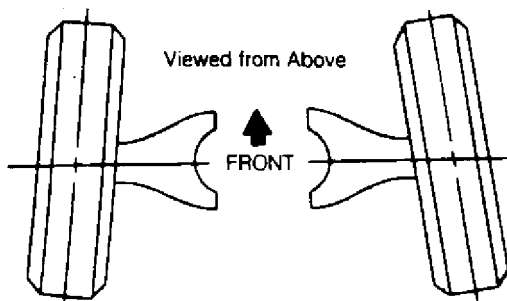


Fig. 5: Wheel Toe-In (Dimension A Less Dimension B)

TOE-OUT ON TURNS

- 1) Toe-out on turns (turning radius) is a check for bent or damaged parts, and not a service adjustment. With caster, camber, and

WHEEL ALIGNMENT THEORY/OPERATION

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toe-in properly adjusted, check toe-out with weight of vehicle on wheels.

2) Use a full floating turntable under each wheel, repeating test with each wheel positioned for right and left turns. Incorrect toe-out generally indicates a bent steering arm. Replace arm, if necessary, and recheck wheel alignment.

STEERING AXIS INCLINATION

1) Steering axis inclination is a check for bent or damaged parts, and not a service adjustment. Vehicle must be level and camber should be properly adjusted. See Fig. 6.

2) If camber cannot be brought within limits and steering axis inclination is correct, steering knuckle is bent. If camber and steering axis inclination are both incorrect by approximately the same amount, the upper and lower control arms are bent.

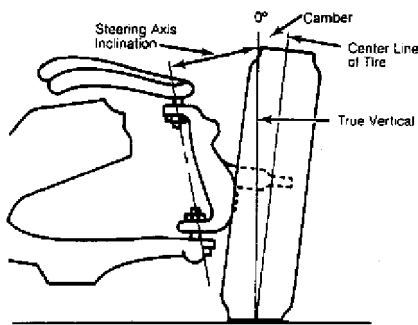


Fig. 6: Checking Steering Axis Inclination

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WIPER/WASHER SYSTEM

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ARTICLE BEGINNING

Wiper/Washer Systems
VOLKSWAGEN

Cabriolet, Fox, Golf, GTI, Jetta,
Quantum, Scirocco, Vanagon

DESCRIPTION

All models are equipped with 2-speed wipers. A standard or optional intermittent feature is also available. The wiper control is the right-hand lever on the steering column. Some models are equipped with a rear wiper/washer system.

REMOVAL & INSTALLATION

FRONT WIPER MOTOR

Removal (Cabriolet, Jetta & Quantum)

1) Open hood and disconnect wiring connector. Pry linkage off motor crank arm. Remove 4 bolts and motor. DO NOT remove motor bracket when removing motor.

2) On Quantum models, remove wiper motor frame before removing or installing motor.

Installation

Check crank arm alignment by running motor and allowing it to park. Crank arm should be at 20 degree angle to motor centerline. See Fig. 1. To complete installation, reverse removal procedure, installing left linkage rod first.

Removal (Golf, GTI & Scirocco)

Remove connecting linkage from motor crank arm. Disconnect wiring connector. Mark position of wiper motor crank arm. Remove wiper motor crank arm and 3 mounting bolts. Slide motor out from beneath bracket and remove motor.

Installation

Check crank arm alignment by running motor and allowing it to park. Crank arm should be in line with the motor centerline, and linkage ball should point away from motor. See Fig. 1. Reverse removal procedure to complete installation.

Removal (Vanagon)

Remove wipers, arms and shaft nuts. Remove glove box and instrument cluster. Remove wiper linkage rods by extending fully to passenger side. Disconnect wiring connector. Remove wiper bracket bolts and bracket. Remove crank arm, 3 bolts and wiper motor.

Installation

WIPER/WASHER SYSTEM

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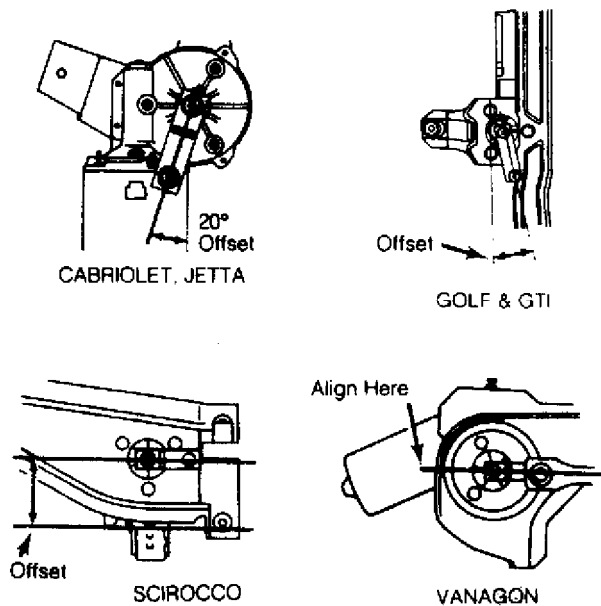
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Connect motor wiring, run motor and allow it to park. Align crank arm and linkage rod as shown. See Fig. 1. Reverse removal procedure to install.

