Chapter 1 The principle for EFI and Actuator

Ⅰ. Intake air pressure and intake temperature sensor

Usage: Measure baro pressure equal or below 115kPa in manifold and intake air temperature to supply load information for engine.

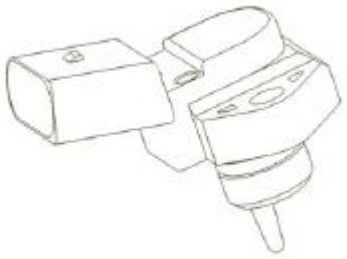
Constitute and **principle**: The sensor consists of two sensors, MAP and IAT, which mounted on rear of the intake manifold pipe.

MAP: Map consists of one silicon chip that etched a film on the chip. There are 4 piezoelectric resistances that consist of a Wiston bridge. The information processing circuit is also on the chip. The chip consists of closed reference space with a metal shell. The air absolute pressure in the space is nearly to zero. In this way, a micro electric-mechanic system is formed. The active face of the chip is endured a pressure nearly to zero, and MAP pressure applies on the back of the chip through a connecting pipe. The thickness of the chip is only several microns（μm）, so the change of MAP pressure will result the mechanical deform for the chip together with 4 resistances to change their resistance. The voltage signal that is linearity with pressure is formed after processing by information processing circuit in the chip.

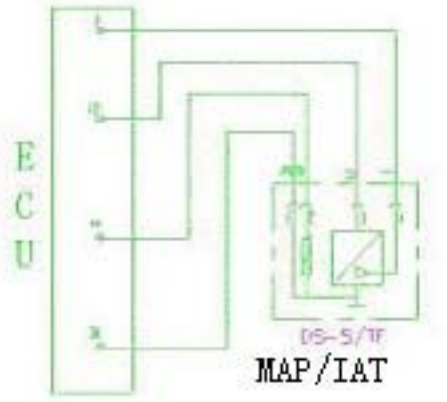
Intake air temperature: IAT is a resistor with negative temperature coefficient (NTC). Like coolant temperature sensor, the resistance decreased with the temperature increasing. ECU in engine monitors the change of intake air temperature (corresponding in series circuit).

Diagnosis: The open, short or wear of sensor could be detected by the rear electronic unit of MAP.

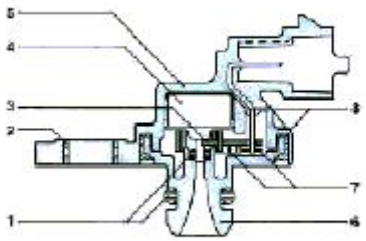
ECU will judge the malfunction of sensor if the out put signal exceeds the signal outside the curve of output feature. For example, if the intake air pressure is higher than the up limit or lower than lower limit, ECU will judge that sensor is malfunction (The intake air pressure is below lower limit in starting, but ECU can judge starting condition), trouble light will on at same time and engine will run at malfunction mode.



MAP/IAT



Section drawing of MAP/IAT
Pins: No. 1 Ground
No. 2 Output signal of temperature
No. 3 To 5V
No. 4 Output pressure signal



Section drawing of MAP/IAT
1. Seal 2. Stainless steel bush
3. PCB plate 4. Sensor element 5. Shell
6. Support 7. Welding connection
8. Felt connection

II. TPS

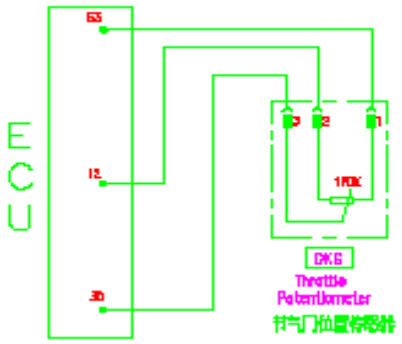
Usage: TPS is used to supply Throttle angle signal. According to this signal, ECU will receive engine load signal and working condition signal (such as starting, idle, back up, partial load, and full load) as well as acceleration and deceleration signal. The sensor is trilinear type, ECU detects turndown ratio of throttle by monitors the change of voltage

Constitute and principle: TPS is an angle sensor with linear output. It consists of 2 arc slip resistances and 2 slip arms. The shaft of arm and throttle shaft connect to one axes. The both ends of slip resistances attach 5V mains voltage Us. When running throttle, arm run together and slides on resistor. Put out Up as output voltage. So it is an angle potentiometer.

Diagnosis: ECU monitors if throttle angle exceeds the up limit or lower limit of output signal. If so, ECU will judge TPS malfunction, engine will run at malfunction mode, MIL will on (Knock sensor or dirty will cause engine malfunction).

Install: Screw torque for bolts: 1.5 Nm-2.5 Nm

Outline of TPS



Circuit Diagram of TPS

Pins: Run throttle counterclockwise (see from one side of sensor on shaft into throttle): 1. Ground 2. 5V source 3. 5V source

III． Coolant temperature sensor TF-W

Usage: CTS is used to supply Coolant temperature information for the timing and fuel inject pulse width control on engine start, idle, normal running.

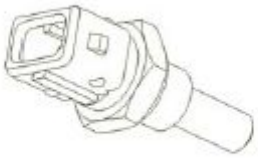
Constitute and principle: CTS is a thermal sense resistor with NTC. The resistance decreases with coolant temperature increases, but it is not in linearity. The resistor is enclosed in copper bush. The change of resistance is transformed into changing voltage to ECU by a voltage distribute circuit to monitor the change of water temperature.

Diagnosis: When coolant temperature is over up limit, or below lower limit, MIL is on, engine run at malfunction mode. ECU control ignition and fuel inject according to set temperature. Fan runs at high speed.

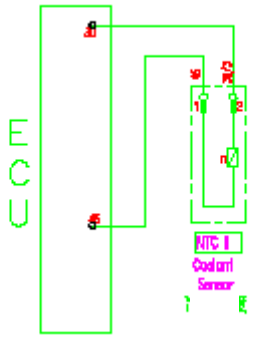
Limit data: 2.5±5%KΩ

Install Hint: Screw torque: 15±2 Nm

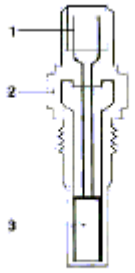
Hint: There are 2 sensors in vehicle. One is single pin water temperature and supply water temperature signal for water temp meter; the other is double pins and supplies the temperature signal to ECU.



Outline of CTS



Circuit diagram of coolant temperature sensor
Pins: There are 2 pins that could be exchangeable.



Section drawing of Coolant temp **sensor**
1. Connector 2. Sleeve 3. NTC resistor

IV、 knock sensor KS

Usage: Supply knock signal to ECU for knock control.

Constitute and principle:

KS is vibration acceleration sensor mounted on cylinder body. The sensitive element is a piezoelectricity element. The vibration of cylinder is transformed to piezoelectric crystal through mass block in sensor. The pressure of crystal produce voltage on two polar faces and change vibration signal into output AC voltage signal. Because the frequency of vibration caused by engine knock is much higher than normal frequency of engine vibration signal, so ECU can distinguish knock and non-knock signals after filtering the signal of KS. When engine load, speed and coolant temperature exceed gate value, and not set KS malfunction information record, the signal of KS will be used to closed loop control for knocking. When the control is actuated, the signal of KS will input to ECU for integral after amplify and filter. When certain integral value in crank angle exceeds gate value, ECU will consider the knock happens, and reduce 1 degree of ignition advanced-angle. If knock happens on next cycle, ECU will reduce 1 degree of ignition advanced-angle

again; If no knocking happen in next cycles, ECU will resume the angle to normal value.
Diagnosis: ECU monitors each sensor, actuator, power amplifying circuit and detecting circuit. KS will mark malfunction position once following situations happen:

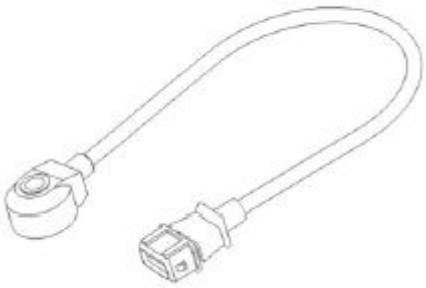
KS malfunction

KS control data processing circuit malfunction

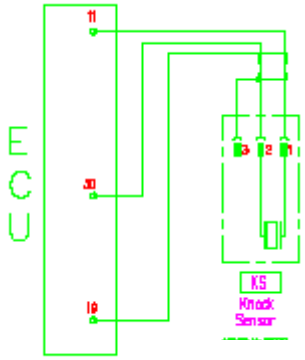
Cylinder identification signal is non-trustable

After KS marks the malfunction position, knock closed loop control will shut off and reduce 1 safety degree for ignition advanced-angle stored in ECU. When wrong frequency is below set value, malfunction position will reset.

Install Hint: Screw torque 20±5 Nm.



KS with cable



Circuit diagram of KS

Pins: pin 1 and pin 2 connect ECU, pin 3 connects shield.

The shield wire of sensor is folded on outside of signal wire and connects to pin 19# on ECU. All shield wires on shielded sensors connect to pin 19 #on ECU.

V. Oxygen sensor

Usage: The sensor is used to supply the information that if oxygen is superfluous after the fuel in cylinder combusted completely in intake air. ECU uses the information to closed loop control for quantitative fuel and transforms or purifies three venomous ingredients such as HC, CO and NOx in catalystic converter

Constitute and principle: The sense element is a ceramic pipe with freakles. The outside of pipe is surrounded by exhaust of engine, and inside is touched with atmosphere. The pipe wall is one kind of solid electrolyte with electric heating pipe in it to heat ceramic body to 300 C° for ceramic body to work. The oxygen ion can pass pipe freely.

The concentration differential is transformed into electric differential with this feature to form electric signal. If mixture is richer, electric differential and output voltage are higher; if mixture is leaner, electric differential and output voltage are lower.

The working voltage of sensor fluctuates between 0.1-0.9V with 5-8 times every 10 seconds. Sensor is aging if the frequency is below this value and needs replacing. The sensor cannot be repaired.

Diagnosis: ECU monitors each sensor, actuator, power amplifying circuit and detecting circuit. ECU will mark the malfunction position for oxygen sensor once one of following situations happen:

Battery voltage is not trustable.

MAP signal is not trustable.

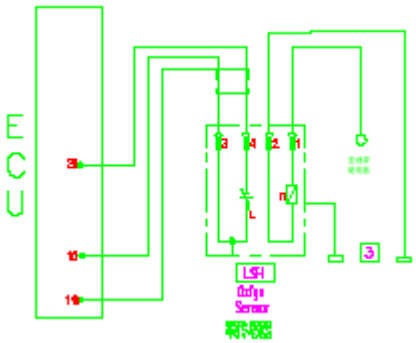
Coolant temperature signal is not trustable.

Injector driver is fault.

After marking malfunction position for oxygen sensor, fuel ration closed loop control will shut off and will be carry on according to basic inject time stored in ECU.

Install hint: The screw torque of sensor is 50-60 Nm. Smear antirust oil on the sensor after replacing.

Oxygen sensor



Circuit diagram of oxygen sensor

Oxygen sensor bear cable. The other end of cable is electric connector. There is asbestos Cover on outside.

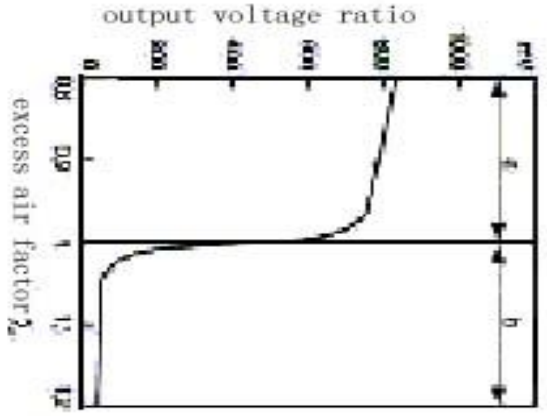
Pins on connector:

No. 1: Connect heat supply (+)/white

No. 2: Connect heat supply (-)/white

No. 3: Connect signal (-)/gray

No. 4: Connect signal (+)/black



Response of oxygen sensor at 600ºC

VI、Electronic control unit **ECU**

Usage: ECU is central part of electronic control system. Sensors supply every signal for ECU. After calculation, ECU will control the action of actuator such as injector and ignition coil to control engine operation.

