Fuel System

General Information

SPECIFICATIONS

Items			Specification
Sensors	BPS(Booster pressure sensor)	Supply voltage	5 V
		Operating voltage	0.5~4.5 V
		Operating temperature	-40~125°C
		Operating pressure	50~500 kpa
		Current	MAX. 10 mA
	IAT(Intake air temperature)	Type	Thermistor
		Resistance	2.31~2.56 kΩ [At 20°C(68°F)]
			0.30~0.34 kΩ [At 80°C(176°F)]
	WTS(Water temperature sensor)	Type	Thermistor
		Resistance	2.31~2.59 kΩ [At 20°C(68°F)]
			0.314~0.331 kΩ [At 80°C(176°F)]
	TDC(Top dead center) sensor	Type	Hall sensor
	CKP(Crankshaft positon sensor)	Type	Magnetic
	APS(Accel positon sensor)	Type	Variable resistance(Potentiometer)
		Voltage	5 V ± 1%
		Current	Max. 10 mA
	Fuel pressure sensor	Type	Piezo electricity
Actuator	Injector	Type	Electromagnetic
		Resistance	0.45 Ω
Supply control valve	SCV	Current	Active : Below 1.29 A
			When stopped :Below 1.16 A
Fuel tank		Capacity	100 L
Fuel pressure of high pressure side		Max. pressure	1,800 bar
Supply pump		Type	Included into high pressure pump mechanical type
		Power	Mechanical gear type
Fuel filter		Type	Filter

EGR Valve specification

Items	Specification
Valve type	Flap type
Control type	Electric DC motor

Sealant

Water temperature sensor(Coolant temperature sensor)	Loctite 200 or equivalent

Inspection

Item	Reference value
Idle speed(rpm)	650±25

Tightening torque

Items	Kgf.m	N.m	lb-ft
ECM mounting bolt	1.9 ~ 2.8	18.6 ~ 27.4	13.8 ~ 20.4
Mass air flow sensor mounting bolt	0.8 ~ 1.2	7.8 ~ 11.8	5.8 ~ 8.7
Crankshaft position sensor mounting bolt	0.8 ~ 1.2	7.8 ~ 11.8	5.8 ~ 8.7
TDC sensor mounting bolt	0.8 ~ 1.2	7.8 ~ 11.8	5.8 ~ 8.7
EGR valve mounting bolt(Inlet pipe)	1.0 ~ 1.4	9.8 ~ 13.7	7.2 ~ 10.1
EGR valve mounting bolt(EGR cooler)	1.0 ~ 1.4	9.8 ~ 13.7	7.2 ~ 10.1
High pressure pipe(rail-injector 1,2,3,4,5,6)	4 ~ 5	39 ~ 49	29 ~ 36
Common rail assembly mounting bolt	1.9 ~ 2.8	18.6 ~ 27.4	13.8 ~ 20.4
Fuel filler pipe assembly mounting bolt	0.8 ~ 1.2	7.8 ~ 11.8	5.8 ~ 8.7
Fuel return pipe mounting bolt	0.8 ~ 1.2	7.8 ~ 11.8	5.8 ~ 8.7
Fuel supply pump flange mounting bolt	10 ~ 13	98.6 ~ 128	72.3 ~ 94
Fuel supply pump mounting bolt	1.9 ~ 2.8	18.6 ~ 27.4	13.8 ~ 20.4
Injector clamp bolt	2.9 ~ 3.1	28.42 ~ 29.4	21 ~ 22.4

TROUBLESHOOTING

Symptom	Possible causes	Remedy
Engine does not crank.	Low cranking speed	Repair the starter or charge or replace battery.
	Low voltage to glow plug system	If the test light turns on indicating low voltage when it turns “ON”, check relay and wiring.
	Defective glow plug	Replace the glow plug.
	Air in the fuel system	Air bleeding of fuel system
	Injection pipe is connected incompletely.	Connect the pipe correctly
	Improper injection timing	Check ECM.
	Poor injection	Check, replace injector.
	Mechanical defect of engine	Test compression, repair engine.
	Simultaneous failures of TDC sensor and CKP sensor	Check and tighten correctly.
Idle is improper or idle speed is unstable or irregular.	Loose fuel hose connection between filter and supply pump.	Tighten or repair.
	Air in the fuel system	Air bleeding of fuel system
	Fuel filter is clogged. Or fuel supply is no good because fuel line or injection pipe leaks, pinched or pressed.	Check hose or fuel line. Replace fuel filter if necessary.
	Poor injection	Check, replace injector.
	Improper injection timing	Check ECM.
	Mechanical defect of engine	Test compression, repair engine.
	Defective supply pump	Let the engine at idle after replacing pump.
	Engine defect at high gear range	Observe correct shift speed.
	EGR valve malfunction	Check or replace EGR valve.
Exhaust gas (Black, blue, white)	Engine temperature stays below engine operating temperature.	Check cooling system. Replace thermostat.
	Abnormal at max. RPM	Check and replace supply pump.
	Defective Injection nozzle	Check and repair or replace.
	Improper injection timing	Check ECM.
	Exhaust system malfunction	Check for deformed or clogged.
	Mechanical defect of engine	Test compression, repair engine.
	Defective supply pump	Replace supply pump.
	EGR valve malfunction	Check or replace EGR valve.

Symptom	Possible causes	Remedy
Engine lacks power, acceleration is delayed(Speedometer is normal, no clutch slip)	Abnormal at max. RPM	Check, replace supply pump.
	Contaminated air cleaner filter	Clean or replace.
	Fuel filter is clogged. Or fuel supply is no good because fuel line or injection pipe leaks, pinched or pressed.Or fuel filter leaks.	Check hose or fuel line. Replace fuel filter if necessary.
	Air in fuel system	Air bleeding of fuel system
	Defective supply nozzle	Check, repair or replace.
	Improper injection timing	Check ECM.
	Mechanical defect of engine	Test compression, repair engine.
	Defective injection pump	Check after replacing pump.
	EGR valve malfunction	Check, replace EGR valve.
Excessive fuel consumption	Contaminated air cleaner filter	Clean, replace air cleaner filter.
	Fuel leaks	Check all pipes, hoses and connection. Replace or tighten as required.
	Clogged return pipe and hose.	Check and replace the return line, blow air if clogged and drain the fuel.
	Defective injection nozzle	Check. Repair or replace.
	Mechanical defect of engine	Compression test, replace engine.
	Defective supply pump	Replace pump.
	EGR valve malfunction	Check or replce EGR valve.

Engine control

Symptom	Possible causes	Remedy
Engine will not turn off.	Injector wiring short	Check injector wiring.
	Starting switch harness is damaged.	Replace.

Engine starting system

Symptom	Possible causes	Remedy
Engine does not crank	Low battery voltage	Recharge or replace the battery.
	Battery cable connection is loose, corroded or worn.	Replace or retighten.
	Fusible link is swelled.	Replace the fusible link.
	Defective starter motor.	Repair.
	Defective injector	Replace.
Cranking speed is low	Low battery voltage	Recharge or replace the battery.
	Battery cable connection is loose, corroded or worn	Repair or replace.
	Defective starter motor	Repair
Starter motor continues to run.	Defective starter motor	Repair
	Defective ignition switch	Replace the ignition switch.
Starter motor runs but engine is not cranking.	Defective wiring	Repair wiring.
	Starter motor, pinion gear damaged	Repair starter motor.
	Ring gear damaged	Replace flywheel or torque converter gear.

Fuel tank and fuel line

Symptom	Possible causes	Remedy
Poor engine performance due to insufficient fuel supply	Fuel pipe is twisted or bended	Repair or replace.
	Fuel pipe or hose is clogged	Clean or replace.
	Fuel filter is clogged	Replace.
	Entry of water to fuel filter	Replace fuel filter or clean fuel tank or fuel line.
	Foreign materials intrude in fuel tank. Fuel tank rusts.	Clean or replace.
	Defective supply pump operation (Clogged filter in pump)	Replace.
Fuel filter warning lamp blinks.	Excessive water is in fuel filter.	Drain the water collected in the fuel filter (Loosen the drain plug at the bottom of fuel filter.)
Engine check lamps blinks.	Clogged fuel filter.	Replace fuel filter.

Troubleshooting procedure

Troubles / Check items	Engine does not crank	Restart after engine stop	Hard to crank the engine	Stay in high rpm (without any accel pedal pressing)	Knocking during acceleration (during warm-up)	Vibrates at idle	Lacks of power	Poor engine operation, ignition fail, knocking	Bucking (sudden movement)
Self-diagnosis	1	1	1	1	1	1	1	1	1
Vehicle supply voltage	2		2					9	3
Main relay	3	3	3					11	4
Fuse/plug wire harness	4	2						8	2
Terminal 33(C10) (IG ON/OFF signal)	5	4	4					10	5
CKP sensor	6		6			15		12	
Run out of fuel	7								
Wrong fuel	8	5	7			2	3	3	
Fuel shortage								2	
Air mixture in fuel	9	6	8			3		4	
Low pressure circuit (fuel)	10	7	12			4	4	7	
High pressure circuit (fuel)	14	8	13			12	14	17	
Fuel filter	11		9			5	5	5	
Supply pump	16		11					6	
Fuel pre-heater	12		10			6	6		
Wrong injector connection	13		16		3	11	17	13	
Injector	15	9			4	9	13	14	
Mechanical components (Pressure valve gap, compression etc.)	19		18				16	18	8
Defective ECU	20								
TDC sensor	22		5						
Water temperature sensor (WTS)			14		2		15		
Coolant loss									
Glow plug system	21		16						

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Troubles / Check items	Engine does not crank	Restart after engine stop	Hard to crank the engine	Stay in high rpm (without any accel pedal pressing)	Knocking during acceleration (during warm-up)	Vibrates at idle	Lacks of power	Poor engine operation, ignition fail, knocking	Bucking (sudden movement)
Self diagnosis	1	1	1	1	1	1	1	1	1
Rail pressure sensor (RPS)	18		15			10	11	15	
Accel position sensor (APS)				2			7		
Mechanical defect of accel				3			8		
Booster pressure sensor						8	12		
Air filter is clogged			17			7	2		
Defective turbo charger							9		
Waist gate valve connection							10		
Check the valve tension								16	
Clutch switch									6
Brake switch									7
Vehicle speed signal									7
Check the Oil level									
Radiator fan									
Radiator is defective or clogged									
Defective IG switch									
AC pressure SW									
AC SW									
Plug adhesion			6						
Leaks at the connection of turbo and intake manifold			6				11		
EGR valve							15		

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Troubles / Check items	Engine overruns, accel	White/blue smoke	Discharging black smoke	Engine overheat	Engine stop is impossible with ignition key	Diagnostic lamp remains on or blinking	AC is not turn on
Self diagnosis	1	1	1	1	1	1	1
Vehicle voltage supply							
Main relay					4	2	2
Fuse/plug wire harness					3		
ECM connector 33(CFD-ECM)(starting ON/OFF signal)							
CKP sensor							
Run out of fuel				2			
Wrong fuel							
Fuel shortage		3					
Air into the fuel		4					
Fuel filter							
Supply pump		5					
Fuel pre-heater							
Wrong injector connection							
Injector			7	7			
Mechanical components (Pressure valve gap, compression etc.)					5		
Defective ECU							
TDC sensor	6	2	6	3			5
Water Temperature Sensor (WTS)				6			
Coolant loss							
Glow plug system							
EGR valve			5				
AMF sensor			4				

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Troubles / Check items	Engine overruns, accel	White/blue smoke	Discharging black smoke	Engine overheat	Engine stop is impossible with ignition key	Diagnostic lamp remains on or blinking	AC is not turn on
Rail pressure sensor (RPS)							
Accel position sensor (APS)	3						6
Mechanical defect of accel	2						
Booster pressure sensor			3				
Air filter is clogged			2				
Defective turbo charger	4						
Waist gate valve connection	5						
Check the valve tension							
Clutch switch							
Brake switch							
Vehicle speed signal							
Check the oil level		6					
Radiator fan				4			
Radiator is defective or clogged				5			
Defective IG switch					2		
AC pressure SW							4
AC SW							3
Plug adhesion							
Leaks at the connection of turbo and In-manifold							

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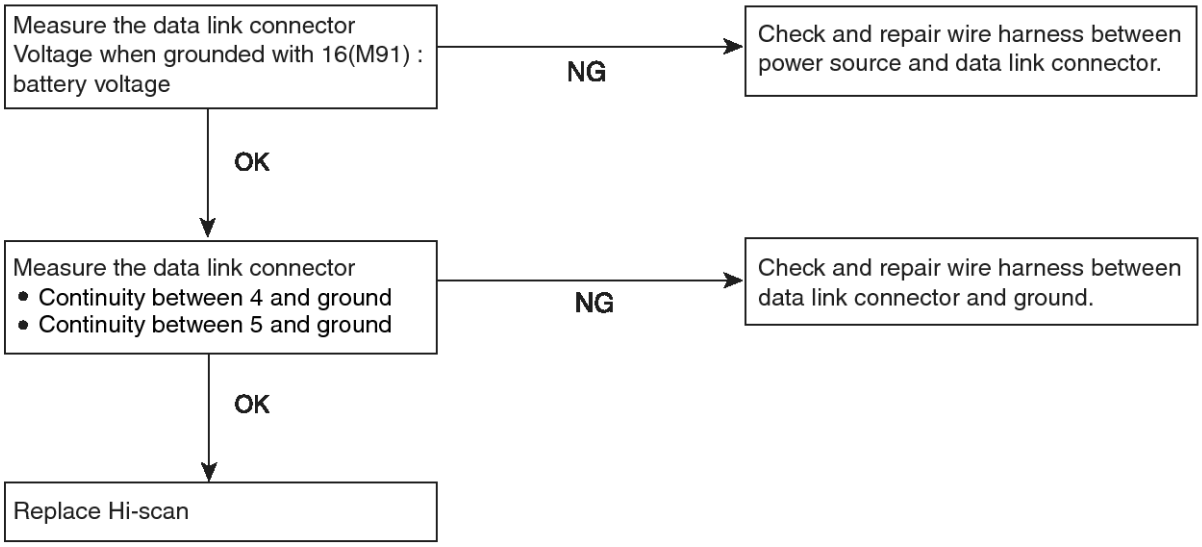
SERVICE PROCEDURE

Communication with diagnosis equipment is not possible

(Impossible communication with all systems)



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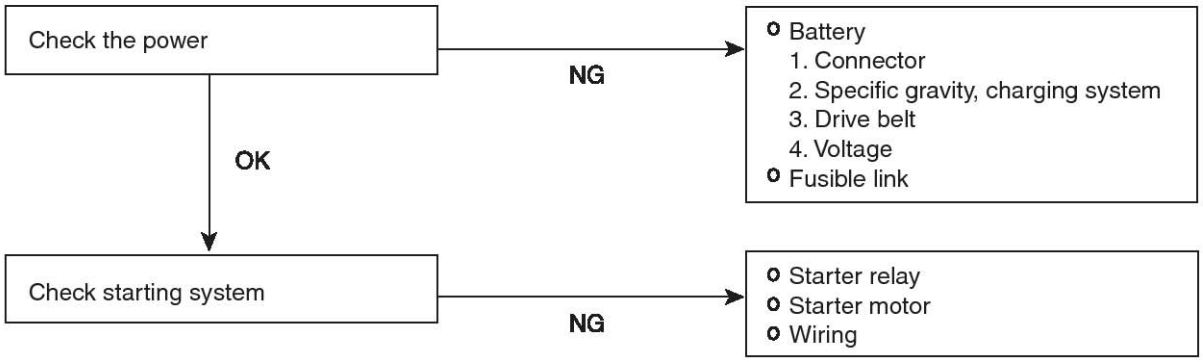
When communication between diagnosis equipment and ECM is not possible

Trouble symptoms	Probable causes
It shows at least one of the following symptoms. When power is not supplied to ECM, ECM ground circuit is defective. Defective ECM Wrong communication line between ECU and Hi-scan	 Power supply circuit to ECM is defective.ECM Malfunction ECM Circuit between ECU and DLC is open.

Engine does not start.



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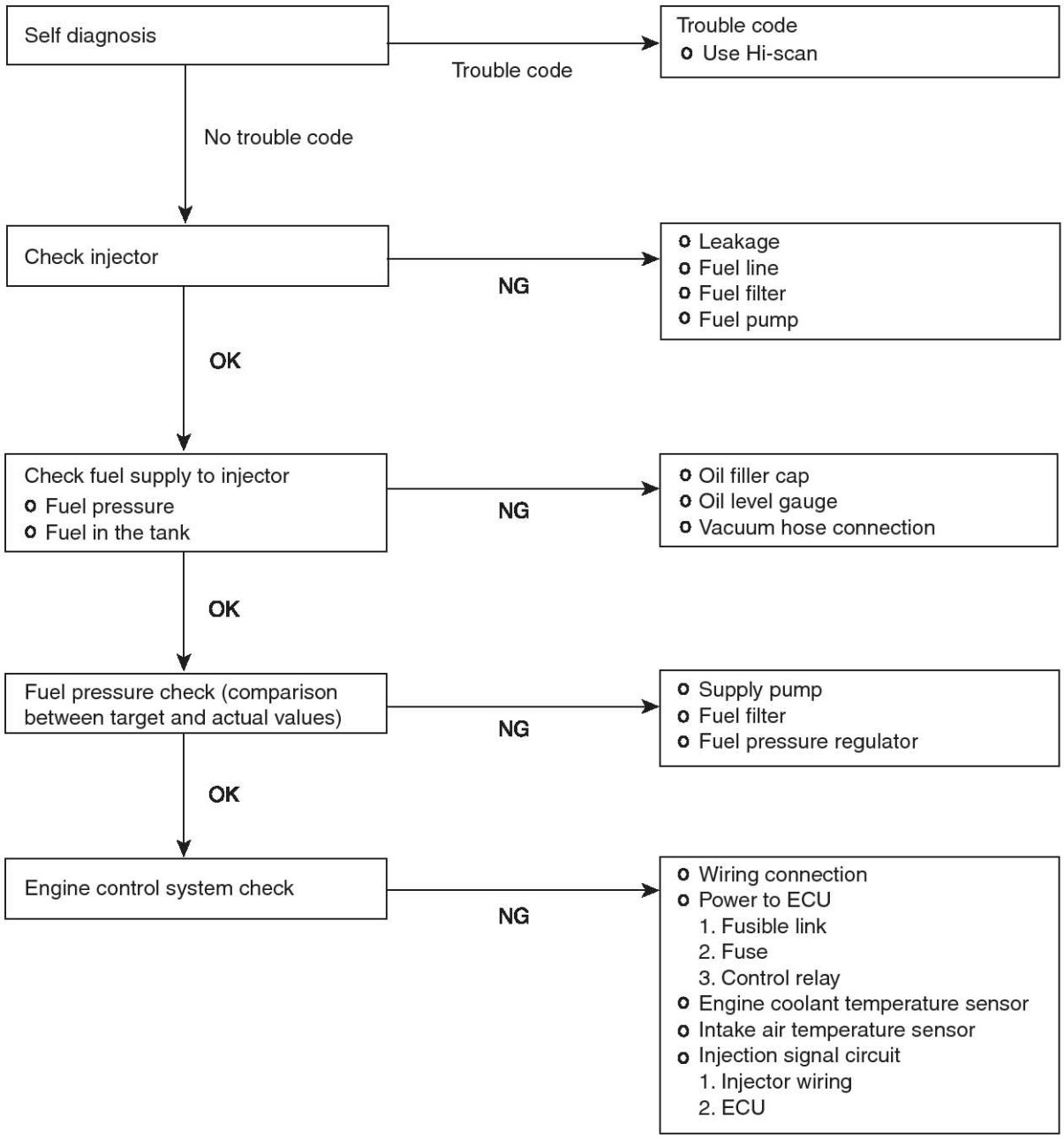
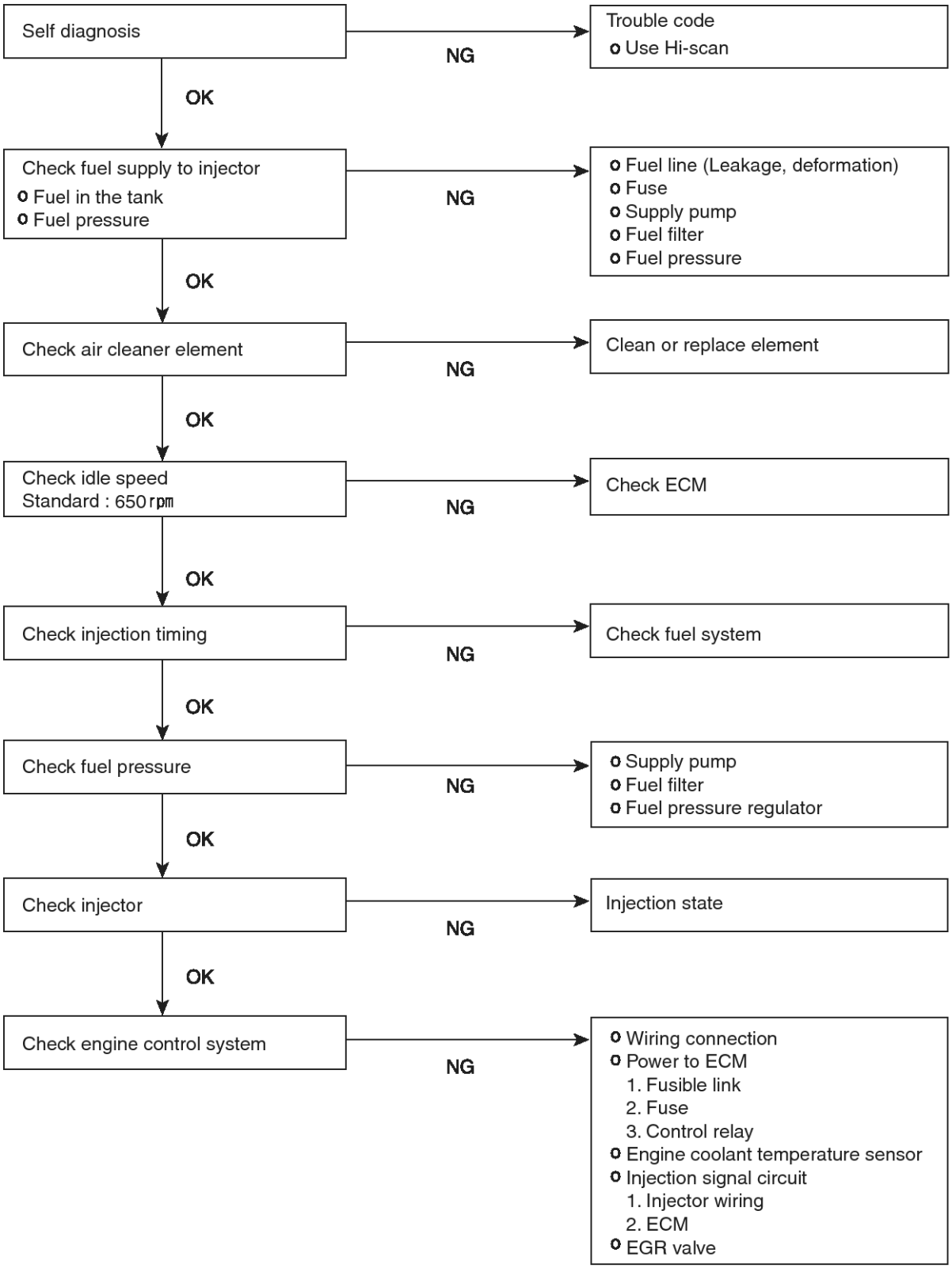
It is difficult to start the engine. (Possible cranking)



SDGFL9007L

Unstable idle or engine stall.



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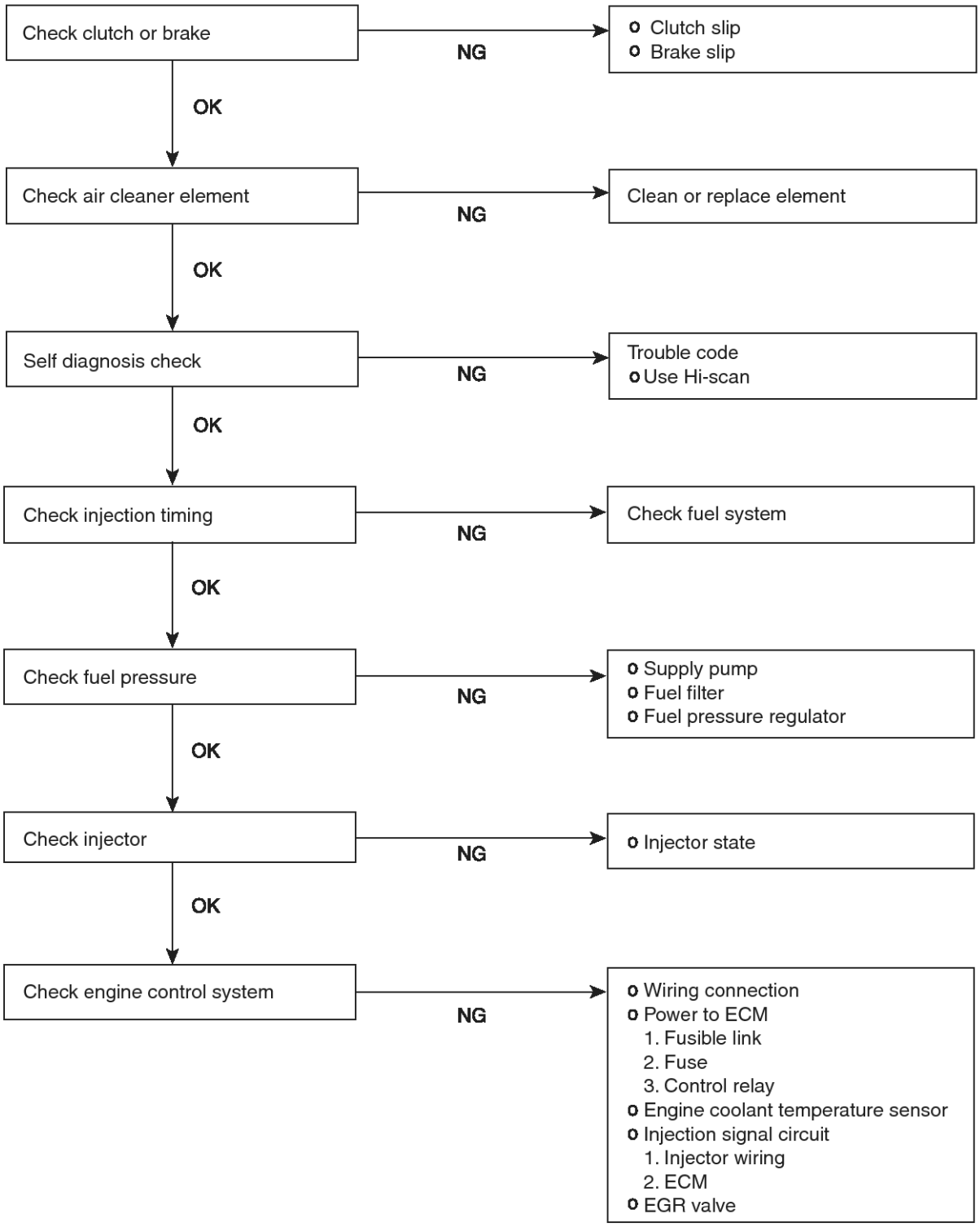
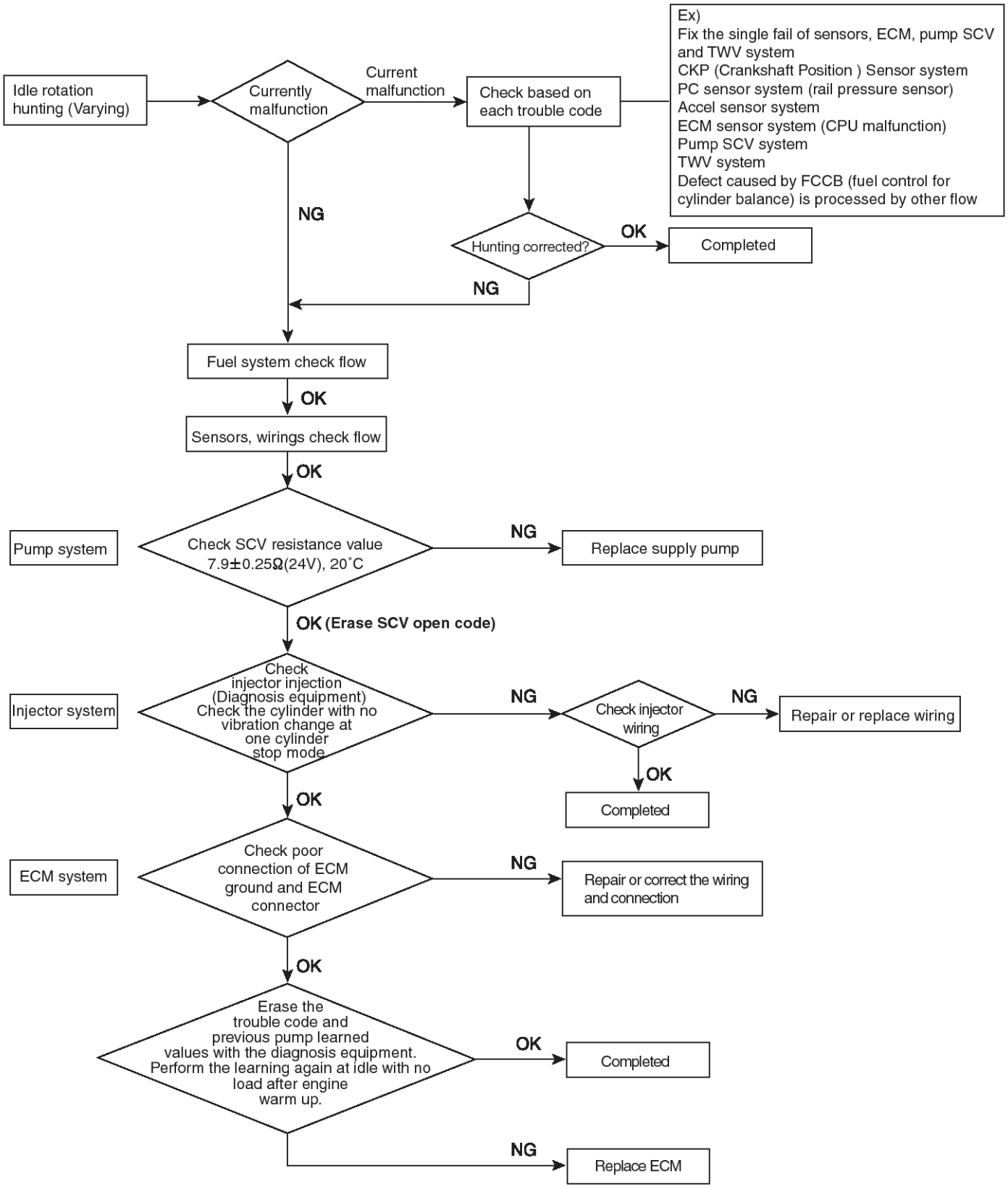
Engine hesitation or poor acceleration



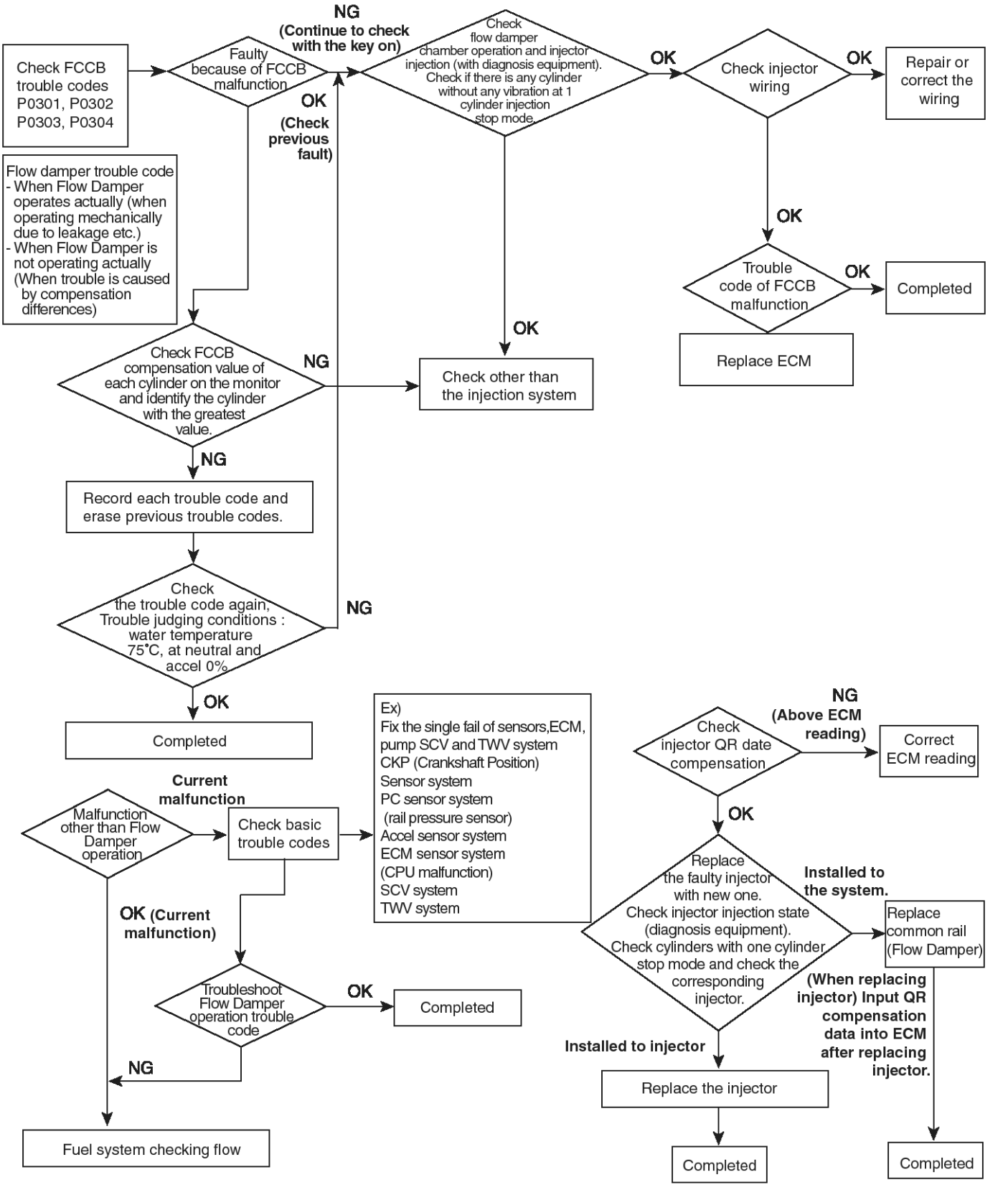
SDGFL9009L

Troubleshooting flow chart when HUNTING(Varying) occurs



SUDFL9004L

Troubleshooting flow chart when FCCB(Fuel control cylinder balance) fails.