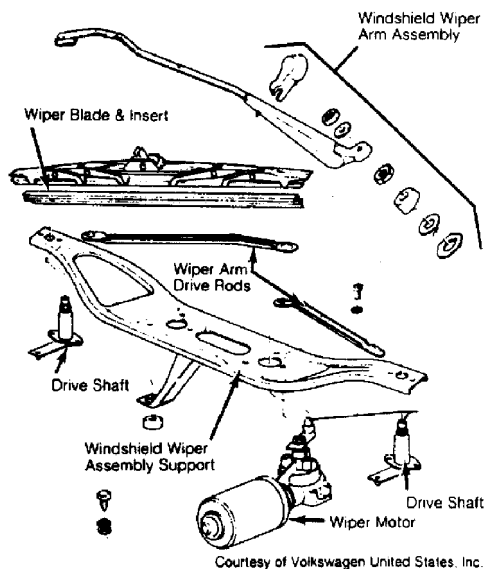
Removal & Installation (Fox)

For removal and installation of Fox wiper motor and components, refer to illustration. See Fig. 2.



Courtesy of Volkswagen United States, Inc.

Fig. 1: Aligning Front Wiper Motor Crank Arm
Courtesy of Volkswagen United States, Inc.



Courtesy of Volkswagen United States, Inc.

Fig. 2: Exploded View of Fox Front Wiper Components
Courtesy of Volkswagen United States, Inc.

WIPER/WASHER SYSTEM

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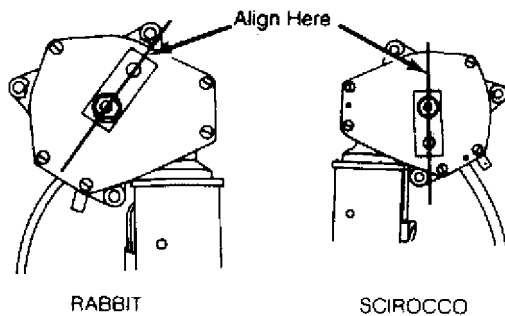
REAR WIPER MOTOR

Removal

Remove inner trim panel on rear hatch. Disconnect wiring connector and pry linkage off motor crank arm. Remove motor crank arm, motor bolts and motor.

Installation

Check crank arm alignment by running motor and allowing it to park. Install crank arm in correct position. See Fig. 3. Reverse removal procedure to complete installation.



Courtesy of Volkswagen United States, Inc.

Fig. 3: Aligning Rear Motor Crank Arm During Installation
Courtesy of Volkswagen United States, Inc.

END OF ARTICLE

WIRING DIAGRAM SYMBOLS

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ARTICLE BEGINNING

WIRING DIAGRAMS

How To Use The Wiring Diagrams

INTRODUCTION

The wiring diagrams and technical service bulletins, containing wiring diagram changes, are obtained from the domestic and import manufacturers. These are checked for accuracy and are all redrawn into a consistent format for easy use.

All diagrams are arranged with the front of the vehicle at the left side of the first page and the rear of the vehicle at the right side of the last page. Accessories are shown near the end of the diagram.

Components are shown in their approximate location on the vehicle. Due to the constantly increasing number of components on vehicles today, it is impossible to show exact locations.

In the past, when cars were simpler, diagrams were simpler. All components were connected by wires, and diagrams seldom exceeded 4 pages in length. Today some wiring diagrams require more than 16 pages. It would be impractical to expect a service technician to trace a wire from page 1 across every page to page 16.

Removing some of the wiring maze reduces eyestrain and time wasted searching across several pages. Today, the majority of diagrams now follow a much improved format, which permits space for internal switch details and connector shapes.

Any wires that don't connect directly to their components are identified on the diagram to indicate where they go. There is a legend on the first page of each diagram, detailing component location. It refers you to sub-systems, using grid NUMBERS at the top and bottom of the page and grid LETTERS on each side. This grid system works in a manner similar to that of a road map.