Constitute: There are shield shell and

etched amplifier in ECU. Many electronic control units are integrated on the etched amplifier to control EFI system.

Install: ECU is fixed under instrument panel by screws. Note to insert pins vertically during installation, otherwise it will cause terminals getting out to influence the normal operation of engine.

Outline and internal structure diagram

pin	connection point	type	pin	connetion point	type
1	ignition coil (pin 2)	output	29	step motor pin A	output
2	power ground	ground	30	sensor ground(IAT, TPS, KS, coolant temperation, A/C evaporator temperation)	ground
3	fuel pump relay pull-in coil(pin 86)	output	31	fan relay pull-in coil	output
4	step motor pin B	output	32	no use	
5	canistor control valve (pin 2)	output	33	no use	
6	no use		34	No.4 injector (pin 2)	output
7	MAP signal(pin 4)	input	35	No.3 injector(pin 2)	output
8	code switch 1	input	36	no use	
9	speed signal	input	37	main relay output(pin 87)	power
10	oxygen sensor(pin 3)	ground	38	no use	
11	KS signal(pin 1)	input	39	A/Cevaporator temperation sensor signal	output
12	5V poweer(hall sensor, MAP TPS)	Poweer	40	Connect A/Ccompressors magnetic cluch relay output(pin 87)	output
13	no use		41	A/C switch	input
14	injector ground	ground	42	no use	
15	no use		43	no use	
16	No.2 injector (pin 2)	input	44	IAT signal (pin 2)	input
17	No.1 injector (pin 2)	output	45	coolant temperature signal(pini)	input
18	8Afuse-battery permanence positive pole	power	46	main relay pull-in coil(pin 86)	output
19	Power ground	ground	47	no use	
20	no use	output	48	hall sensor ground(pin 1)	ground
21	step motor pin D	output	49	hall sensor signal (pin 2)	input
22	A/Ccompressors magnetic clutch pull-in coil (pin 86)	output	50	no use	
23	MIL	output	51	adjust ignition timing	input
24	Anther driver(A/Ccompressors, fuel pump) power ground	ground	52	code switch 2	input
25	no use		53	TPS signal 9pin 3)	input
26	step motor (pin c)	output	54	engine tachometer output	output
27	switch, ignition coil(uni-spark coil pin 5, double-spark coil pin 3)	input	55	fault diagnosis connetor (K wire)	output input
28	oxygen sensor signal(pin 4)	input			

Definition of Pins on ECU

Power: The battery supply voltage to ECU through pin 18. When main relay is on, battery supplies voltage through pin 37 and when ignition switch is on, battery supply voltage through pin 27.
Attention: Pin 8 and pin 52 are used for making richer fuel/air mix during after-sales service. They are mainly used on bad engine starting condition because of aging parts or bad part.
Warning: This function is only use for when vehicle have some severe abnormity, or cause emission deteriorating.

pin	Method 1	Method 2	Method 3	Method 4
8	Not used	Ground	Not used	Ground
52	Not used	Not used	Ground	Ground
Upgraded degree	Normal	Thick	Thicker	Thickest

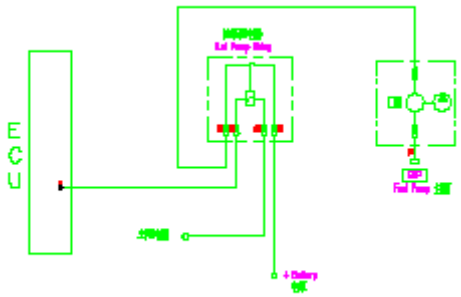
Control strategy for pin 8 and pin 52

VII. Fuel pump

Usage: Fuel pump feeds fuel with certain pressure and flow quantity to engine.
Constitute and principle: The pump consists of DC motor, vane pump and cover (together with cone way valve, decompression valve and anti-electromagnetic interference elements). The pump and motor are mounted on same shaft and sealed in same shell. Pump and motor in shell are surrounded by fuel for abstraction of heat and lubrication.
Battery current supplies to pump through pump relay. The relay only switches on pump circuit during engine starting and running. When engine stops for malfunction, pump will stop automatically. The maximum pressure on outlet of pump is decided by decompression valve that is between 450 kPa and 650 kPa. But the pressure in whole fuel system fluctuates with the fluctuating of intake manifold pressure. Fuel regulator decides the differential (usually is 300 kPa) between system pressure and manifold pressure.
Note: The temperature of fuel has great influence on pump performance. When working under high temperature for a long time, the pump pressure will drop rapidly if fuel temperature is over certain value. If engine cannot be heat started, please check carefully

whether the high temperature working performance is good.

Diagram of Fuel pump



Circuit diagram of fuel pump

Pins: There are 2 pins on pump to connect pump relay. Marks "+"and"-"are cut on the shell of pump.

VIII. Injector

Usage: Injector injects atomized fuel to engine in specified time according to instruction of ECU.

Constitute and principle: ECU sends pulses to injector coil to form magnetic field force. When the force increased enough to overcome the resultant force of spring pressure, weight of needle valve and friction, needle valve begins to lift and inject process starts. The maximum lift height of needle valve does not exceed 0.1 mm. When inject pulses stop, needle valve closes again by the pressure of return spring.

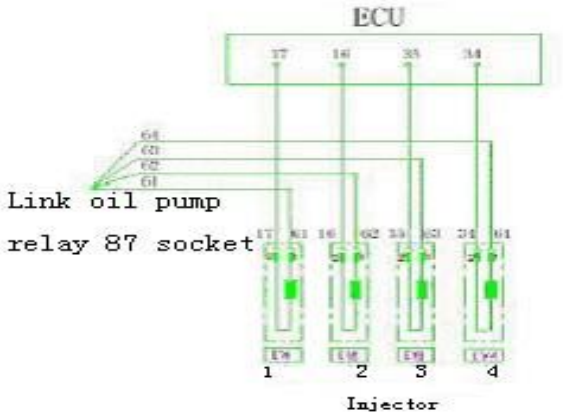
Install hint: The injector must use suitable connector.

In order to mounting easily, recommend to smear non-silicon clear oil on the surface of O-ring connected with fuel distribution pipe. Pay attention to not pollute internal injector and injector hole by oil.

Install injector vertically to injector seat, then clamp injector on the seat by clip.

Note: For long stopped vehicle, please check carefully if the fuel cohered blocks injector.
Diagnosis: S11 EFI system does not diagnose the injector itself, but diagnoses for injector driver. When injector driver is short to battery voltage or overload, short to ground or open, ECU will mark malfunction position. Oxygen sensor closed-loop control and self-study pre-control will shut off. The last self-study data is effective. After troubleshooting, malfunction position reset.

Diagram of Injector



Circuit diagram of injector

Pins: There are 2 pins on each injector. One of pins marked (+) on side of shell connects pin 87 on pump relay, and another connects pin 17,16, 35, 34 on ECU.

IX. Step motor DLA

Function: Step motor with idle actuator offers by-pass intake air channel. When throttle

closes, air will enter engine through the channel. ECU can regulate the sectional area of channel to adjust mass airflow and adjust inject fuel amount. When engine works, ECU will control step motor according to different working conditions to change the operation of engine. ECU increases or reduces the sectional area of by-pass channel to increase or reduce engine speed to realize engine close-loop control at idle.

Constitute and principle: Step motor is a micro-motor that consists of several steel stators and one rotor. A coil is reeled on each stator. Rotor is a permanent magnet with a nut on the center. All stator coils is always connected with electricity. If changing current direction in one coil, rotor will turn a degree. When current direction in each stator coil is changed in suitable order, rotating fileld is formed to run rotor in certain direction.

Diagnosis: ECU can monitor the short or open of two coils for step motor and lights MIL. Engine runs at malfunction mode.

Diagram of Step motor

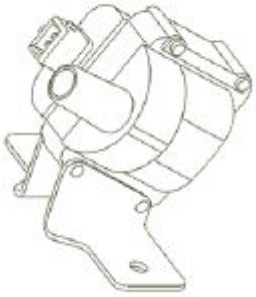
Circuit diagram of step motor

Pins:
Pin A: Connect pin 29 on ECU.
Pin B: Connect pin 4 on ECU.
Pin C: Connect pin 26 on ECU.
Pin D: Connect pin 21 on ECU.

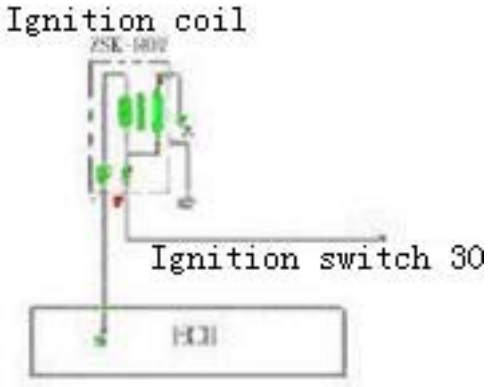
X. Ignition coil ZSK-ROV

Function: Ignition coil transforms low voltage on primary coil into high voltage on

secondary coil and produces sparks through spark plug to light fuel-air mixture in cylinder.
Constitute and principle: Ignition coil consists of primary coil, secondary coil, iron core and shell. When battery voltage supplies on primary coil, the coil is charged. Once ECU cuts off the return loop of primary coil, charging stops. The high voltage is induced in secondary coil at same time.
Diagnosis: ECU does not have diagnosis function for ignition coil. So if ignition coil is fault, DTC does not exist. It can judge if the coil works normally only by checking resistance of ignition coil. Usually, ignition coil produces more heat during the working, but over heat of coil will result in increasing for coil resistance. It will cause unstable running and automatically stopping work for engine.
Primary coil: 0.47 ohms.
Secondary coil: 8 ohms.



Ignition coil(with distributor)



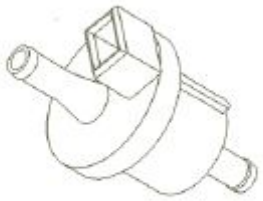
Circuit diagram of ignition coil(with distributor)
Pins: There are 2 pins on low voltage side of coil. Pin marked (+) connects battery and the other connects ECU.

XI. Canister control valve

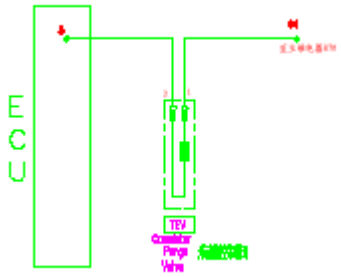
Usage: The valve is used to control flow to clean canister. The valve is controlled by ECU according to engine load, lasting time and frequency of pulses. The fuel vapor in canister will accumulate to leak fuel for polluting environment. The function of canister solenoid valve is to open the solenoid valve to pass superfluous vapor into intake air pipe to be in combustion.

Constitute and principle: The Canister control valve consists of magnetic coil、armature and valve、etc . There is filter on inlet. Air flow quantity through the valve is related with the frequency of electric pulses that put out to control valve by ECU and with the pressure differential between inlet and outlet. If no pulses, canister control valve will close. ECU controls the electrify time for canister solenoid valve to indirectly control the Air flow of clearing air.