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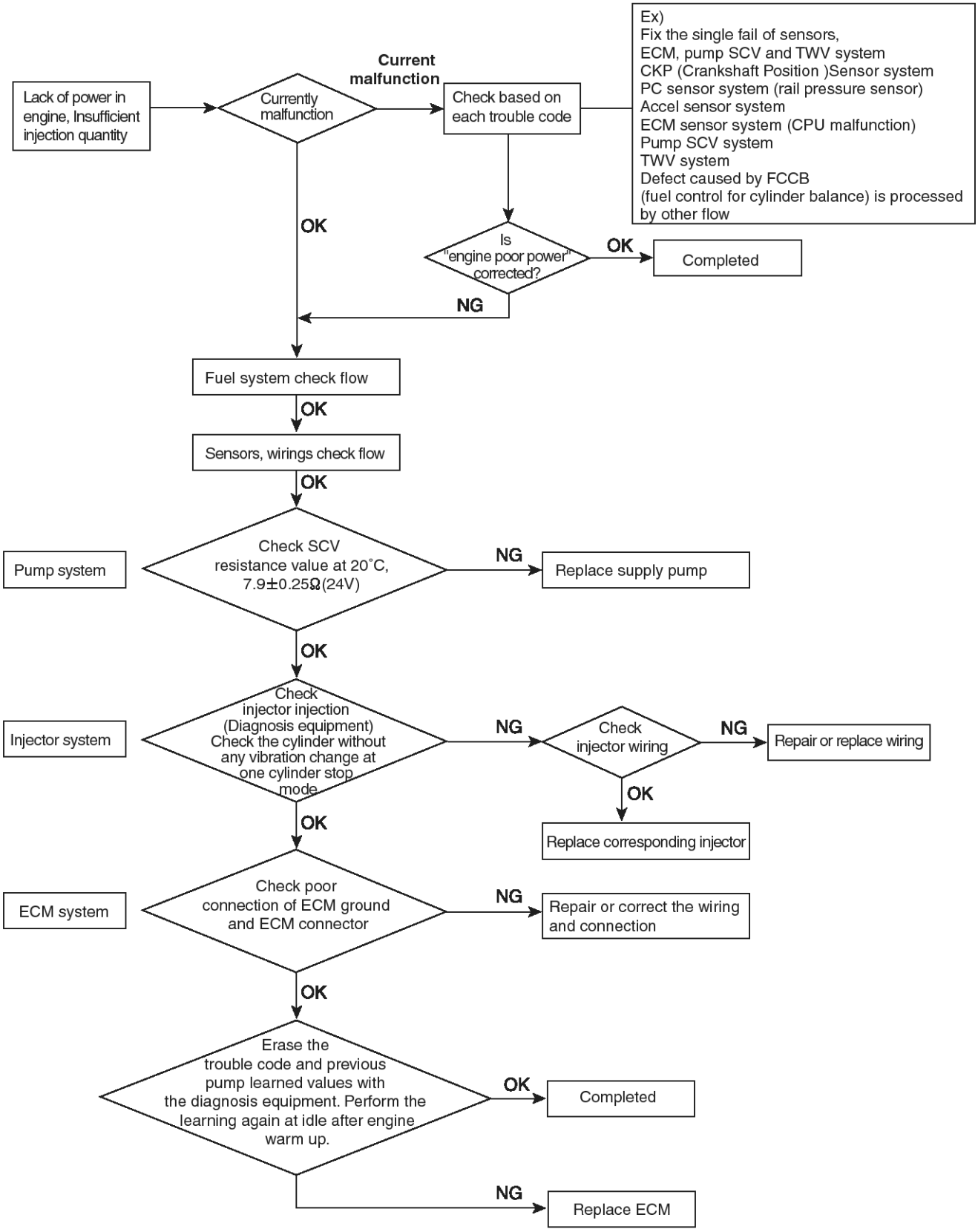
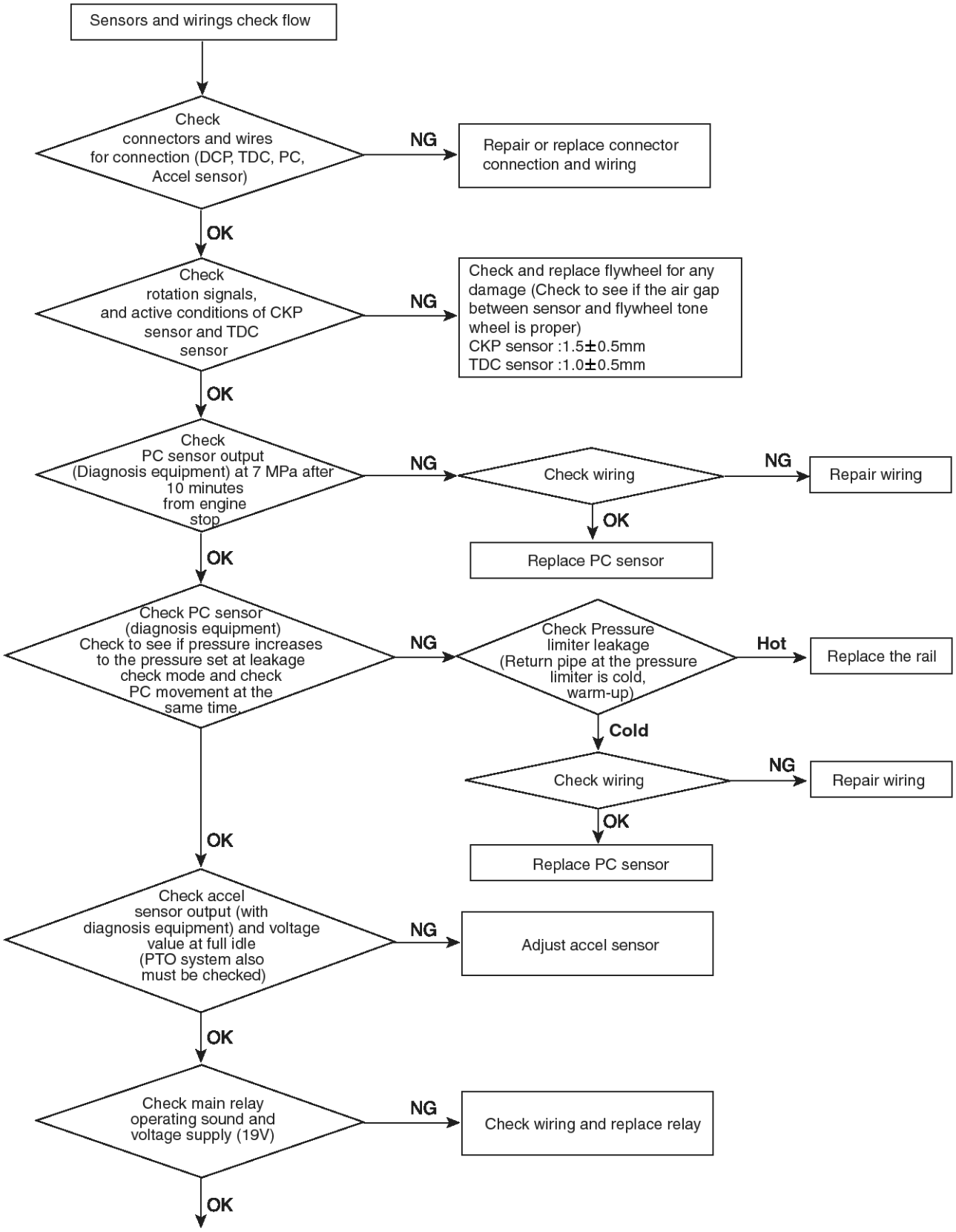
Troubleshooting flow chart when engine is lack of power



SUDFL9006L

Troubleshooting flow chart in systems of sensors and wirings



SDGFL9013L

CRS RAIL PRESSURE CHECK

■Items to check in the vehicle

1. Check for customer complaint and trouble symptoms.
2. Check reoccurrence or not for customer complaint and trouble symptoms mentioned above.
3. Record DTC codes or record the detailed DTC codes by using Hi-scan.

   Inspect and repair causes due to DTC codes.
4. Check rail pressure when turning ignition key to NO(Engine OFF).

   If the rail pressure is displayed, check it according to inspection procedure of remaining pressure.
5. Check for connector of rail pressure sensor.

   Check for wiring tension between rail pressure sensor and connector of vehicle side.

   Check that wiring between rail pressure sensor and connector of vehicle side is tight or not due to vibration(under driving) with interference in bracket of engine/vehicle etc.

   Check rail pressure sensor wire for clamp conditoin.

   Check that wire of rail pressure senor is clamped securely or not.

   Check rail pressure sensor and connector of vehicle side for connection conditon.

   With connector connected, check connector for shaking(with right and left/ back and forth).

   If there is free play, check for output of rail pressure/rail pressure sensor using Hi-scan or oscilloscope.
6. Check for wiring related to the output of rail pressure sensor.

   Check for voltage between each terminal of rail pressure sensor in the ECM side and terminal (-) of battery.

   Check wire between rail pressure sensor and ECM for continuity(resistance).
7. Visual check of connector

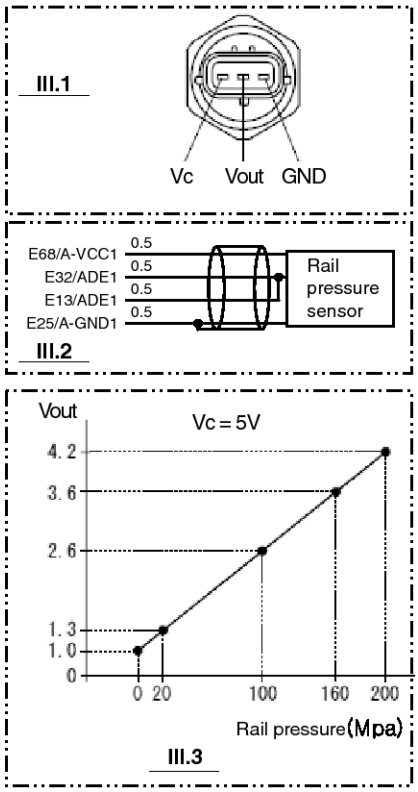
   Check each terminal contact part of rail pressure sensor for wear.

   Check connector housing of rail pressure sensor for wear.

   Check locking part/ guide part of rail pressure sensor connector for damage or deformation.

   Check the inside of rail pressure sensor connector for foreign materials(such signs as water, oil, spark, tracking etc.).

   Check the opposite connector for foreign materials, wear, damage, existence or not of rubber seal or shrinkage of rubber seal etc..



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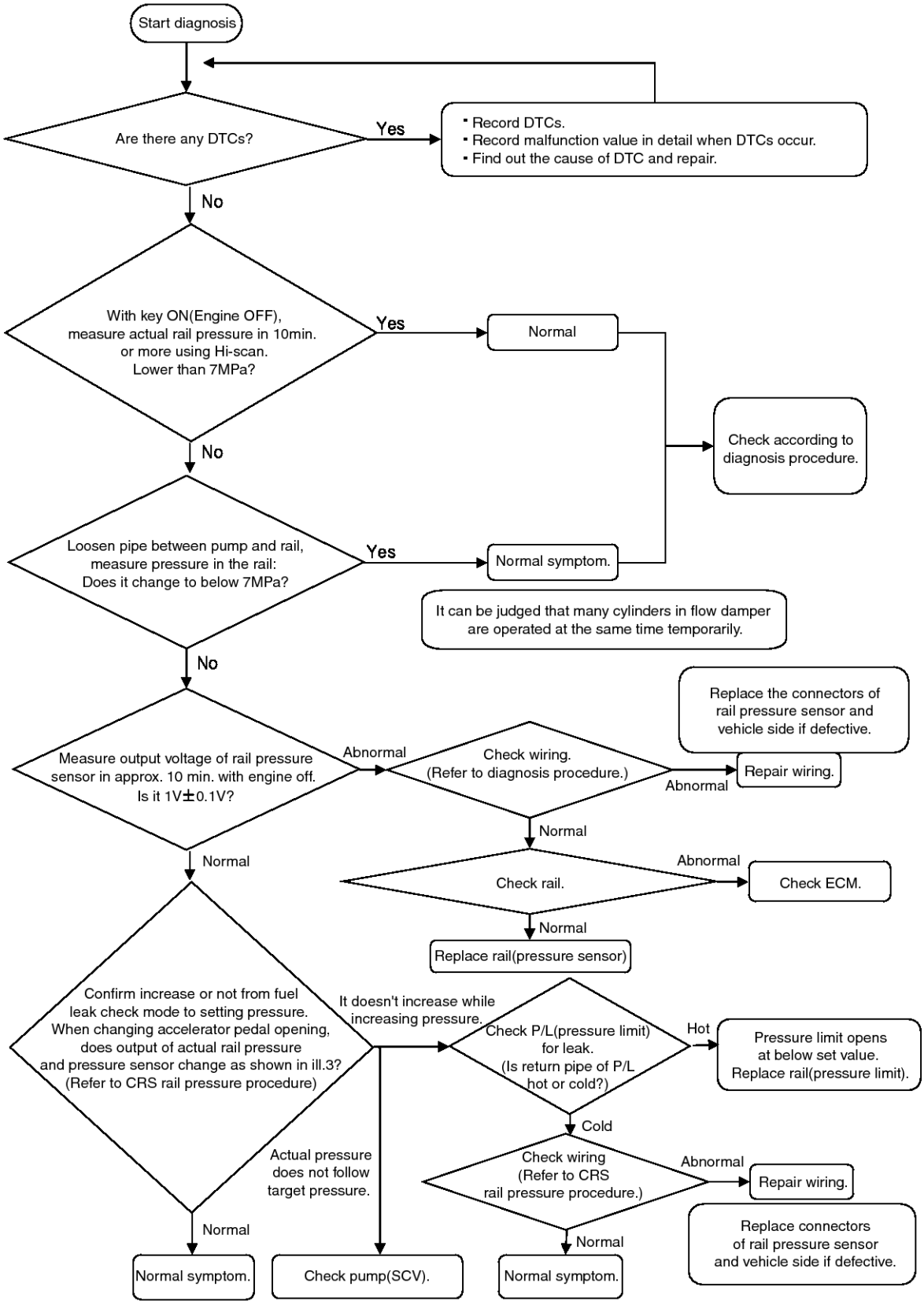
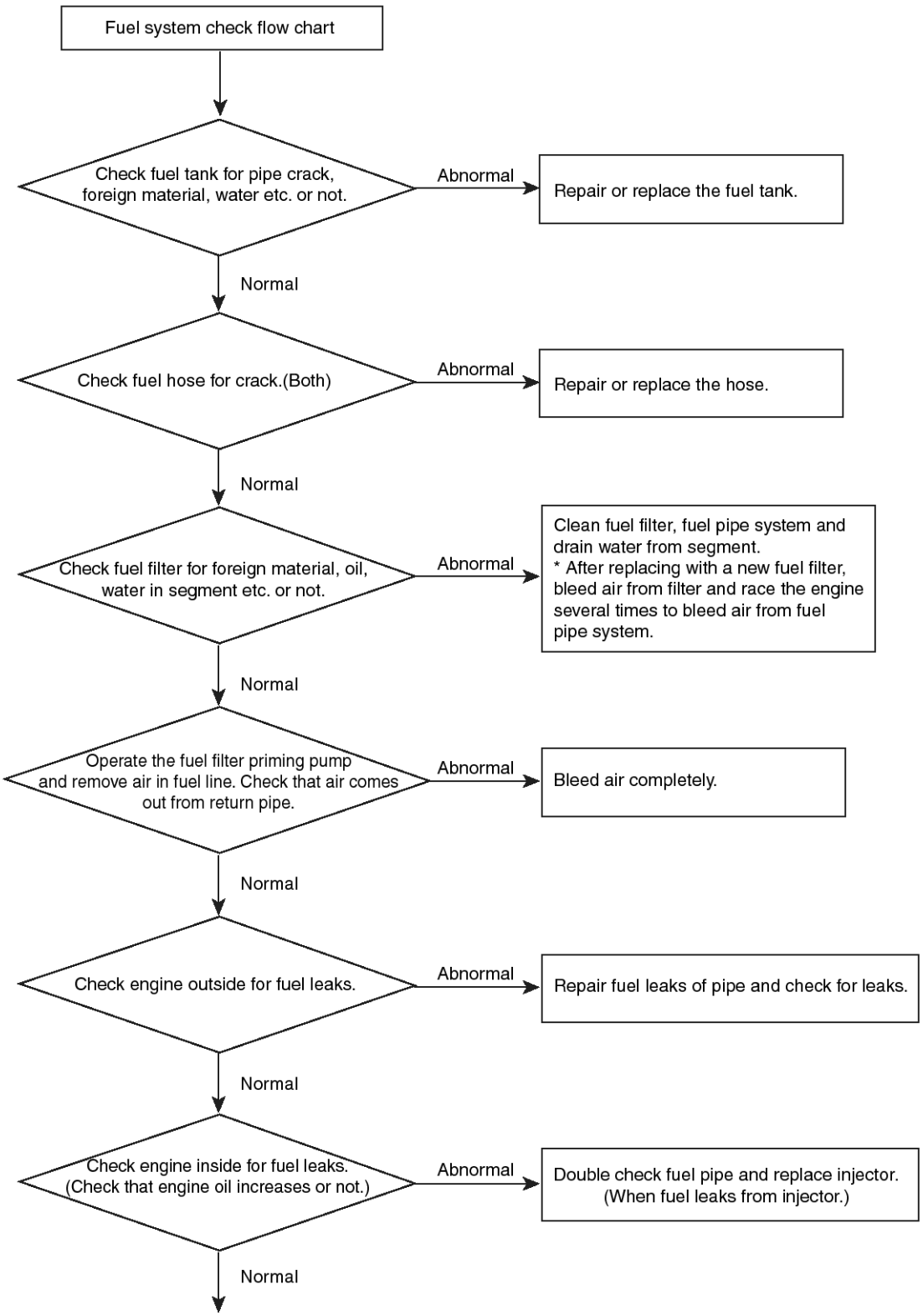
Rail pressure sensor terminal		Voltage check			Check wiring between rail pressure sensor and ECM	
Item	Pin No.	Check condition	ECM terminal side reference value	Measured value noise or not	Reference value/measured condition	Measured value
Vc	E68	Key On	4.9~5.1		Below 2[ohm]/Key Off	
Vout	E32	Key On/EngineOff	0.9~1.1		Below 2[ohm]/Key Off	
		Engine On/at Accel.	Refer to illustration 3		Below 2[ohm]/Key Off	
Vout	E13	Key On/Engine Off	0.9~1.1		Below 2[ohm]/Key Off	
		Engine On/at Accel.	Refer to illustration 3		Below 2[ohm]/Key Off	
GND	E25	Key On	0±0.1		Below 2[ohm]/Key Off	

CRS Rail pressure check flow chart



SDGFL9015L

Fuel system check processor



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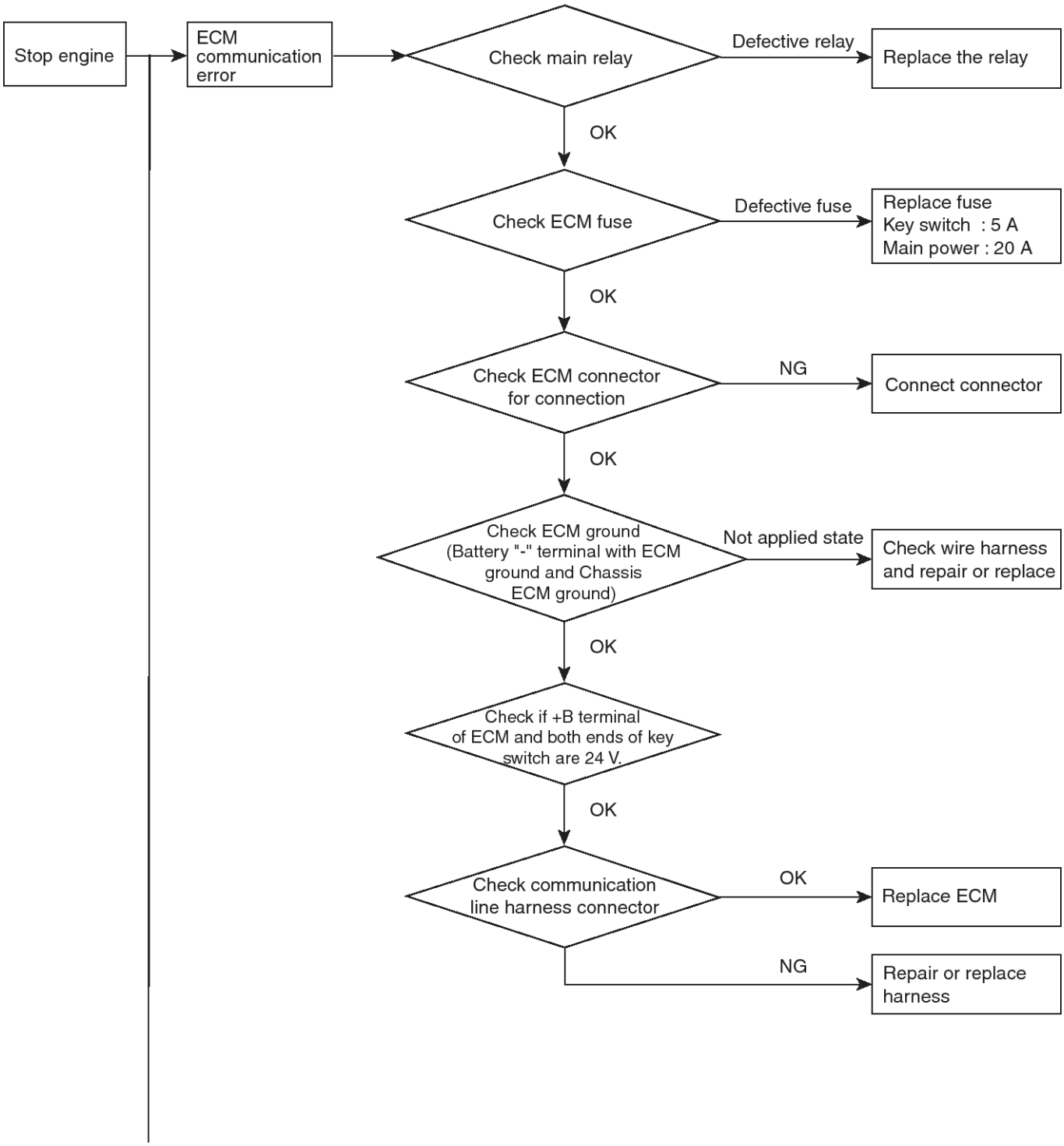
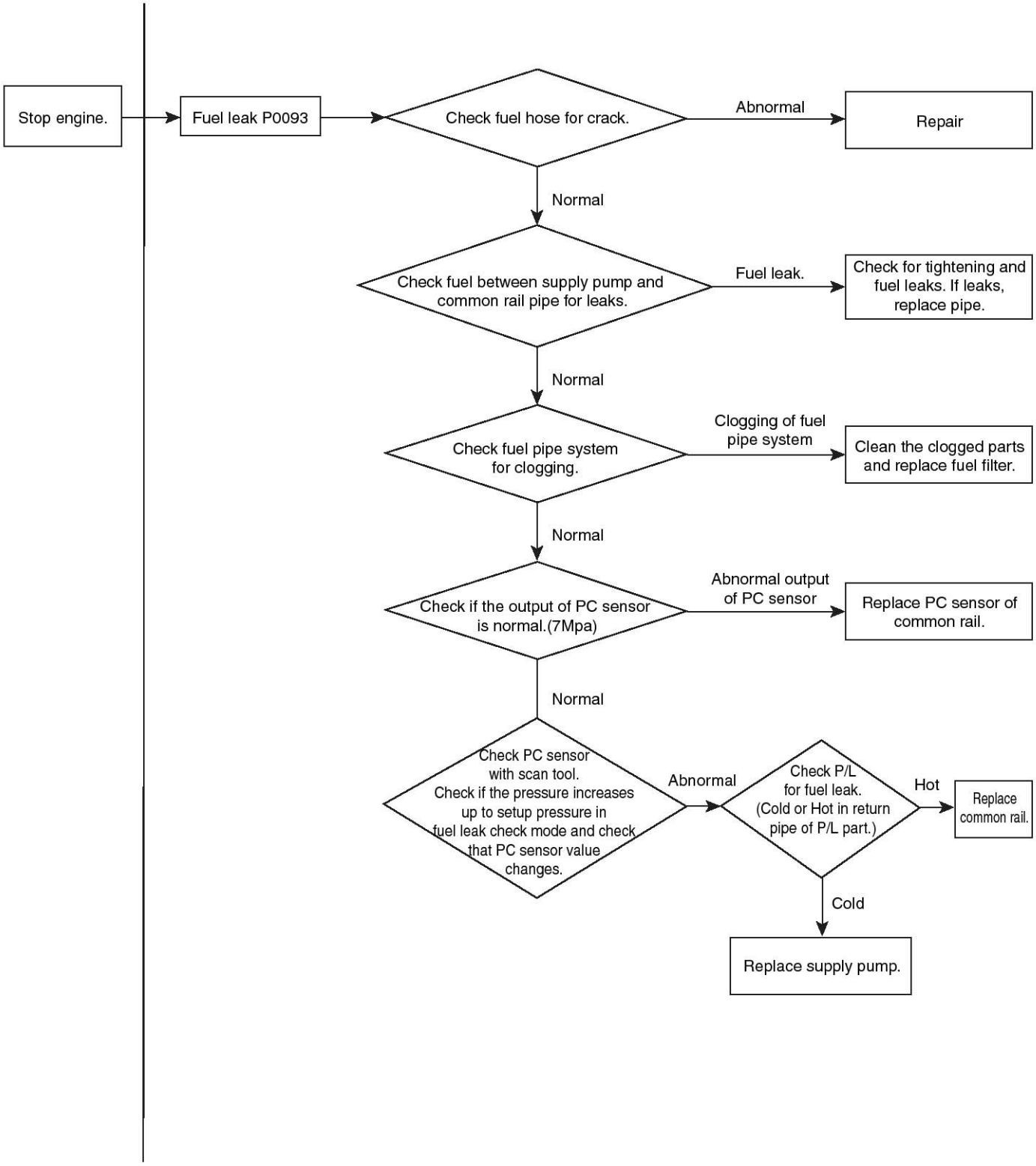
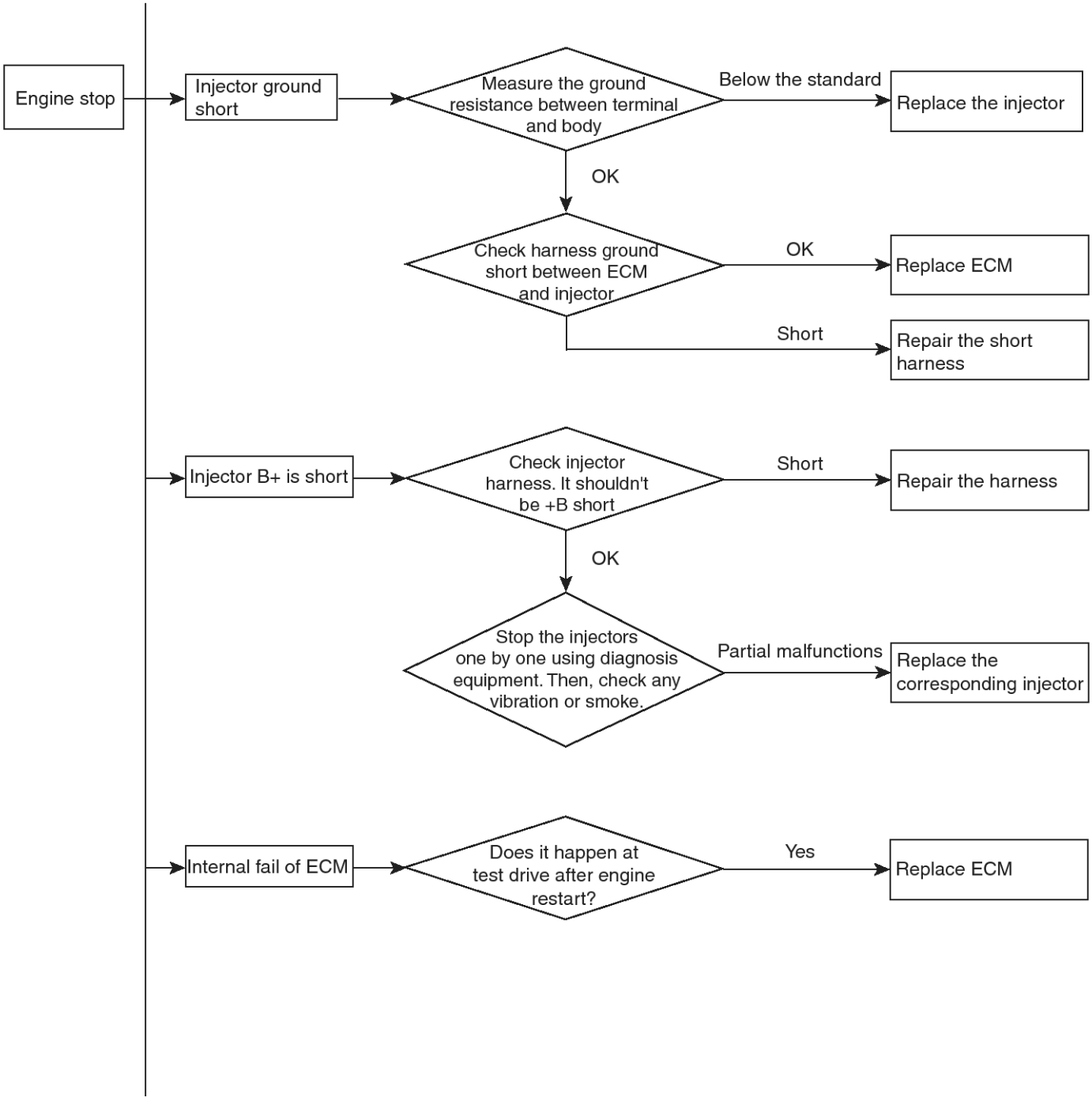
Troubleshooting flow chart when the engine stops



SUDFL9008L


Stop engine.
Fuel leak P0093
Check fuel hose for crack.
Abnormal
Repair
Normal
Check fuel between supply pump and common rail pipe for leaks.
Fuel leak.
Check for tightening and fuel leaks. If leaks, replace pipe.
Normal
Check fuel pipe system for clogging.
Clogging of fuel pipe system
Clean the clogged parts and replace fuel filter.
Normal
Check if the output of PC sensor is normal.(7Mpa)
Abnormal output of PC sensor
Replace PC sensor of common rail.
Normal
Check PC sensor with scan tool. Check if the pressure increases up to setup pressure in fuel leak check mode and check that PC sensor value changes.
Abnormal
Check P/L for fuel leak. (Cold or Hot in return pipe of P/L part.)
Hot
Replace common rail.
Cold
Replace supply pump.

SUDFL9009L


Engine stop
Injector ground short
Measure the ground resistance between terminal and body
Below the standard
Replace the injector
OK
Check harness ground short between ECM and injector
OK
Replace ECM
Short
Repair the short harness
Injector B+ is short
Check injector harness. It shouldn't be +B short
Short
Repair the harness
OK
Stop the injectors one by one using diagnosis equipment. Then, check any vibration or smoke.
Partial malfunctions
Replace the corresponding injector
Internal fail of ECM
Does it happen at test drive after engine restart?
Yes
Replace ECM

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Stop engine.
No trouble codes.
Fuel system
Check that fuel is delivered from fuel filter outlet.
Insufficient fuel
Check that fuel is not empty or hose cracks etc.
Normal
Check that air enters into fuel.
Air bubble
Bleed air until there is no air bubble.
Normal
Check the fuel tank and filter in fuel system for water or not.
Separate water.
Replace fuel, drain water, check parts of injection system and replace when carbon is mixed.
Normal
Check fuel quality is good or not.
Poor quality of fuel in use
Replace injector or use good quality of fuel.
Stop engine.
Electrical system
Disconnect engine stop switch connector and inspect.
Impossible repair
Replace switch.
OK
Apply voltage to engine stop switch and inspect.
Not applied.
Repair wiring and inspect.
OK
Check wire to wire for short. (24V short)
Short

SUDFL9010L

Electronic Engine Control System

DESCRIPTION

DIESEL CONTROL SYSTEM

Inspection of the diesel control system

If the components of the diesel control system (sensor, ECM, injector etc.) have a problem, the proper amount of fuel for various engine-operating conditions can not be supplied and also the following situations can occur.

1. It is hard to start the engine or does not start the engine at all.
2. Idling is unstable.
3. Engine driving performance is bad.

   If any of the above conditions are met, first perform a routine diagnosis that includes basic engine checks (ignition system malfunction, incorrect engine adjustment etc). Then, inspect the components of the diesel control system with multi-purpose tester or digital multi-meter.

   ⚠CAUTION

   Before removing or installing any part, read the diagnostic trouble codes and then, disconnect the battery negative (-) terminal.

   Before disconnecting the cable from battery terminal, turn the ignition switch to OFF. If the battery cable is removed or connected during engine operation or the situation in which the ignition switch is ON, then the ECU semiconductor could be damaged resulting in inaccurate operation.

Self-diagnosis

The ECM sends the input/output signals to various parts of engine(some signals at all times and the others under specified conditions).

After the specific time elapses the first detection of irregular signal, the ECU judges this as an irregularity and it records the diagnostic trouble code. And then it sends the signal to the self-diagnosis output terminal. The diagnosis results can be checked by the Hi-scan. In addition, Diagnostic Trouble Codes (DTC) will be directly backed up by the battery so that it will remain in the ECM even if the ignition switch is turned off. The diagnostic trouble codes will, however, be erased when battery terminal or ECM connector is disconnected.