HOW TO USE THE WIRING DIAGRAMS

1) On the first page of the diagram, you will find a listing of major electrical components or systems. Locate the specific component or system you wish to trace. A grid number and letter will follow the component's name.

2) Use the grid NUMBERS (arranged horizontally across the top and bottom of each page) to find the page of the wiring diagram that contains the component you're seeking. When you reach this page, use the grid LETTERS on the side of the page to determine the component's vertical location.

3) Locate the circuit you need to service. The internals are shown for switches and relays to assist you in understanding how the circuit operates.

NOTE: In some of the newer wiring diagram articles in this product, there is a Legend for the wiring diagrams that has

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① TEMP SENS (GND)

② BATTERY (+)

③ FUEL GAUGE (INST CLSTR)

Black BLK BK

WIRING DIAGRAM SYMBOLS

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Blue		BLU		BU
Brown		BRN		BN
Clear		CLR		CR
Dark Blue		DK BLU		DK BU
Dark Green		DK GRN		DK GN
Green		GRN		GN
Gray		GRY		GY
Light Blue		LT BLU		LT BU
Light Green		LT GRN		LT GN
Orange		ORG		OG
Pink		PNK		PK
Purple		PPL		PL
Red		RED		RD
Tan		TAN		TN
Voilet		VIO		VI
White		WHT		WT
Yellow		YEL		YL
AA				

WIRING DIAGRAM SYMBOL IDENTIFICATION

NOTE: Standard wiring symbols are used on diagrams. The list below will help clarify any symbols that are not easily understood at a glance. Most components are labeled "Motor", "Switch" or "Relay" in addition to being drawn with the standard symbol.

WIRING DIAGRAM SYMBOLS

Views of the symbols used in the WIRING DIAGRAM articles are in the following graphics. See Figs. 3 through 25.



Fig. 3: Circuit Breaker

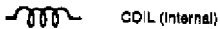


Fig. 4: Coil (Internal)



Fig. 5: Connector

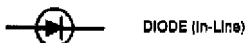


Fig. 6: Diode (In-Line)



Fig. 7: Diode (Internal)



Fig. 8: Diode (Light Emitting)

WIRING DIAGRAM SYMBOLS

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DEFOGGER GRID

Fig. 9: Defogger Grid



FUSE

Fig. 10: Fuse



FUSIBLE LINK

Fig. 11: Fusible Link



GROUND

Fig. 12: Ground



GLOW PLUG, RESISTOR (In-Line)
MIRROR HEATER

Fig. 13: Glow Plug Resistor (In-Line) or Mirror Heater



INJECTOR, PHOTOCCELL

Fig. 14: Injector (Diesel) or Photocell (Gasoline)



INTERNAL FUSE,
THERMAL LIMITER

Fig. 15: Internal Fuse, Thermal Limiter



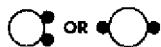
LAMP (Dual Element)

Fig. 16: Lamp (Dual Element)



LAMP (Single Element)

Fig. 17: Lamp (Single Element)



MOTOR

Fig. 18: Motor



RESISTOR (Internal)

Fig. 19: Resistor (Internal)



SENSOR, THERMISTOR

Fig. 20: Sensor, Thermistor



SOLENOID

Fig. 21: Solenoid



SOLID STATE DEVICE,
TRANSISTOR

Fig. 22: Solid State Device, Transistor



SWITCH (Internal)

Fig. 23: Switch (Internal)