Diagnosis: ECU does not have diagnosis function for canister control valve, but can diagnoses canister control valve driver. When canister control valve driver is short to battery voltage or over load, short to ground and open, the basic self-study of fuel metering closed-loop control is shut off. If canister solenoid valve is fault, engine will be unstable idle or over high idle.



Canister control valve



Circuit diagram of canister control valve TEV-2

Pins: There 2 pins on canister control valve. One connects pin 87 on main relay and the other connects pin 5 on ECU

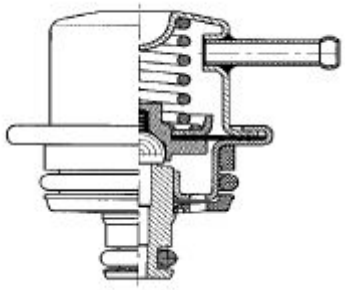
XII．Fuel pressure regulator

Usage: This regulator is not electric component, but it is used to regulate the fuel pressure in fuel distribution pipe for gasoline engine electronic control system to keep constant value with the differential of manifold. It controls fuel rate and makes easy for ECU to control fuel inject pulse width.

Constitute and principle: As shown in the figure, a film made of rubber-fiber separates the regulator to up and down chambers. The up chamber connects manifold through connector with hose. There is a spring in the up chamber. The down chamber is filled with the fuel that flows from the regulator through fuel inlet. The lower part of film gets the fuel pressure in fuel distribution pipe and the upper part of film gets the pressure of manifold and spring force. Film deforms to open or close the valve. Since the degree of deforming is very small, the action force of the spring could be taken as constant. So the open and close of valve is decided by the difference between the fuel pressure both in the lower chamber and the upper chamber. If the valve is closed at first, the differential of pressure will increase because of engine load reducing or fuel pressure increasing, which results lifting the film by fuel pressure to open the valve. In this way, even the engine working condition is changed, the pressure differential between fuel distribution pipe and manifold keeps constant. This is the basic precondition for control fuel fixing quantity. In fact, when fuel flow increases, the differential increases a little with linearity. When MAP pressure changing, the differential will change little too.

Fuel request: The regulator can use the fuel according to the standard of " Unleaded gasoline for vehicle" in GB 17930-1999 and " The standard for controlling injurant in fuel" in GWKB 1-1999.

Fuel pressure regulator



Section drawing of fuel pressure regulator

Mounting position: The regulator is mounted on fuel general supplying pipe with one end connecting with the pipe, one with return fuel pipe to fuel tank, and the other end connecting with intake air pipe to supply vacuum source for the regulator.

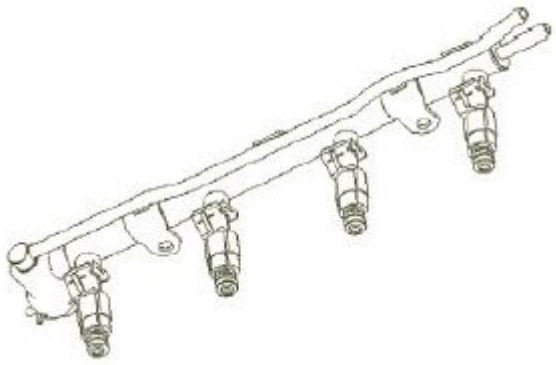
XIII. Steel fuel distributing pipe assembly

Usage: To store and distribute fuel and return superfluous fuel into fuel tank. Injector and fuel pressure regulator are mounted on the tank to offer stable pressure circumstance to balance the fuel pressure and amount of fuel for smooth running of engine.

Constitute: The fuel distributing pipe assembly consists of injector(EV) , regulating valve (DR) and fuel distributing pipe (KVS-S).

Install request: Clamp in/out fuel pipe and rubber hose with clip. The type of clip should be matched with rubber hose to insure the seal between in/out fuel pipe and the hose.

Diagnosis: Usually, fuel distributing pipe assembly is seldom to be fault. Mostly bad installing causes the fuel leakage. Pay more attention during installation. Don't install the seal that are used.



Fuel distributing pipe assembly

Chapter 2 Basic principle for EFI diagnosis

(1) Fault information record

ECU continually detect the sensors, actuator, related circuit, MIL and battery voltage etc. ECU itself, and carry on reliability test for sensor output signal, actuator drive signal and internal signal (such as oxygen closed loop control, knock control, idle control and battery voltage control). Once the malfunction in one link is found, or one signal is not true, ECU will set the malfunction information record on RAM memory. The record exists as DTC form and displays as the order of DTC appearing. 12 malfunction information records at most can be stored in memory.

Malfunction can de divided as stable malfunction or temporary malfunction such as the fault caused by short-lived, harness open or bad contact for inserters according to the frequency

(2) Malfunction status

If the lasting time for one malfunction detected exceeds stable time settled, ECU will consider it as a stable fault and stores it as “stable malfunction”. If it disappears, ECU will store it as “temporary malfunction” or “not existing”. If it is detected again, it will be “temporary malfunction”, but the existing history malfunction does not influence the normal use of engine.

(3) Malfunction types

Short to positive pole of battery
Short to ground
Open (In the case of up or down resistors, ECU will identify the open fault in input terminal as short between input terminal and battery positive pole or short to ground).

(4) Malfunction frequency counter

Foe each malfunction detected, one independent frequency counter value (Hz) will be set. The frequency counter value (Hz) will decide the storing time for store the malfunction information to the stores when this malfunction disappears or eliminates.
When malfunction is detected first time, Hz is set to initial value 40. If malfunction do not change, the value will keep on.
Once the malfunction detected disappears and keeps for a while, HZ will be deducted 1 when starting engine or engine speed exceeds the speed after starting. ECU will consider the malfunction disappears, but the record still exists.
If the fault such as bad contact frequently appears and disappears, Hz will increase 1 but does not exceeds up limit 100.
If Hz is deducted to zero, the fault information records in the store will be cleared completely.

(5) Limp drive home

For some important faults detected, if their lasting time exceeds the setting stable time, ECU will apply some software countermeasures, for example, to close some control function of oxygen sensor closed loop control and set substitute value for some unbelievable value. At the moment, through the working condition of engine is not so good, but the vehicle can be drive home. In this way, vehicle can drive home or service station for repairing to void stop on road. Once the fault detected disappears and Hz deducted to 40, the normal values will be used again.

(6) Fault warning

Some M1.5.4 system vehicles equip MIL. When some important parts such as ECU, MAP, TPS, CTS KS, O2, phase sensor, injector, idle actuator, 2 drive poles of step motor, canister control valve, fan relay are fault, ECU will turn MIL on and warning until the faults disappear.

(7) Fault read out

The malfunction information records can be read out from ECU by diagnosis, or be read by flashing DTC codes. If the faults relate the function of fuel-air mixture ratio regulator, engine will read malfunction information records after running at least 5 minutes.

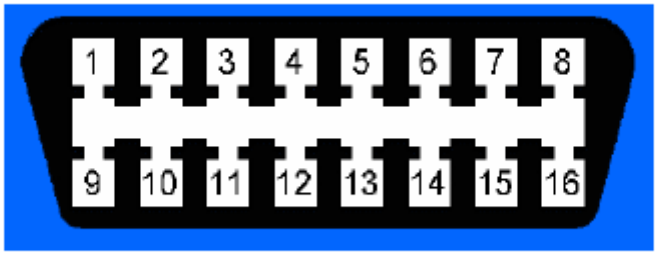


Fig. 3-1 ISO 9141-2 Standard diagnosis connector

Read DTC by flashing light

The flashing DTC is the DTC which could be read out by flashing light in MIL. In the vehicle equipped MIL, MIL will be flashing light. The other end of K-line terminal connects pin 55 of ECU.

Method: Turn on ignition switch, but not run engine. Use K-line terminal to ground pin 55 of ECU for more than 2.5s and then disconnected. The light will flash. Flashing DTC is 2 digits with hexadecimal, and each digit consists with o or 1-9. Every light on will last 0.3s, and is on again after 0.3s. The flashing times mean one digit. If flashing 10 times, it means 0. First flashing means high position number and later flashing means low position number. There 1 second between 2 digits. After 2 numbers displayed, it will flash again after stopping 3s and display some number. One number will flash 2 times (totally flash 3 times). Then the next one. The process circles until engine start again or ignition switch turns off, or ground pin 55 with K-line for more than 2.5s. According to DTC, the malfunction, position, condition, solving or reset condition can be found in “malfunction information record set condition” in this manual can be found.

(8) Clear DTC

When eliminate the faults, DTC should be cleared. There are 5 methods:

For DTC appears on igniting but not keeps on to stable time, it will not be recorded.

When Hz reach to zero, DTC in store will be cleared automatically.

Clear DTC by using diagnostic equipment with the order of “clear DTC”.

Remove ECU terminals or battery terminals to clear DTC outside of RAM.

Ground pin 55 of ECU 2 times for more than 2.5s.

(9) Finding faults

Getting above DTC means only to know the faults position, but not the real fault because the

reason for one fault may be the electric or mechanical one such as sensor, ECU or actuator damage, or open circuit or short circuit or even mechanical damage.
Fault is internal, but the appearances are various. Firstly use tester or flashing light to check if existing any DTC, and troubleshoot the faults accord to DTC, then find the reason of fault according to engine symptom.

4． The condition for malfunction information record

No.	Malfunction information name	The condition for marking malfunction position	Software method during malfunction happens	Flash - ing code	The reset position condition
1	Knock control，test pulse, zero test(Condition : Engine RPM is below 5000, Engine temp is equal or below gate value for actuating knock control, or mass flow for each turn is equal or below gate value for knock control) malfunction	In continues test pulse measuring, the frequency that pulse integral value is equal or below gate value of voltage exceeds the set value.	Setting KS, harness or hardware malfunction: Ignition advanced angle reduced to a safety value: If load signal(mass flow for each turn) is over gate value for knock control, and engine temp is over gate value for actuating knock control, the ignition will put off a safety angle for knock control.	1	Fault frequency does not exceed set value
		In continues zero test, the frequency that pulse integral value is over gate value of voltage exceeds the set value.			Fault frequency does not exceed set value
		In continues integrator original voltage testing, the frequency that integrator original voltage is below the maximum value exceeds the set value.			Fault frequency does not exceed set value
		In continues integrator original voltage testing, the frequency that integrator original voltage is over the maximum value exceeds the set value.			Fault frequency does not exceed set value
2	No malfunction			11	
3	A/C evaporator temp is not trustable	A/C evaporator temp is below low trustable limit	A/C evaporator temp= A/C evaporator temp substitute value	13	A/C evaporator temp resumes between the up and lower limit
		A/C evaporator temp is over up trustable limit			
4	TPS signal is	TPS angle is over the upper limit	TPS angle =TPS angle substitute value Setting	14	angle resumes between the up

	not trustable	TPS angle is below upper limit	TPS mal-function position. Only in shutting off fuel it will be deal with idle. Partial load and fully load can be identified only. If actual mass flow is below the gate value at idle substitute condition during TPS is in malfunction, and it is in shutting off fuel, idle emergency running could be carried. If actual mass flow is over the sum of gate value and allowed differential value, idle emergency running could not be carried. If load signal(mass flow for each turn) is over the load gate value in full load substitute condition during TPS is in malfunction, and the RPM is over the RPM gate value in full load substitute condition during TPS is in malfunction, engine will run at full load condition. If one of conditions can not be satisfied, it does not run at full load condition. Now close the trigger for transition working condition initial compensation function related with TPS. Don't permit to open the buffer function for idle control and the self-study function of idle air. Set idle controller integrator to zero.		and lower limits.