⚠CAUTION

If, in most of diesel control system, the connector of a sensor is disconnected with the ignition switch turned ON, the diagnostic trouble code (DTC) is recorded in the ECM. In this case, if the battery negative terminal (-) is disconnected for 15 seconds or more, then the diagnosis memory will be erased.

Self-diagnosis check procedure

⚠CAUTION

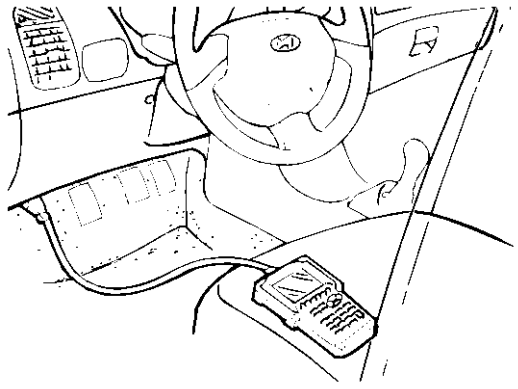
As DTC code may not be detected due to low battery voltage, the battery condition should be checked prior to inspection.

Since DTC code is erased if the battery or the ECM connector is disconnected, don't disconnect the battery until the diagnostic trouble codes are completely read and recorded safely.

It is most desirable to erase the diagnostic trouble codes using Hi-scan after completing check and repair. After disconnecting ground cable from the battery negative (-) terminal for 15 seconds or more, reconnect the cable and check if the trouble codes have been erased. (At this time, ignition switch must be turned off).

Inspection procedure (Using Hi-scan)

1. Turn off the ignition switch.
2. Connect the Hi-scan connector to the connector of DLC (Data Link Connector) for the trouble diagnosis as shown in the figure.
3. Turn the ignition switch ON.
4. Check the diagnostic code using Hi-scan.
5. Repair the parts having faults shown in the diagnosis chart.
6. Erase the diagnostic trouble codes.
7. Disconnect the Hi-scan.



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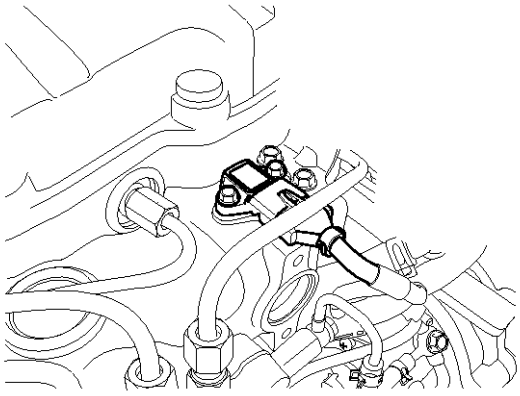
NOTICE

When using a tester manufactured by other company, operate the tester by referring to the manual of the company.

When erasing the diagnostic trouble codes, use Hi-scan if possible. Though DTC can be erased by disconnecting the battery terminal, doing so, the data for learning control in ECM would be erased at the same time.

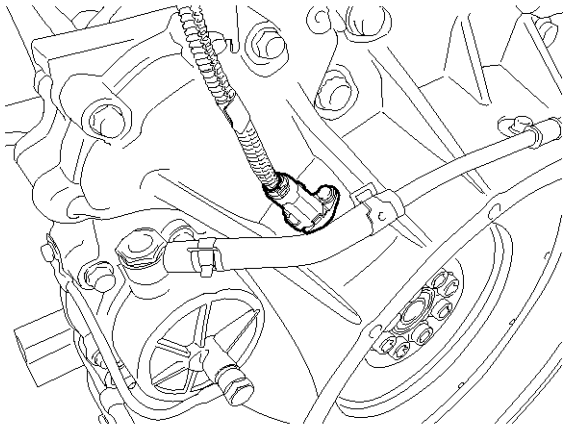
DIESEL CONTROL SYSTEM COMPONENTS LOCATION

1. Intake air temperature sensor and intake air pressure sensor



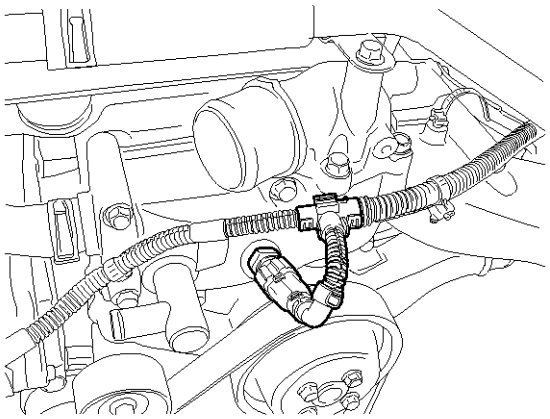
SDFFL7503D

2. Crankshaft position sensor



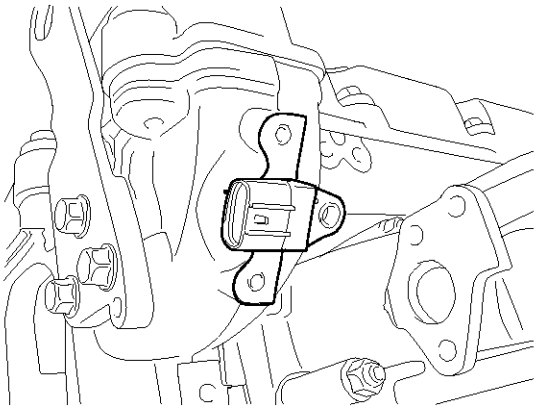
SDFFL7504D

3. Water temperature sensor(Coolant temperature sensor)



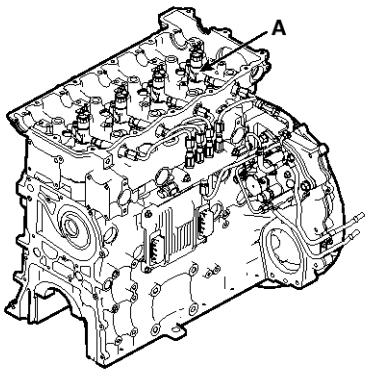
SDFFL7505D

4. Camshaft sensor



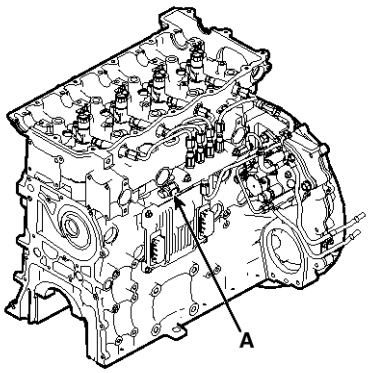
SDFFL7506D

5. Injector(A)



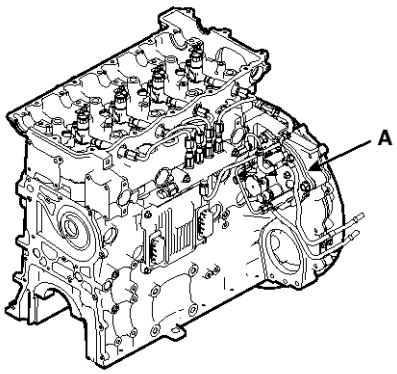
SDFFL7009D

6. Rail pressure sensor(A)



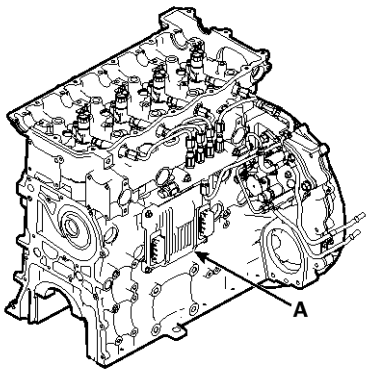
SDFFL7006D

7. Supply control valve(SCV, A)



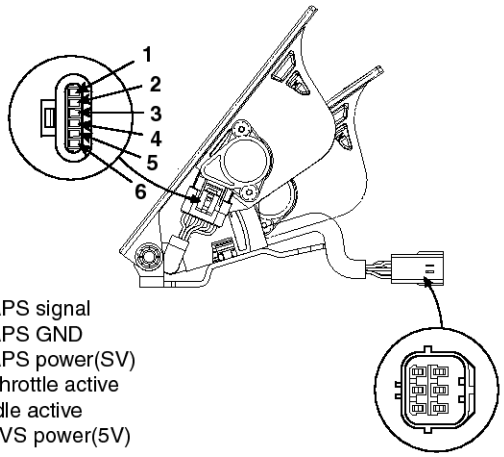
SDFFL7007D

8. ECM(Engine control module, A)



SDFFL7008D

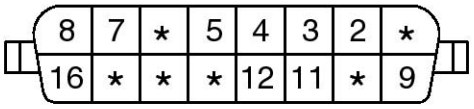
9. Accelerator position sensor



1. APS signal
2. APS GND
3. APS power(SV)
4. Throttle active
5. Idle active
6. 1VS power(5V)

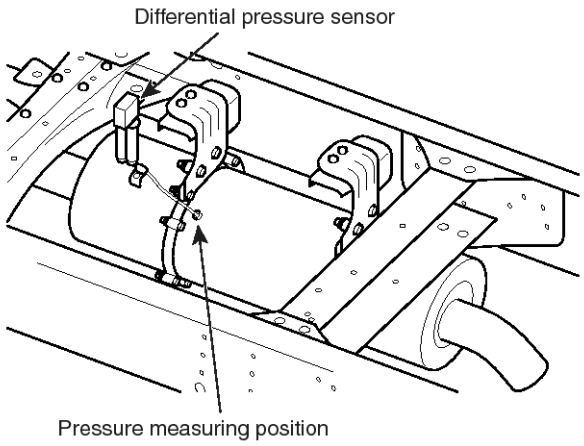
SUDFL9016L

10. DLC connector



SDFFL7314D

11. DPS(Differential Pressure Sensor)

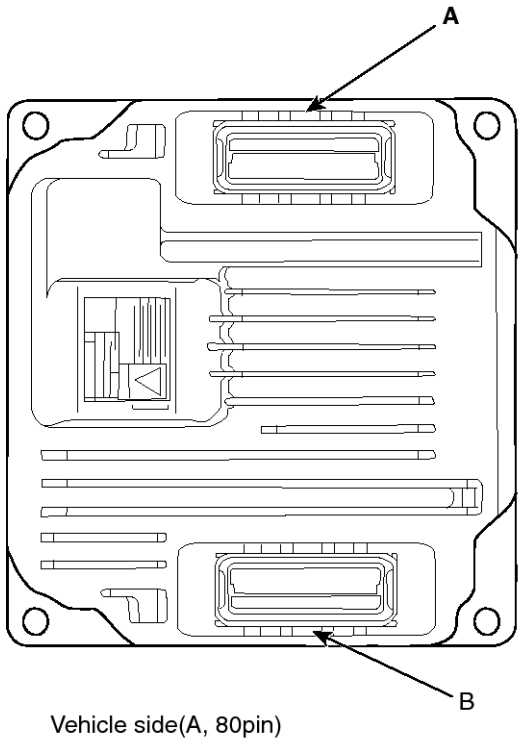


SUDFLDTC9108L

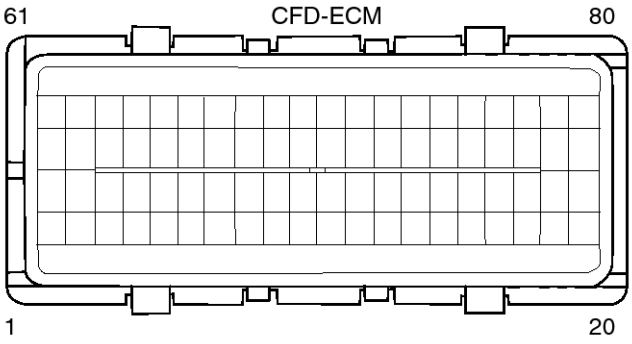
ECU(Engine Control Unit)

COMPONENTS

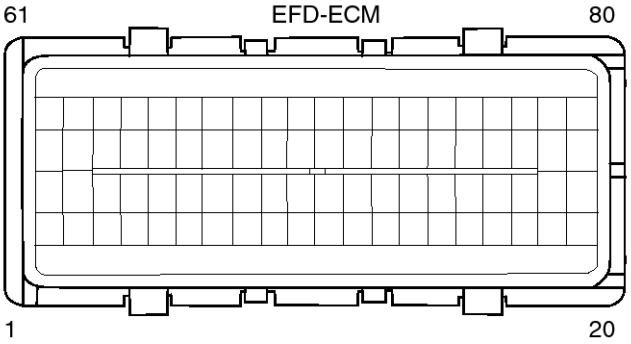
ECM PIN CONNECTOR



Vehicle side(A, 80pin)



Engine side(B, 80pin)



SUDFL9011L

Vehicle side(80pin connector) - ECM connector(CFD-ECM)

Terminal	Abbr.	Terminal name	Terminal	Abbr.	Terminal name
1	+BF	+B (For fly back)	41	SWV25	-
2	PWR-ACT1	-	42	SWV23	Stop lamp switch
3	OUTV1	Main relay	43	SWV21	Self-diagnosis switch
4	OUTV2	Exhaust brake relay	44	SWV19	Cruise main ON/OFF switch
5	OUTV3	Starter relay	45	A-ground 10	Sensor ground10
6	SOUT6	Check engine lamp and fuel pressure flashing	46	A-ground 12	Sensor ground 12
7	SOUT4	Glow lamp	47	ADV1	Accelerator position sensor 1
8	SOUT2	PTO lamp	48	ADV3	-
9	SOUT1	MIL lamp	49	ADV5	Exhaust temperature sensor 1
10	SWV6	PTO emergency switch	50	A-VCC10	Sensor power supply 10
11	SWV4	Neutral switch	51	A-VCC11	Sensor power supply 11
12	SWV2	Starter switch	52	SWV17	Remote PTO idle up & engine service start switch
13	SWV1	Ignition switch	53	SWV15	Idle down & PTO idle down & cruise resume switch
14	VS	Vehicle speed sensor	54	SWV13	A/C switch
15	POUT1	A/C control	55	SWV11	Clutch switch
16	CAN1L	CAN1L	56	SWV9	Exhaust brake switch
17	CAN2L	CAN2L	57	CAN-SLD	CAN1 shield ground
18	+B	+B	58	+B	+B
19	BATT	Battery	59	P-ground	Power ground
20	CASE-ground	Case ground	60	ground	Signal ground
21	+BF	+B (for fly back)	61	SWV26	PTO switch(Cap outside)
22	OUTV4	Warning lamp relay	62	SWV24	Starter relay monitor switch
23	OUTV1	Main relay	63	SWV22	Idle warm up switch
24	OUTV5	Heater relay	64	SWV20	Built-in data capture switch
25	SOUT8	Alternator control cut	65	A-ground 11	Sensor ground 11
26	SOUT7	Cruise lamp	66	A-ground 13	-
27	SOUT5	Overheat lamp	67	ADV2	Accel position sensor 2
28	SOUT3	Exhaust brake lamp	68	ADV4	PTO accel position sensor
29	SWV8	Door open switch	69	ADV6	Exhaust temperature sensor 2
30	SWV7	Bus rear flap switch	70	ADV7	Differential pressure sensor
31	SWV5	PTO switch	71	A-VCC12	Sensor power supply 12

Terminal	Abbr.	Terminal name	Terminal	Abbr.	Terminal name
32	SWV3	Engine stop switch	72	SWV18	Remote PTO idle down & engine service stop switch
33	SWV1	Key switch	73	SWV16	QT cut switch
34	TAC1	Tachometer	74	SWV14	Idle up & PTO idle up & cruise set switch
35	PIN5	-	75	SWV12	Brake switch
36	CAN1H	CAN1H	76	SWV10	Idle switch
37	CAN2H	CAN2H	77	KWP	-
38	+B	+B	78	+B	+B
39	P-ground	Power ground	79	P-ground	Power ground
40	Ground	Signal ground	80	P-ground	Power ground

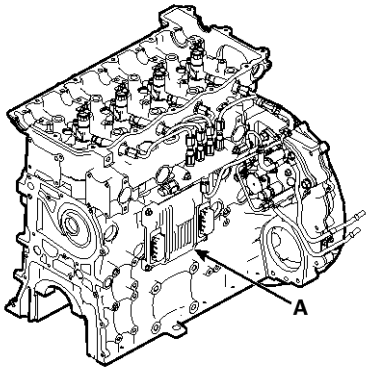
Engine side(80 pin connector) - ECM connector(EFD-ECM)

Terminal	Abbr.	Terminal name	Terminal	Abbr.	Terminal name
80	OUTE5	DC motor 1H	40	SWE1	Heater monitor switch
79	OUTE1	-	39	SWE3	-
78	OUTE3	Fan ON/OFF 2	38	ADE9	-
77	PWR-ACT2	Power ACT2	37	ADE7	Ambient temperature sensor
76	AUX2	-	36	ADE13	EGR valve position sensor
75	PWR-PCV	Not in use	35	ADE6	-
74	PCV1	Not in use	34	ADE4	Intake temperature sensor
73	PCV2	Not in use	33	ADE2	Fuel temperature sensor
72	SCV-HI	HP-4 high	32	ADE1	Rail pressure sensor
71	SCV-LO	HP-4 low	31	PIN2+	-
70	AUX1	Not in use	30	PIN1+	-
69	A-VAF	MAF power supply	29	NE+	Engine RPM sensor+
68	A-VCC1	Sensor power supply 1	28	G-VCC	Cam angle sensor power
67	COM1	Injection power 1	27	G-ground	Cam angle sensor ground
66	TWV1	Injection #1	26	INJ-SLD	Injection shield ground
65	TWV3	Injection #3	25	A-ground1	Sensor ground 1
64	TWV5	-	24	A-ground3	Sensor ground 3
63	COM2	Injection power2	23	A-ground5	Sensor ground 5
62	TWV2	Injection #2	22	CAN3H	CAN3H
61	TWV4	Injection #4	21	TWV6	-
60	OUTE6	DC motor 1L	20	SWE2	Fuel inlet pressure switch

Terminal	Abbr.	Terminal name	Terminal	Abbr.	Terminal name
59	OUTE2	Fan ON/OFF 1	19	ADE10	-
58	OUTE4	-	18	ADE8	-
57	PWR-ACT2	Power ACT2	17	ADE14	-
56	PWR-ACT2	Power ACT2	16	ADE12	-
55	PWR-PCV	Not in use	15	ADE5	Water temperature sensor
54	PCV1	Not in use	14	ADE3	Boost sensor
53	PCV2	Not in use	13	ADE1	Rail pressure sensor
52	SCV-HI	HP-4 high	12	ADE11	Air MAS flow sensor
51	SCV-LO	HP-4 low	11	PIN2-	-
50	NE(MRE)	-	10	PIN1-	-
49	PRD+	Not in use	9	NE-	Engine RPM sensor -
48	A-VCC2	Sensor power supply 2	8	G	Cam angle sensor signal
47	COM1	Injection power1	7	PIN3	-
46	TWV1	-	6	NE-SLD	NE Shield ground
45	TWV3	-	5	A-ground 2	Sensor ground 2
44	TWV5	-	4	A-ground 4	Sensor ground 4
43	COM2	Injection power 2	3	A-ground 6	Sensor ground 6
42	TWV2	-	2	CAN3L	CAN3L
41	TWV4	-	1	TWV6	-

REMOVAL

1. After the engine stops, wait for about 30 seconds.
2. Disconnect the battery ground line.
3. Remove ECU connector wiring sequentially.
4. Loosen ECU bracket mounting bolt and remove ECU(A).



SDFFL7008D

5. Installation is in the reverse of removal.

Adjustment procedure after replacing ECU

1. Perform work procedure using diagnostic tool when replacing with a new ECU.
2. Input injector QR correction value using diagnostic tool with the ignition key ON.

   Follow the instructions on the diagnostic tool as to how to input injector QR correction value.

   If the input of injector QR correction value was completed, start the engine in 10 sec. after turning the ignition key OFF.

   ⚠CAUTION
   In case QR correction value described on the injector is not input in the ECU, there may cause engine performance and exhaust gas problem.
3. Select learning initialization instructed by diagnostic tool and perform pump learning initialization and accelerator sensor learning.
4. According to the instructions on diagnostic tool, select parameter setting and perform work in sequence.

Mass Air Flow Sensor

INSPECTION

DESCRIPTION

MAF sensor is built into the vehicle for controlling the EGR system precisely.

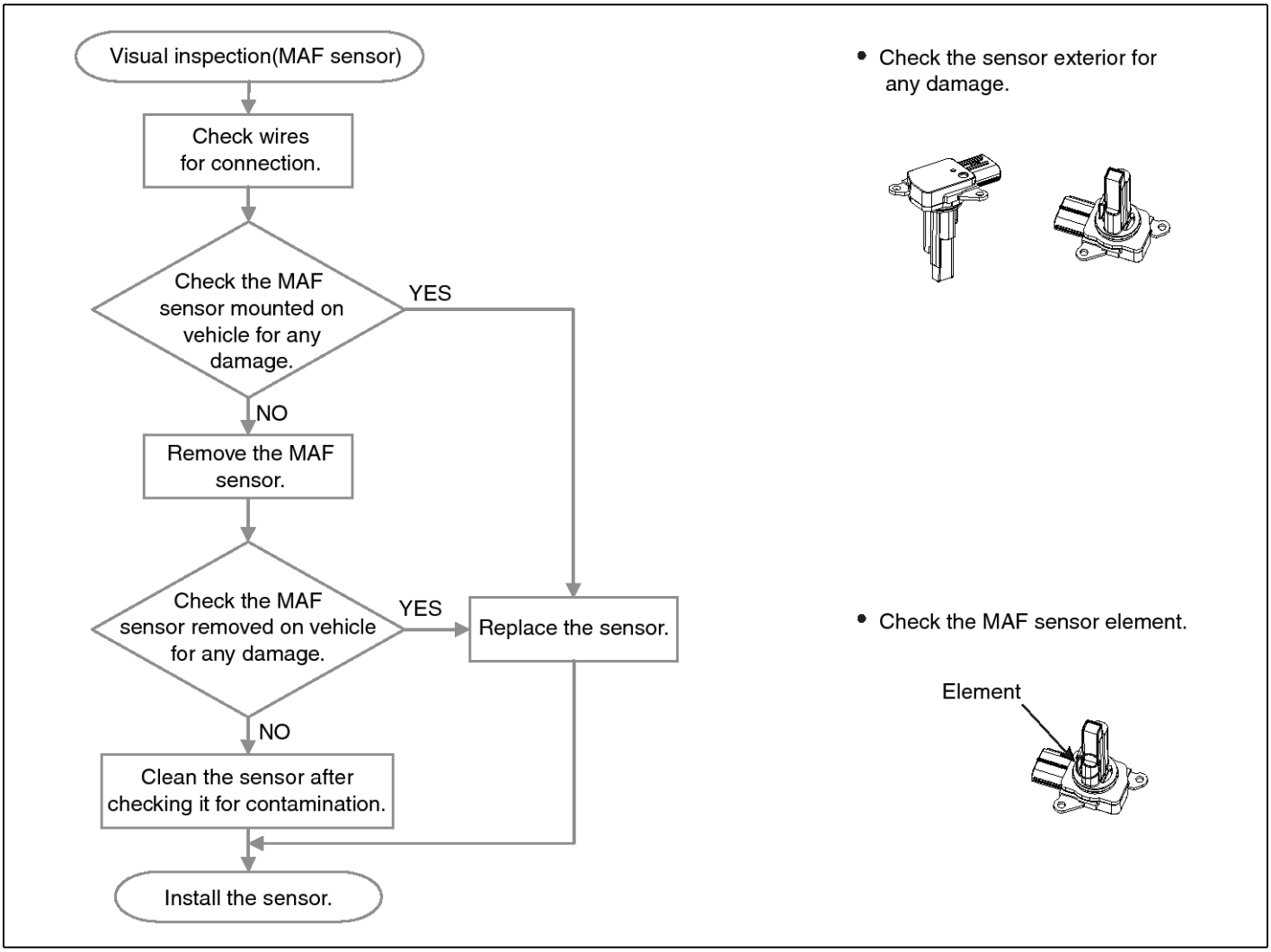
The air flow, supplied to an engine, is measured lower than actual air flow due to contamination of MAF sensor.

Then EGR system can't be controlled precisely.

To prevent it in advance, you have to clean the MAF sensor periodically.

Clean the MAF sensor every 6 months or 60,000 km using "Carb and Choke Cleaner".

VISUAL INSPECTION

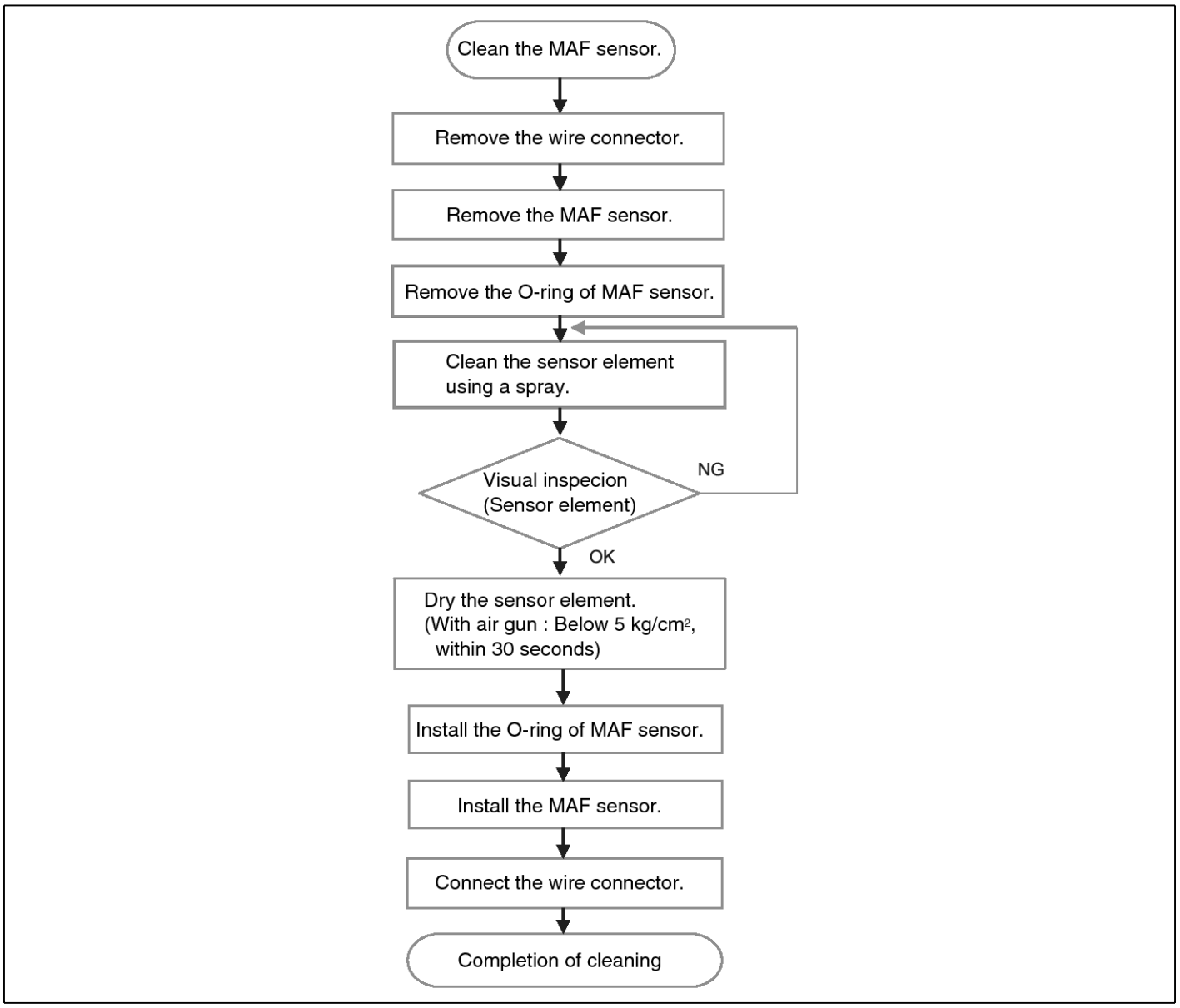


SGZFL9028L

⚠CAUTION

1. **Don't impact or drop the sensor when replacing it.**
2. **Don't use the sharp tool at removing the sensor, otherwise the O-ring may be damaged.**

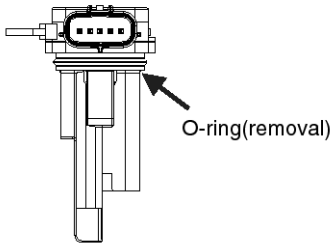
Procedure and caution when cleaning the sensor



SGZFL9029L

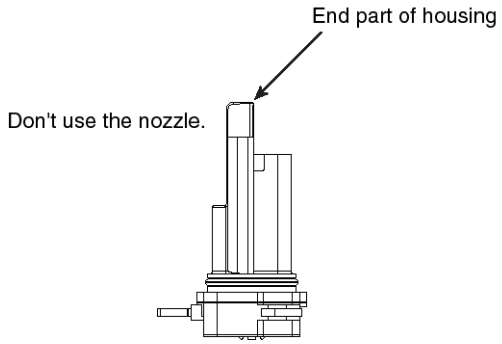
⚠CAUTION

1. **To remove the O-ring of MAF sensor**
   - **Remove the O-ring of MAF sensor to prevent it from damage by cleaning spray and clean the sensor element.**



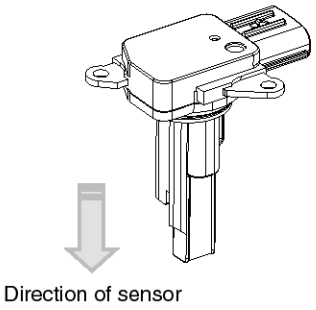
SGZFL9030L

2. **Procedure of atomizing the spray**
   - **Atomize the spray to the end part of sensor housing.**
   - **Don't use the nozzle of spray to prevent the sensor element from damage.**
   - **Atomize the spray with 2~3 times for 2~3 seconds.**



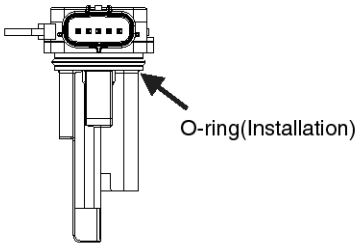
SGZFL9031L

3. **To dry the sensor element**
   - **Using the air gun : Below 5 bar, within 30 seconds.**
   - **After atomizing the spray, dry the sensor like below picture for 20 minutes.**



SGZFL9032L

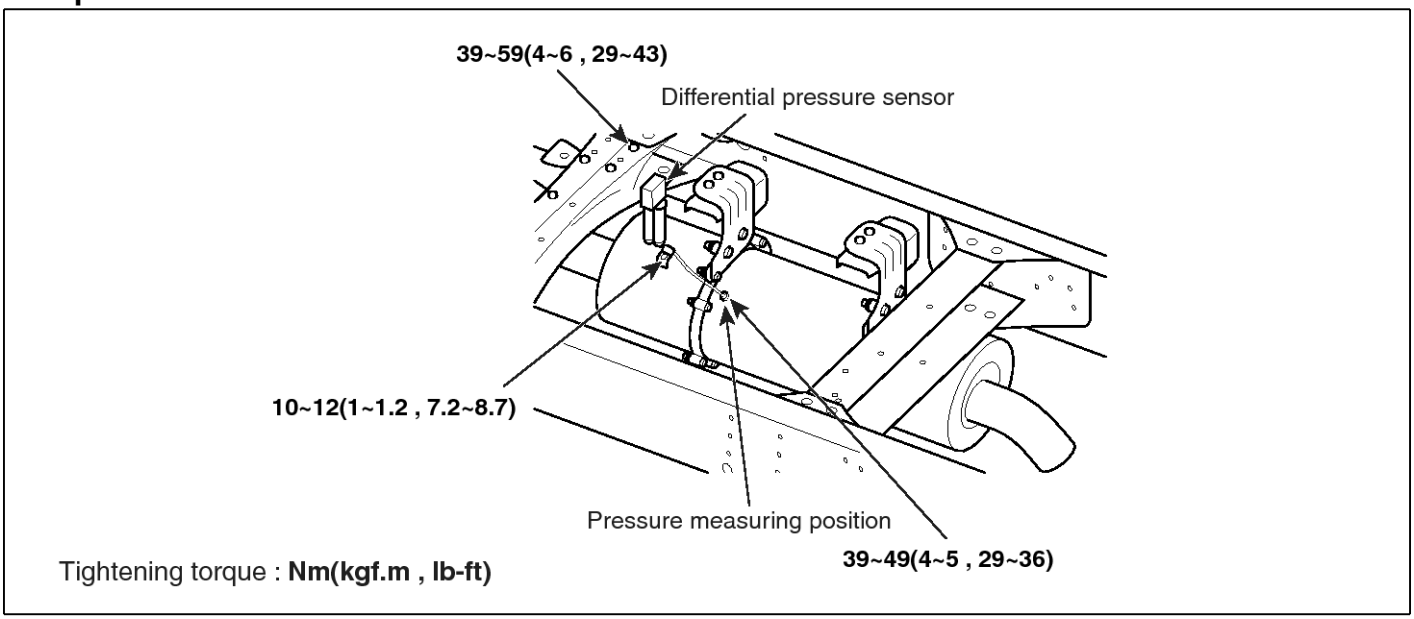
4. **To install the O-ring of MAF sensor**
   - **Install the O-ring after completing to dry the sensor.**



SUDFL9500L

Differential Pressure Sensor(DPS)

Components

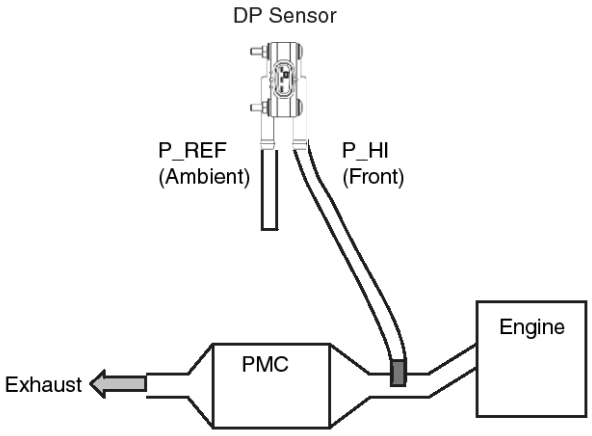


SUDFLDTC9109L

Description

The differential pressure sensor is installed upper side of PMC and measures the pressure difference between before and after PMC.