WIRING DIAGRAM SYMBOLS

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TWO PIN SWITCH

Fig. 24: Two Pin Switch



VARIABLE RESISTOR
OR POTENTIOMETER

Fig. 25: Variable Resistor or Potentiometer

END OF ARTICLE

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ARTICLE BEGINNING

1987 Wiring Diagrams
Volkswagen

Quantum

COMPONENT LOCATION MENU

COMPONENT LOCATIONS TABLE

AA

Component	Figure No. (Location)
A/C RELAY	2 (C-D 4-5)
A/C SYSTEM	2 (D-E 4-6)
A/C TIME DELAY RELAY	2 (E 5-6)
AFTER RUN THERMO SW	3 (E 9)
ALTERNATOR	1 (B 3)
BACK-UP LT SW	2 (A 6)
BATTERY	1 (A 2)
CAT ELAPSED MILE COUNTER	5 (B 17)
CENTRAL LOCK SW	6 (D 22)
CIG LIGHTER	3 (B 10)
COLNT FAN AFTER RUN RLY	3 (E 8)
COLNT LOW LEVEL CTRL UNIT	4 (C 12)
DIR SW	4 (A 15)
DISTRIBUTOR	1 (C 2)
DOOR SWS	3 (A 8-9)
EMERGENCY FLASHER SW	4 (A 14-15)
FRESH AIR FAN SW (W/ A/C)	2 (E 7)
FRESH AIR FAN SW (W/O A/C)	2 (D 7)
FUEL GAUGE SENDER	6 (B 23)
FUEL PUMP	6 (C 23)
FUEL PUMP RELAY	2 (C 5)
FUSE/RELAY PANEL	2, 3, 4 (B-D 4-15)
GEAR SELECT SW	2 (A 6)
HORN RELAY	3 (C 8)
IGN CONTROL UNIT	1 (B 1)
IGNITION COIL	1 (B 2)
IGNITION SW	2 (A 4)
INSTRUMENT CLUSTER	5 (A-D 19)
INTERIOR LIGHTS	3 (A 9-10)
INTERIOR LT CTRL UNIT	3 (C 9)
LIGHT SW	4 (A 12-13)
LOAD REDUCTION RELAY	2 (C 7)
LOW COOLANT SW	4 (D 12)
OXS CONTROL UNIT	1 (D-E 3)
POWER ANTENNA	6 (E 21)
POWER MIRRORS	6 (C-D 20-21)
POWER SUNROOF	6 (D-E 20-21)
POWER WINDOWS	6 (A-B 20-23)
REAR WASHER MOTOR	6 (D 23)

WIRING DIAGRAMS

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REAR WIPER MOTOR	6 (D 23)
REAR WIPER/WASHER RELAY	3 (D 9)
SEAT BELT WARNING RELAY	3 (C 8)
STARTER	1 (A 3)
STOP LIGHT SW	3 (A 11)
UPSHIFT RELAY	2 (C 7)
UPSHIFT SWS	2 (A 7)
WIPER MOTOR	3 (D 11)
WIPER/WASHER INTERM RELAY	3 (C-D 10-11)
WIPER/WASHER SW	3 (E 10-11)
AA	

WIRING DIAGRAM

WIRING DIAGRAMS

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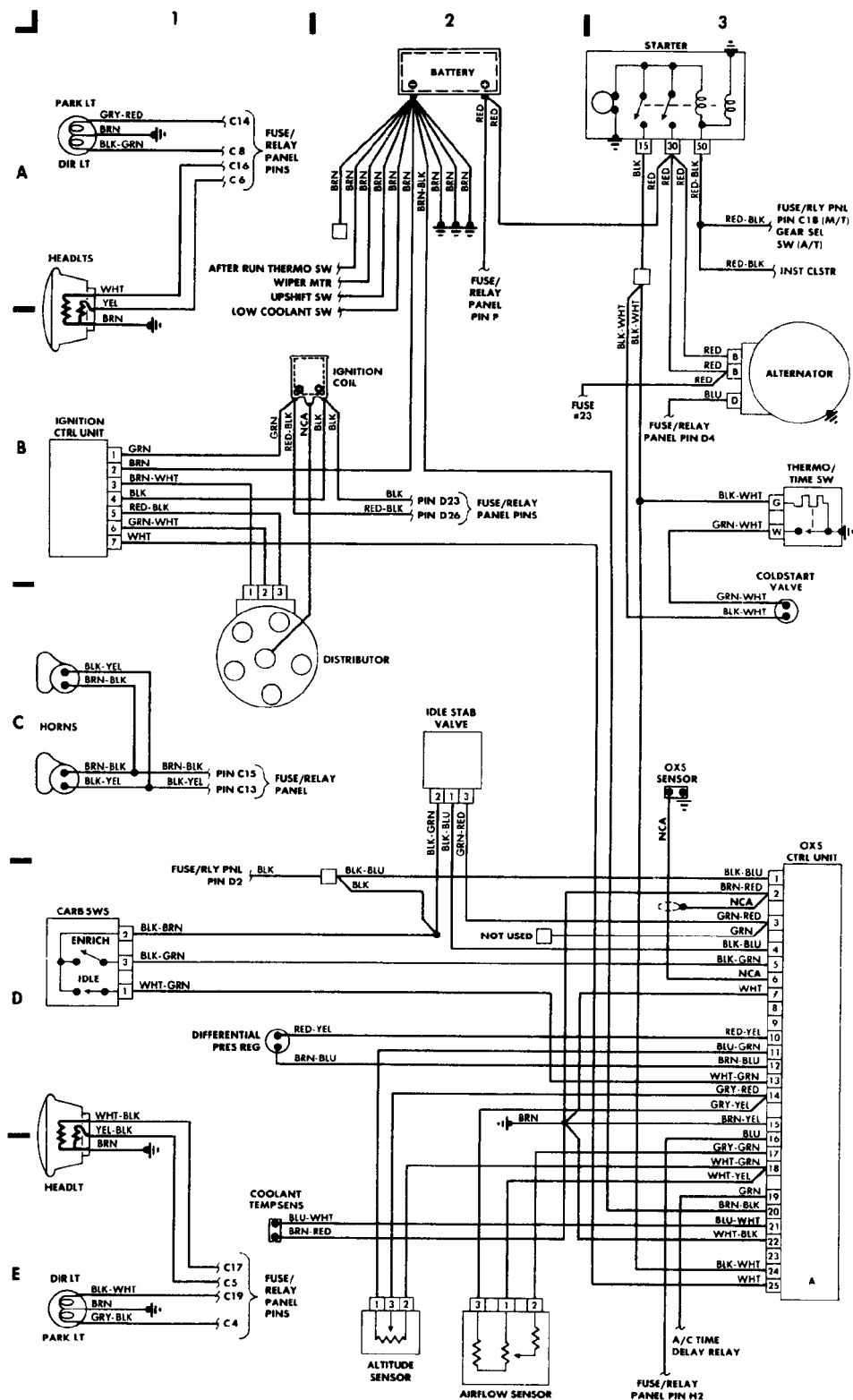