5	KS malfunction	When RPM exceeds the gate value to activate diagnose KS malfunction, the reference voltage to diagnose KS malfunction will be below its gate value.	Set malfunction signal record for KS, harness and hardware: Ignition advanced angel is reduced to a safety value. If load signal(mass flow for each turn) is over gate value for knock control, and engine temp is over gate value for actuating knock control, the ignition will put off a safety angle for knock control. Full load ignition will be put off same safety angle for knock control.	15	Fault frequency does not exceed set value
6	MAP signal is not trustable	MAP pressure is over the trustable upper limit In non-start working condition or engine RPM is below the gate value to diagnose MAP malfunction, MAP pressure is below the trustable upper limit	Set malfunction information mark for main load sensor. Take the load information (mass flow for each turn) as load signal input according to TPS angle and RPM: Select ignition advanced angle: If TPS is fault, set two fixed emergency running signal according to below or over the gate value for RPM. Close oxygen sensor closed-loop control self-study (the data at moment is effective). Close idle closed-loop control self-study (the data at moment is effective).	16	MAP pressure resumes between the up and lower limits.
7	Oxygen sensor signal is not trustable	Oxygen sensor signal keeps over the upper limit for over the specified time (short to battery voltage).	Close oxygen sensor closed-loop control	17	

		Under the condition of satisfying oxygen sensor normal operation, the signal voltage keeps over the specified time between gate values for rich mix or lean mix (open circuit)	Close oxygen sensor closed-loop control		
		Oxygen sensor signal keeps below the lower limit for over the specified time (short to battery voltage).	Close self-study pre-control for oxygen sensor closed-loop control, canister cleaning and oxygen sensor closed-loop control: Make oxygen sensor closed-loop control correct coefficient =1.4s.		
		Oxygen sensor signal voltage is below lower limit, and inject time for oxygen sensor closed-loop control correct coefficient keeps over 1.4s (short to ground)	Close oxygen sensor closed-loop control, and make the upper limit for injecting closed-loop control correct coefficient equal to old one.		
8	Oxygen sensor injecting closed-loop control correct coefficient is not trustable	The injecting closed-loop control correct coefficient equals to the upper limit for over 10s.	Non	31	The closed-loop out voltage is in the scale of adjusting
		The injecting closed-loop control correct coefficient equals to the lower limit for over 10s.			
9	Over maximum RPM	Over maximum identifying malfunction RPM	Non	33	Not over RPM
10	ECU malfunction	ROM/EPROM malfunction	Set malfunction information record for KS, harness or hardware:	34	Troubleshooting
		RAM malfunction			Troubleshooting

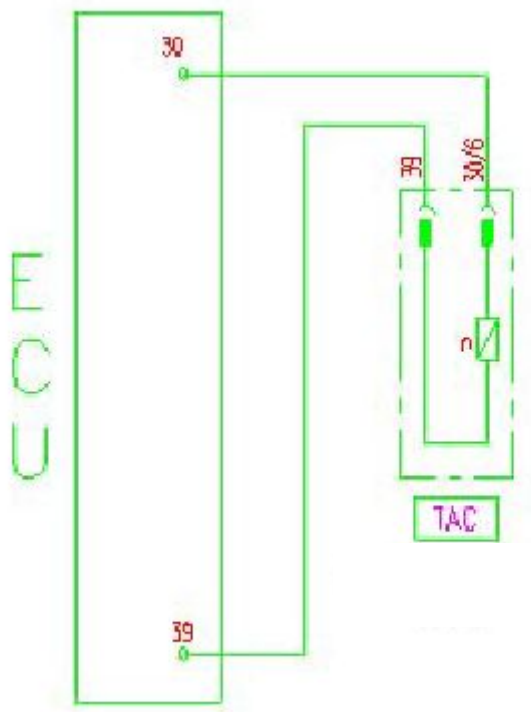
		Knock control data processing circuit (zero test, pulse test) malfunction	Reduce ignition advanced angle to a safety degree. Other conventional function is still possible		Troubleshooting
11	Self-study for injection time addition of oxygen sensor closed-loop control	Mix self-study addition factor of injector is over the upper limit for each stroke Mix self-study addition factor of injector is below the lower limit for each stroke	Non	35	Mix self-adapt addition factor of injector is between the upper limit and lower limit
12	Self-study for injection time multiplication of oxygen sensor closed-loop control	Mix self-study multiplication factor of injector is over the upper limit for malfunction identification Mix self-study multiplication factor of injector is below the lower limit for malfunction identification	Non	36	Mix self-adapt multiplication factor of injector is between the upper limit and lower limit
13	Self-study for leaked air addition of oxygen sensor closed-loop control	Mix self-study addition factor of leaked air is over the upper limit for malfunction identification Mix self-study addition factor of leaked air is below the lower limit for malfunction identification	Non	37	Mix self-adapt addition factor of leaked air is between the upper limit and lower limit
14	Battery voltage is not trustable	Battery voltage is over the trustable upper limit In non-start working condition, the battery voltage is below the gate value. The lasted time is over permitted lasting time of voltage dropping after starting.	Close oxygen sensor closed-loop control self-study and idle control air self-study, and the last data is effective.	38	Battery voltage resumes to normal value

15	Speed signal is not trustable	Engine RPM is over the lowest gate value for identifying speed malfunction. Load signal (mass flow for each turn) is over the load gate value for identifying speed malfunction. Speed signal is below lower limit for identifying speed malfunction. Above 3 conditions lasting time is over the lasting time for identifying speed malfunction.	Make speed =substitute for non-trustable speed	41	Engine RPM is over the lowest gate value for identifying speed malfunction. Load signal (mass flow for each turn) is below the load gate value for identifying speed malfunction. Speed signal is not below lower limit for identifying speed malfunction.
		Speed signal is over upper limit for identifying speed malfunction. It's lasting time is over the lasting time for identifying speed malfunction.			Engine RPM is over the lowest gate value for identifying speed malfunction. Load signal (mass flow for each turn) is below the load gate value for identifying speed malfunction. Speed signal is not below lower limit for identifying speed malfunction.

16	Fan relay malfunction	Short to battery voltage	Non	42	Eliminate
		Short to ground			Eliminate
		Open circuit			Eliminate
17	Cylinder identification signal is not trustable	No TDC mark malfunction, and no activating phase sensor, camshaft RPM reaches a certain value	Forbid to trigger cylinder number counter: If load signal(mass flow for each turn) is over gate value for knock control, and engine temp is over gate value for actuating knock control, the ignition will put off a safety angle for knock control.	43	Under the condition of correct signal, RPM of crankshaft exceeds a set value.
		No TDC mark malfunction, and the time of phase signal is over set value.			
18	MIL driver malfunction	Short to ground	Non	45	Eliminate
		Short to Battery			Eliminate
		Open circuit			Eliminate
19	Idle actuator EWD3 and step motor driver malfunction	Short to ground	No substitute Close idle closed-loop control response curve self-study and air self-study function, and the last data is effective. Make response curve self-study=EPROM value.	EWD 3 and No.1. driver 61 of step motor , No. 2 driver of step motor	Eliminate
		Short to Battery			Eliminate
		Open circuit			Eliminate
		load short			Eliminate

The steps for diagnosis according to malfunction information record

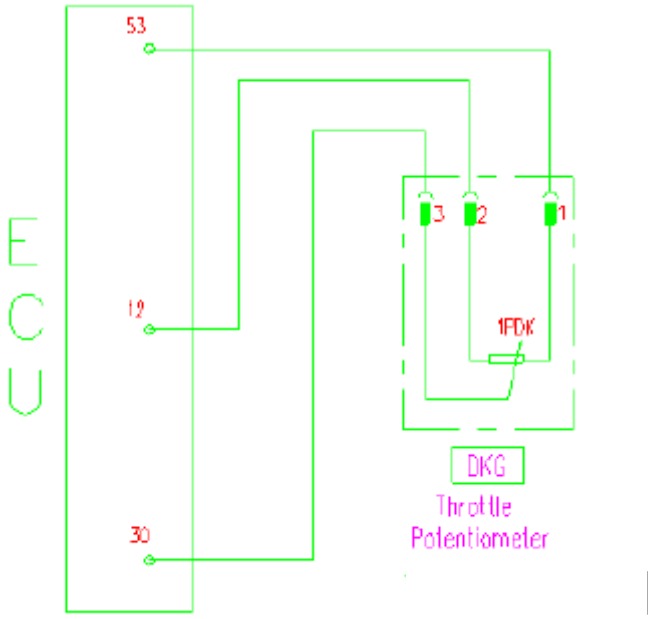
DTC 13 A/C evaporator outlet temperature sensor



Circuit diagram for A/C evaporator temperature sensor

No.	Operation steps	Test results	Next step
1	"ON".Turn on ignition key.		Next
2	Pull out connector of A/C evaporator temperature sensor, measure if the volt between 2 pins is 5V with multimeter.	Yes	Next
		No	4
3	Check any open or short between 2 pins with multimeter.	Yes	Replace sensor
		No	Replace ECU
4	Connect adaptor between ECU and harness, check any open or short between pin 30 , 39 of ECU and pin (1) and (2) of sensor with multimeter.	Yes	Repair or replace harness
		No	Replace ECU

DTC 14 TPS



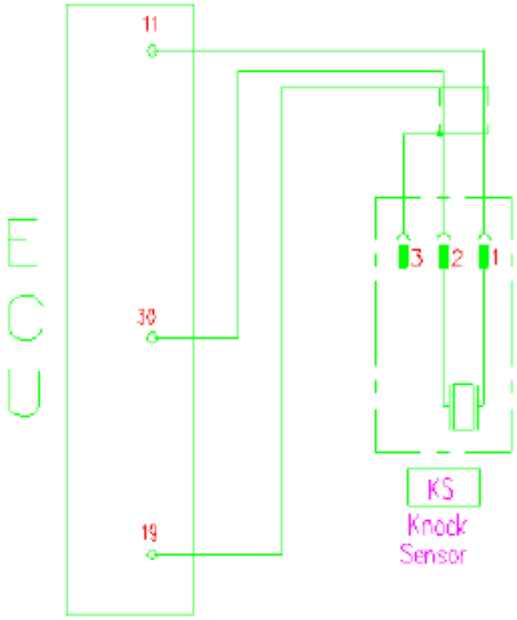
Circuit diagram of TPS

No.	Operation steps	Test results	Next step
1	Turn on ignition key to “ON”.		Next
2	Pull out connector of A/C evaporator temperature sensor, measure if the volt between 2 pins is 5V with multimeter.	Yes	Next
		No	5
3	Measure the resistance between pin (1) and (2) if in 1.6 to 2.4k with multimeter.	Yes	Next
		No	Replace sensor
4	Run slowly TPS from one end to another and check any open or short between pin (1) and (3).	Yes	Replace sensor
		No	Replace ECU
5	Connect adaptor between ECU and harness, check any open or short between pin 12 , 30 of ECU and pin (1) and (2) of sensor with multimeter.	Yes	Repair or replace harness
		No	Replace ECU

Note: For M1.5.4 with distributor, 5V voltage is supplied by pin 12 of ECU to TPS and Hall

sensor. If the DTC displays when vehicle cannot be started, it cannot be clear DTC from TPS. Please check if short in Hall sensor.