It also has a purpose to monitor that PMC is arbitrarily removed by a user.



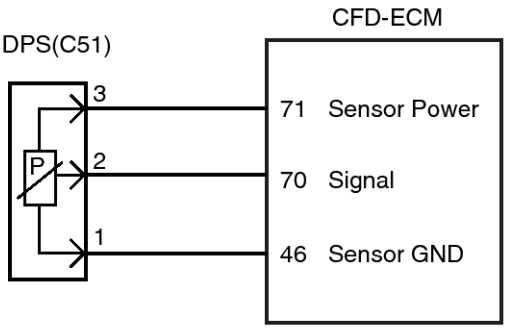
SUDFLDTC9110L

Specifications

Differential Pressure (kPa)	Output Voltage (V)
0	1
10	1.35
20	1.7
30	2.05
40	2.4
50	2.75
60	3.1
70	3.45
80	3.8
90	4.15
100	4.5

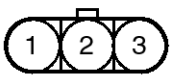
Part Circuit Diagram

[Circuit Diagram]



[Harness Connector]

C51
DPS



CFD-ECM

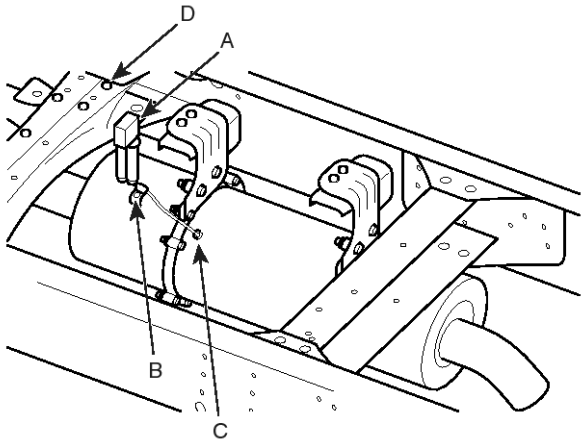
61	62	*	64	65	*	67	68	*	70	71	72	*	74	75	76	77	78	79	80
*	*	43	*	45	46	47	*	*	50	*	52	53	54	55	56	*	58	59	60
21	*	23	24	*	*	27	28	*	*	31	*	33	34	*	36	37	38	39	40
1	*	3	4	5	6	7	8	9	10	11	12	13	14	*	16	17	18	19	20

SUDFLDTC9112L

Replacement

The differential pressure sensor

1. Turn the ignition switch OFF and disconnect the battery (-) cable.
2. Disconnect the differential pressure sensor connector(A).



SUDFLDTC9111L

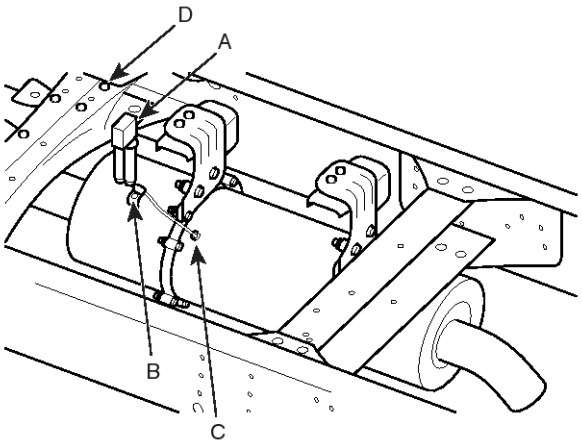
3. Remove the clip connected to the differential pressure sensor pipe.
4. Remove the mounting bolt(D).
5. The installation is the reverse order of removal.

NOTICE

Regarding as the tightening torque, refer to "Components".

The differential pressure sensor pipe

1. Turn the ignition switch OFF and disconnect the battery (-) cable.
2. Remove the clip connected to the differential pressure sensor pipe.



SUDFLDTC9111L

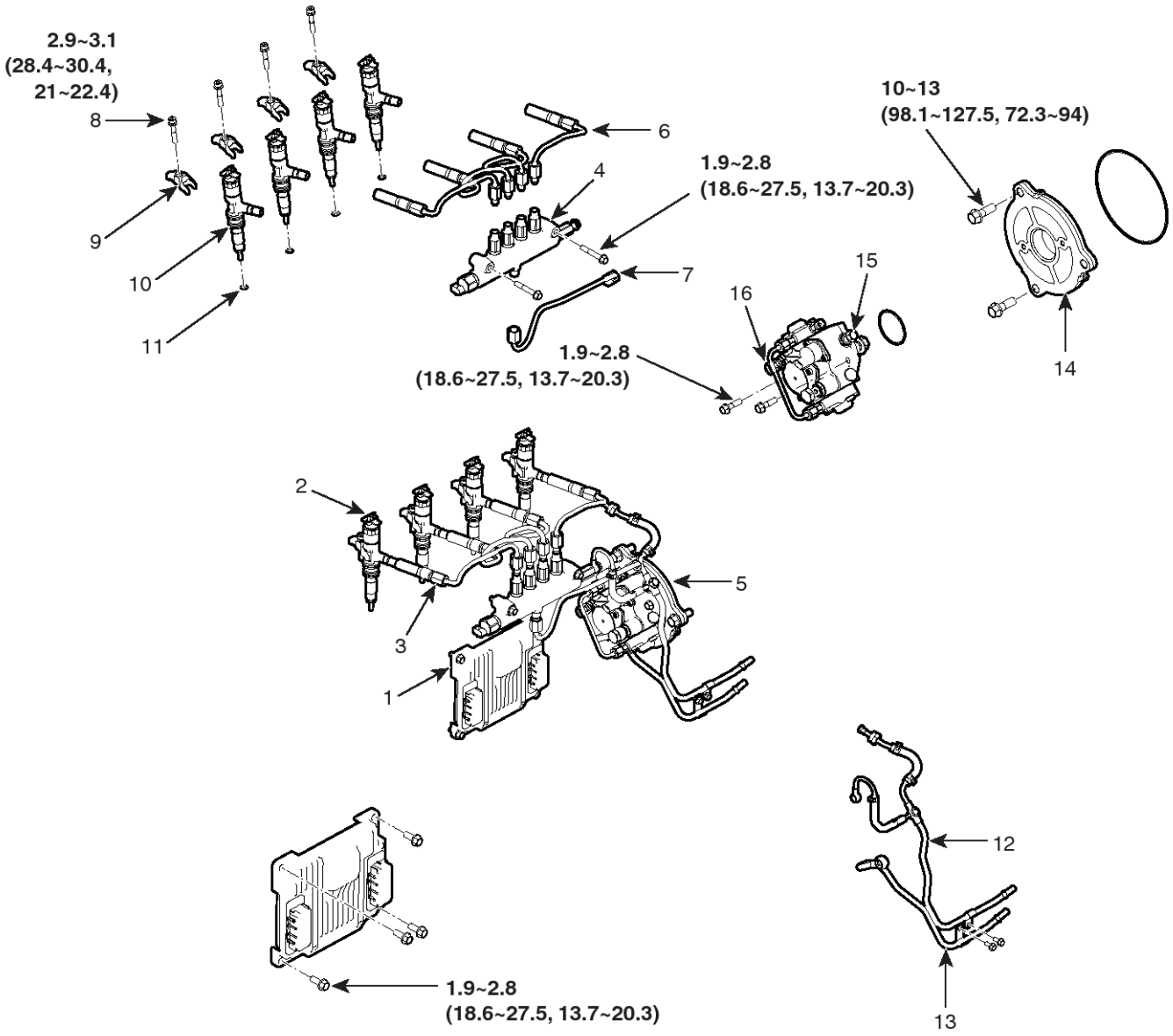
3. Remove the bracket bolt(B).
4. Remove the differential pressure sensor pipe(C).
5. The installation is the reverse order of removal.

NOTICE

Regarding as the tightening torque, refer to "Components".

Electronic Fuel Supply System

COMPONENTS

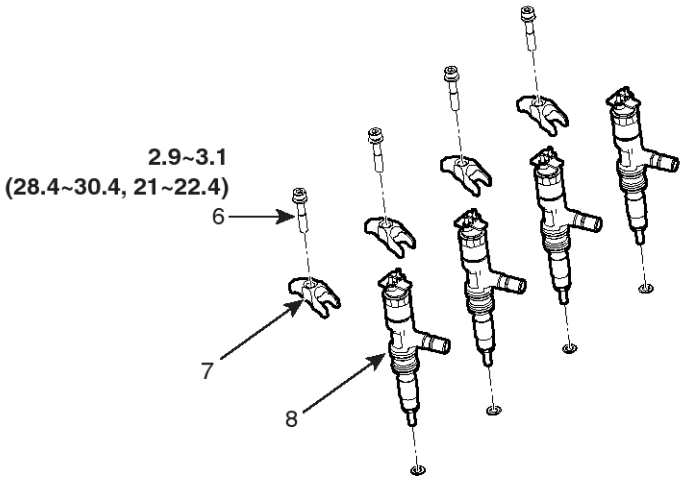


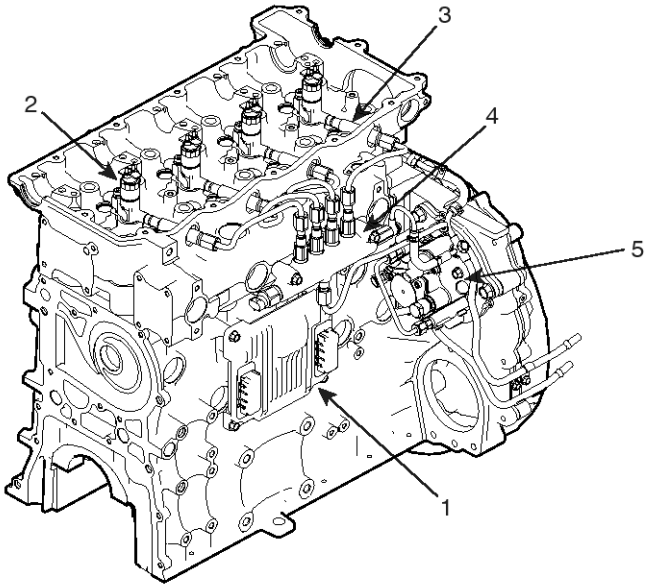
Tightening torque **: kgf.m (N.m, lb-ft)**

1. ECM
2. Injector assembly
3. Injection pipe
4. Common rail assembly
5. Fuel supply pump
6. High pressure(common rail~injector)
7. High pressure pipe(common rail~supply pump)
8. Injector clamp bolt
9. Injector clamp
10. Injector assembly
11. Nozzle gasket
12. Fuel return pipe
13. Fuel supply pipe
14. Fuel pump flange
15. Overflow screw
16. Fuel temperature sensor

Injector

COMPONENTS





Tightening torque **: kgf.m (N.m, lb-ft)**

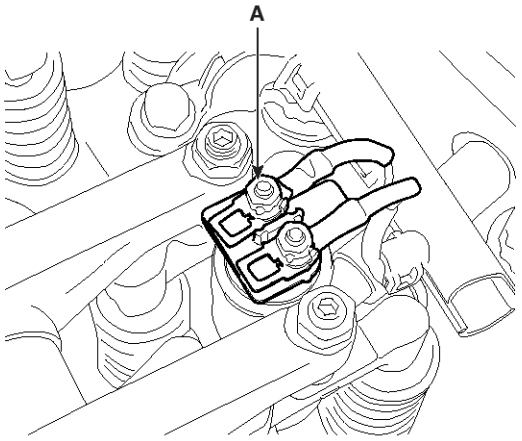
1. ECM
2. Injector assembly
3. Injector pipe
4. Common rail assembly
5. Fuel supply pump
6. Injector clamp bolt
7. Injector clamp
8. Injector assembly

REMOVAL

⚠CAUTION

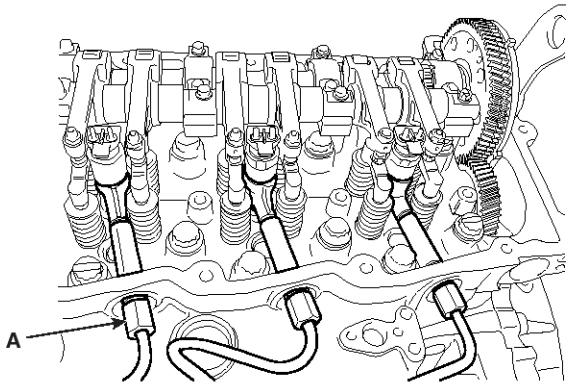
- **Since common rail fuel injection operates under high pressure(1,800bar), a special care should be taken.**
- **While engine is running or within 1 min. after engine stops, any works should not be performed in relation to common rail fuel injection system.**
- **In particular, as the injector solenoid generates high temperature heat, do not touch it with bare hands. Start the service works only when the engine has been cooled down enough after engine stops.**
- **Always keep the safety precautions.**
- **Ensure working area cleans all the time, and place the removed injector on the clean cloth. And pay attention to injector nozzle so that it is not contaminated by any foreign materials.**
- **Remove the protective caps which prevents foreign material inflow for injector and fuel hose immediately just before installation.**
- **When installing or removing injector, clean the contacting portion of the injector and be sure to replace O-ring and nozzle gasket with new ones.**
- **Apply diesel oil to the O-ring of injector and insert them into the cylinder head.**
- **Install the injector to the cylinder head vertically and install it correctly not to cause any damage such as shock.**
- **Be sure to observe the specified tightening torque of bolts when inserting and tightening the injector.**
- **Never reuse the high pressure fuel pipe.**

1. Turn the ignition key OFF. .
2. Disconnect the negative(-) terminal of battery.
3. Remove the rocker cover.
4. Remove the rocker arm assembly and disconnect the injector ground(A).



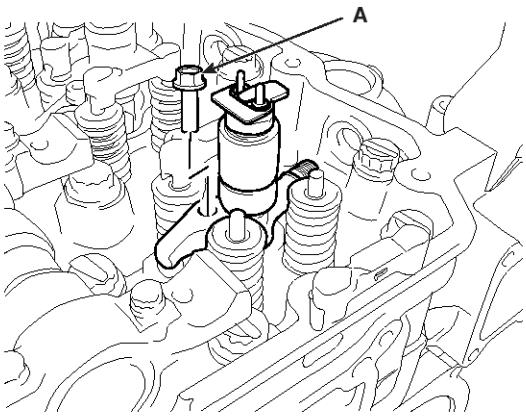
SDFFL7508D

5. Remove the high pressure fuel pipe(A).



SDFFL7509D

6. Loosen the injector clamp bolt(A) and remove the injector.



SDFFL7510D

INSTALLATION

1. Installation is in the reverse of removal.
2. When installing, tighten the bolts to the specified torque.

High pressure fuel pipe mounting bolt : 4 ~ 5 kgf.m (39.2~49N.m, 28.9~36.2 lb-ft)
Injector clamp mounting bolt : 2.9 ~ 3.1 kgf.m (28.4~30.4N.m, 21~22.4 lb-ft)

REPLACEMENT

⚠CAUTION

- **Since the common rail fuel injection operates under high pressure(1,800bar), a special care should be taken.**
- **While engine is running or within 1 min. after engine stops, any works should not be performed in relation to common rail fuel injection system.**
- **In particular, as the injector solenoid generates high temperature heat, do not touch it with bare hands. Start the service works only when the engine has been cooled down enough after engine stops.**
- **Always keep the safety precautions.**
- **Ensure working area cleans all the time, and place the removed injector on the clean cloth. And pay attention to injector nozzle so that it is not contaminated by foreign materials.**
- **Remove the protective caps which prevents foreign material inflow for injector and fuel hose immediately just before installation.**
- **When installing or removing injector, clean the injector contacting portion and be sure to replace O-ring and nozzle gasket with new ones.**
- **Apply diesel oil to the O-ring of injector and insert them into the cylinder head.**
- **Install injector to the cylinder head vertically and install it correctly not to cause any damage such as shock.**
- **Be sure to observe the specified tightening torque of bolts when inserting and tightening the injector.**
- **Never use the high pressure fuel pipe.**

1. Remove injector.
2. Install the injector.
3. Input injector QR correction value using diagnostic tool with the ignition key ON.

   Follow the instructions on the diagnostic tool as to how to input injector QR correction value.

   If the input of injector QR correction value was completed, start the engine in 10 sec. after turning the ignition key OFF.

   ⚠CAUTION

   In case QR correction value described on the injector is not input in the ECM, there may cause engine performance and exhaust gas problem.

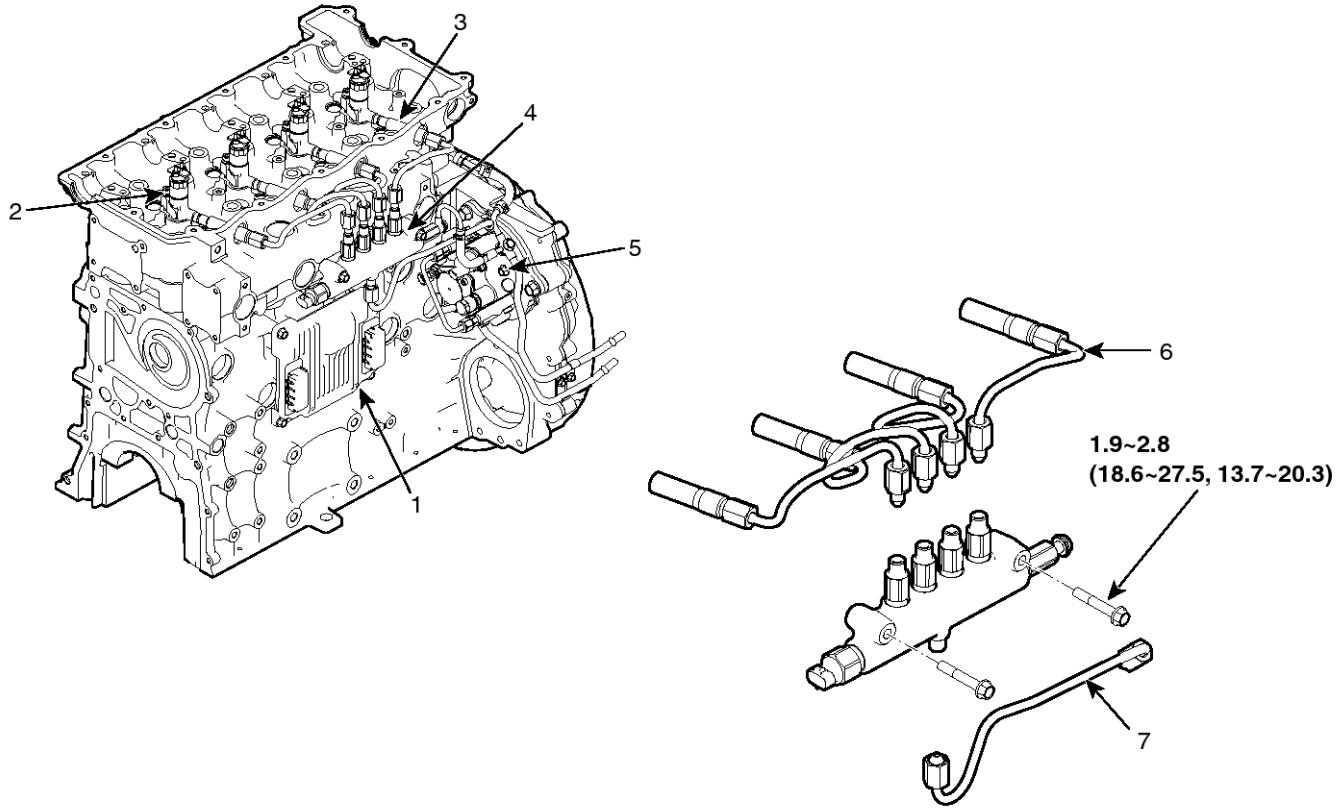
CLEANING

Clean the injector as follows to be reused.

1. Clean the injector by setting the injector vertically to the clean container.
2. Remove dust or dirt from the injector body and nozzle sealing with clean cloth if necessary.

Common rail Assembly

COMPONENTS



Tightening torque **: kgf.m (N.m, lb-ft)**

1. ECM
2. Injector assembly
3. High pressure pipe
4. Common rail assembly
5. Fuel supply pump
6. High pressure(common rail~injector)
7. High pressure pipe(common rail~supply pump)

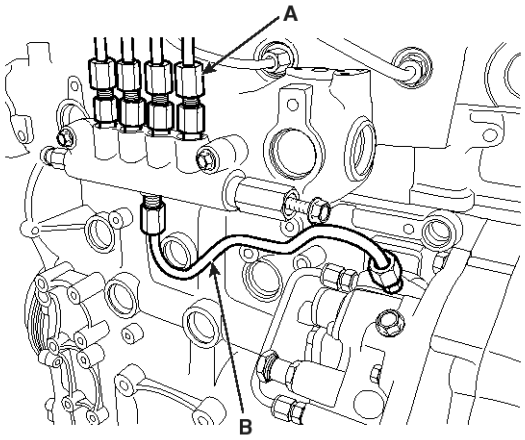
SUDFL9014L

REMOVAL

⚠CAUTION

- **Since common rail fuel injection operates under high pressure(1,800bar), a special care should be taken.**
- **While engine is running or within 1 min. after engine stops, any works should not be performed in relation to common rail fuel injection system.**
- **In particular, as the injector solenoid generates high temperature heat, do not touch it with bare hands. Start the service works only when the engine has been cooled down enough after engine stops.**
- **Always keep the safety precautions.**
- **Never reuse the high pressure fuel pipe.**

1. Turn the ignition key OFF.
2. Disconnect the negative(-) terminal of battery.
3. Disconnect high pressure pipe (A) leading to injector from rail.



SDFFL7514D

4. Remove the injector pipe(B) connected from the supply pump to the common rail.
5. Remove the return fuel hose.
6. Remove the rail pressure sensor.

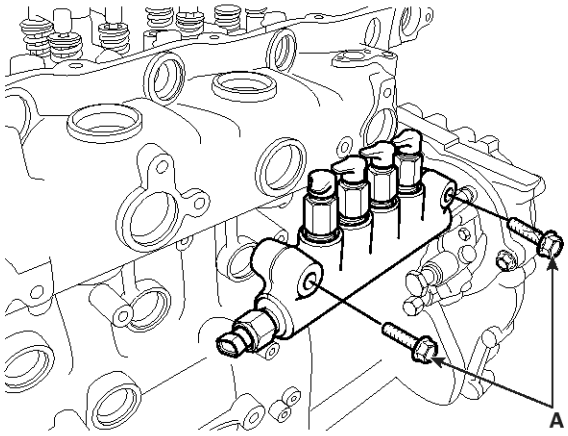
   ⚠CAUTION

   A special care should be taken as the fuel remaining in the rail leaks.

7. Remove the common rail assembly mounting bolt and the common rail assembly(A).

INSTALLATION

1. Install the common rail assembly mounting bolt(A).

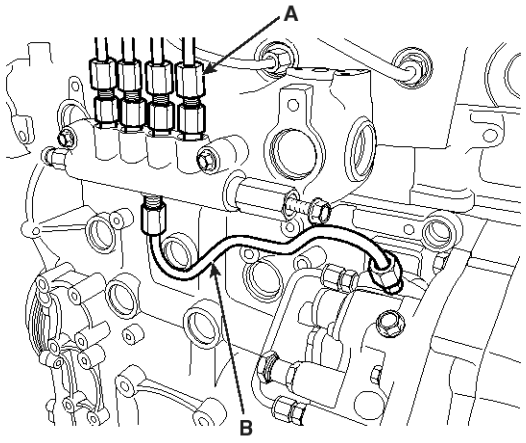


SDFFL7515D

Common rail assembly mounting bolt : 1.9 ~ 2.8 kgf.m (18.6~27.5N.m, 13.7~20.3lb-ft)

2. Tighten the injector pipe(B) connected to the common rail from the high pressure fuel pipe(A) and the supply pump.

High pressure fuel pipe mounting bolt : 4 ~ 5 kgf.m (39.2~49N.m, 28.9~36.2lb-ft)



SDFFL7514D

Accelerator Pedal

DESCRIPTION

APS (Accelerator Position Sensor) senses the acceleration pressure of the driver and delivers it to the ECM. Output voltage of accelerator position sensor has a functional relation with the accelerator pedal position.

This functional relation comes from the Potentiometer built-in the sensor.

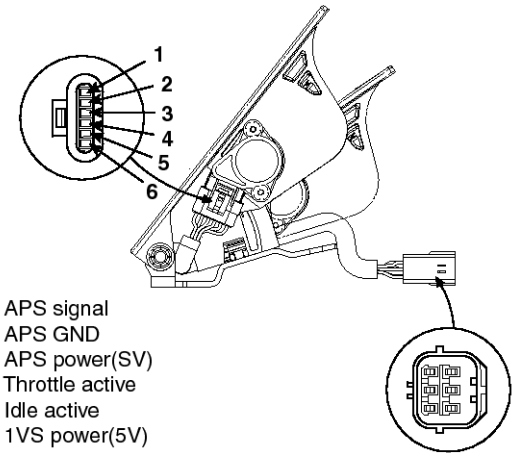
In other words, the positon of pedal is calculated from the output voltage of the sensor.

REMOVAL

1. Disconnect accelerator pedal connector and remove mounting bolt, accelerator pedal.
2. Installation is the reverse order of removal.

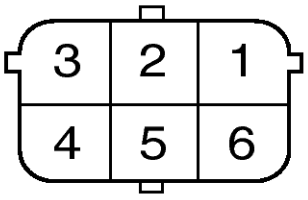
INSPECTION

1. Connect the voltmeter to the terminals No. 1 and 2 of accelerator position sensor.



1. APS signal
2. APS GND
3. APS power(SV)
4. Throttle active
5. Idle active
6. 1VS power(5V)

SDGFL9026L



1. APS GND
2. APS signal
3. APS power(5V)
4. 1VS power(5V)
5. Throttle active
6. Idle active

SDGFL9027L

2. Connect DC 5 V to terminal No. 3.
3. Check to see if the measurement voltage between terminal No. 1 and No. 2 satisfies the specified voltage.

At idle : 0.65 V
At full stroke : 3.85 V

4. Connect DC 5 V to terminal No.4.
   1) Check to see if the measurement voltage between terminal No. 1 and No. 6 satisfies the specified voltage.

At idle : 5 V
At full stroke : 0 V

   2) Check to see if the measurement voltage between terminal No. 1 and No. 5 satisfies the specified voltage.

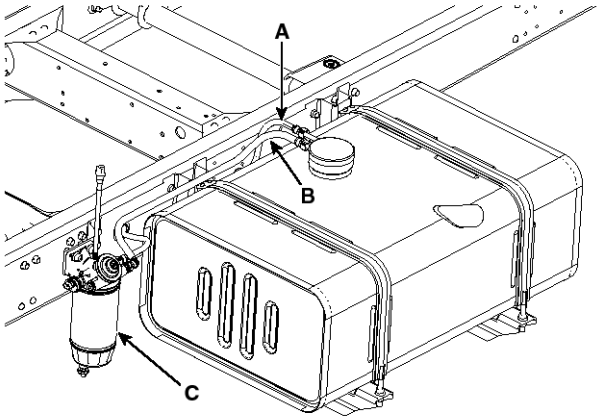
At idle : 0 V
At full stroke : 5 V

Fuel Tank and Fuel Filter

REPLACEMENT

FUEL TANK AND FUEL FILTER (Truck)

1. Park the vehicle on a flat surface, stop the engine and disconnect the negative(-) terminal of battery.
2. Disconnect the sender connector on the top of fuel tank.
3. Remove the return hose (A) and the supply hose (B).



SDFFL7400D

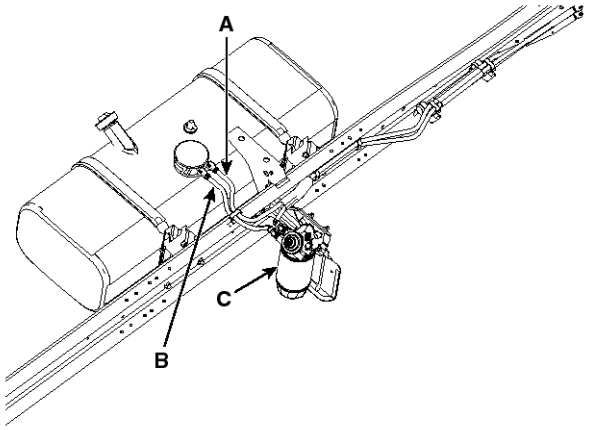
4. Support the fuel tank assembly with the jack. Loosen the fuel tank band mounting nut and remove the fuel tank assembly by removing the mounting bolt.
5. Disconnect the connector and hose and remove the fuel filter (C).
6. Installation is in the reverse of removal.

   Tighten the lower nut to the 0.8 ~ 1.0kgf.m and the upper nut to the 2 ~ 3kgf.m and install the fuel tank band to the bracket.

Fuel tank mounting bolt : 4.5 ~ 6 kgf.m (44.1~58.8N.m, 32.5~43.4lb-ft)

FUEL TANK AND FUEL FILTER (Bus)

1. Park the vehicle on a flat surface, stop the engine and disconnect the negative(-) terminal of battery.
2. Disconnect the sender connector on the top of fuel tank.
3. Remove the return hose (A) and the supply hose (B).



SDFFL7401D

4. Support the fuel tank assembly with the jack. Loosen the fuel tank band mounting nut and remove the fuel tank assembly by removing the mounting bolt.
5. Disconnect the connector and hose and remove the fuel filter (C).
6. Installation is in the reverse of removal.

   Tighten the lower nut to the 0.8 ~ 1.0kgf.m and the upper nut to the 1.9 ~ 2.8kgf.m and install the fuel tank band to the bracket.

Fuel tank mounting bolt : 4.5 ~ 6 kgf.m (44.1~58.8N.m, 32.5~43.4lb-ft)
Fuel filter mounting bolt : 8 ~ 11 kgf.m (78.4~107.9N.m, 57.9~79.6lb-ft)

INSPECTION

1. General check
   a. Crack, bending, deformation, deterioration and clogging of hose or pipe
   b. Clogging or damage of fuel filter
2. When the filter has to be checked
   a. When the fuel in the tank is drained out and then replenished again for maintenance
   b. When fuel filter is replaced
   c. When fuel main hose (pipe) is removed

      Loosen the air plug of fuel filter.

      Cover air plug hole with cotton cloth and keep pumping until it stops bubble.

      When bubbles are removed completely, fasten the air plug and continue to pump until pump operation effort feels heavy.
3. Water drain from the fuel filter

   Check for the water level of transparent bowl and if water is filled with one-third, be sure to drain water by the following sequence.

   ⚠CAUTION
   If the vehicle is driven without draining the water, it may cause fatal trouble to the supply pump and injector.

   a. Drain the water by turning about half way.

      ⚠CAUTION
      Since water is drained even if the plug is not fully loosened, be careful not to loosen drain plug fully.

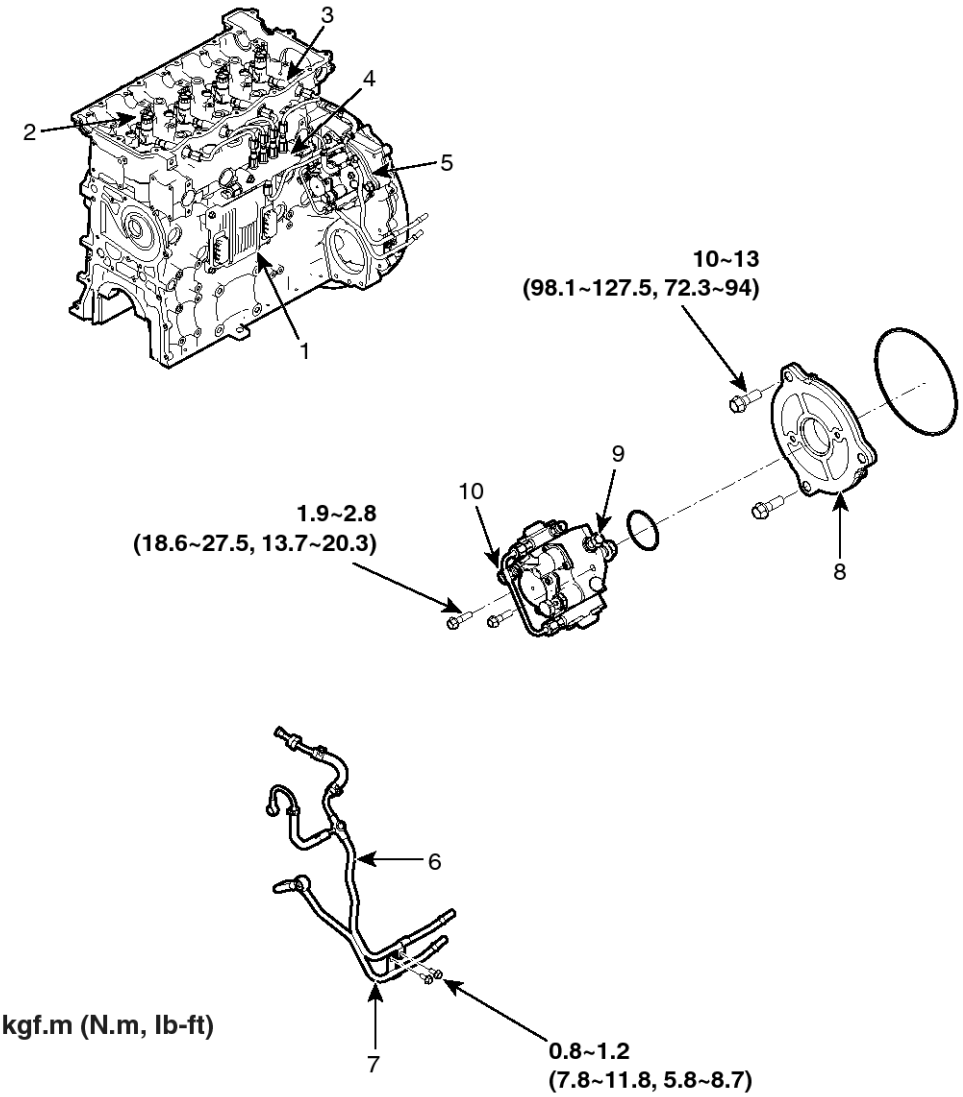
   b. If diesel fuel drains after water has been drained completely, fasten the drain plug by hand.