Fig. 1: Engine Compartment (Grids 1-3)

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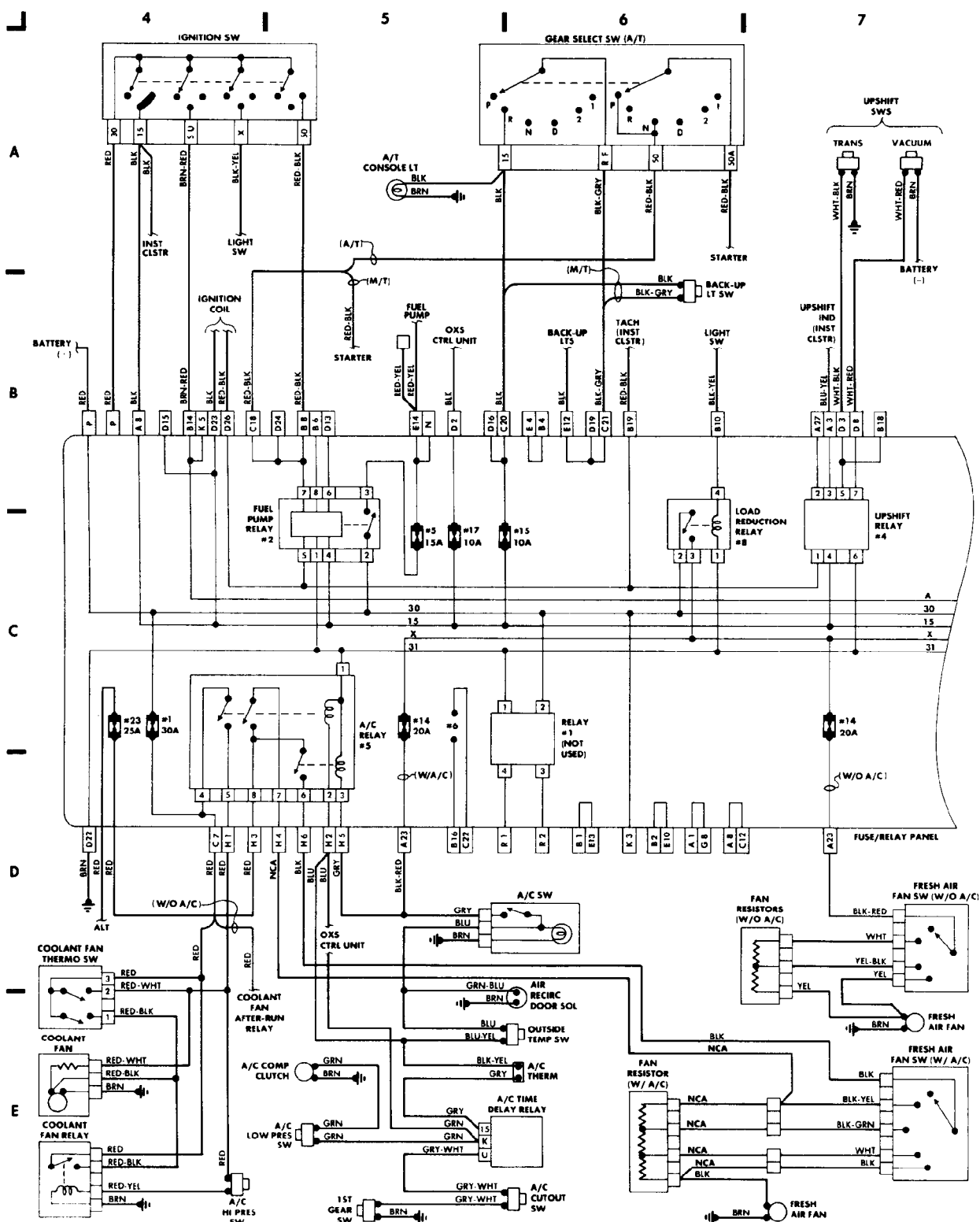
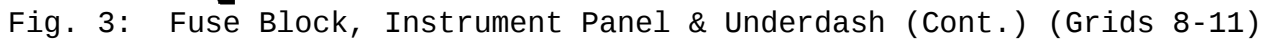