DTC 15 KS

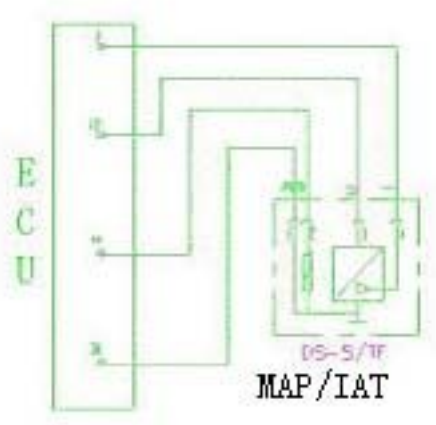


Circuit diagram for KS

No.	Operation steps	Test results	Next step
1	Turn off ignition key, engine nor run.		Next
2	Pull out connector of KS sensor, measure if the resistance between pin 1、 pin 2 of sensor and between pin 1 and pin 3 is over 1M with multimeter.	Yes	Next
		No	Replace sensor
3	Slightly knock around sensor with small hammer and check if any AC signals putout between pin 1 and pin 2 of sensor.	Yes	Next
		No	Replace sensor
4	Turn on ignition key but engine not startup		Next
	Connect adaptor between ECU and harness and	Yes	Repair or replace harness

	check any open or short between pin 11, pin 30, pin 19 of ECU and pin 1 and pin 2 and pin 3 with multimeter.	No	Replace ECU

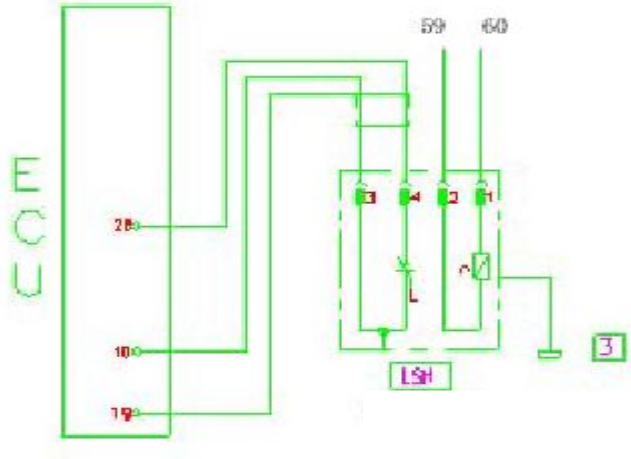
DTC 16 MAP and IAT



Circuit diagram of MAP and IAT

No.	Operation steps	Test results	Next step
1	Turn on ignition key to “ON”		Next
2	Pull out the connectors on harness of MAP and IAT and check if the voltage between pin 1 and pin 2 is 5V with multimeter.	Yes	4
		No	Next
3	Connect the adaptor between ECU and harness, check if open or short between pin 30, pin 12, pin 7 of ECU and pin 1, pin 3, pin 4 separately with multimeter.	Yes	Repair or replace harness
		No	Next
4	Turn on ignition key but engine not startup		Next
5	Put in to neutral gear and run engine at idle. Step down accelerate pedal to fully open. Check if the voltage between pin 4 and pin 1 of sensor is increasing to 5 V with multimeter.	Yes	Replace ECU
		No	Replace ECU or sensor

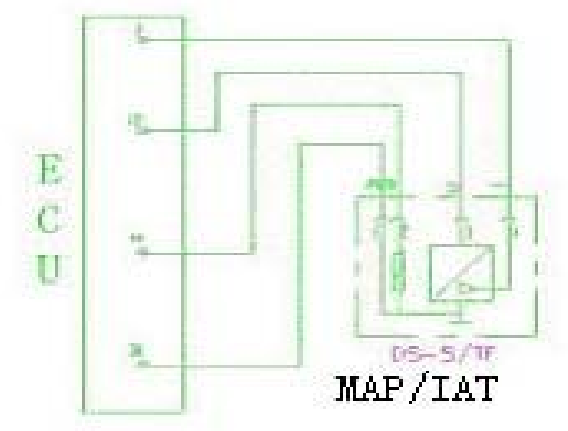
DTC 17 Oxygen sensor



Circuit diagram of oxygen sensor

No.	Operation Steps	Test result	Next step
1	Turn on ignition key to “ON”.		Next
2	Put out the connector on oxygen sensor and check if the voltage between pin 1 and pin 2 is 12 V.	Yes	Next
		No	4
3	Check if the resistance between pin 1 and pin 2 on oxygen sensor is from 6 to 25.	Yes	Replace ECU
		No	Replace sensor
4	Check if the fuse of heated oxygen sensor burns out.	Yes	Replace
		No	Next
5	Check if open or short between pin 1 on sensor and pin 87 on fuel pump relay, check open or short between pin 2 and pin 59.	Yes	Repair or replace harness
		No	Next
6	Insert the connector of oxygen sensor harness. Put N gear and run engine at idle to normal coolant temperature.		Next
7	Put out connector on oxygen sensor harness; check if there is any 0.1 –0.9 V output voltage between pin 4 and pin 3.	Yes	Next
		Yes	Replace sensor
8	Connect adaptor between ECU and harness. Check if open or short between pin 10 on ECU, pin 28 and pin 3, pin 4 separately.	Yes	Repair or replace harness
		No	Replace ECU

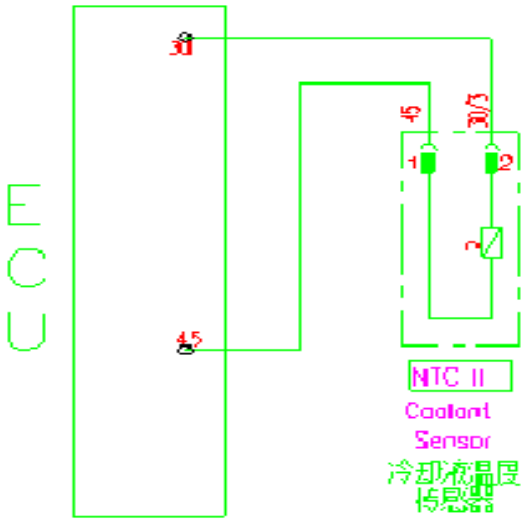
DTC 18 IAT



Circuit diagram of MAP and IAT

No.	Operation Steps	Test result	Next step
1	Turn on ignition key to “ON”.		Next
2	Put out the connectors on MAP and IAT harness. Check if the voltage between pin 1 and pin 3 is 5 V.	Yes	Next
		No	4
3	。Check if the resistance between pin 1 and pin 2 is suit to the temperature (see related parts in this manual).	Yes	Replace ECU
		No	Replace sensor
4	Connect the adaptor between ECU and harness. Check if open or short between pin 30, pin 12, pin 44 on ECU and pin 1, pin 3, pin 2 separately.	Yes	Repair or replace harness
		No	Replace ECU

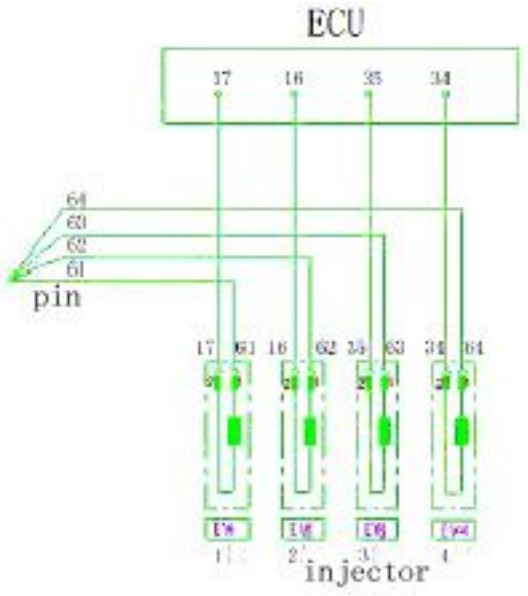
DTC 19 Coolant temperature sensor



Circuit diagram of CTS

No.	Operation Steps	Test result	Next step
1	Turn on ignition key to “ON”.		Next
2	Put out the connector on CTS harness, check if the voltage between pin 1 and pin 2 is 5V.	Yes	Next
		No	4
3	Check if the resistance between pin 1 and pin 2 is suit to the temperature (see related parts in this manual).	Yes	Replace ECU
		No	Replace sensor
4	Connect the adaptor between ECU and harness. Check if open or short between pin 30, pin 45 on ECU and pin 1, pin 2 separately.	Yes	Repair or replace harness
		No	Replace ECU

DTC 22、23、24（、21） in CYL 1, CYL 2, CYL 3 (CYL 4) injector driver

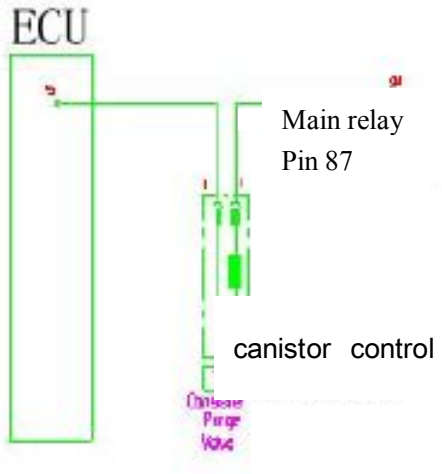


Circuit diagram of injector

No.	Operation Steps	Test result	Next step
1	Turn on ignition key without engine run.		Next
2	Put out all connectors on injector harness; connect two probes of multimeter on pin 1 and engine ground.		Next
3	Turn on ignition key to “ON”. See if the display on multimeter is 12 V for 1 second once turning on the key.	Yes	Repeat step 2
		Yes	6
		No	Next
4	Use multimeter to check if open or short between pin 87 on pump relay output and pin 1 on each injector.	Yes	Repair or replace harness
		No	Next
5	Repair or replace pump replay, main relay and circuit.	Yes	Repair or replace harness

6	Connect the adaptor between ECU and harness. Check if open or short between pin 17, pin 16, pin 35, pin 34 on ECU and pin 2 on each injector separately.	No	Next
7	Use multimeter to check if resistance between pin 1 and pin 2 on injector is 12—16V in 20℃.	Yes	Repeat step 7
		Yes	Next
		No	Replace injector
8	Reinsert all injector connector. Put N gear and run engine at idle. Put out each injector connector in turn and check if the vibration of engine become serious.	Yes	Repeat step 8
		No	Replace ECU

DTC 25 Canister control driver

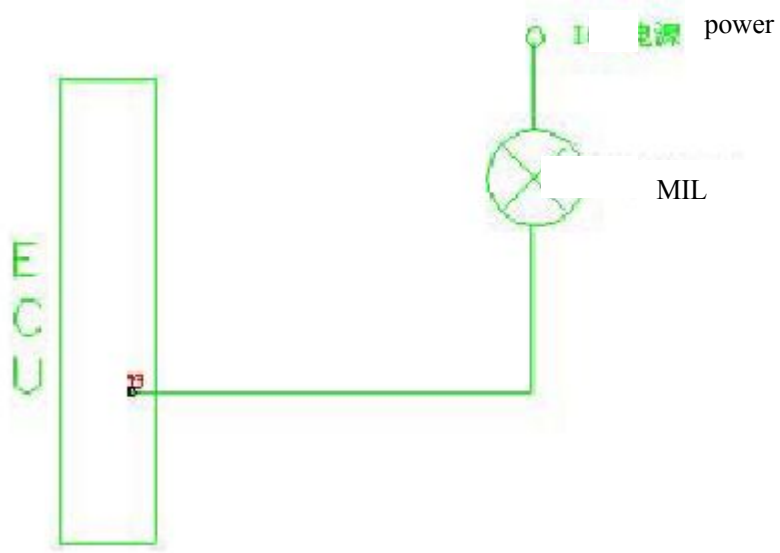


Circuit diagram of canister control valve

No.	Operation Steps	Test result	Next step
1	Run engine at idle to normal coolant temperature.		Next

2	Put out the connector on canister valve and check if the voltage between two pins is 12 V.	Yes	Next
		No	5（Check live wire）
3	Reinsert connector of canister valve harness. Run engine to 1500 RPM. Touch valve with hand and check if any slightly vibration or impact on valve.	Yes	Next
		No	7（Check ground wire）
4	Use multimeter to check if resistance between pin 1 and pin 2 is 22—30.	Yes	Replace ECU
		No	Replace canister control valve
5	Use multimeter to check if open or short between pin 87 on main relay and pin 1 on valve.	Yes	Repair or replace harness
		No	Next
6	Repair or replace main relay and circuit.		
7	Shut off engine. Connect adaptor between ECU and harness. Use multimeter to check if open or short between pin 5 on ECU and pin 2 on valve.	Yes	Repair or replace harness
		No	Replace ECU