Tightening torque : 1.7~1.9 kgf.m
(16.7~18.6N.m, 12.3~13.7lb-ft)

Electronic Injection Pump

Supply Pump

COMPONENTS



Tightening torque **: kgf.m (N.m, lb-ft)**

1. ECM
2. Injector assembly
3. Injection pipe
4. Common rail assembly
5. Fuel supply pump
6. Fuel return pipe
7. Fuel supply pipe
8. Fuel pump flange
9. Overflow screw
10. Fuel temperature sensor

SUDFL9015L

REMOVAL

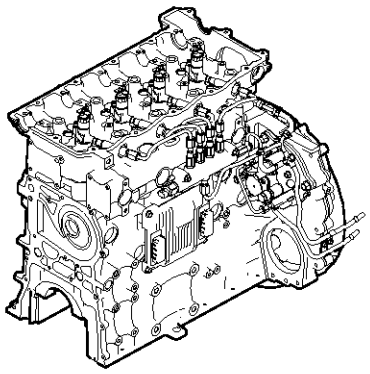
⚠CAUTION

- **Since common rail fuel injection operates under high pressure(1,800bar), a special care should be taken.**
- **While engine is running or within 1 min. after engine stops, any works should not be performed in relation to common rail fuel injection system.**
- **In particular, as the injector solenoid generates high temperature heat, do not touch it with bare hands. Start the service works only when the engine has been cooled down enough after engine stops.**
- **Always keep the safety precautions.**
- **Ensure working area cleans all the time, and place the removed injector on the clean cloth. And pay attention to injector nozzle so that it is not contaminated by any foreign materials.**
- **Remove the protective caps which prevents foreign material inflow for injector and fuel hose immediately just before installation.**
- **When installing or removing injector, clean the contacting portion of the injector and be sure to replace O-ring and nozzle gasket with new ones.**
- **Apply diesel oil to the O-ring of injector and insert them into the cylinder head.**
- **Install the injector to the cylinder head vertically and install it correctly not to cause any damage such as shock.**
- **Be sure to observe the specified tightening torque of bolts when inserting and tightening the injector.**
- **Never reuse the high pressure fuel pipe.**

1. Turn the ignition key OFF.
2. Disconnect the negative(-) terminal of battery.
3. Disconnect the supply pump connector.
4. Disconnect the low pressure pipe.
5. Disconnect the high pressure pipe.
6. Remove the flange mounting bolt and remove the supply pump assembly from the flyhwheel housing.

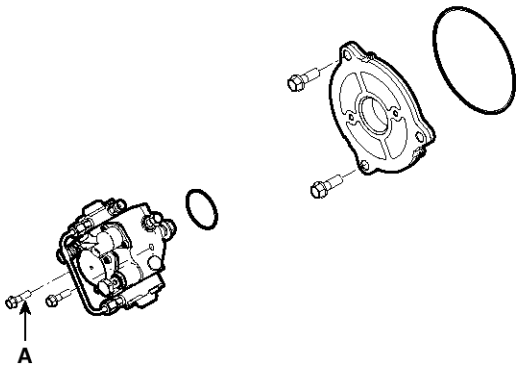
   NOTICE

   When removing the supply pump, remove the pump, flange and the supply pump gear from the assembly.



SUDFL9017L

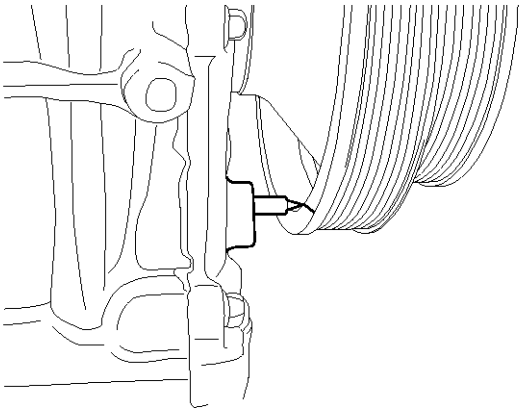
7. Remove the supply pump mounting hexagon bolt(A) and remove the supply pump.



SUDFL9018L

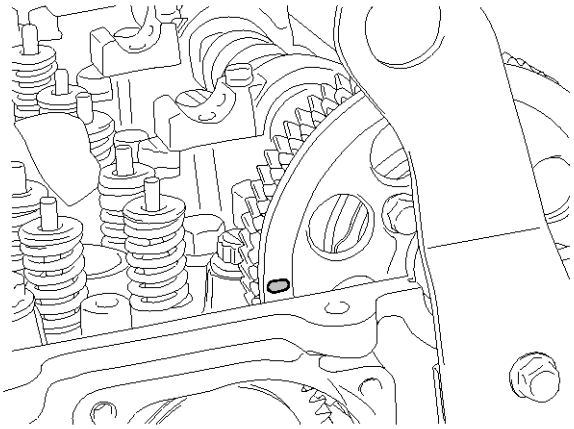
INSTALLATION

1. Rotate the crankshaft to align the cylinder No. 1 at the TDC (Top Dead Center) position.
   a. Align the mark(or painting) at damper pulley circumferential surface of crankshaft with the direction mark on block surface.



SUDFL9019L

   b. Open rocker cover, in view from the rear of engine, align the mark(or painting) of TDC sensor gear plate with the head contact surface of block from the left.

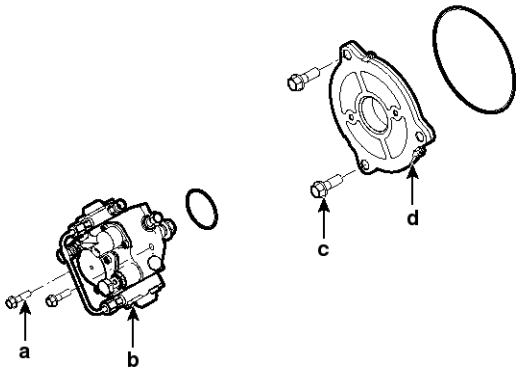


SDFFL7512D

   c. If the above mentioned two items are satisfied, cylinder #1 is at TDC position.

2. Engine installation after assembling pump gear and plate
   a. Assemble plate to pump and temporarily assemble gear to pump shaft. Assemble to the direction of flange (d) from pump (b) and insert O-ring between pump (b) and flange (d), then tighten bolt (a).

Supply pump mounting bolt : 1.9~2.8 kgf.m (18.6~27.5 Nm, 13.7~20.3 lb.ft)

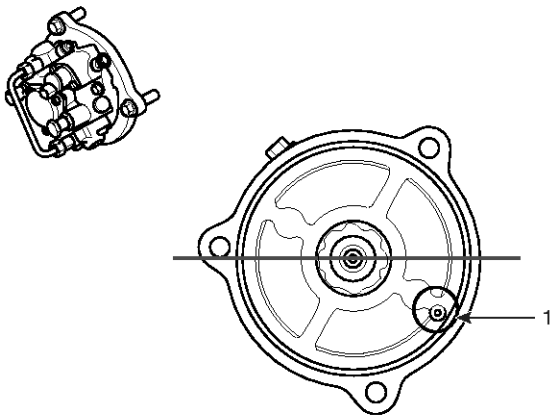


SUDFL9020L

   b. When tightening flange and pump, tighten those so that the mark(1) of flange backside faces the upper side of straight line as shown in the figure.

   Align the part that the number of supply pump gear is marked with the mark (1) of flange backside and assemble supply pump gear to supply pump.

Supply pump gear mounting nut : 6~7 kgf.m (58.8~68.6 Nm, 43.40~50.6 lb.ft)



SUDFL9021L

c. After assembling as above, and also insert O-ring between pump assembly and block.

d. When installing supply pump assembly to engine, double check above mentioned items and engage supply pump gear part with counterpart gear and then tighten it with bolts.

Flange mounting bolt : 10~13 kgf.m(98.1~127.5 Nm, 72.3~94.0 lb.ft)

3. Tighten high pressure pipe.

High pressure pipe mounting bolt : 4~5 kgf.m(39.2~49.0 Nm, 28.9~36.2 lb.ft)

NOTICE

At assembling, assemble those from center to outside in sequence for convenience's sake.

4. Installl low pressure pipe.
5. Install supply pump connector.
6. Install rocker cover.
7. When replacing with the new pump, erase learning value of the previous pump and be sure to perform "Pump learning initialization" using the diagnostic tool to start the learning of new pump newly.

CAUTION

Be sure to perform the above mentioned "Pump learning initialization" when replacing with the new pump.

If the above mentioned "Pump learning initialization" is not performed with the diagnostic tool after replacing with new pump, the engine performance could be deteriorated and there may have problems in the emission gas.

DTC Troubleshooting Procedures

BASIC TROUBLESHOOTING

BASIC TROUBLESHOOTING GUIDE

1	Bring Vehicle to Workshop

2	Analyze Customer's Complaint.
• Ask the customer about the conditions and environment relative to the issue (Use CUSTOMER PROBLEM ANALYSIS SHEET).	

3	Verify Symptom, and then Check DTC and Freeze Frame Data
• Connect scan tool to Diagnostic Link Connector (DLC). • Record the DTC and freeze frame data. **NOTICE** *To erase DTC and freeze frame data, refer to Step 4.*	

	Confirm the Inspection Procedure for the System or Part
Using the SYMPTOM TROUBLESHOOTING GUIDE CHART, choose the correct inspection procedure for the system or part to be checked.	

4	Erase the DTC and Freeze Frame Data
(WARNING) NEVER erase DTC and freeze frme data before completing Step 2 MIL/DTC in "CUSTOMER PROBLEM ANALYSIS SHEET".	

5	Inspect Vehicle Visually
• Go to Step 10, if you recognize the problem.	

6	Recreate (Simulate) Symptoms the DTC
• Try to recreate or simulate the symptoms and conditions of the malfunction as described by customer. • If DTC(s) is/are displayed, simulate the condition according to troubleshooting procedure for the DTC.	

7	Confirm Symptoms of Problem
• If DTC(s) is/are not displayed, go to Step 8. • If DTC(s) is/are displayed, go to Step 10.	

8	Recreate (Simulate) Symptom
• Try to recreate or simulate the condition of the malfunction as described by the customer.	

9	Check the DTC
• If DTC(s) does(do) not occur, refer to BASIC INSPECTION in INTERMITTENT PROBLEM PROCEDURE. • If DTC(s) occur(s), go to Step 10.	

10	Perform troubleshooting procedure for DTC

11	Adjust or repair the vehicle

12	Confirmation test

13	END

CUSTOMER PROBLEM ANALYSIS SHEET

1. VEHICLE INFORMATION

(I) VIN:
(II) Production Date:
(III) Odometer Reading: (km)

2. SYMPTOMS

☐ Unable to start	☐ Engine does not turn over ☐ Incomplete combustion ☐ Initial combustion does not occur
☐ Difficult to start	☐ Engine turns over slowly ☐ Other_____
☐ Poor idle	☐ Rough idle ☐ Incorrect idle ☐ Unstable idle(High: _____ rpm, Low: _____rpm) ☐ Other _____
☐ Engine stall	☐ Soon after starting ☐ After acceleration pedal depressed ☐ After acceleration pedal released ☐ During A/C ON ☐ Shifting from N to D-range ☐ Other _____
☐ Others	☐ Poor driving (Surge) ☐ Knocking ☐ Poor fuel economy ☐ Back fire ☐ After fire ☐ Other _____

3. ENVIRONMENT

Problem frequency	☐ Constant ☐ Sometimes (_____) ☐ Once only ☐ Other _____
Weather	☐ Fine ☐ Cloudy ☐ Rainy ☐ Snowy ☐ Other _____
Outdoor temperature	Approx. _____ °C/°F
Place	☐ Highway ☐ Suburbs ☐ Inner City ☐ Uphill ☐ Downhill ☐ Rough road ☐ Other _____
Engine temperature	☐ Cold ☐ Warming up ☐ After warming up ☐ Any temperature
Engine operation	☐ Starting ☐ Just after starting (____ min) ☐ Idle ☐ Racing ☐ Driving ☐ Constant speed ☐ Acceleration ☐ Deceleration ☐ A/C switch ON/OFF ☐ Other _____

4. MIL/DTC

MIL (Malfunction Indicator Lamp)	☐ Remains ON ☐ Sometimes lights up ☐ Does not light
DTC	☐ Normal ☐ DTC (_____) ☐ Freeze Frame Data

BASIC INSPECTION PROCEDURE

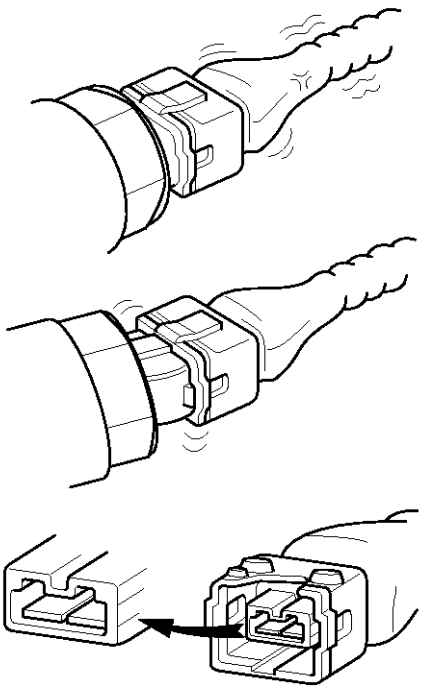
The measured resistance at high temperature after vehicle running may be high or low. So all resistance must be measured at ambient temperature (20℃, 68°F), unless there is any notice.

NOTICE

The measured resistance in except for ambient temperature (20℃, 68°F) is reference value.

Sometimes the most difficult case in troubleshooting is when a problem symptom occurs but does not occur again during testing. An example would be if a problem appears only when the vehicle is cold but has not appeared when warm. In this case, technician should thoroughly make out a "CUSTOMER PROBLEM ANALYSIS SHEET" and recreate (simulate) the environment and condition which occurred when the vehicle was having the issue.

1. Clear Diagnostic Trouble Code (DTC).
2. Inspect connector connection, and check terminal for poor connections, loose wires, bent, broken or corroded pins, and then verify that the connectors are always securely fastened.



BFGE321A

3. Slightly shake the connector and wiring harness vertically and horizontally.
4. Repair or replace the component that has a problem.
5. Verify that the problem has disappeared with the road test.

● SIMULATING VIBRATION

a. Sensors and Actuators

: Slightly vibrate sensors, actuators or relays with finger.

WARNING

Strong vibration may break sensors, actuators or relays

b. Connectors and Harness

: Lightly shake the connector and wiring harness vertically and then horizontally.

● SIMULATING HEAT

a. Heat components suspected of causing the malfunction with a hair dryer or other heat sourre.

WARNING

- **DO NOT heat components to the point where they may be damaged.**
- **DO NOT heat the ECM directly.**

● SIMULATING WATER SPRINKLING

a. Sprinkle water onto vehicle to simulate a rainy day or a high humidity condition.

WARNING

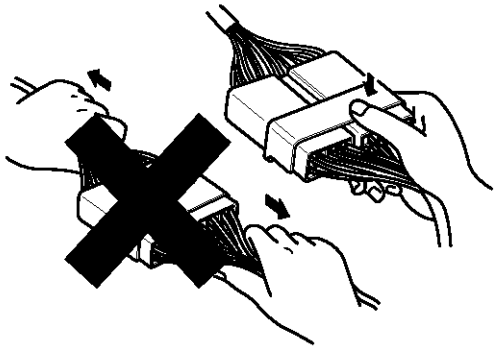
DO NOT sprinkle water directly into the engine compartment or electronic components.

● SIMULATING ELECTRICAL LOAD

a. Turn on all electrical systems to simulate excessive electrical loads (Radios, fans, lights, etc.).

CONNECTOR INSPECTION PROCEDURE

1. Handling of Connector
   a. Never pull on the wiring harness when disconnecting connectors.



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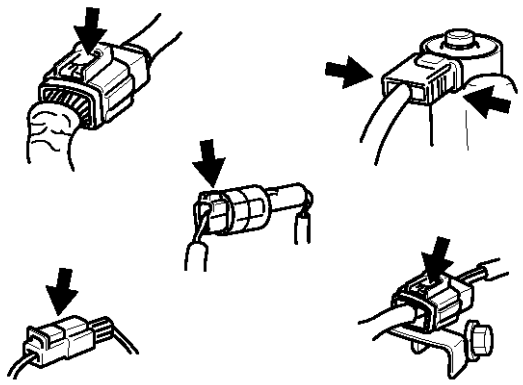
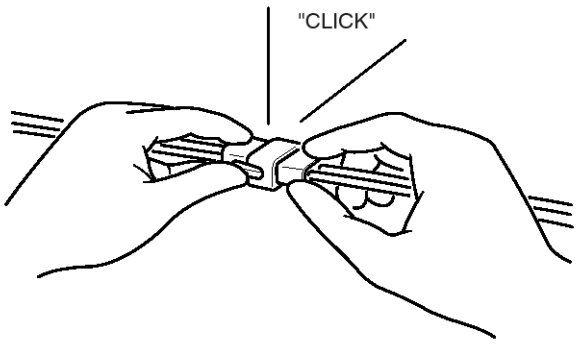
b. When removing the connector with a lock, press or pull locking lever.



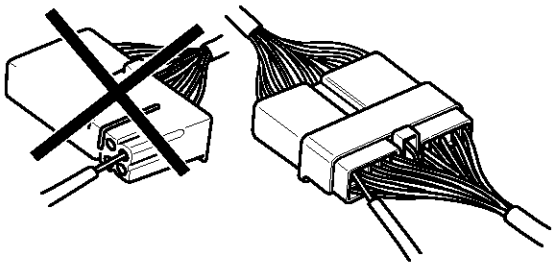
BFGE015G

c. Listen for a click when locking connectors. This sound indicates that they are securely locked.



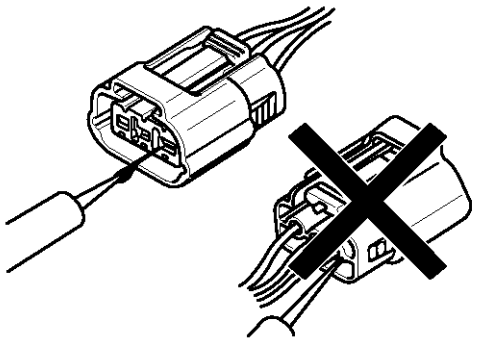
BFGE015H

d. When a tester is used to check for continuity, or to measure voltage, always insert tester probe from wire harness side.



BFGE015I

e. Check waterproof connector terminals from the connector side. Waterproof connectors cannot be accessed from harness side.



BFGE015J

NOTICE

- *Use a fine wire to prevent damage to the terminal.*
- *Do not damage the terminal when inserting the tester lead.*

2. Checking Point for Connector
   a. While the connector is connected:

      Hold the connector, check connecting condition and locking efficiency.

   b. When the connector is disconnected:

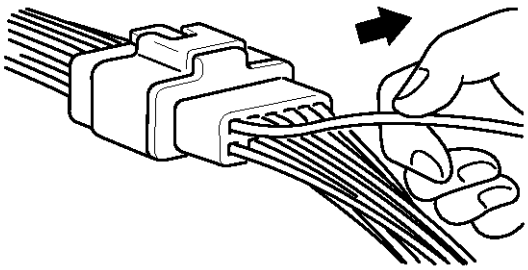
      Check missed terminal, crimped terminal or broken core wire by slightly pulling the wire harness.

      Visually check for rust, contamination, deformation and bend.

   c. Check terminal tightening condition:

      Insert a spare male terminal into a female terminal, and then check terminal tightening conditions.

   d. Pull lightly on individual wires to ensure that each wire is secured in the terminal.



BFGE015K

3. Repair Method of Connector Terminal
   a. Clean the contact points using air gun and/or shop rag.

      NOTICE

      Never use sand paper when polishing the contact points, otherwise the contact point may be damaged.

   b. In case of abnormal contact pressure, replace the female terminal.

WIRE HARNESS INSPECTION PROCEDURE

1. Before removing the wire harness, check the wire harness position and crimping in order to restore it correctly.
2. Check whether the wire harness is twisted, pulled or loosened.
3. Check whether the temperature of the wire harness is abnormally high.
4. Check whether the wire harness is rotating, moving or vibrating against the sharp edge of a part.
5. Check the connection between the wire harness and any installed part.
6. If the covering of wire harness is damaged; secure, repair or replace the harness.

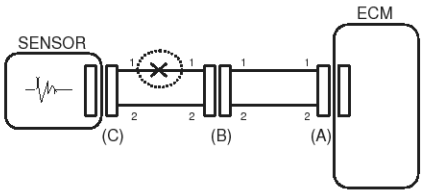
ELECTRICAL CIRCUIT INSPECTION PROCEDURE

● CHECK OPEN CIRCUIT

1. Procedures for Open Circuit
   - Continuity Check
   - Voltage Check

   If an open circuit occurs (as seen in [FIG. 1]), it can be found by performing Step 2 (Continuity Check Method) or Step 3 (Voltage Check Method) as shown below.

FIG 1



BFGE501A

2. Continuity Check Method

NOTICE

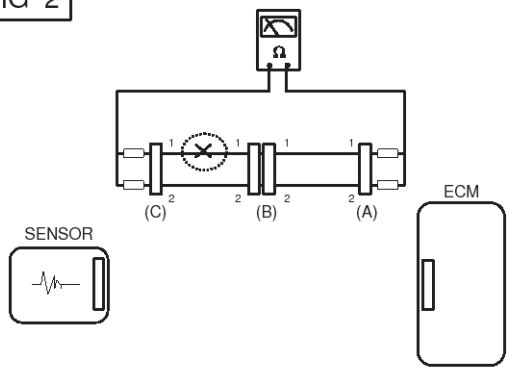
When measuring for resistance, lightly shake the wire harness above and below or from side to side.

Specification (Resistance)
1Ω or less → Normal Circuit
1MΩ or Higher → Open Circuit

a. Disconnect connectors (A), (C) and measure resistance between connector (A) and (C) as shown in [FIG. 2].

In [FIG.2.] the measured resistance of line 1 and 2 is higher than 1Ω MΩ and below 1 Ω respectively. Specifically the open circuit is line 1 (Line 2 is normal). To find exact break point, check sub line of line 1 as described in next step.

FIG 2

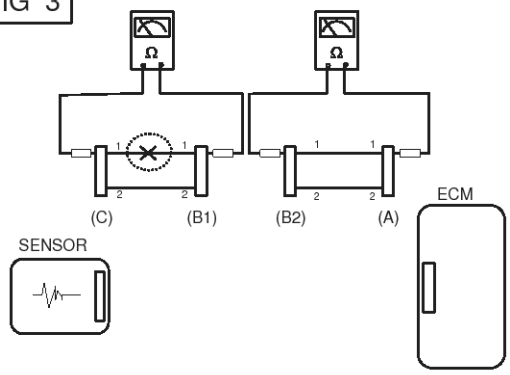


BFGE501B

b. Disconnect connector (B), and measure for resistance between connector (C) and (B1) and between (B2) and (A) as shown in [FIG. 3].

In this case the measured resistance between connector (C) and (B1) is higher than 1MΩ and the open circuit is between terminal 1 of connector (C) and terminal 1 of connector (B1).

FIG 3



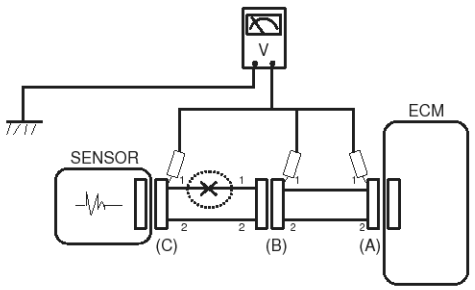
BFGE501C

3. Voltage Check Method

a. With each connector still connected, measure the voltage between the chassis ground and terminal 1 of each connectors (A), (B) and (C) as shown in [FIG. 4].

The measured voltage of each connector is 5V, 5V and 0V respectively. So the open circuit is between connector (C) and (B).

FIG 4



BFGE501D

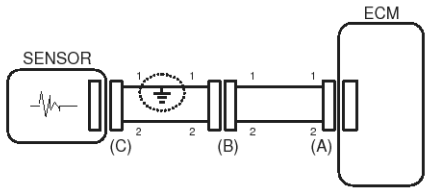
● CHECK SHORT CIRCUIT

1. Test Method for Short to Ground Circuit

• Continuity Check with Chassis Ground

If short to ground circuit occurs as shown in [FIG. 5], the broken point can be found by performing below Step 2 (Continuity Check Method with Chassis Ground) as shown below.

FIG 5



BFGE501E

2. Continuity Check Method (with Chassis Ground)

NOTICE

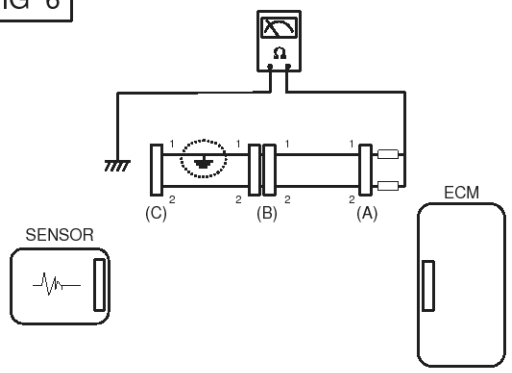
Lightly shake the wire harness above and below, or from side to side when measuring the resistance.

Specification (Resistance)
1Ω or less → Short to Ground Circuit
1㏁ or Higher → Normal Circuit

a. Disconnect connectors (A), (C) and measure for resistance between connector (A) and Chassis Ground as shown in [FIG. 6].

The measured resistance of line 1 and 2 in this example is below 1 Ω and higher than 1㏁ respectively. Specifically the short to ground circuit is line 1 (Line 2 is normal). To find exact broken point, check the sub line of line 1 as described in the folowing step.

FIG 6

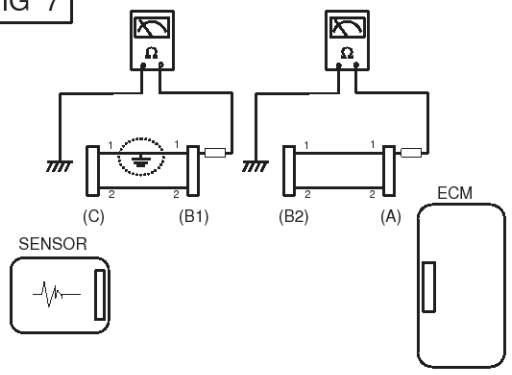


BFGE501F

b. Disconnect connector (B), and measure the resistance between connector (A) and chassis ground, and between (B1) and chassis ground as shown in [FIG. 7].

The measured resistance between connector (B1) and chassis ground is 1Ω or less. The short to ground circuit is between terminal 1 of connector (C) and terminal 1 of connector (B1).

FIG 7



BFGE501G

ECM(TICS) Problem Inspection Procedure

1. Test ECM(TICS) connector: Disconnect the ECM(TICS) connector and visually check the ground terminals on ECM(TICS) side and harness side for bent pins or poor contact pressure. If the problem is found, repair it.
2. If problem is not found step 1, the ECM(TICS) could be faulty. If so, replace the ECM(TICS) with a new one, and then check the vehicle again. If the vehicle operates normally then the problem was likely with the ECM(TICS).
3. Re-test the original ECM(TICS): Install the original ECM(TICS)(may be broken) into a known-good vehicle and check the vehicle. If the problem occurs again, replace the original ECM(TICS) with a new one. If problem does not occur, this is intermittent problem (Refer to Intermittent Problem Procedure in Basic Inspection Procedure.)

ABBREVIATION

ABS: Anti-lock brake system

APS: Accelerator pedal sensor

A/C: Air conditioning

B: Battery

BATT: Battery

Comp: Compressor

DTC : Diagnostic trouble code

ECTS: Engine coolant temperature sensor

ECU: Electronic control unit

ETCM: Electronic time control module

EUI: Electronic unit injection

IATS : Intake air temperature sensor

IG: Ignition

MIL: Malfunction indicator lamp(Check engine lamp)

NTC: Negative Temperature Coefficient

PTO: Power take-off

NC: Normal close

NO: Normal open

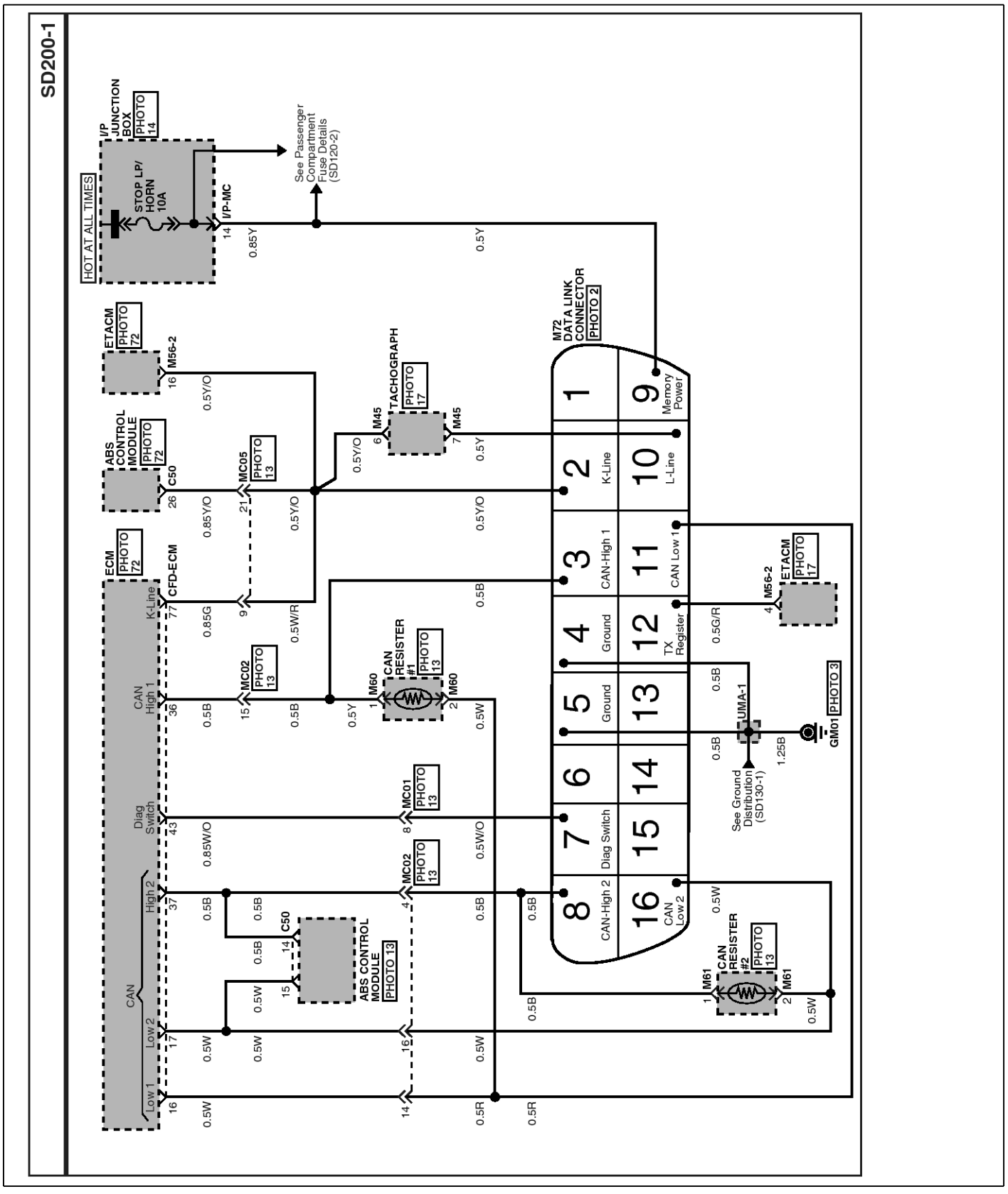
RPM: Revolution per minute

Sw: Switch

Sig: Signal

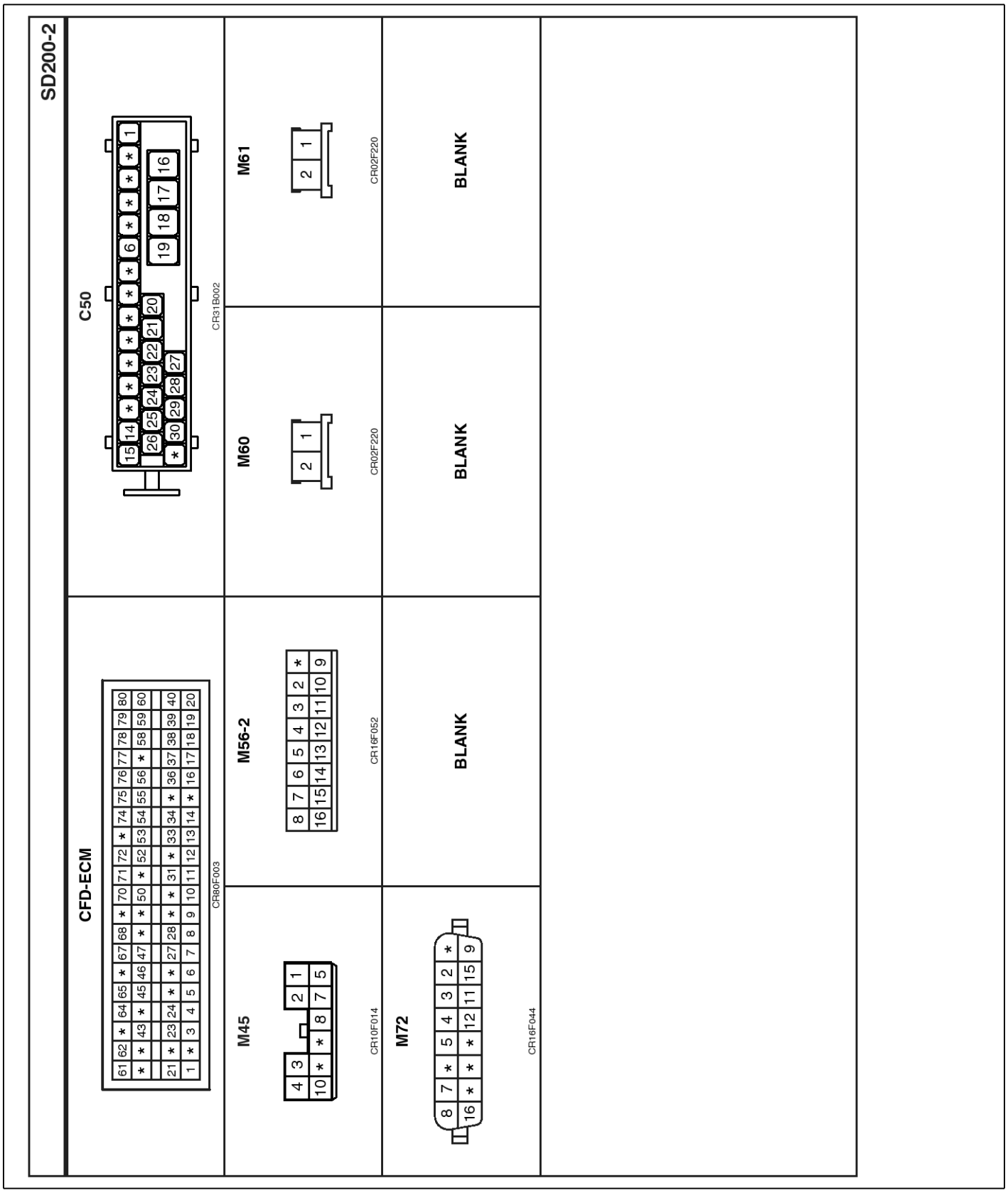
SCHEMATIC CIRCUIT

Data Link Details (1)