Fig. 2: Fuse Block, Instrument Panel & Underdash (Grids 4-7)

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WIRING DIAGRAMS

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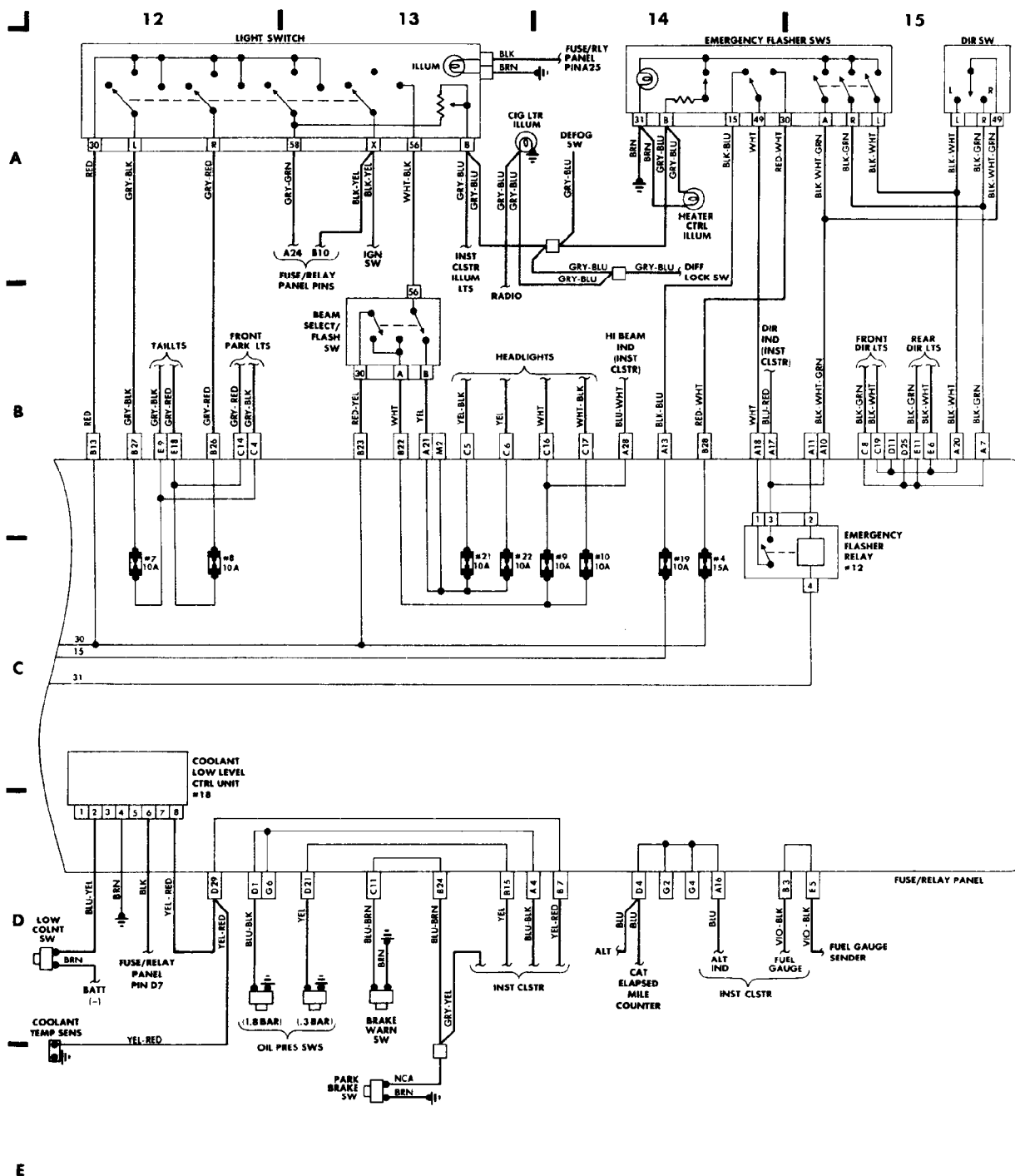