DTC 45 MIL driver



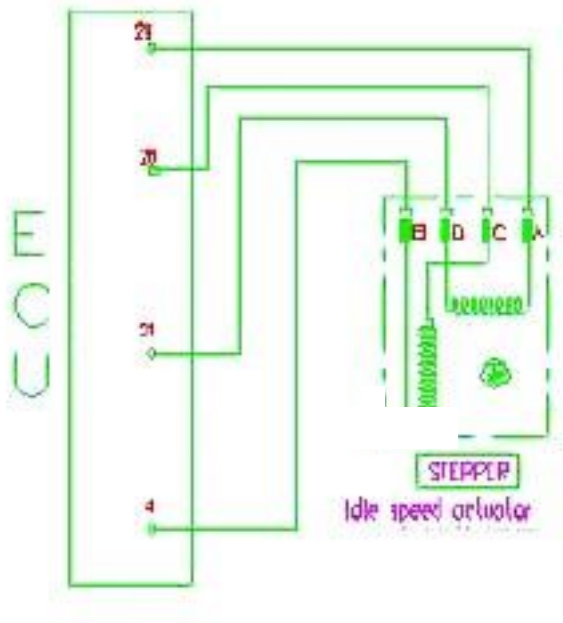
Circuit diagram of MIL

NO.	Operation Steps	Test result	Next step
1	Turn on ignition key to “ON”.		Next
2	Remove instrument panel. Put out MIL bulb. Use multimeter to check if the voltage in MIL socket is 12 V.	Yes	Next
		No	5（Check live wire）
3	Use multimeter to check if MIL bulb is good.	Yes	Next
		No	Replace bulb.
4	Connect the adaptor between ECU and harness. Check if open or short between pin 23 on ECU and input connector of MIL.	Yes	Repair or replace harness
		No	Replace ECU
5	Check if the fuse in oxygen heating circuit is burn out.	Yes	Replace fuse
		No	Next
6	Use multimeter to check if open or short between pin 87 on main relay and pin 1 on MIL socket.	Yes	Repair or replace harness
		No	Next
7	Repair or replace main relay and circuit.		

In vehicle equipped with MIL, when other fault information is recorded, MIL will be on except the fault of A/C evaporator temperature sensor, fuel pump driver and canister control

valve.

DTC 61, 62 No. 1 and No. 2 coil driver in step motor



Circuit diagram of idle actuator/step motor

No.	Operation steps	Test results	Next step
1	Turn on ignition key but engine not startup.		Next
2	Put out the connector on step motor and check if the resistance between pin A, pin D, and pin B, pin C is 40—80.	Yes	Next
		No	Replace idle actuator
3	Use multimeter to check if the resistance between pin A and pin B as well as Pin B and pin D are infinite.	Yes	Next
		No	Replace bulb or actuator
4	Use multimeter to check if voltages between pin A and pin D as well as pin B and pin C are □12V.	Yes	Replace actuator
		No	Next
5	Connect adaptor between ECU and harness. Use multimeter to check if open or short between pin 29, pin 4, pin 26, pin 21 on ECU and pin A, B, C D on step motor.	Yes	Repair or replace harness
		No	Replace ECU

6. The diagnosis steps according to engine symptoms

Before beginning diagnosis steps according to engine symptoms, the primary checking should be carried out:

(1) Make any abnormal situation for ECU and MIL (except vehicle without MIL).

(2) Use diagnoses instrument or flashlight to check to insure no any malfunction information records.

(3) Use diagnoses instrument to check the idle data on heated engine of EFI system to insure everything is OK.

Name	Parameter
Intake temperature: tans	20-70°C
Battery voltage: ub	12-14V
Engine coolant temperature: tmot	80-90°C
Engine load :tl	1.8-3.0 ms
A/F ratio integrator	5%-5%
Ignition advance angle	5-10°CA
Throttle angle of rotation wdkbl	0
Injection time	4-7 ms
Engine speed n	Expected idle±50 rpm
Canister control valve ratio	0
Self adapting for A/F ratio: xfra	0.95-1.05
Self adapting for A/F ratio: xtra	120-140
Intake manifold absolute pressure	350-650 hPa
Oxygen sensor voltage	0.1-0.8V undulating quickly
Intake air input	6-12 kg/h
Idle adjust state	60-100

.

(4) Make sure the symptoms that driver told exist and check the exact position of symptom. Then begin appearance check:

Check if clear or substance on harness ground.

Check if any break, twist in vacuum pipe or if connect correctly.

Check if any block in vacuum pipe.

Check if any stave or damage on intake air pipe.

Check if the seal between throttle body and manifold is good.

Check if any break, aging on high voltage line in ignition system or wiring correctly.

Check if the connection of wires is correct or any loose/bad contact on connector.

1）Engine does not run or run slowly on starting

No.	Operation steps	Test step	Next step
1	Check if the voltage between two binding post on battery is 10—12.5 V.	Yes	Next
		No	Repair or replace battery
2	Turn on ignition key to “ON”. Check if the voltage on positive poles of binding post of battery connected with the key is 10—12.5 V.	Yes	Next
		No	Repair poles or replace wires
3	Keep ignition key on start position. Check if the voltage on positive pole of binding post of starter connected with ignition key is 8V.	Yes	Next
		No	Replace bulb, replace actuator, repair or replace ignition key
4	Keep ignition key on start position. Check if the voltage on positive pole of binding post starter is 8V.	Yes	Next
		No	Repair poles or replace wires
5	Use multimeter to check if open or short for starter.	Yes	Repair or replace start motor
		No	Next
6	Check if engine blocks for bad lubrication.	Yes	trouble shooting
		No	Next
7	If in winter, check if the resistance of starter is too big that resulted by wrong lubricant or gear oil.	Yes	Replace suitable oil
		No	Repair or replace timing belt

2）Engine can run but cannot start successfully (with distributor)

No.	Operation steps	Test results	Next step
1	Turn on ignition key to "ON". Use diagnostic equipment to check if malfunction information record exist.	Yes	Eliminate malfunction
		No	Next
2	Pull out ignition wire and connect ignition plug with the electrode 5—10 mm from engine body. Run engine with starter and check if high voltage ignition in blue and white appears.	Yes	8
		No	Next
3	Check if the resistance of high voltage wire is normal (about 16k̃/ m. Exact data was afforded by manufacturer).	Yes	Next
		No	Repair or replace high voltage wire
4	Check if any ablation damage or crack on distributor cove and distributor rotor.	Yes	Replace
		No	Next
5	Check if any loose or damage for identification ring in distributor.	Yes	Replace
		No	Next
6	Check if ignition coil is normal.	Yes	Next
		No	Replace
7	Check if distributor and high voltage coil inserter is good.	Yes	Next
		No	Connect plug
8	Turn on ignition key to "ON". Check if fuel pump relay and fuel pump can work for 3 seconds.	Yes	Next
		No	Repair fuel pump circuit
9	Connect fuel pressure gauge valve. Short pin 30 on fuel pump relay and pin 87 to start fuel pump. Check if fuel pressure is 250—300 kPa.	Yes	Next
		No	13
10	Pull out fuel distribution pipe together with injector. Pull out injector connector on harness. Supply 12V voltage directly from battery to injector. Check if injector can inject fuel.	Yes	12
		No	Next
11	Re-check if injector can inject fuel after cleaning.	Yes	Next
		No	Replace injector
12	Check If fuel deterioration or containing water.	Yes	Replace fuel
		No	18
13		Yes	Next

	Check if fuel pressure below 250 kPa.	No	17
14	Shut off fuel gauge valve. Connect ignition key again to run fuel pump for 3 seconds. Check if fuel pressure can be set up.	Yes	Next
		No	16
15	Open fuel gauge valve, use return fuel blocker to clamp fuel pipe for no returning fuel. Check if fuel pressure can be set up soon.	Yes	Replace oil pressure regulator
		No	Repair or replace injector and oil pipe
16	Check if fuel pipe is leaked or blocked.	Yes	Repair or replace oil inlet
		No	Replace fuel pump
17	Check returning fuel pipe is blocked or bend.	Yes	Repair or replace oil return pipe
		No	Replace fuel pressure regulator
18	Connect adaptor between ECU and harness. Check if voltage exist on pin 18,27,37. Check if the positive source on above pins and ground wires of pin 2,14,24,19 on ECU are normal.	Yes	Next
		No	Repair or replace harness
19	Check if intake air system parts are leakage.	Yes	Repair
		No	Next
20	Check if MAP or IAT are blocked.	Yes	Repair or replace
		No	Next
21	Check if CTS is normal.	Yes	Next
		No	Repair or replace
22	Check if engine cannot start because mechanical reason such as cylinder clearance and cylinder leakage.	Yes	Eliminate malfunction
		No	Replace ECU

3）Heat start difficult

No.	Operation steps	Test results	Next step
1	Turn on ignition key. Use diagnostic equipment to check if malfunction information record exist.	Yes	Eliminate malfunction
		No	Next
2	Connect fuel pressure gauge valve. Short pin 30 on fuel pump relay and pin 87 to start fuel pump. Check if fuel pressure is 250—300 kPa.	Yes	Next
		No	9
3	Disconnect fuel pipe. Shut off ignition key. After 1 hour, check if pressure in fuel system can keep 150—200 kPa.	Yes	Next
		No	Repair fuel system leakage
4	Connect fuel pipe. Use returning fuel blocker to block returning fuel pipe and shut off fuel pressure gauge valve. Shut off ignition key. After 1 hour, check if pressure in fuel system can keep 150—200 kPa.	Yes	Replace fuel pressure regulator
		No	Next
5	Check if injector and fuel pipe leaks fuel.	Yes	Replace injector and fuel pipe
		No	Next
6	Pull out water temperature sensor connector and run engine. Check if engine can start.	Yes	Check coolant temperature and circuit
		No	Next
7	Connect adaptor between ECU and harness. Check if voltage exist on pin 18,27,37. Check if the positive source on above pins and ground wires of pin 2,14,24,19 on ECU are normal.	Yes	Next
		No	Repair or replace harness
8	Replace fuel and heat start engine again. Check if engine can start.	Yes	Harness
		No	Replace ECU
9	Check if fuel pipe blocked or bend, or if fuel pump regulator can work normally.	Yes	Next
		No	Repair or replace
10	Use multimeter to check if voltages between two ends of fuel pump inserter exists.	Yes	Next
		No	Repair or replace fuel pump relay and leading line
11	Check if fuel pump resistance is correct.	Yes	Next
		No	Replace fuel pump

12	Check if fuel pump blocked.	Yes	Replace fuel pump
		No	Replace ECU

4） RPM is normal but difficult in starting

No.	Operation steps	Test results	Next step
1	Turn on ignition key. Use tester to check if malfunction information record exists.	Yes	Eliminate malfunction
		No	Next
2	Check if air filter is through.	Yes	Next
		No	Replace
3	Check if MAP pressure is 35—65 kPa at idle after start.	Yes	Next
		No	Eliminate intake system leak
4	Step down throttle slightly and check engine can start easily.	Yes	Replace or check throttle valve
5	Connect fuel pressure gauge valve. Short pin 30 on fuel pump relay and pin 87 to start fuel pump. Check if fuel pressure is 250—300 kPa.	Yes	Next
		No	9
6	Use special connector to supply 12 V voltage from battery to injector and check if injector works normally.	Yes	8
		No	Next
7	Re-check if injector can inject fuel after cleaning.	Yes	Next
		No	Replace injector
8	Replace fuel. Check If fuel deteriorates or contains water.	Yes	Replace fuel
		No	14
9	Check if fuel pressure below 250 kPa.	Yes	Next
		No	13
10	Shut off fuel gauge valve. Connect ignition key again to run fuel pump for 3 seconds. Check if fuel pressure can be set up.	Yes	Next
		No	12
11	Open fuel gauge valve, use return fuel blocker to clamp fuel pipe for no returning fuel. Check if fuel pressure can be set up soon.	Yes	Replace fuel pressure regulator
		No	Repair and replace injector or fuel pipe
12	Connect fuel pressure gauge valve. Short pin 30 on fuel pump relay and pin 87 to start fuel pump. Check if fuel pressure is 250—300 kPa	Yes	Repair and replace fuel pipe