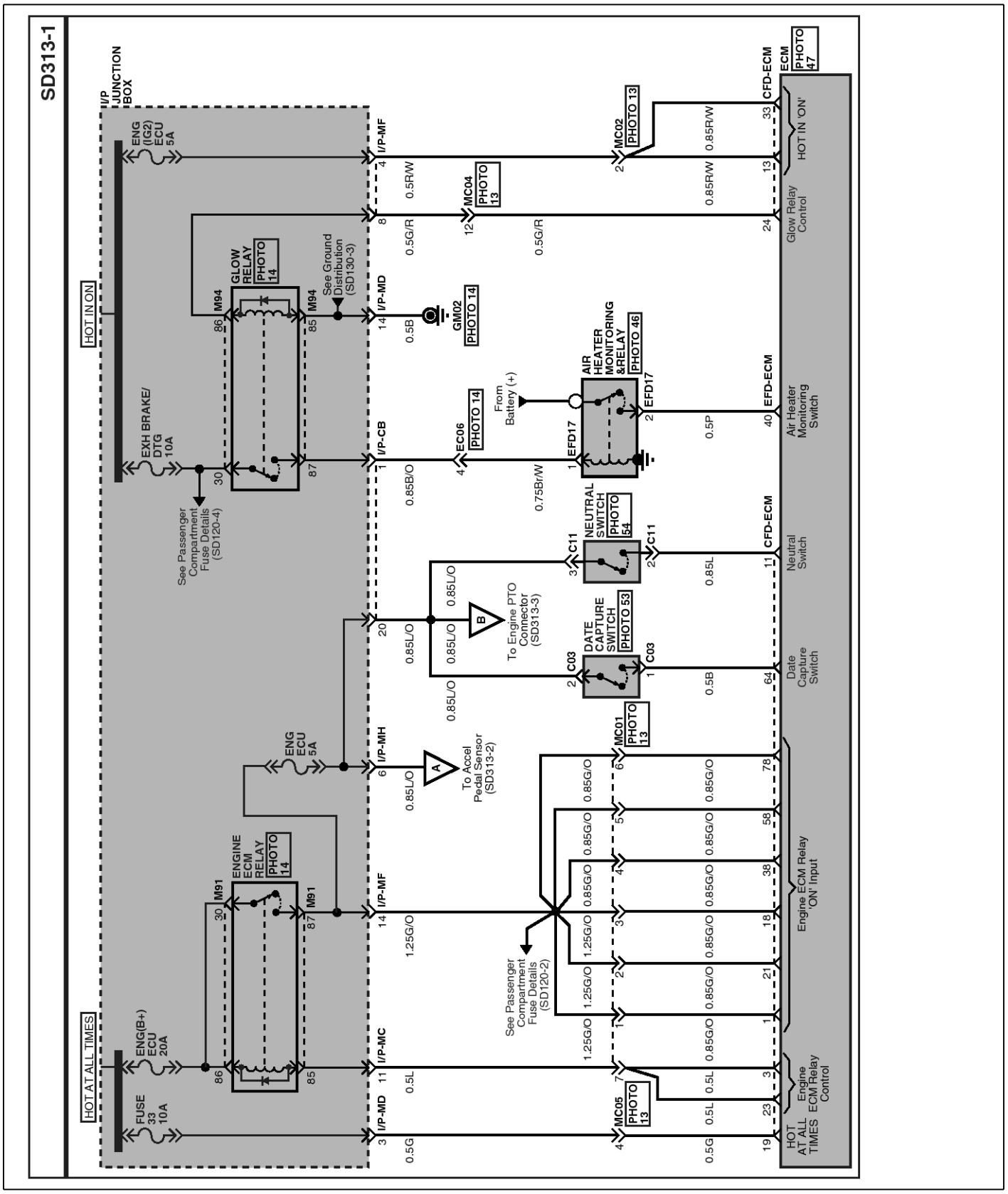
SUDFLDTC9078L

Data Link Details (2)



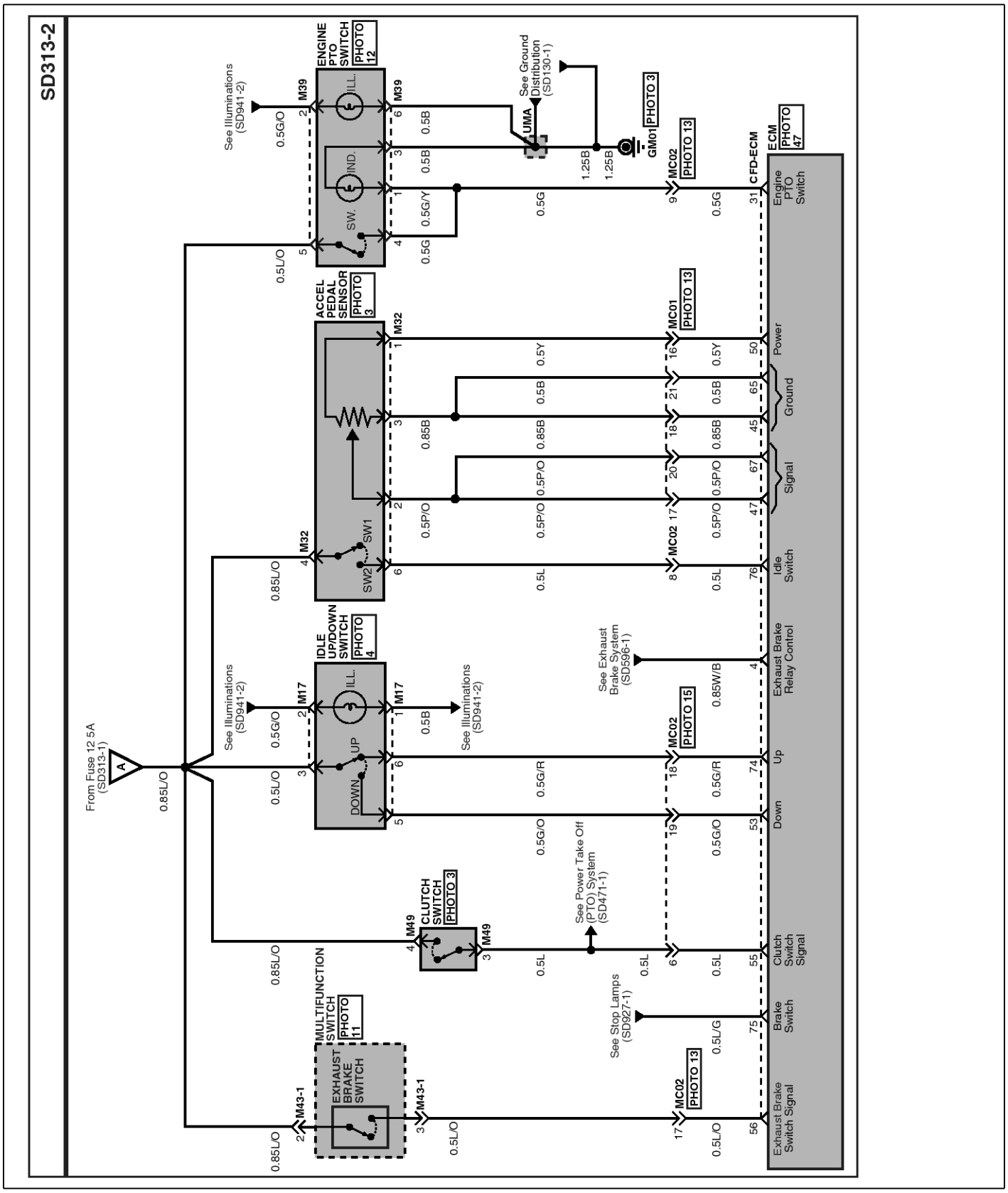
SUDFLDTC9079L

Engine Control System (D4GA : F-ENG) (1)



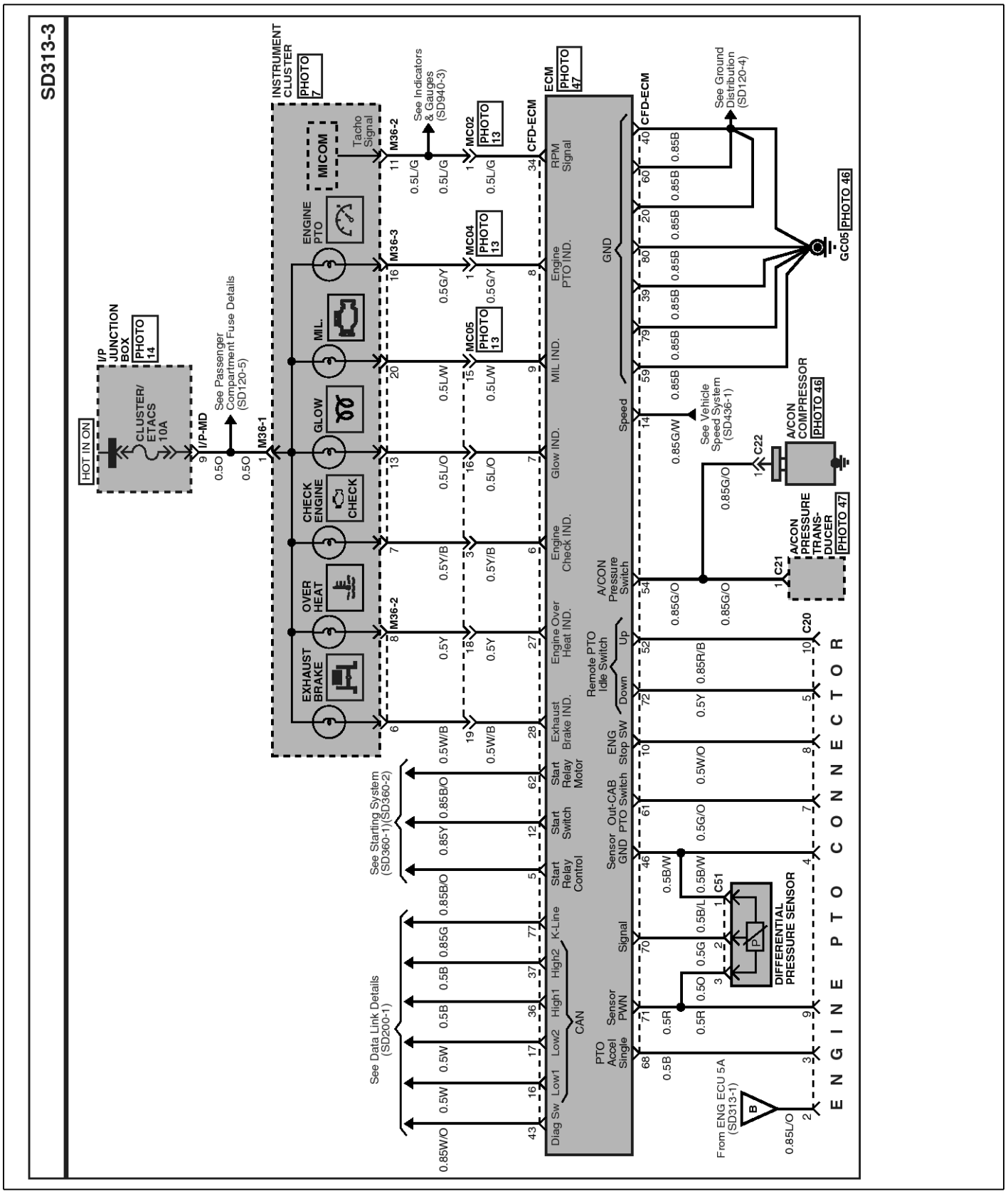
SUDFLDTC9080L

Engine Control System (D4GA : F-ENG) (2)



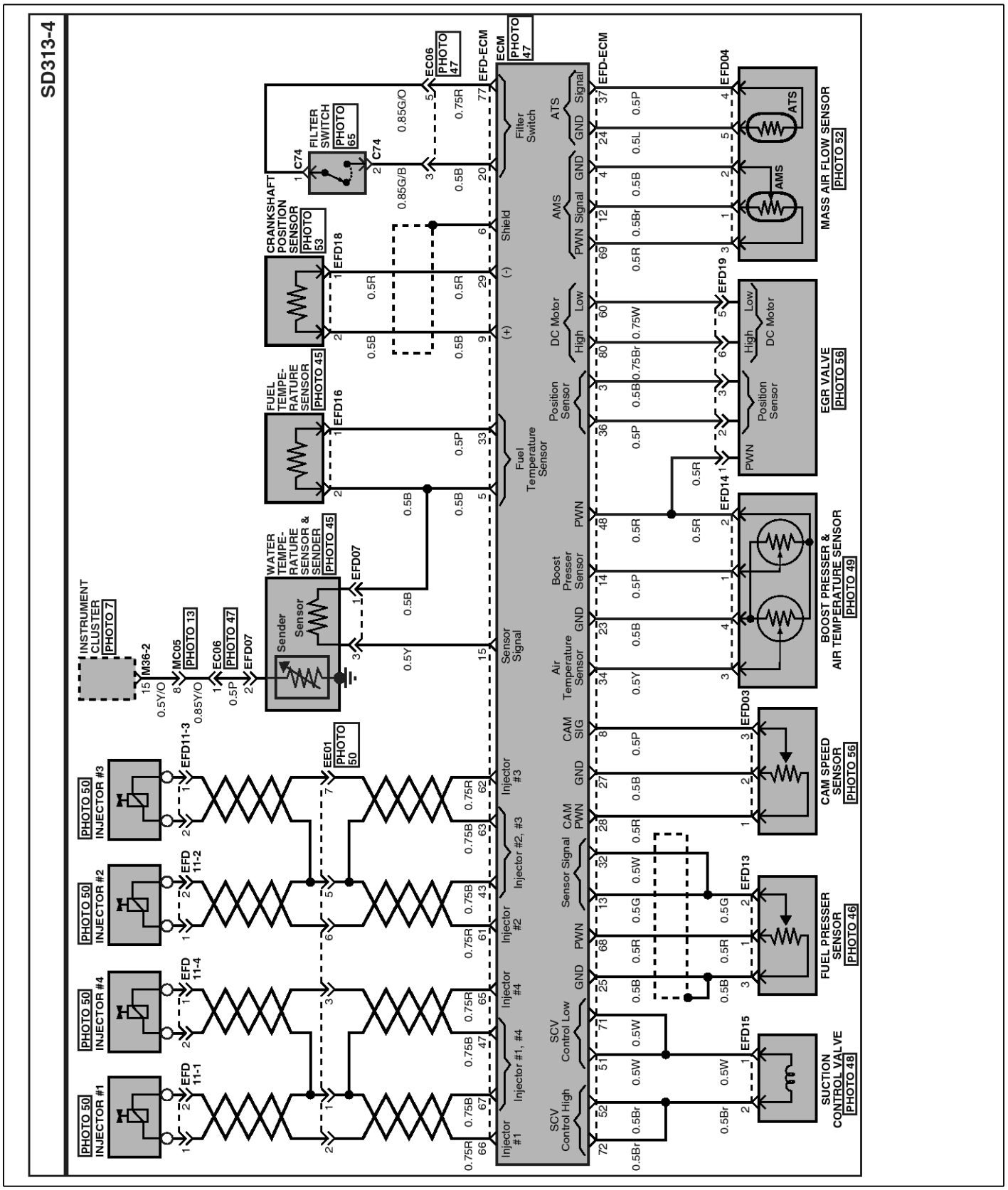
SUDFLDTC9081L

Engine Control System (D4GA : F-ENG) (3)



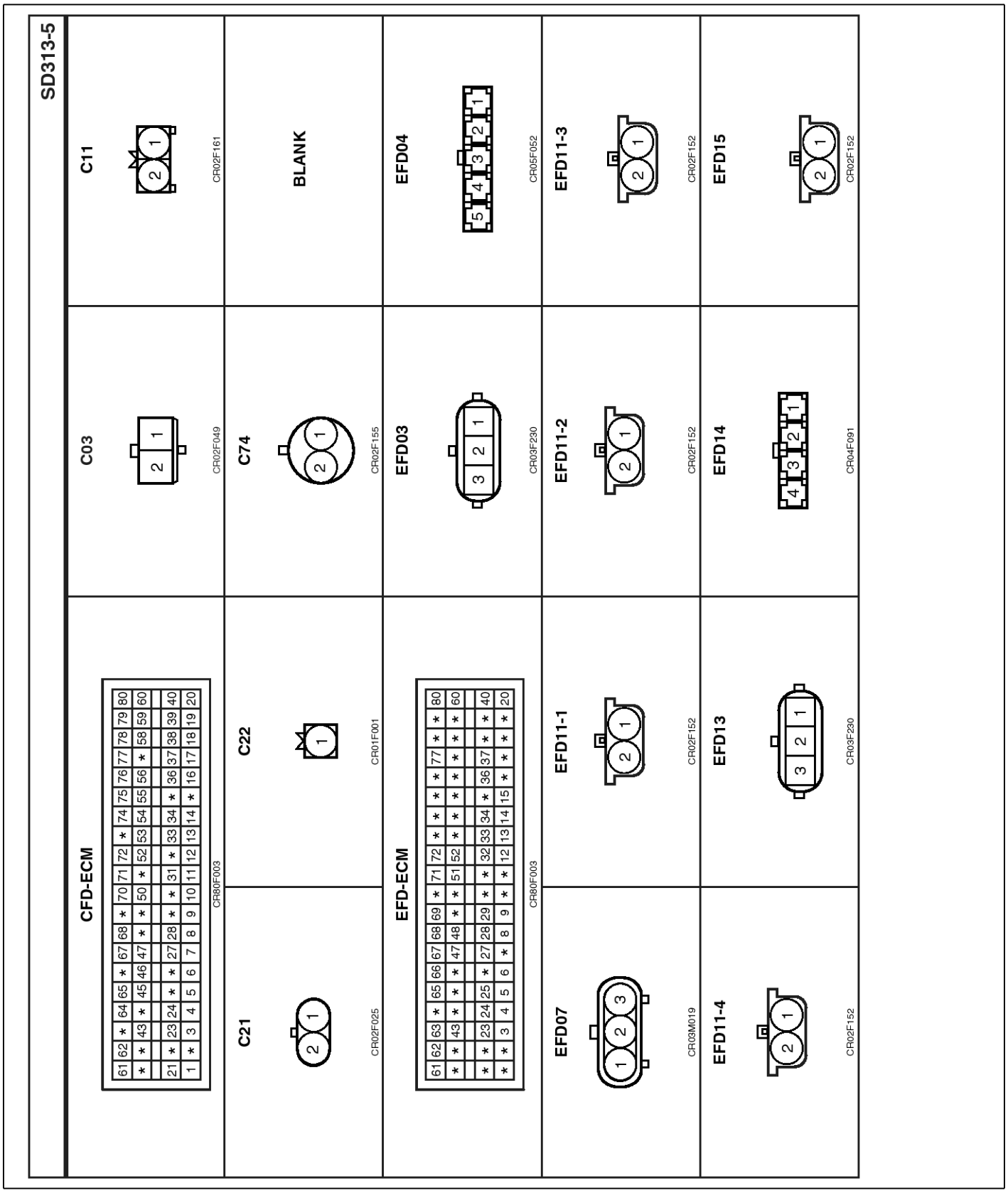
SUDFLDTC9082L

Engine Control System (D4GA : F-ENG) (4)



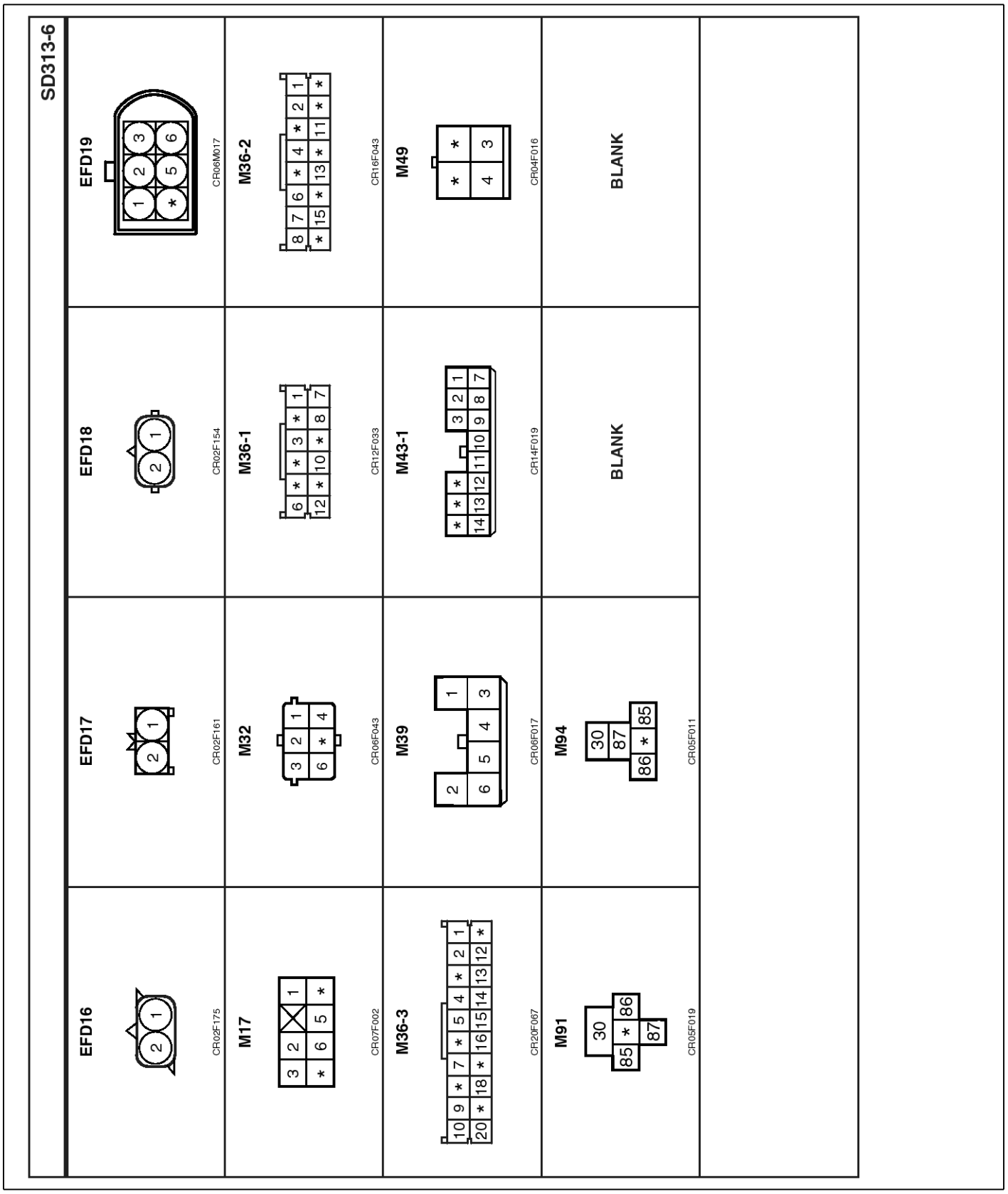
SUDFLDTC9083L

Engine Control System (D4GA : F-ENG) (5)



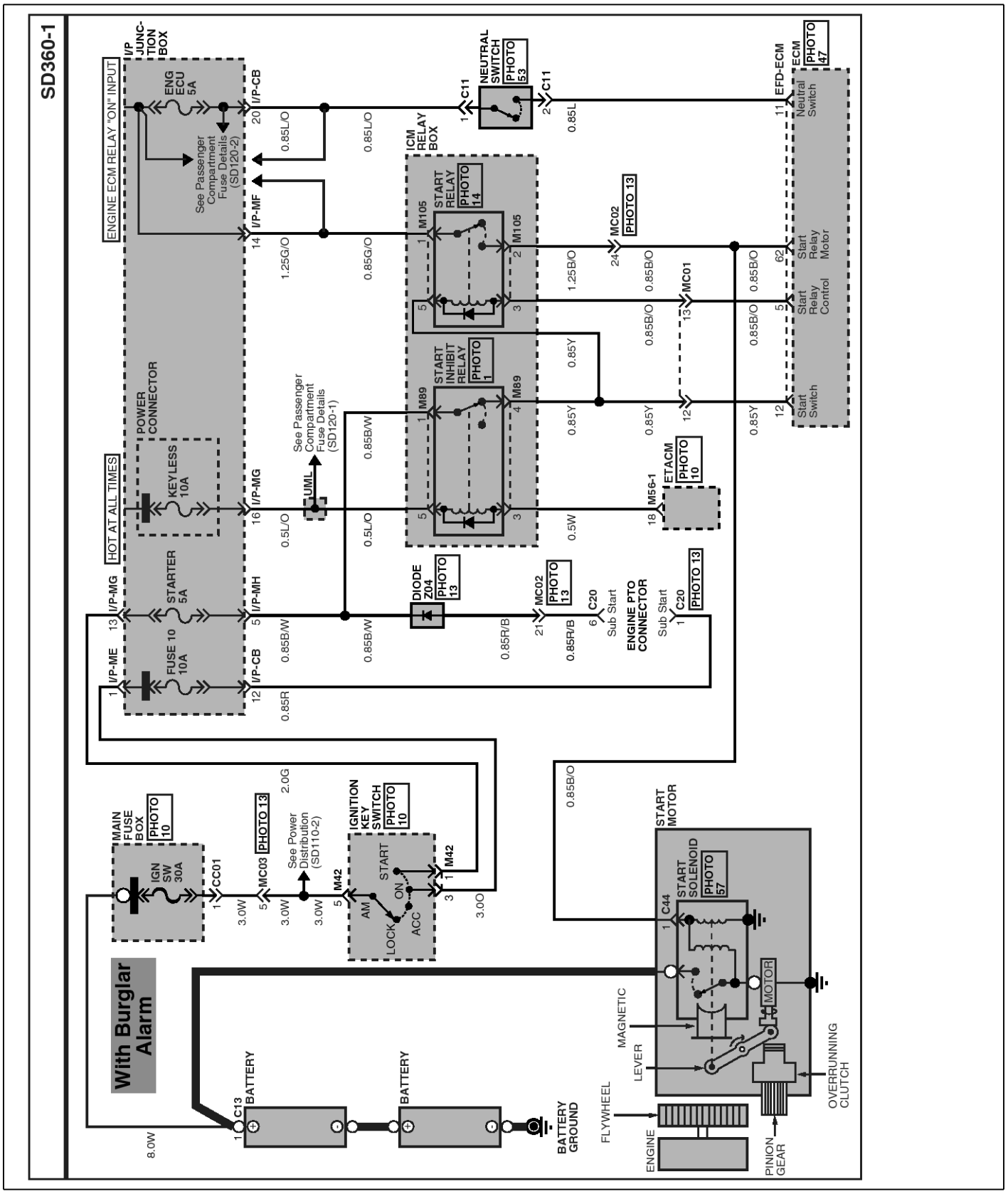
SUDFLDTC9084L

Engine Control System (D4GA : F-ENG) (6)



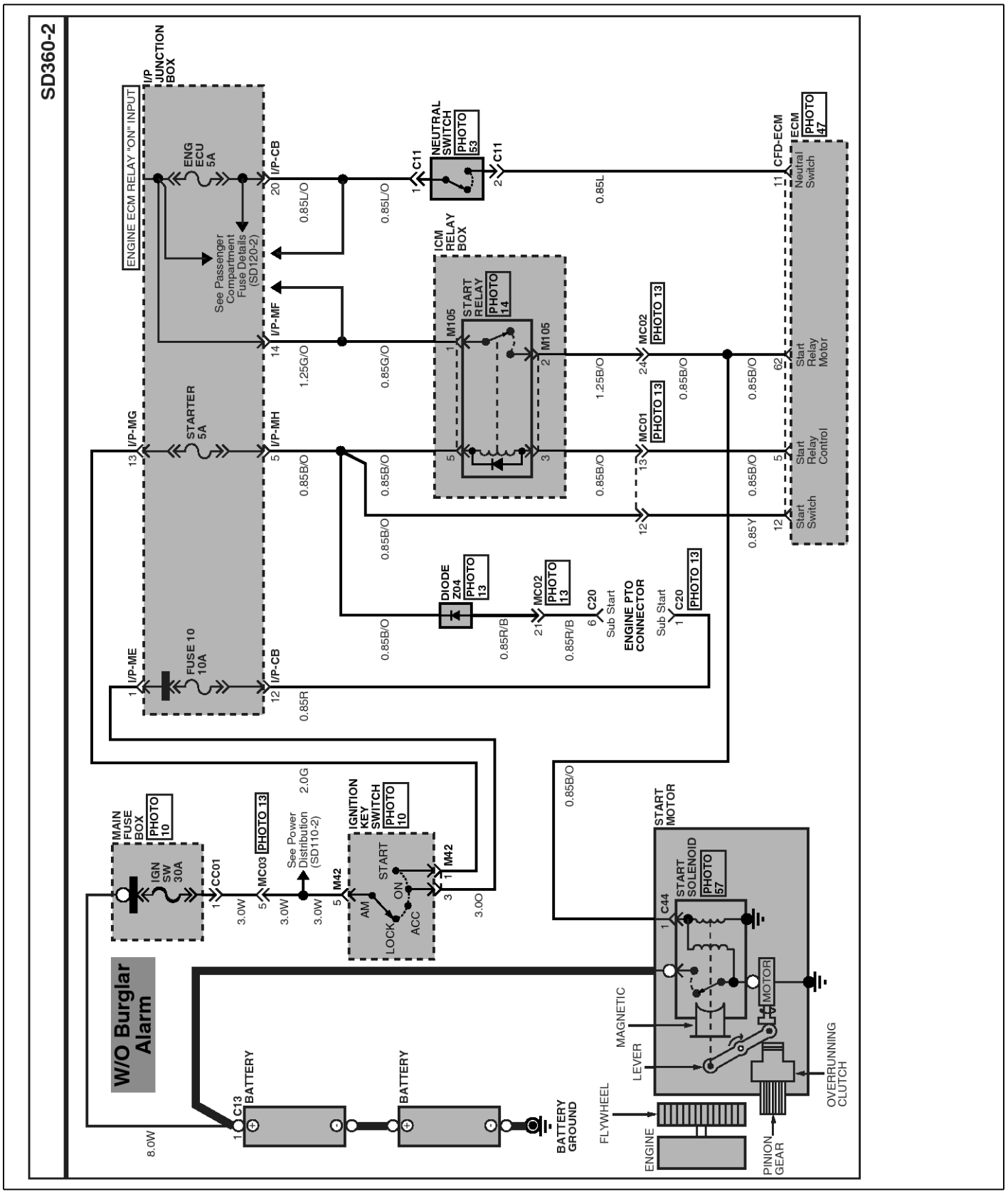
SUDFLDTC9085L

Starting System (1)



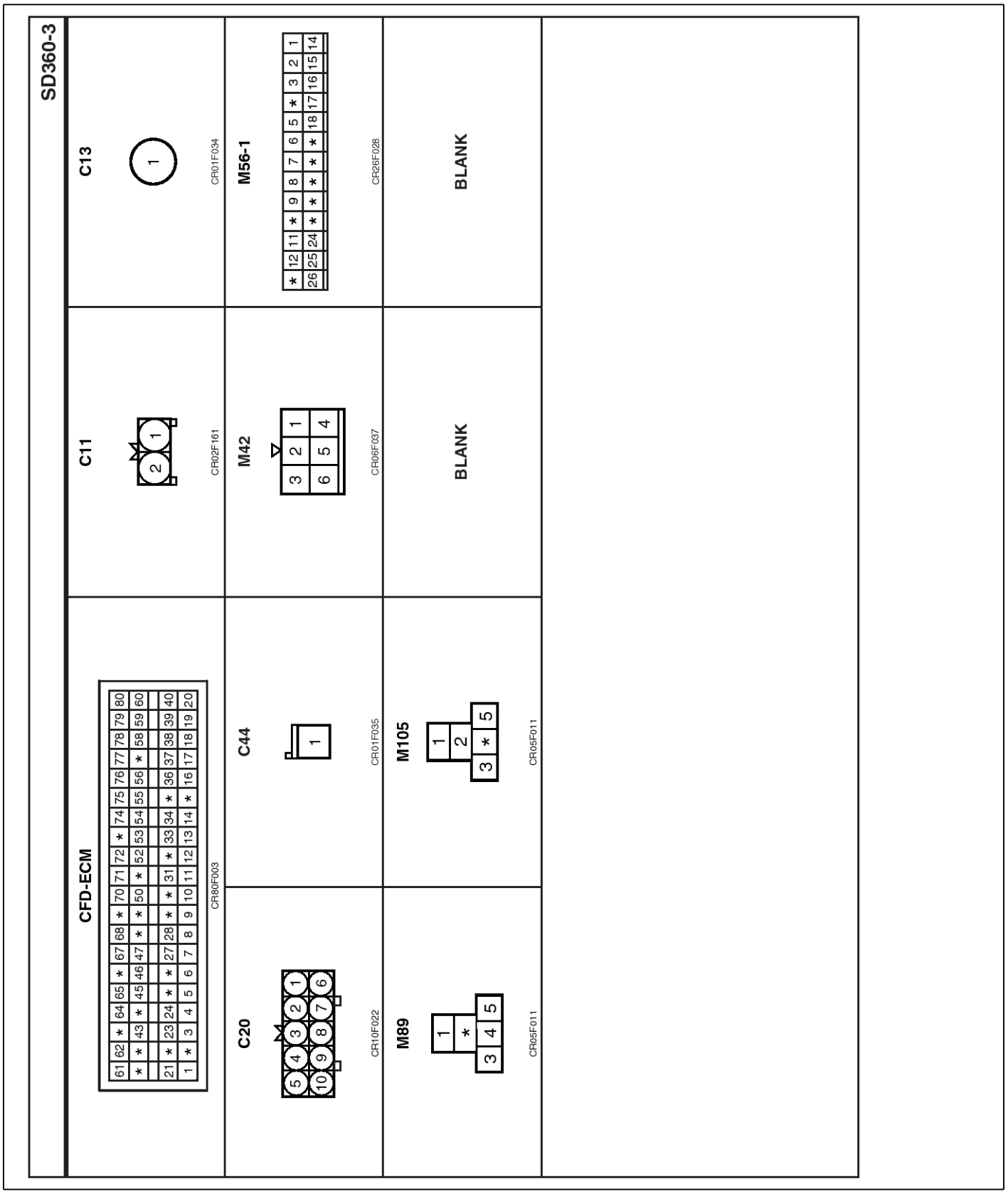
SUDFLDTC9086L

Starting System (2)