Fig. 4: Fuse Block, Instrument Panel & Underdash (Cont.) (Grids 12-15)

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WIRING DIAGRAMS

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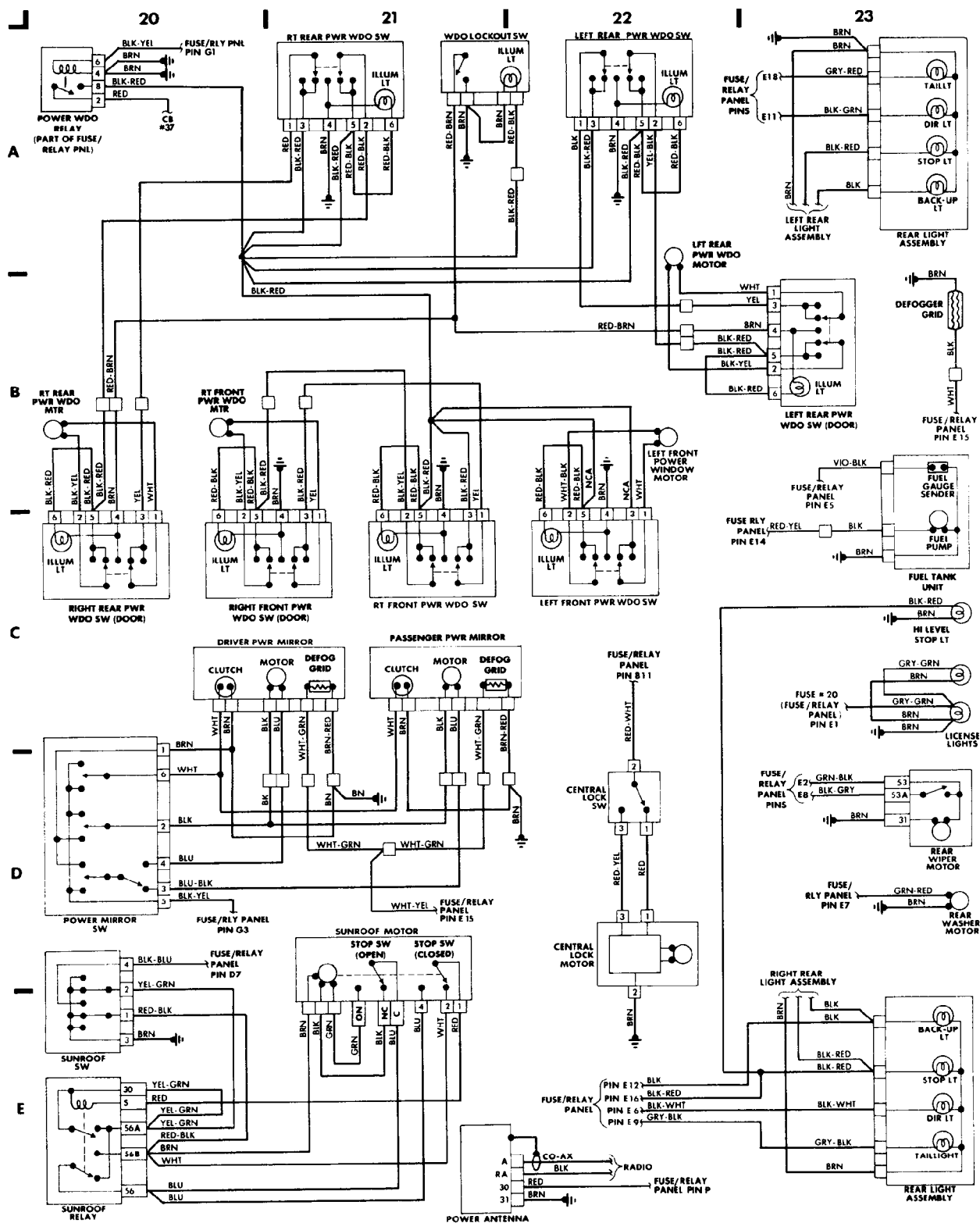