		No	Replace fuel pump
13	Check returning fuel pipe is blocked or bend.	Yes	Repair or replace returning fuel pipe
		No	Replace fuel pressure regulator
14	Pull out idle actuator connector before coolant temperature reaches 35ºC and check if engine speed is dropping.	Yes	Next
		No	Repair or replace idle actuator
15	Turn on ignition key. Check voltages on following pins are normal: 12 V for pin 27 and zero for pin 14 and 19.	Yes	Next
		No	Check harness or connector
16	Run engine at idle. When coolant temperature reaches normal, ground pin 51 and check if ignition advance angle is 6.75º crank angle.	Yes	Next
		No	Adjust ignition advance angle
17	Check if cylinder pressure is normal.	Yes	Next
		No	Trouble shooting
18	Check if MAP and IAT blocks.	Yes	Repair or replace
		No	Next
19	Check if coolant temperature sensor is normal.	Yes	Replace ECU
		No	Repair or replace

5）Cold start difficult

No.	Operation steps	Check results	Next step
1	Turn on ignition key. Use tester to check if malfunction information record exists.	Yes	Eliminate malfunction
		No	Next
2	Use multimeter to check if coolant temperature sensor is normal. Or link 1.5k resistors between pin 45 and pin 30 on ECU to replace coolant temperature sensor for starting engine. If engine can start, coolant temperature sensor is normal.	Yes	Next
		No	Replace sensor

3	Turn on ignition key. Check if voltages on following pins are normal: 12 V for pin 27 and zero for pin 14 and 19.	Yes	Next
		No	Check harness and connector
4	Check if air filter is through.	Yes	Next
		No	Replace
5	Check if MAP pressure is 35—65 kPa at idle after start.	Yes	Next
		No	**Eliminate intake leakage system malfunction**
6	Step down throttle slightly and check engine can start easily.	Yes	Check throttle and idle pass
		No	Next
7	Pull out idle actuator connector before coolant temperature reaches 35ºC and check if engine speed is dropping.	Yes	Next
		No	Repair or replace idle actuator
8	Connect fuel pressure gauge valve. Ground pin 86 on fuel pump relay. Turn on ignition key to run fuel pump relay and fuel pump to check if fuel pressure is 250—300 kPa.	Yes	Next
		No	12
9	Use special connector to supply 12 V voltages from battery to injector and check if injector works normally.	Yes	11
		No	Next
10	Re-check if injector can inject fuel after cleaning.	Yes	Next
		No	Replace injector
11	Check if fuel deteriorate or containing water.	Yes	Replace fuel
		No	17
12	Check if fuel pressure below 250 kPa.	Yes	Next
		No	16
13	Shut off fuel gauge valve. Connect ignition key again to run fuel pump for 3 seconds. Check if fuel pressure can be set up.	Yes	Next
		No	15
14	Open fuel gauge valve, use return fuel blocker to clamp fuel pipe for no returning fuel. Check if fuel pressure can be set up soon.	Yes	Replace fuel pressure regulator
		No	Repair or replace injector and fuel pipe
15	Check if fuel pipe is leaked or blocked.	Yes	Repair or replace intake fuel pipe
		No	Replace fuel pump
16	Check returning fuel pipe is blocked or bend.	Yes	Repair or replace returning fuel pipe
		No	Replace fuel pressure regulator

17	Check if cylinder compressed pressure is normal.	Yes	Next
		No	Trouble shooting
18	Check if intake air system is leak.	Yes	Repair
		No	Next
19	Check if MAP and IAT blocks.	Yes	Repair or replace
		No	Replace ECU

6）Unstable idle at any situation

1	Turn on ignition key. Use diagnostic equipment to check if malfunction information record exists.	Yes	Eliminate malfunction
		No	Next
2	Check if EWD3 idle actuator or step motor actuator blocked.	Yes	Repair or replace idle actuator
		No	Next
3	Turn on ignition key. Connect adaptor between ECU and harness. Check if voltages on pin 44,45 (output signal for IAT and CTS), pin 21,29,4,26 (output signal for step motor) and pin 4, 26 (for EWD3) are normal.	Yes	Check harness and connector
		No	Next
4	Run engine at idle. Shut off each cylinder use spark out one by one and check if engine speed is dropping or fluctuates.	Yes	8
		No	Next
5	Check if each injector works normally.	Yes	Next
		No	Check injector and harness
6	Check if the resistance of secondary wire is normal (about 16k̃/ m. Exact data was afforded by manufacturer).	Yes	Next
		No	Replace
7	Check if any ablation damage or crack on distributor cove and rotor.	Yes	`Replace
		No	Next
8	Check if spark plug is normal.	Yes	Next

		No	Replace spark plug
9	Connect fuel pressure gauge valve. Short pin 30 and pin 87 of fuel pump relay to start fuel pump. Check if fuel pressure is 250—300 kPa.	Yes	Next
		No	13
10	Use special connector to supply 12 V voltages from battery to injector and check if injector works normally.	Yes	12
		No	Next
11	Re-check if injector can inject fuel after cleaning.	Yes	Next
		No	Replace injector
12	Replace fuel. Check If fuel deteriorates or containing water.	Yes	Replace fuel
		No	18
13	Check if fuel pressure below 250 kPa.	Yes	Next
		No	17
14	Shut off fuel gauge valve. Connect ignition key again to run fuel pump for 3 seconds. Check if fuel pressure can be set up.	Yes	Next
		No	16
15	Open fuel gauge valve, use return fuel blocker to clamp fuel pipe for no returning fuel. Check if fuel pressure can be set up soon.	Yes	Replace fuel pressure regulator
		No	Repair and replace injector or fuel pipe
16	Check if fuel pipe is leaked or blocked.	Yes	Repair or replace fuel pipe
		No	Replace fuel pump
17	Check returning fuel pipe is blocked or bend.	Yes	Repair or replace returning fuel pipe
		No	Replace fuel pressure regulator
18	Check if sensor holes on MAP and IAT block.	Yes	Cleaning
		No	Next
19	Run engine at idle. After coolant temperature reaches actuating temperature for closed loop control, check if oxygen sensor works normally.	Yes	Next
		No	Check oxygen sensor and harness
20	Check if intake air system leaks.	Yes	Eliminate leak
		No	Next
21	Check if cylinder pressure is normal.	Yes	Next
		No	Trouble shooting
22	Run engine at idle. After coolant temperature reaches normal, ground pin 51 on ECU and check if ignition advance angle is 6.75º crank angle.	Yes	Replace ECU
		No	Adjust ignition advance angle

1	Turn on ignition key. Use diagnostic equipment to check if malfunction information record exists.	Yes	Eliminate display malfunction
		No	Next
2	Check if air filter is through.	Yes	Next
		No	Replace
3	Check if MAP pressure is 35—65 kPa at idle in heating engine process.	Yes	Next
		No	Eliminate intake system malfunction
4	Shut off engine ,turn on ignition key. Connect adaptor between ECU and harness. Check if voltages on pin 44,45 (output signal for IAT and CTS)and pin 12 (for 4.5-5V power of sensor) are normal.	Yes	Next
		No	Check
5	Pull out idle actuator connector before heat start engine and check if engine speed is normal	Yes	Next
		No	Replace idle actuator
6	Check if coolant temperature sensor is normal	Yes	Next
		No	Replace
7	Run engine at idle. After coolant temperature reaches normal, ground pin 51 on ECU and check if ignition advance angle is 6.75°crank angle.	Yes	Replace ECU
		No	Adjust ignition advance angle

7） Unstable idle at warmup

8）Unstable idle after warmup

1	Turn on ignition key. Use diagnostic equipment to check if malfunction information record exists	Yes	Eliminate malfunction
		No	Next
2	Turn on ignition key. Connect adaptor between ECU and harness. Check if voltages on pin 7,44,45, 28(output signal for MAP, IAT,TCS and oxygen sensor)and pin 4,21,26,29(output to idle actuator)are normal	Yes	Next
		No	Repair or replace harness
3	Shout off engine .Check if air filter is through	Yes	Next
		No	Replace
4	Check if MAP pressure is 35—65 kPa at idle	Yes	Next

		No	Eliminate intake system leak
5	Connect fuel pressure gauge valve. Short pin 30 and pin 87 of fuel pump relay to start fuel pump. Check if fuel pressure is 250—300 kPa.	Yes	Next
		No	9
6	Use special connector to supply 12 V voltages from battery to injector and check if injector works normally.	Yes	8
		No	Next
7	Re-check if injector can inject fuel after cleaning.	Yes	Replace
		No	Replace injector
8	Check if fuel is deterioration or containing water	Yes	Replace fuel
		No	14
9	Check if fuel pressure below 250 kpa	Yes	Next
		No	13
10	Shut off fuel gauge valve. Connect ignition key again to run fuel pump for 3 seconds. Check if fuel pressure can be set up.	Yes	Next
		No	12
11	Open fuel gauge valve, use return fuel blocker to clamp fuel pipe for no returning fuel. Check if fuel pressure can be set up soon.	Yes	Replace fuel pressure regulator
		No	Repair and replace injector or fuel pipe
12	Check if fuel inlet is leak or block	Yes	Repair or replace fuel inlet
		No	Replace fuel pump
13	Check if return fuel pipe is block or bend	Yes	Repair or replace return fuel pipe
		No	Replace fuel pressure regulator
14	Run engine at idle. After coolant temperature reaches normal, ground pin 51 on ECU and check if ignition advance angle is 6.75□crank angle.	Yes	Next
		No	Adjust ignition advance angle
15	Pull out coolant temperature sensor and check if engine is normal	Yes	Replace coolant temperature sensor
		No	Next
16	Check if cylinder pressure of engine is normal	Yes	Next
		No	Trouble shooting
17	Check if the resistance of secondary wire is normal (about 16k̃/ m. Exact data was afforded by manufacturer)。	Yes	Next
		No	Replace
18	Check if any ablation damage or crack on	Yes	Replace

	distributor cover and distributor	No	Next
19	Check if spark plug is normal	Yes	Replace ECU
		No	Replace spark plug

9）Unstable idle or stall on load condition(with A/C etc,.)

1	Turn on ignition key. Use diagnostic equipment to check if malfunction information record exists	Yes	Eliminate malfunction
		No	Next
2	Turn on A/C switch. Turn on ignition key. Connect adaptor between ECU and harness. Check if pin 40 and 41(A/C switch) have signal input	Yes	Next
		No	Repair A/C circuit
3	Check if A/C system pressure, magnetic clutch of compressor and A/C pump are normal	Yes	Next
		No	Repair or replace
4	Turn on ignition key. Check if voltage on pin 4, 21, 26, 29 (output to idle actuator) are normal	Yes	Next
		No	Check control circuit
5	Remove step motor and check if step motor is jamming or does not work flexibly	Yes	Repair or replace step motor
		No	Next
6	Turn engine and open A/C. Through amount of step Check if idle actuator is normal with diagnostic equipment (The normal steps afford else)	Yes	Replace ECU
		No	Replace idle actuator

ECU can take not only the low-level signal but also high-level signal of its No. 41 pin as requesting signal. No. 41 pin should be high-level signal if ECU takes low-level signal of its No. 41 pin as requesting signal, under the condition of A/C switch off. vice versa.