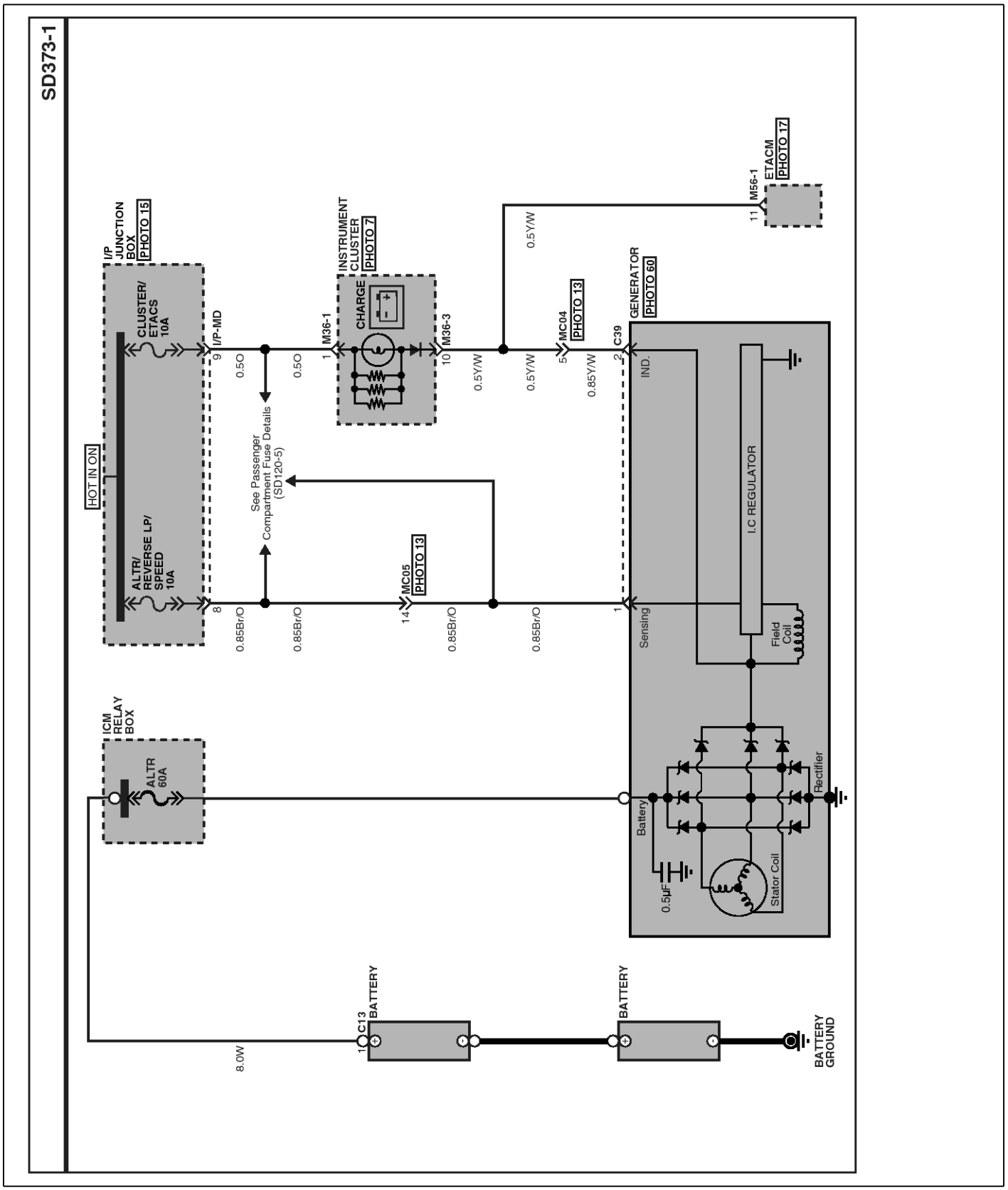
SUDFLDTC9087L

Starting System (3)



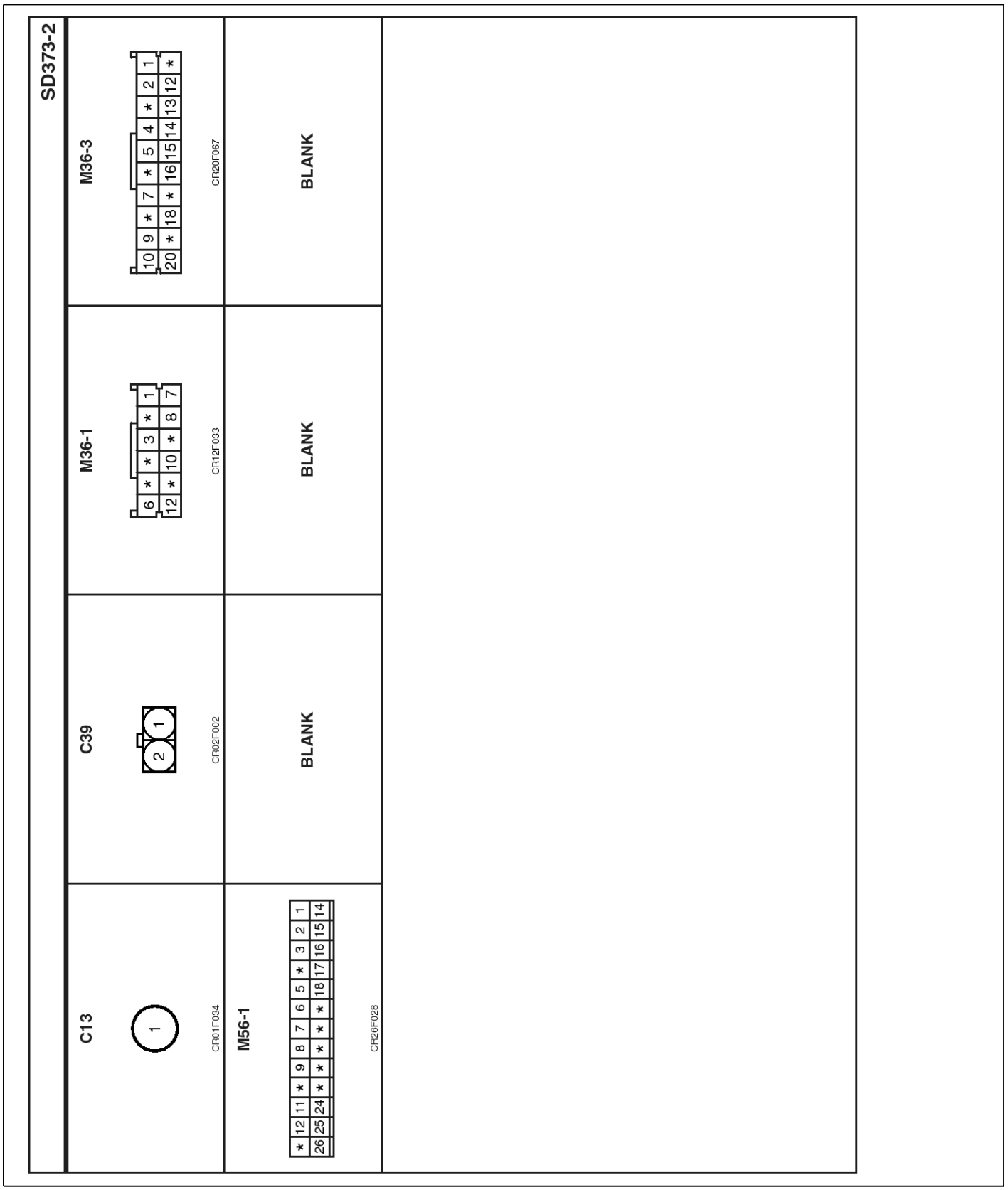
SUDFLDTC9088L

Charging System (1)



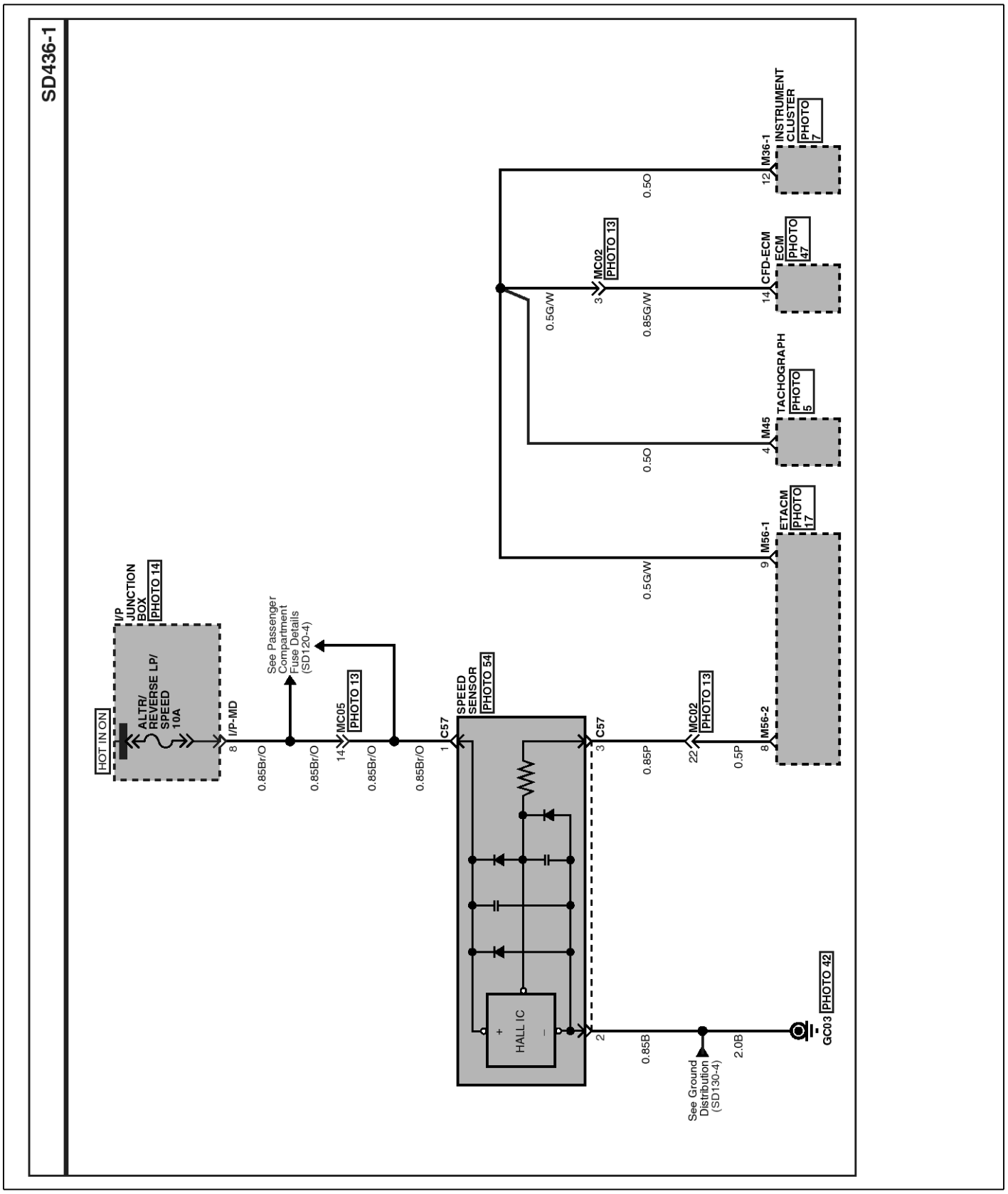
SUDFLDTC9089L

Charging System (2)



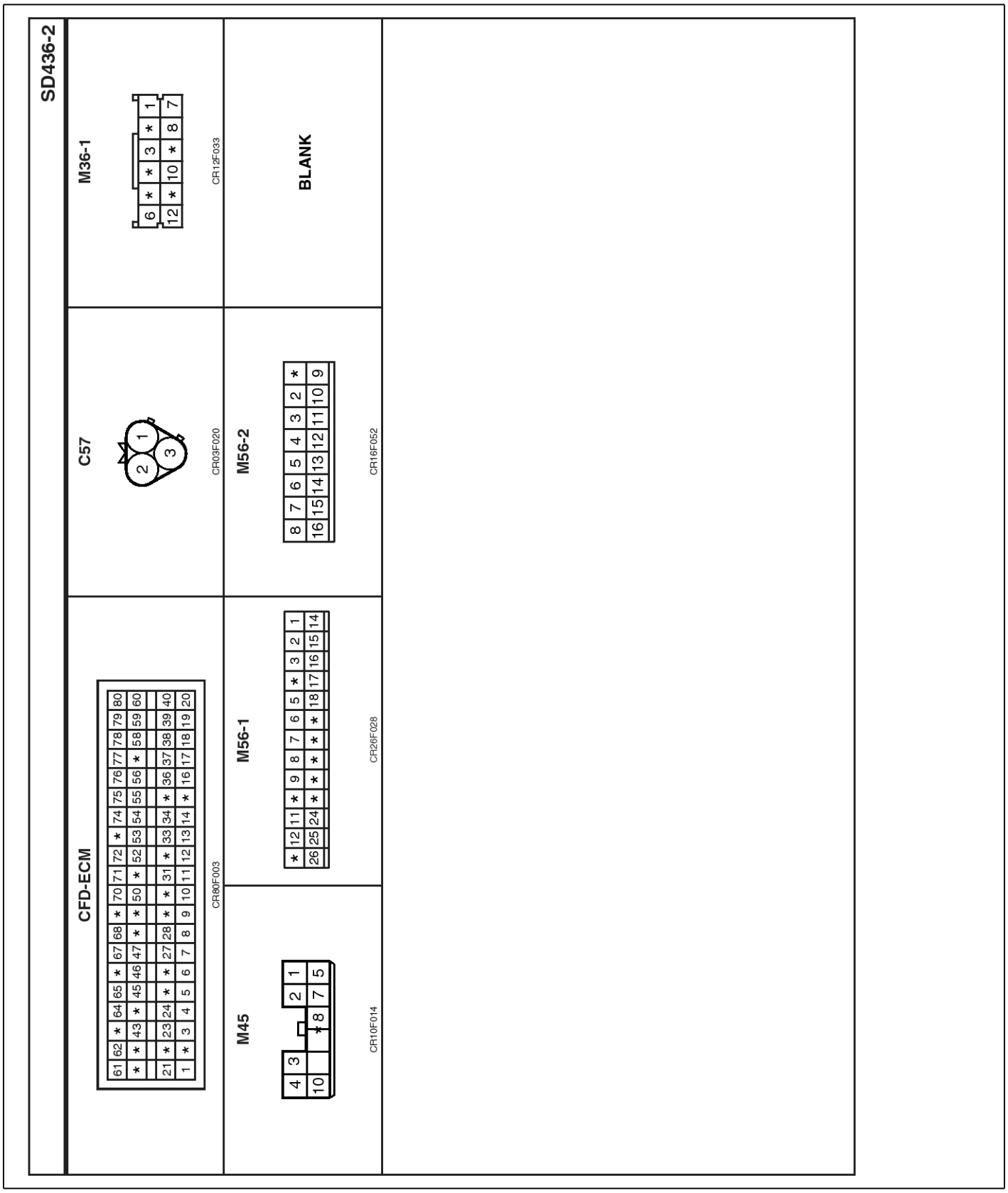
SUDFLDTC9090L

Vehicle Speed System (1)

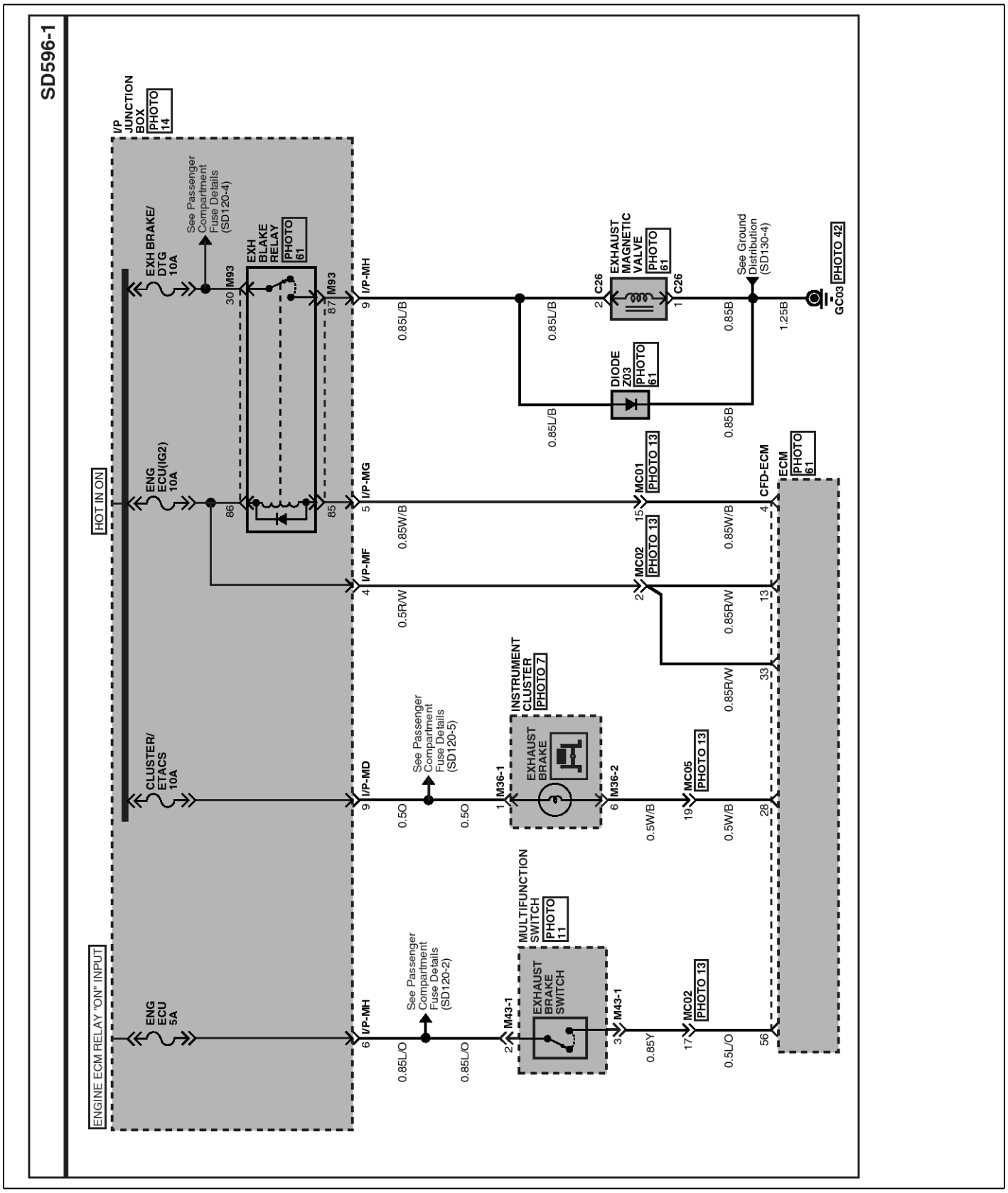


SUDFLDTC9091L

Vehicle Speed System (2)

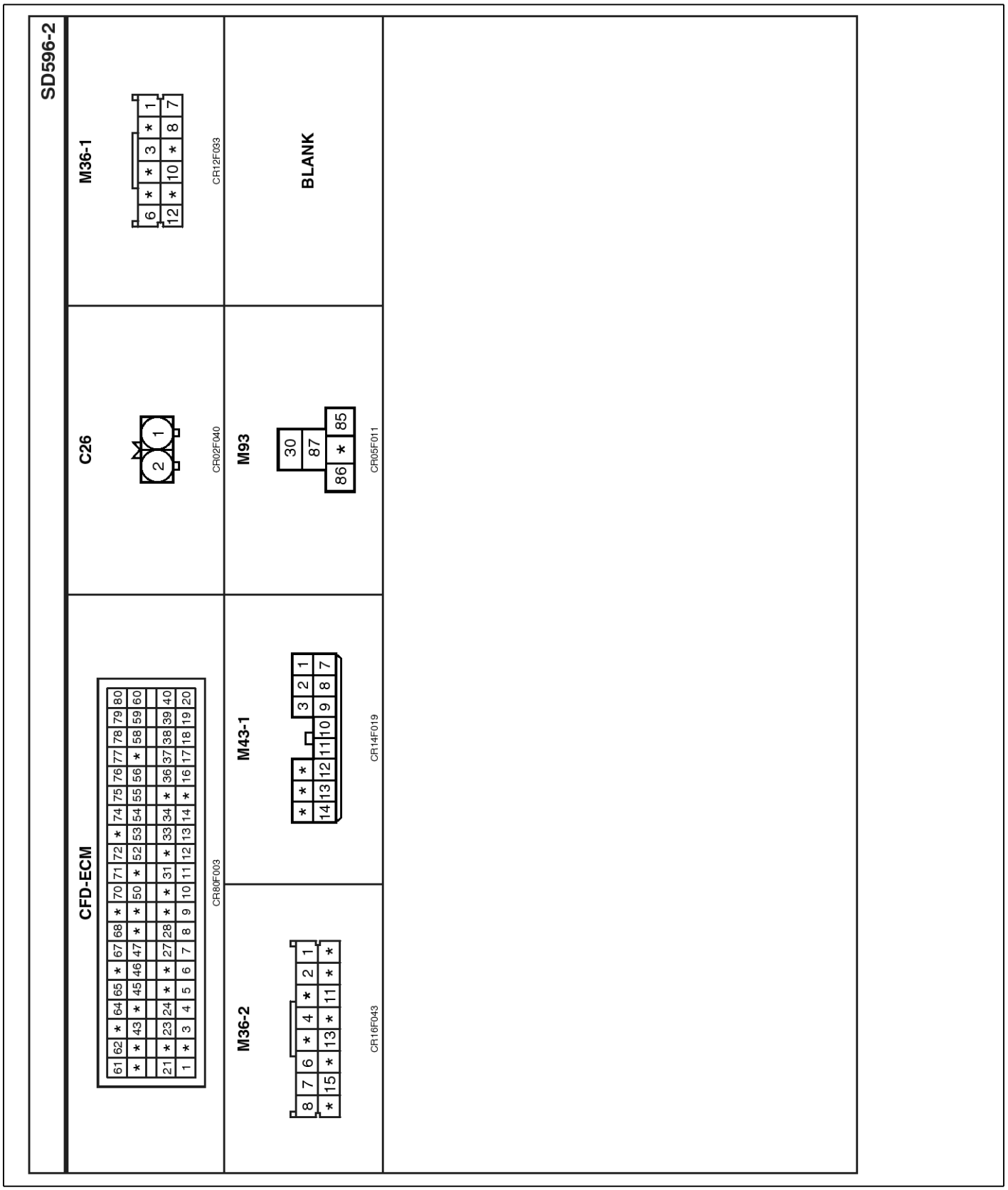


Exhaust Brake System (1)



SUDFLDTC9093L

Exhaust Brake System (2)



SUDFLDTC9094L

DTC LIST

No	Code	Description
1	P0072	Intake Air Temp. Sensor(with MAF) Signal Too Low
2	P0073	Intake Air Temp. Sensor(with MAF) Signal Too High
3	P0088	Common Rail Pressure Exceeds Upper Limit
4	P0101	MAF Sensor Performance Invalid
5	P0102	MAF Sensor Signal Too Low
6	P0103	MAF Sensor Signal Too High
7	P0107	Atmosphere Pressure Sensor Signal Too Low
8	P0108	Atmosphere Pressure Sensor Signal Too High
9	P010A	MAF Sensor Performance Invalid #2
10	P0112	Intake Air Temp. Sensor Signal Too Low
11	P0113	Intake Air Temp. Sensor Signal Too High
12	P0116	Coolant Temp. Sensor Performance Invalid
13	P0117	Coolant Temp. Sensor Signal Too Low
14	P0118	Coolant Temp. Sensor Signal Too High
15	P0120	Accel. Pedal Sensor No.1 Not Open
16	P0121	Accel. Pedal Sensor No.1 Not Close
17	P0122	Accel. Pedal Sensor No.1 Signal Too low
18	P0123	Accel. Pedal Sensor No.1 Signal Too high
19	P0182	Fuel Temp.(Pump) Sensor Signal Too Low
20	P0183	Fuel Temp.(Pump) Sensor Signal Too High
21	P0192	C/Rail Pressure Sensor Signal Too Low
22	P0193	C/Rail Pressure Sensor Signal Too High
23	P0194	C/Rail Pressure Sensor Signal Keeping the Middle Range
24	P0195	C/Rail Pressure Sensor Signal offsef
25	P0196	C/Rail Pressure Sensor Signal Moment offset
26	P0201	TWV1 Output Open Load/Injector Coil Open
27	P0202	TWV4 Output Open Load/Injector Coil Open
28	P0203	TWV2 Output Open Load/Injector Coil Open
29	P0204	TWV3 Output Open Load/Injector Coil Open
30	P0217	Coolant Temp. Exceeds Upper Limit
31	P0219	Engine Overrun
32	P0220	Accel. Pedal Sensor No.2 Not Open
33	P0221	Accel. Pedal Sensor No.2 Not Close
34	P0222	Accel. Pedal Sensor No.2 Signal Too Low

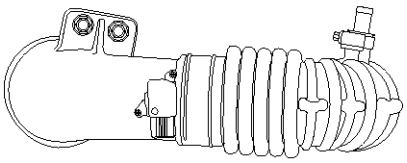
No	Code	Description
35	P0223	Accel. Pedal Sensor No.2 Signal Too High
36	P0225	Idle Switch Stuck Closed
37	P0226	Idle Switch Stuck Opened
38	P0237	Boost Pressure Sensor Signal Too Low
39	P0238	Boost Pressure Sensor Signal Too High
40	P0335	Crank Sensor No Pulse
41	P0336	Crankshaft Position Sensor Performance Invalid
42	P0340	Cam Sensor No Pulse
43	P0341	Camshaft Position Sensor Performance Bank 1
44	P0401	EGR Insufficient Flow (EGR Negative Deviation)
45	P0403	EGR Control DC Motor Output 1, 2 Open Load, Motor Open Load
46	P0404	EGR Control DC Motor Output 1, 2 Short to BATT/GND, Motor short
47	P0405	EGR Lift Sensor1 Signal Too Low
48	P0406	EGR Lift Sensor1 Signal Too High
49	P0501	Vehicle Speed Sensor Signal Invalid
50	P0502	Vehicle Speed Sensor Input Open / Short
51	P0503	Vehicle Speed Sensor Frequency Too High
52	P0541	Air Heater Monitor system Failure(LOW)
53	P0542	Air Heater Monitor system Failure(HIGH)
54	P0562	Vehicle System Voltage Too Low
55	P0563	Vehicle System Voltage Too High
56	P0601	Check Sum Error - Flash area
57	P0602	QR Data Is Not Written
58	P0603	QR Data Error
59	P0604	QR Definition Error
60	P0606	ECM Main CPU Fault
61	P0607	ECM Watchdog IC Fault
62	P0615	Starter Switch Short to BATT
63	P0627	SCV(+, -) Output Open Load/Short to GND
64	P0629	SCV(+, -) Output Short to BATT
65	P0642	Battery 5V Reference1 Circuit Low (VCC1L)
66	P0643	Battery 5V Reference1 Circuit High (VCC1H)
67	P0652	Battery 5V Reference2 Circuit Low (VCC2L)
68	P0653	Battery 5V Reference2 Circuit High (VCC2H)
69	P0698	Battery 5V Reference3 Circuit Low (VCC11L = VCC3L)

No	Code	Description
70	P0699	Battery 5V Reference3 Circuit High (VCC11H = VCC3H)
71	P069E	Battery 5V Reference4 Circuit Low (VCC10/12L = VCC4L)
72	P069F	Battery 5V Reference4 Circuit High (VCC10/12H = VCC4H)
73	P0704	Clutch Switch Circuit Malfunction(Manual Transmission Only)
74	P0850	Neutral Switch Circuit Malfunction(Manual Transmission Only)
75	P1120	Both Accel. Pedal Sensor Signal Invalid
76	P1132	ASC(PTO) Accel. Pedal Sensor Signal Too low
77	P1133	ASC(PTO) Accel. Pedal Sensor Signal Too high
78	P1190	Actual Rail Pressure Over
79	P1218	Abnormal High Pressure Mode #3
80	P1219	Abnormal High Pressure Mode #1
81	P1221	Actual Rail Pressure Was Less Than Target Pressure
82	P1222	Fuel Filter diagnosis level 1
83	P1223	Fuel Filter diagnosis level 2
84	P1231	Exhaust Brake MV1 Output Open Load/Short to GND
85	P1232	Exhaust Brake MV1 Output Short to BATT
86	P1383	Air Heater[Glow Relay] Output Open Load/Short to BATT
87	P1384	Air Heater[Glow Relay] Output Short to GND
88	P1616	Main Relay Diagnostics
89	P1642	MAF Sensor's Power Supply Failure Short to BATT
90	P1643	MAF Sensor's Power Supply Failure Short to GND
91	P2002	PMC Removal Diagnosis
92	P2146	COM1 Output Open Load (Both TWV 1 and TWV 3 Open Load)
93	P2147	COM1 Output Short to GND (TWV 1 or 3 Output Short to GND)
94	P2148	COM1 Output Short to BATT (TWV 1 or 3 Output Short to BATT)
95	P2149	COM2 Output Open Load (Both TWV 2 and TWV 4 Open Load)
96	P2150	COM2 Output Short to GND (TWV 2 or 4 Output Short to GND)
97	P2151	COM2 Output Short to BATT (TWV 2 or 4 Output Short to BATT)
98	P2293	Pressure Limiter Activated
99	P2413	EGR Valve Open/Close Stuck
100	P2454	Differential Pressure Sensor Signal Too Low
101	P2455	Differential Pressure Sensor Signal Too High
102	P2503	Capacitor Charge-up Circuit Malfunction (Insufficient Charge)
103	P2504	Capacitor Charge-up Circuit Malfunction (Excessive Charge)
104	U0001	CAN1 BUS / Node Error (500K)

No	Code	Description
105	U0010	CAN2 BUS / Node Error (250K)

P0072 Intake Air Temp. Sensor(with MAF) Signal Too Low

COMPONENT LOCATION



SUDFL8100D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   The IATS(Intake air temperature sensor) integrated with the air amount sensor and the boost pressure sensor is a thermistor type of negative characteristics which the more temperature increases the less voltage gets and it detects the air temperature entered through the engine.

   In Euro-4 diesel engine, the intake air temperature sensor is installed in the front(built-in intake air sensor) and rear(built-in boost sensor) of turbocharger so that it measures both the ambient air temperature and the air temperature passed through turbocharger and intercooler to measure more precise intake air amount.

   The ECM which received information from the sensors controls the correction of EGR and fuel amount according to intake air temperature.(In the electronic control diesel engine, it is very important for the intake air temperature sensor to measure density according to the air temperature for the exact EGR feedback control.)

2. DTC DESCRIPTION

   If the output voltage of the intake air temperature sensor is below 0.1V for more than 3,016ms, the ECM judges this as a fault and DTC P0072 is set. The possible causes are defective air temperature sensor, wiring& resistance problem, short to ground of terminal 37 of ECM connector (EFD-ECM).

   Check lamp and MIL come on together when the condition continued for 2 driving cycle times. Check lamp will go off after 3 driving cycle times when the system returns to normal.

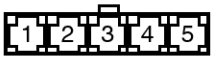
   The smoke and a lack of power may occur as fuel quantity correction and injection time correction will not be controlled by ECM depending on intake air temperature but the vehicle can be driven.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Defective wiring and sensor • Short to ground of terminal 37 of ECM connector (EFD-ECM)
Enable Conditions	• Engine running			
Threshold Value	• Below 0.1V			
Diagnosis Time	• 3,016ms			
Fail Safe	Fuel Cut	No	Intake air temperature • IG ON: -25℃ • Engine running: 25℃	
	Fuel Limit	Yes		
	Check lamp	ON		

SPECIFICATION

Temperature (℃)	Resistance (kΩ) of terminal No ④,⑤
-20	16.0 ± 2.4
20	2.45 ± 0.24
60	0.580 ± 0.087



Sensor connector

SUDFLDTC9001L

SIGNAL CIRCUIT INSPECTION

1. Signal Voltage Inspection
   1) Leave the air temperature sensor connector (EFD04) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 4 of the air temperature harness connector and chassis ground.
      ■ Specification: Air temperature sensor signal power approx. 5V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to "Component Inspection" procedure.

      NO

      ▶Go to "Signal Short to Ground Inspection" procedure.
2. Signal Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the air temperature sensor connector (EFD04) and the ECM connector(EFD-ECM).
   3) Measure resistance between terminal 4 of the air temperature sensor harness connector and chassis ground.
      ■ Specification: Infinite
   4) Is the resistance measured within specification?