Fig. 6: Rear Compartment & Accessories (Grids 20-23)

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1987 Volkswagen Quantum/Quantum Syncro All Categories All Sections

Title List for Volkswagen Technical Site

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* A/C-HEATER SYSTEM UNIFORM INSPECTION GUIDELINES *

* BRAKE SYSTEM UNIFORM INSPECTION GUIDELINES *

* ELECTRICAL SYSTEM UNIFORM INSPECTION GUIDELINES *

* ENGINE SYSTEMS UNIFORM INSPECTION GUIDELINES *

* EXHAUST SYSTEM UNIFORM INSPECTION GUIDELINES *

* STEERING UNIFORM INSPECTION GUIDELINES *

* SUSPENSION UNIFORM INSPECTION GUIDELINES *

* SYMPTOM CHECK LIST *

2.22L 5-CYL

A - ENGINE/VIN ID

A/C SYSTEM GENERAL DIAGNOSTIC PROCEDURES

A/C SYSTEM PRECAUTIONS

A/C-HEATER SYSTEM - MANUAL

ABBREVIATIONS

ABBREVIATIONS

ALTERNATOR & REGULATOR - BOSCH

ALTERNATOR & REGULATOR - SEV MOTOROLA

ANTI-LOCK BRAKE SAFETY PRECAUTIONS

AXLE SHAFTS - FRONT

AXLE SHAFTS TROUBLE SHOOTING

BOSCH CIS-E SYSTEM

BRAKE SYSTEM

CLUTCH

COMPUTER RELEARN PROCEDURES

COOLING SYSTEM SPECIFICATIONS

DEFOGGER - REAR WINDOW

DRIVE AXLE - GEAR TOOTH CONTACT PATTERNS

DRIVE AXLE - REAR

ELECTRICAL COMPONENT LOCATOR

ELECTROSTATIC DISCHARGE WARNING - BASIC INFORMATION

EMISSION APPLICATION

EMISSION CONTROL VISUAL INSPECTION PROCEDURES

ENGINE COOLING FAN

ENGINE OVERHAUL PROCEDURES - GENERAL INFORMATION

FUEL EVAPORATION SYSTEM

FUEL INJECTION SYSTEM - BOSCH CIS

FUEL PUMP - ELECTRIC

FUSES & CIRCUIT BREAKERS

GEAR TOOTH CONTACT PATTERNS

GENERAL COOLING SYSTEM SERVICING

HOW TO USE SYSTEM WIRING DIAGRAMS

IGNITION SYSTEM - BOSCH HALL EFFECT

INSTRUMENT PANEL - STANDARD

JACKING & HOISTING

LOOSE CRUISE CONTROL CABLE MAY NOT RETURN TO IDLE

MAINTENANCE INFORMATION
MAINTENANCE REMINDER LIGHT RESET PROCEDURES
METRIC CONVERSIONS
METRIC CONVERSIONS
PCV SYSTEM
POSSIBLE STALLING DUE TO RESTRICTED FUEL FLOW
PRE-ALIGNMENT CHECKS
SCHEDULED SERVICES - GASOLINE
SERVICE INDICATOR & WARNING LIGHTS
STARTER - BOSCH
STEERING COLUMN
STEERING COLUMN SWITCHES
STEERING GEAR - MANUAL
STEERING SYSTEM - POWER
SUSPENSION - FRONT
SUSPENSION - REAR (4WD)
SUSPENSION - REAR (FWD)
SYSTEM WIRING DIAGRAMS
TRANSMISSION REMOVAL & INSTALLATION - M/T
TRANSMISSION SERVICING - A/T
TRANSMISSION SERVICING - M/T
TROUBLE SHOOTING - BASIC PROCEDURES
TUNE-UP - 5-CYL
VACUUM DIAGRAMS
WAVEFORMS - INJECTOR PATTERN TUTORIAL
WHEEL ALIGNMENT SPECIFICATIONS & PROCEDURES
WHEEL ALIGNMENT THEORY/OPERATION
WIPER/WASHER SYSTEM
WIRING DIAGRAM SYMBOLS
WIRING DIAGRAMS