10）Periodically unstable(ECU needs self-learning again)

1	Turn on ignition key. Use diagnostic equipment to check if malfunction information record exists	Yes	Trouble shooting
		No	Next
2	Check if air filter is through。	Yes	Next
		No	Replace
3	Check if intake pressure is 35—65 kPa at idle	Yes	Next
		No	Repair
4	Run engine at idle. Shut off each cylinder one by	Yes	7

	one and check if engine speed is dropping or fluctuates.	No	Next
5	Turn on ignition key. Connect adaptor between ECU and harness. Check if voltages on pin 7,44,45, 28(output signal for MAP, IAT, TCS and oxygen sensor),19(ground),27(ignition switch)and pin 4, 21,26, 29 (output to idle actuator)are normal	Yes	Next
		No	Repair or replace harness
6	Run engine at idle. After coolant temperature reaches normal, ground pin 51 on ECU and check if ignition advance angle is 6.75°crank angle.	Yes	Next
		No	Adjust ignition advance angle
7	Check if sensor holes on MAP and IAT block.	Yes	cleaning
		No	Next
8	Check if fuel is deterioration or containing water	Yes	Replace fuel
		No	Next
9	Use special connector to supply 12 V voltages from battery to injector and check if injector works normally.	Yes	Next
		No	Repair harness and injector
10	Check if the resistance of ignition wire is normal	Yes	Next
		No	Replace
11	Check if any ablation damage or crack on distributor cover and distributor	Yes	Replace
		No	Next
12	Check if spark plug is normal	Yes	Replace ECU
		No	Replace spark plug

11）Idle is too high (ECU needs self–learning again)

1	Turn on ignition key. Use diagnostic equipment to check if malfunction information record exists。	Yes	Eliminate malfunction
		No	Next
2	Check if throttle pedal bracing wire is blocked or too tight.	Yes	Adjust or replace
		No	Next
3	Check if canister control valve, fuel pressure regulator, PVC vacuum pipe and vacuum power-assisted hose of braking system are good	Yes	Repair or replace
		No	Next
4	Step down brake pedal and check if idle is too high while engine idle running and in neutral.	Yes	Next
		No	6

5	Clamp vacuum power-assisted hose and check if idle is normal	Yes	Repair or replace vacuum actuator
		No	Next
6	Clamp PVC vacuum hose and check if idle is normal	Yes	Replace PVC
		No	Next
7	Clamp canister control valve hose and check if idle is normal	Yes	Replace canister control valve
		No	Next
8	Check if idle actuator is not flexibly or blocked	Yes	Repair or replace
		No	Next
9	Check if intake pipe have leak	Yes	Repair or replace
		No	Next
10	Check if sealing washer of injector is good	Yes	Next
		No	Replace sealing washer
11	Check if MAP and IAT are good	Yes	Replace ECU
		No	Replace sensor

12）Speed of engine is low or switch off while accelerating

1	Turn on ignition key. Use diagnostic equipment to check if malfunction information record exists。	Yes	Eliminate malfunction
		No	Next
2	Check if air filter is through	Yes	Next
		No	Replace
3	Check if speed is normal at idle	Yes	Next
		No	Next
4	Check if intake pressure is 35—65 kPa at idle	Yes	Next
		No	Repair
5	Run engine at idle. After coolant temperature reaches normal, ground pin 51 on ECU and check if ignition advance angle is 6.75º crank angle.	Yes	Next
		No	Adjust ignition advance angle
6	Connect fuel pressure gauge valve. Short pin 30 on fuel pump relay and pin 87 to start fuel pump. Check if fuel pressure is 250—300 kPa	Yes	Next
		No	10
7	Use special connector to supply 12 V voltages from battery to injector and check if injector works normally.	Yes	9
		No	Next
8	Re-check if injector can inject fuel after cleaning.	Yes	Next
		No	Replace injector
9	Check if fuel is deterioration or containing water	Yes	Replace fuel

	。	No	15
10	Check if fuel pressure below 250 kPa.	Yes	Next
		No	14
11	Shut off fuel gauge valve. Connect ignition key again to run fuel pump for 3 seconds. Check if fuel pressure can be set up.	Yes	Next
		No	13
12	Open fuel gauge valve, use return fuel blocker to clamp fuel pipe for no returning fuel. Check if fuel pressure can be set up soon。	Yes	Replace fuel pressure regulator
		No	Replace and repair injector or fuel pipe
13	Check if fuel pipe is leaked or blocked.	Yes	Repair or replace fuel pipe
		No	Replace fuel pump
14	Check returning fuel pipe is blocked or bend.	Yes	Repair or replace returning fuel pipe
		No	Replace fuel pressure regulator
15	Turn on ignition key. Connect adaptor between ECU and harness. Check if voltages on pin 53(output signal for TPS), pin 30 (ground connection) and pin 12(for 4.5-5V power of sensor) are normal.	Yes	Next
		No	Repair or replace harness
16	Check if ignition coil, distributor, high voltage wire and spark plug are normal	Yes	Replace ECU
		No	Repair or replace relate unit

13）Accelerate is slow

1	Turn on ignition key. Use diagnostic equipment to check if malfunction information record exists	Yes	Eliminate malfunction
		No	Next
2	Shout off engine. Check if air filter is through	Yes	Next
		No	Replace
3	Check if speed is normal at idle	Yes	Next
		No	Reference trouble shooting of idle system

4	Check if intake pressure is 35—65 kPa at idle	Yes	Next
		No	Repair
5	Turn on ignition key. Connect adaptor between ECU and harness. Check if voltages on pin 53(output signal for TPS), pin 30 (ground connection) and pin 12(for 4.5-5V power of sensor) are normal.	Yes	Next
		No	Repair or replace
6	Run engine at idle. After coolant temperature reaches normal, ground pin 51 on ECU and check if ignition advance angle is 6.75º crank angle.	Yes	Next
		No	Adjust ignition advance angle
7	Connect fuel pressure gauge valve. Short pin 30 on fuel pump relay and pin 87 to start fuel pump. Check if fuel pressure is 250—300 kPa	Yes	Next
		No	11
8	Use special connector to supply 12 V voltages from battery to injector and check if injector works normally.	Yes	10
		No	Next
9	Re-check if injector can inject fuel after cleaning.	Yes	Next
		No	Replace injector
10	Check if fuel is deterioration or containing water	Yes	Replace fuel
		No	16
11	Check if fuel pressure below 250 kPa.	Yes	Next
		No	15
12	Shut off fuel gauge valve. Connect ignition key again to run fuel pump for 3 seconds. Check if fuel pressure can be set up.	Yes	Next
		No	14
13	Open fuel gauge valve, use return fuel blocker to clamp fuel pipe for no returning fuel. Check if fuel pressure can be set up soon	Yes	Replace pressure regulator
		No	Repair and replace injector or fuel pipe
14	Check if fuel pipe is leaked or blocked.	Yes	Repair or replace fuel pipe
		No	Replace fuel pump
15	Check returning fuel pipe is blocked or bend.	Yes	Repair or replace fuel pipe
		No	Replace pressure regulator
16	Check if exhaust system and TWC is blocked	Yes	Replace or cleaning
		No	Replace ECU

14）Poor performance of acceleration and powerlessness

1	Check if it exists malfunction as following: clutch slipping, air pressure of tire is low, braking drag, size of tire and four-wheeled alignment are incorrect	Yes	Repair
		No	Next
2	Check if throttle can full-open	Yes	Next
		No	Repair or replace throttle
3	Turn on ignition key. Use diagnostic equipment to check if malfunction information record exists。	Yes	Eliminate malfunction
		No	Next
4	Run engine at idle. After coolant temperature reaches normal, ground pin 51 on ECU and check if ignition advance angle is 6.75º crank angle.	Yes	Next
		No	Adjust ignition advance angle
5	Turn on ignition key. Connect adaptor between ECU and harness. Check if voltages on pin 7,53,44, 45, 28 (output signal for MAP, TPS, IAT, TCS and oxygen sensor), 28,30(signal ground connection for sensor) and pin 12 (for 4.5-5V power of sensor) are normal	Yes	Next
		No	Repair or replace harness
6	Check if intake pressure is 35—65 kPa at idle after start	Yes	Next
		No	Repair
7	Connect fuel pressure gauge valve. Short pin 30 on fuel pump relay and pin 87 to start fuel pump. Check if fuel pressure is 250—300 kPa	Yes	Next
		No	11
8	Use special connector to supply 12 V voltages from battery to injector and check if injector works normally.	Yes	10
		No	Next
9	Re-check if injector can inject fuel after cleaning.	Yes	Next
		No	Replace injector
10	Check if fuel is deterioration or containing water	Yes	Replace fuel
		No	16
11	Check if fuel pressure below 250 kPa.	Yes	Next
		No	15
12	Shut off fuel gauge valve. Connect ignition key again to run fuel pump for 3 seconds. Check if fuel pressure can be set up.	Yes	Next
		No	14
13	Open fuel gauge valve, use return fuel blocker to clamp fuel pipe for no returning fuel. Check if fuel pressure can be set up soon。	Yes	Replace pressure regulator
		No	Repair and replace injector or fuel pipe

14	Check if fuel pipe is leaked or blocked.	Yes	Repair or replace fuel inlet
		No	Replace fuel pump
15	Check returning fuel pipe is blocked or bend	Yes	Repair or replace returning fuel pipe
		No	Replace pressure regulator
16	Check if the date of MAP or IAT is normal。	Yes	Next
		No	Replace sensor
17	Check if ignition coil, distributor, ignition wire and spark plug are normal	Yes	Next
		No	Replace or adjust
18	Check if A/C system is malfunction.	Yes	Check A/C system
		No	Replace ECU

15）A/C system malfunction

1	Check if there is full coolant and check if A/C belt, A/C clutch, pressure switch are normal	Yes	Next
		No	Eliminate malfunction
2	Turn on A/C switch at engine idle. Check if A/C thermistor is malfunction	Yes	Eliminate malfunction
		No	Next
3	Turn on A/C switch. Connect adaptor between ECU and harness. Check if output signal for ECU pin 40 and 41(A/C switch)	Yes	Next
		No	Check harness
4	If the vehicle is low-level controlled, Check if A/C can work when turn off A/C.	Yes	Replace bulb or repair harness
		No	Next
5	Check if output low-level is on ECU pin 22(connect earth terminal of A/C relay pull-in coil)	Yes	Repair A/C relay and harness
		No	Replace ECU

8. Precaution for system services

1) Precaution for services EFI

(1) Controller removal request

Remove controller before welding or painting;

Turn off ignition switch when removing controller to void damage;

Don’t remove power wires from battery when engine running or electric appliance is in using;

Don’t start engine with charging set’s high current;

Note that the ambient temperature of controller could not exceed 80C°

(2) Clean request: Please observe following regulations:
Put removed parts on clean place and cover them with suitable cloth.
Only allowed to pull out or insert each harness or tester harness after ignition switch turns off.
Make sure the correction for connecting wires when measuring voltage or ground for electronic control system;
Removing power wires from battery or pulling out controller connector will cause losing the information for diagnosis and self-learning stored in memory.
(3) Precaution for fuel system service
When removing or installing fuel pump in fully or partial fully fuel tank, pay close attention to:
Mounting equipment that could absorb leaked fuel on tank outlet before operation;
Avoid skin touch with fuel directly;
Cover or block out the opened parts if not be used at once;
Take out parts only before installing. Don't use the parts without package;
Don't damage o-ring during installing injector. Smear a little lubricant on o-ring for better fitting;
Don't use compressed air or move vehicle when opening system.

2) Safety precaution
In order to avoid personal hurt or damage injector and ignition unit, pay close attention to:
(1) Don't touch or pull out ignition harness if engine is running or starting;
(2) Pull bout harness connector if engine is started by starter motor (for example in the situation of checking compressed air).