      YES

      ▶ Go to "Power Supply Inspection" procedure.

      NO

      ▶Repair short to ground and then go to "Verification of vehicle repair" procedure.

POWER SUPPLY INSPECTION

1. Power Supply Voltage Inspection
   1) Disconnect the air temperature sensor connector (EFD04).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 3 of the air temperature sensor harness connector and chassis ground.
      ■ Specification: ECM output power approx. 12.72V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to "Ground Circuit Inspection" procedure.

      NO

      ▶ Go to "Power Supply Short to Ground Inspection" procedure.

2. Power Supply Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the air temperature sensor connector (EFD04) and ECM connector(EFD-ECM).
   3) Measure the resistance between the terminal 3 of the intake air temperature sensor harness connector and chassis ground.
      ■ Specification: Infinite
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Ground Circuit Inspection” procedure.

      NO

      ▶ Repair short to ground and then go to “Verification of Vehicle Repair” procedure.

GROUND CIRCUIT INSPECTION

1. Ground Voltage Drop Inspection
   1) Disconnect the air temperature sensor connector (EFD04).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure the voltage drop between the terminal 5 of the air temperature sensor harness connector and chassis ground.
      ■ Specification: Ground voltage drop within 200mV
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Ground Open Inspection” procedure.

      NO

      ▶ Repair the cause of the excessive resistance (poor connection) and then go to “Verification of Vehicle Repair” procedure.
2. Ground Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the air temperature sensor connector (EFD04) and ECM connector(EFD-ECM).
   3) Measure the resistance between the terminal 5 of the air temperature sensor harness connector and the terminal 24 of the ECM connector(EFD-ECM).
      ■ Specification: Continuity (Below 1.0Ω)
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Repair open wiring circuit and then go to “Verification of Vehicle Repair” procedure.

COMPONENT INSPECTION

1. Air Temperature Sensor Resistance Inspection
   1) Turn the ignition OFF.
   2) Disconnect the air temperature sensor connector (EFD04).
   3) Measure the resistance between the terminals 4 and 5 of the air temperature sensor.

■ SPECIFICATION :

Temperature (℃)	Resistance (kΩ) of terminal No ④,⑤
-20	16.0 ± 2.4
20	2.45 ± 0.24
60	0.580 ± 0.087

E04

SUDFLDTC9002L

4) Is the resistance measured within the specification?

YES

▶ Go to “Verification of Vehicle Repair” procedure.

NO

▶ Replace the air temperature sensor and then go to “Verification of Vehicle Repair” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

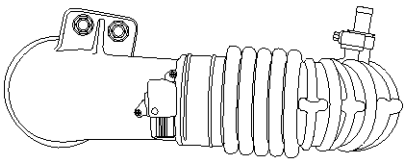
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P0073 Intake Air Temp. Sensor(with MAF) Signal Too High

COMPONENT LOCATION



SUDFL8100D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   The IATS(Intake air temperature sensor) integrated with the air amount sensor and the boost pressure sensor is a thermistor type of negative characteristics which the more temperature increases the less voltage gets and it detects the air temperature entered through the engine.

   In Euro-4 diesel engine, the intake air temperature sensor is installed in the front(built-in intake air sensor) and rear(built-in boost sensor) of turbocharger so that it measures both the ambient air temperature and the air temperature passed through turbocharger and intercooler to measure more precise intake air amount.

   The ECM which received information from the sensors controls the correction of EGR and fuel amount according to intake air temperature.(In the electronic control diesel engine, it is very important for the intake air temperature sensor to measure density according to the air temperature for the exact EGR feedback control.)

2. DTC DESCRIPTION

   If the output voltage of the intake air temperature sensor is above 4.9V for more than 3,016ms, the ECM judges this as a fault and DTC P0073 is set. The possible causes are defective air temperature sensor, wiring& resistance problem, open circuit of terminal 37 of ECM connector (EFD-ECM) and short to power.

   Check lamp and MIL come on together when the condition continued for 2 driving cycle times. Check lamp will go off after 3 driving cycle times when the system returns to normal.

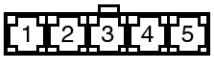
   The smoke and a lack of power may occur as fuel quantity correction and injection time correction will not be controlled by ECM depending on intake air temperature but the vehicle can be driven.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Defective wiring and sensor • Short to B+ terminal 37 of ECM connector (EFD-ECM)
Enable Conditions	• Engine running			
Threshold Value	• Output voltage above 4.9V			
Diagnosis Time	• 3,016ms			
Fail Safe	Fuel Cut	No	Intake air temperature • IG ON: -25℃ • Engine running: 25℃	
	Fuel Limit	Yes		
	Check lamp	ON		

SPECIFICATION

Temperature (℃)	Resistance (kΩ) of terminal No ④,⑤
-20	16.0 ± 2.4
20	2.45 ± 0.24
60	0.580 ± 0.087



Sensor connector

SUDFLDTC9001L

SIGNAL CIRCUIT INSPECTION

1. Signal Voltage Inspection
   1) Leave the air temperature sensor connector (EFD04) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 4 of the air temperature harness connector and chassis ground.
      ■ Specification: Intake air temperature sensor signal power approx. 5V
      Note) The voltage value is different according to intake air temperature.
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Go to “Signal Open Inspection” procedure.
2. Signal Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the air temperature sensor connector (EFD04) and the ECM connector(EFD-ECM).
   3) Measure the resistance between terminal 4 of the intake air temperature sensor harness connector and the terminal 37 of ECM connector(EFD-ECM).
      ■ Specification: Continuity (Below 1.0Ω)
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Signal Short to Power Inspection” procedure.

      NO

      ▶ Repair open circuit and then go to “Verification of vehicle repair” procedure.
3. Signal Short to Power Inspection
   1) Disconnect the air temperature sensor connector (EFD04) and the ECM connector(EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure the voltage between terminal 4 of the air temperature sensor harness connector and chassis ground.
      ■ Specification: Below 0~0.1V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Power Supply Inspection” procedure.

      NO

      ▶ Repair short to power and then go to

"Verification of vehicle repair" procedure.

POWER SUPPLY INSPECTION

1. Power Supply Voltage Inspection
   1) Disconnect the air temperature sensor connector (EFD04).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure the voltage between terminal 3 of the air temperature sensor harness connector and chassis ground.
      ■ Specification: ECM output power approx. 12.70V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to "Ground Circuit Inspection" procedure.

      NO

      ▶ Go to "Power Supply Open Inspection" procedure.
2. Power Supply Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the air temperature sensor connector (EFD04) and ECM connector(EFD-ECM).
   3) Measure the resistance between the terminal 3 of the intake air temperature sensor harness connector and the terminal 69 of ECM connector(EFD-ECM).
      ■ Specification: Continuity (Below 1.0Ω)
   4) Is the resistance measured within specification?

      YES

      ▶ Go to "Power Supply Short to Power Inspection" procedure.

      NO

      ▶ Repair open circuit and then go to "Verification of vehicle repair" procedure.
3. Power Supply Short to Power Inspection
   1) Disconnect the air temperature sensor connector (EFD04) and ECM connector(EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure the voltage between the terminal 3 of the intake air temperature sensor harness connector and chassis ground.
      ■ Specification: Below 0~0.1V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to "Ground Circuit Inspection" procedure.

      NO

      ▶ Repair short to power and then go to "Verification of vehicle repair" procedure.

GROUND CIRCUIT INSPECTION

1. Ground Voltage Drop Inspection
   1) Disconnect the air temperature sensor connector (EFD04).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure the voltage drop between the terminal 5 of the air temperature sensor harness connector and chassis ground.
      ■ Specification: Ground voltage drop within 200mV
   4) Is the voltage measured within specification?

      YES

      ▶ Go to "Ground Open Inspection" procedure.

      NO

      ▶ Repair the cause of the excessive resistance (poor connection) and then go to "Verification of Vehicle Repair" procedure.
2. Ground Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the air temperature sensor connector (EFD04) and ECM connector(EFD-ECM).
   3) Measure the resistance between the terminal 5 of the air temperature sensor harness connector and the terminal 24 of the ECM connector(EFD-ECM).
      ■ Specification: Continuity (Below 1.0Ω)
   4) Is the resistance measured within specification?

      YES

      ▶ Go to "Component Inspection" procedure.

      NO

      ▶ Repair open wiring circuit and then go to "Verification of Vehicle Repair" procedure.

COMPONENT INSPECTION

1. Air Temperature Sensor Resistance Inspection
   1) Turn the ignition OFF.
   2) Disconnect the air temperature sensor connector (EFD04).
   3) Measure the resistance between the terminals 4 and 5 of the air temperature sensor.

■ **SPECIFICATION :**

Temperature (℃)	Resistance (kΩ) of terminal No ④,⑤
-20	16.0 ± 2.4
20	2.45 ± 0.24
60	0.580 ± 0.087

   4) Is the resistance measured within the specification?

YES

▶ Go to “Verification of Vehicle Repair” procedure.

NO

▶ Replace the air temperature sensor and then go to “Verification of Vehicle Repair” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

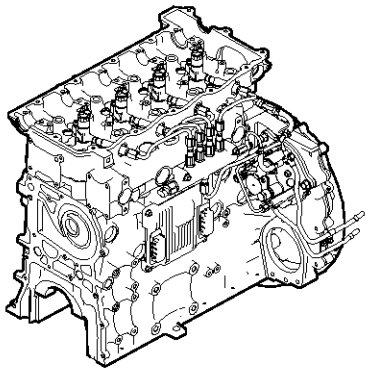
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P0088 Common Rail Pressure Exceeds Upper Limit

COMPONENT LOCATION



SDFFL7104D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   The fuel rail pressure sensor is installed to the common rail assembly and is composed of piezo-electric element. To make the pressure measured by the rail pressure sensor and the pressure required from the ECM even, it is used to control fuel amount by controlling the rail pressure.

   The common rail pressure control valve is controlled by the ECM and is normal open when fuel is not supplied.

   The ECM decides current value sent to the fuel pressure control valve according to engine revolution, fuel amount and rail pressure etc..

2. DTC DESCRIPTION

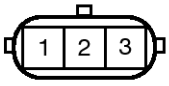
   When the pressure continues to be above 200Mpa from normal value, that is, the output voltage of the sensor is above 4.2V for 2,097ms due to the poor common rail pressure, the ECM judges this as a fault and DTC P0088 is set. The probable causes are the malfunction of overflow valve operation or defective fuel rail pressure sensor. In case of fail safe, the engine power is reduced and the auto cruise is released since the fuel rail pressure is restricted to 700bar(70Mpa) and the fuel amount is restricted to below 70% of the fuel amount at the rated rpm to protect the common rail system.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Fuel filter • Fuel line
Enable Conditions	• Running			
Threshold Value	• Rail pressure sensor output>4.2V			
Diagnosis Time	• Above 2,097.1ms			
Fail Safe	Fuel Cut	No	• Fuel amount is restricted to below 75% of maximum torque.	
	Fuel Limit	Yes		
	Check lamp	ON		

SPECIFICATION

Rail pressure sensor	Specification
Output voltage	Below 2.6 V (Idle state after warm-up)
Rail pressure	40 Mpa (Idle state)



Sensor connector

Component resistance	Specification(20℃)
No. 1, 2	3 kΩ
No. 1, 3	13 kΩ
No. 2, 3	16.4 kΩ

SUDFLDTC9003L

WAVEFORM

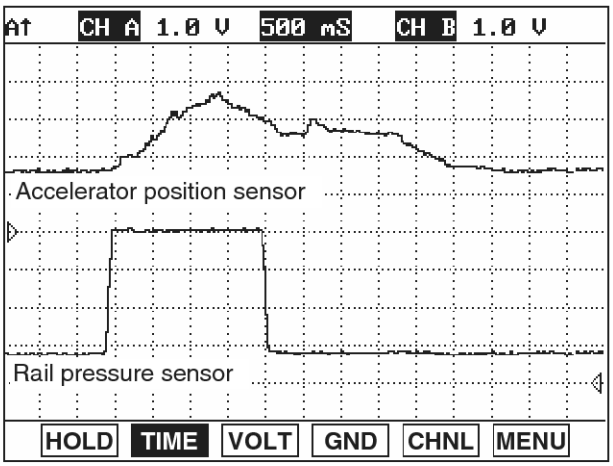


Fig. 1 Measure with oscilloscope waveform

Fig1) indicates waveform which the accelerator position sensor 1 and the rail pressure sensor are measured at the same time, can check the rail pressure sensor output at quick acceleration or deceleration.

SUDFLDTC9004L

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Rail pressure” parameter on the scan tool.

NOTICE

The value of “Rail pressure” varies with the operative condition according to DTC detecting condition. In case of fail safe, be sure to check that the value of “Rail pressure” sets to 70Mpa and the “Fuel amount” is restricted to below 75% of maximum torque.

Parameter	Reference Value
Real C/R pressure (At IG ON)	0.4 Mpa
Real C/R pressure (At idle)	31.6 Mpa
Real C/R pressure (At 1,500 rpm)	91.2 Mpa
Real C/R pressure (At 2,000 rpm)	122.5 Mpa

Start the engine and monitor the pressure change of the rail pressure sensor. The pressure of about 40Mpa is generated at hot idle (650rpm). At this time,

it is also important to check the duty of the rail pressure governor. Check that the duty of about 46.5% indicates from above service data.

This data increase with acceleration and load condition, not only the rail pressure increases up to max. 180Mpa but also the rail pressure governor duty increases up to 95%.

TROUBLESHOOTING AID

The trouble code related to poor rail pressure is necessary to diagnose high pressure fuel system and low pressure fuel system collectively

High pressure fuel system symptom: Poor high pressure of high pressure fuel pump, the poor air tightness or stuck of the ball valve seat of rail pressure governor, clogged overflow valve, the fuel leak of injector nozzle and return circuit

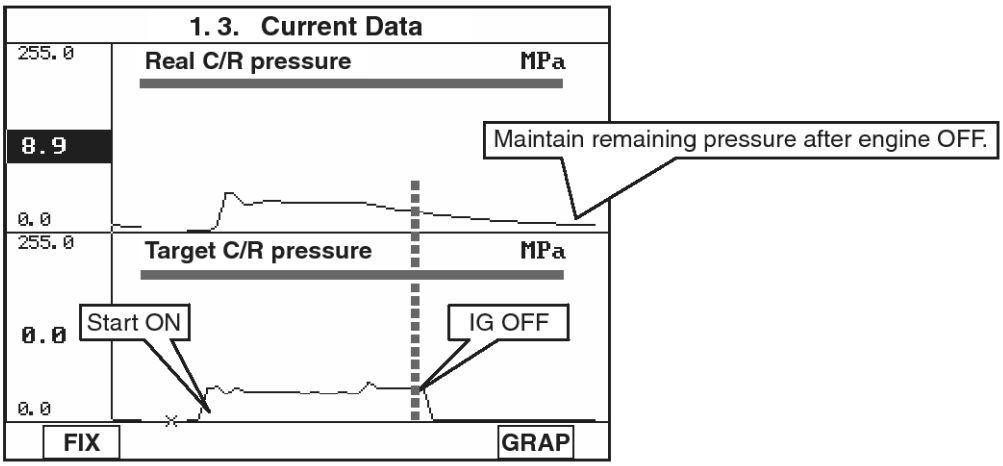
Low pressure fuel system symptom: Poor fuel supply of low pressure fuel pump, clogged fuel filter

NOTICE

Overflow valve plays a role to return fuel to the fuel tank by opening valve to protect fuel system when generating the fuel pressure in common rail with "221Mpa" or more excessively.

NOTICE

It is possible to check by turning the ignition key ON not to lose data due to impossible communication between ECM and scan tool because the main relay switches OFF at stopping the engine.



SUDFLDTC9095L

The above graph waveform indicates the pressure change of the rail pressure sensor at starting ON and OFF. It is possible to diagnose the collective fuel system by checking the condition to maintain the pressure in the common rail at stopping the engine and the time to reach about 40Mpa in the common rail.

1. It is important for the rail pressure to increase quickly at starting.
   - ▶ It is easy to diagnose the supply state of low

pressure fuel pump, the high pressure formation of high pressure fuel pump, the air tightness of rail pressure governor, the air tightness state of injector nozzle and return side.

2. It is important to maintain air tightness at below 101bar of spring tension of common rail pressure governor and to lower fuel pressure gradually at stopping the engine.

   ▶ It is easy to diagnose the air tightness state of rail pressure governor, nozzle and return side.

SIGNAL CIRCUIT INSPECTION

1. Signal Voltage Inspection
   1) Leave fuel pressure sensor connector (EFD13) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure the voltage between the terminal 2 of fuel pressure sensor harness connector and chassis ground.

      ■ Specification:

      Signal power: approx. 1.0V (At IG ON)

      Note) The signal power may be measured differently according to rail pressure.
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Go to “Signal Open Inspection” procedure.
2. Signal Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect fuel pressure sensor connector (EFD13) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 2 of fuel pressure sensor harness connector and the terminal 13, 32 of ECM connector(EFD-ECM).

      ■ Specification: Continuity (Below 1.0Ω)
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Signal Short to Ground Inspection” procedure.

      NO

      ▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.
3. Signal Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect fuel pressure sensor connector (EFD13) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 2 of fuel pressure sensor harness connector and chassis ground.

      ■ Specification: Infinite
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Signal Short to Power Inspection” procedure.

      NO

      ▶ Repair short to ground and then go to “Verification of Vehicle Repair” procedure.
4. Signal Short to Power Inspection
   1) Disconnect fuel pressure sensor connector (EFD13) and ECM connector(EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 2 of fuel pressure sensor harness connector and chassis ground.

      ■ Specification: Below 0~0.1V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Power Supply Inspection” procedure.

      NO

      ▶ Repair short to power and then go to “Verification of Vehicle Repair” procedure.

POWER SUPPLY INSPECTION

1. Power Supply Voltage Inspection
   1) Disconnect fuel pressure sensor connector (EFD13).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 1 of fuel pressure sensor harness connector and chassis ground.

      ■ Specification: Engine ECM output power approx. 5 V
   4) Is the voltage measured within specification?

      YES

▶ Go to “Ground Circuit Inspection” procedure.

NO

▶ Go to “Power Supply Open Inspection” procedure.

2. Power Supply Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect fuel pressure sensor connector (EFD13) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 1 of fuel pressure sensor harness connector and the terminal 68 of ECM connector.
      ■ Specification: Continuity (Below 1.0Ω)
   4) Is the resistance measured within specification?

YES

▶ Go to “Power Supply Short to Ground Inspection” procedure.

NO

▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.

3. Power Supply Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect fuel pressure sensor connector (EFD13) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 1 of fuel pressure sensor harness connector and chassis ground.
      ■ Specification: Infinite
   4) Is the resistance measured within specification?

YES

▶ Go to “Power Supply Short to Power Inspection” procedure.

NO

▶ Repair short to ground and then go to “Verification of Vehicle Repair” procedure.

4. Power Supply Short to Power Inspection
   1) Disconnect fuel pressure sensor connector (EFD13) and ECM connector(EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 1 of fuel pressure sensor harness connector and chassis ground.
      ■ Specification: Below 0~0.1 V
   4) Is the voltage measured within specification?

YES

▶ Go to “Ground Circuit Inspection” procedure.

NO

▶ Repair short to power and then go to “Verification of Vehicle Repair” procedure.

GROUND CIRCUIT INSPECTION

1. Ground Voltage Drop Inspection
   1) Disconnect fuel pressure sensor connector (EFD13).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage drop between the terminal 3 of fuel pressure sensor harness connector and chassis ground.
      ■ Specification: Ground voltage drop within 200 mV
   4) Is the voltage measured within specification?

YES

▶ Go to “Ground Open Inspection” procedure.

NO

▶ Repair the excessive resistance (poor connection) and then go to “Verification of Vehicle Repair” procedure.

2. Ground Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect fuel pressure sensor connector (EFD13) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 3 of fuel pressure sensor harness connector and the terminal 25 of ECM(EFD-ECM).
      ■ Specification: Continuity (Below 1.0Ω)
   4) Is the resistance measured within specification?

YES

▶ Go to “Component Inspection” procedure.

NO

▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.

COMPONENT INSPECTION

1. Fuel Pressure Sensor Inspection
   1) Turn the ignition OFF.
   2) Leave fuel pressure sensor connector (EFD13) connected.
   3) Start the engine. Check and compare fuel pressure according to detecting condition.

      NOTICE

      The value of "rail pressure" varies with driving conditions according to DTC detecting condition. In case of fail safe, be sure to check that fuel pressure is controlled by "70 Mpa".

Parameter	Reference Value
Real C/R pressure (At IG ON)	0.4 Mpa
Real C/R pressure (At idle)	31.6 Mpa
Real C/R pressure (At 1,500 rpm)	65.5 Mpa
Real C/R pressure (At 2,000 rpm)	65.5 Mpa

■ Specification :

Pressure	Output voltage
(MPa)	(V)
0	1.00
100	2.60
180	3.90
200	4.20
230	4.70

   4) Is the measured output value of fuel pressure sensor within specification?

      YES

      ▶ Go to "Verification of Vehicle Repair" procedure.

      NO

      ▶ Replace the fuel pressure sensor and then go to "Verification of Vehicle Repair" procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select "Diagnostic Trouble Codes (DTCs)" mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

   YES

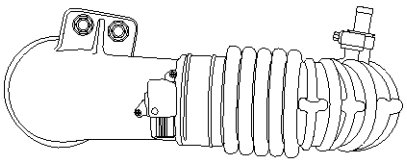
   ▶ Go to the applicable DTC procedure.

   NO

   ▶ System OK

P0101 MAF Sensor Performance Invalid

COMPONENT LOCATION



SUDFL8100D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   Mass Air Flow Sensor(MAFS) is composed of mass air flow sensor and air temperature sensor. It measures air mass to be sucked in engine. ECM performs EGR system feed back control with the information of measured mass air flow. (The role of MAFS in diesel engine is different from gasoline engine. Fuel injection quantity is decided by MAFS signal in gasoline engine.) When the amount of EGR gas (contains no oxygen) flowing into combustion chamber increases, the air passing through MAFS (contains oxygen) decreases. Thus, with the output signal change of MAFS accompanied by EGR actuator actuation, ECM determines the amount of recirculated EGR gas quantity.

2. DTC DESCRIPTION

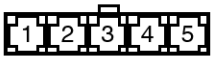
   DTC P0101 is set when abnormal signal is detected from MAF sensor for more than 5,248ms. The possible causes are short or poor connection of ECM connector 12 or MAF sensor malfunction. MIL is blinking when the condition continued 2 driving cycle times. MIL will go off after 3 driving cycle times when the system returns to normal.

DTC DETECTING CONDITION

<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="5">• Defective wiring harness
• MAF sensor</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• Engine running</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• Abnormal signal from MAF sensor</td></tr>
<tr><td>Diagnosis Time</td><td colspan="3">• 5,248ms</td></tr>
<tr><td rowspan="3">Fail Safe</td><td>Fuel Cut</td><td>No</td><td rowspan="3">• Auto cruise release
• Sensor output is set to 0km/h</td></tr>
<tr><td>Fuel limit</td><td>Yes</td></tr>
<tr><td>Check lamp</td><td>OFF</td></tr>
</table>

SPECIFICATION

Temperature (℃)	Resistance (kΩ) of terminal No ④,⑤
-20	16.0 ± 2.4
20	2.45 ± 0.24
60	0.580 ± 0.087



Sensor connector

SUDFLDTC9001L

SIGNAL CIRCUIT INSPECTION

1. Signal Voltage Inspection
   1) Leave the intake air temperature sensor connector (EFD04) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 1 of the intake air temperature harness connector and chassis ground.
      ■ Specification: Sensor signal power Approx. 1.0 V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Go to “Signal Open Inspection” procedure.
2. Signal Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the intake air temperature sensor connector (EFD04) and the ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 1 of the intake air temperature sensor harness connector and the terminal 12 of ECM connector.
      ■ Specification: Continuity (Below 1.0Ω)
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Signal Short to Ground Inspection” procedure.

      NO

      ▶ Repair open circuit and then go to “Verification of vehicle repair” procedure.
3. Signal Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the intake air temperature sensor connector (EFD04) and the ECM connector(EFD-ECM).
   3) Measure resistance between terminal 4 of the intake air temperature sensor harness connector and chassis ground.
      ■ Specification: Infinite
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Signal Short to Power Inspection” procedure.

      NO

      ▶ Repair short to ground and then go to

"Verification of vehicle repair" procedure.

POWER SUPPLY INSPECTION

1. Power Supply Voltage Inspection
   1) Disconnect the intake air temperature sensor connector (EFD04).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 3 of the intake air temperature sensor harness connector and chassis ground.
      ■ Specification: ECM output power approx. 12.92V
   4) Is the voltage measured within specification?
      YES
      ▶ Go to "Ground Circuit Inspection" procedure.
      NO
      ▶ Go to "Power Supply Open Inspection" procedure.
2. Power Supply Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the intake air temperature sensor connector (EFD04) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 3 of the intake air temperature sensor harness connector and the terminal 69 of ECM connector.
      ■ Specification: Continuity (Below 1.0Ω)
   4) Is the resistance measured within specification?
      YES
      ▶ Go to "Power Supply Short to Ground Inspection" procedure.
      NO
      ▶ Repair open circuit and then go to "Verification of vehicle repair" procedure.
3. Power Supply Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the intake air temperature sensor connector (EFD04) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 3 of the intake air temperature sensor harness connector and chassis ground.
      ■ Specification: Infinite
   4) Is the resistance measured within specification?
      YES
      ▶ Go to "Ground Circuit Inspection" procedure.
      NO
      ▶ Repair short to ground and then go to "Verification of vehicle repair" procedure.

GROUND CIRCUIT INSPECTION

1. Ground Voltage Drop Inspection
   1) Disconnect the intake air temperature sensor connector (EFD04).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage drop between the terminal 2 of the intake air temperature sensor harness connector and chassis ground.
      ■ Specification: Ground voltage drop within 200mV
   4) Is the voltage measured within specification?
      YES
      ▶ Go to "Ground Open Inspection" procedure.
      NO
      ▶ Repair the excessive resistance (poor connection) and then go to "Verification of Vehicle Repair" procedure.
2. Ground Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the intake air temperature sensor connector (EFD04) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 2 of the intake air temperature sensor harness connector and the terminal 4 of the ECM connector(EFD-ECM).
      ■ Specification: Continuity (Below 1.0Ω)
   4) Is the resistance measured within specification?
      YES
      ▶ Go to "Component Inspection" procedure.
      NO
      ▶ Repair open wiring circuit and then go to "Verification of Vehicle Repair" procedure.

COMPONENT INSPECTION

1. Intake Air Temperature Sensor Resistance Inspection
   1) Turn the ignition OFF.
   2) Disconnect the intake air temperature sensor connector (EFD04).
   3) Measure resistance between the terminals 1 and 2 of the intake air temperature sensor.

      ■ Specification

      Resistance : 2.168kΩ(At 25˚C)
   4) Is the resistance measured within the specification?

      YES

      ▶ Go to “Verification of Vehicle Repair” procedure.

      NO

      ▶ Replace the intake air temperature sensor and then go to “Verification of Vehicle Repair” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

   YES

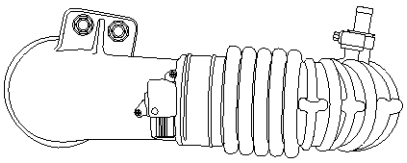
   ▶ Go to the applicable DTC procedure.

   NO

   ▶ System OK

P0102 MAF Sensor Signal Too Low

COMPONENT LOCATION



SUDFL8100D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   Mass Air Flow Sensor(MAFS) is composed of mass air flow sensor and air temperature sensor. It measures air mass to be sucked in engine. ECM performs EGR system feed back control with the information of measured mass air flow. (The role of MAFS in diesel engine is different from gasoline engine. Fuel injection quantity is decided by MAFS signal in gasoline engine.) When the amount of EGR gas (contains no oxygen) flowing into combustion chamber increases, the air passing through MAFS (contains oxygen) decreases. Thus, with the output signal change of MAFS accompanied by EGR actuator actuation, ECM determines the amount of recirculated EGR gas quantity.

2. DTC DESCRIPTION

   If the signal of MAFS is detected lower than 0.15V for above 3,016ms, the ECM judges this as a fault and DTC P0102 is set.

   Check lamp comes on and MIL is blinking when the condition continued 2 driving cycle times. MIL will go off after 3 driving cycle times when the system returns to normal.

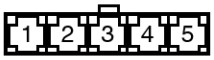
   The probable causes are poor output or poor contact of MAFS circuit.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Defective wiring or sensor • Short to ground or open circuit of ECM connector (EFD-ECM)
Enable Conditions	• Engine running			
Threshold Value	• At lower than 0.15 V of output voltage signal			
Diagnosis Time	• 3,016ms			
Fail Safe	Fuel Cut	No	• EGR control OFF • Fuel amount limit • Auto cruise OFF	
	Fuel Limit	Yes		
	Check lamp	ON		

SPECIFICATION

Temperature (℃)	Resistance (kΩ) of terminal No ④,⑤
-20	16.0 ± 2.4
20	2.45 ± 0.24
60	0.580 ± 0.087



Sensor connector

SUDFLDTC9001L

SIGNAL CIRCUIT INSPECTION

1. Signal Voltage Inspection
   1) Leave the intake air temperature sensor connector (EFD04) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 1 of the intake air temperature harness connector and chassis ground.
      ■ Specification: Sensor signal power Approx. 1.0 V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Go to “Signal Open Inspection” procedure.
2. Signal Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the intake air temperature sensor connector (EFD04) and the ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 1 of the intake air temperature sensor harness connector and the terminal 12 of ECM connector.
      ■ Specification: Continuity (Below 1.0Ω)
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Signal Short to Ground Inspection” procedure.

      NO

      ▶ Repair open circuit and then go to “Verification of vehicle repair” procedure.
3. Signal Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the intake air temperature sensor connector (EFD04) and the ECM connector(EFD-ECM).
   3) Measure resistance between terminal 4 of the intake air temperature sensor harness connector and chassis ground.
      ■ Specification: Infinite
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Signal Short to Power Inspection” procedure.

      NO

      ▶ Repair short to ground and then go to

"Verification of vehicle repair" procedure.

POWER SUPPLY INSPECTION

1. Power Supply Voltage Inspection
   1) Disconnect the intake air temperature sensor connector (EFD04).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 3 of the intake air temperature sensor harness connector and chassis ground.
      ■ Specification: ECM output power approx. 12.92V
   4) Is the voltage measured within specification?
      YES
      ▶ Go to "Ground Circuit Inspection" procedure.
      NO
      ▶ Go to "Power Supply Open Inspection" procedure.
2. Power Supply Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the intake air temperature sensor connector (EFD04) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 3 of the intake air temperature sensor harness connector and the terminal 69 of ECM connector.
      ■ Specification: Continuity (Below 1.0Ω)
   4) Is the resistance measured within specification?
      YES
      ▶ Go to "Power Supply Short to Ground Inspection" procedure.
      NO
      ▶ Repair open circuit and then go to "Verification of vehicle repair" procedure.
3. Power Supply Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the intake air temperature sensor connector (EFD04) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 3 of the intake air temperature sensor harness connector and chassis ground.
      ■ Specification: Infinite
   4) Is the resistance measured within specification?
      YES
      ▶ Go to "Ground Circuit Inspection" procedure.
      NO
      ▶ Repair short to ground and then go to "Verification of vehicle repair" procedure.

GROUND CIRCUIT INSPECTION

1. Ground Voltage Drop Inspection
   1) Disconnect the intake air temperature sensor connector (EFD04).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage drop between the terminal 2 of the intake air temperature sensor harness connector and chassis ground.
      ■ Specification: Ground voltage drop within 200mV
   4) Is the voltage measured within specification?
      YES
      ▶ Go to "Ground Open Inspection" procedure.
      NO
      ▶ Repair the excessive resistance (poor connection) and then go to "Verification of Vehicle Repair" procedure.
2. Ground Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the intake air temperature sensor connector (EFD04) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 2 of the intake air temperature sensor harness connector and the terminal 4 of the ECM connector(EFD-ECM).
      ■ Specification: Continuity (Below 1.0Ω)
   4) Is the resistance measured within specification?
      YES
      ▶ Go to "Component Inspection" procedure.
      NO
      ▶ Repair open wiring circuit and then go to "Verification of Vehicle Repair" procedure.

COMPONENT INSPECTION

1. Intake Air Temperature Sensor Resistance Inspection
   1) Turn the ignition OFF.
   2) Disconnect the intake air temperature sensor connector (EFD04).
   3) Measure resistance between the terminals 1 and 2 of the intake air temperature sensor.

      ■ Specification

      Resistance : 2.168kΩ(At 25˚C)
   4) Is the resistance measured within the specification?

      YES

      ▶ Go to “Verification of Vehicle Repair” procedure.

      NO

      ▶ Replace the intake air temperature sensor and then go to “Verification of Vehicle Repair” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

   YES

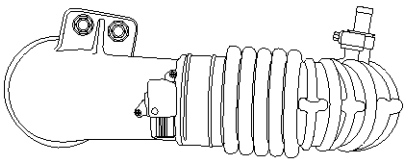
   ▶ Go to the applicable DTC procedure.

   NO

   ▶ System OK

P0103 MAF Sensor Signal Too High

COMPONENT LOCATION



SUDFL8100D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   Mass Air Flow Sensor(MAFS) is composed of mass air flow sensor and air temperature sensor. It measures air mass to be sucked in engine. ECM performs EGR system feed back control with the information of measured mass air flow. (The role of MAFS in diesel engine is different from gasoline engine. Fuel injection quantity is decided by MAFS signal in gasoline engine.) When the amount of EGR gas (contains no oxygen) flowing into combustion chamber increases, the air passing through MAFS (contains oxygen) decreases. Thus, with the output signal change of MAFS accompanied by EGR actuator actuation, ECM determines the amount of recirculated EGR gas quantity.

2. DTC DESCRIPTION

   If the signal of MAFS is detected higher than 4.85V for above 3,016ms, the ECM judges this as a fault and DTC P0103 is set.

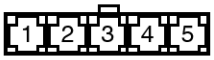
   Check lamp comes on and MIL is blinking when the condition continued 2 driving cycle times. MIL will go off after 3 driving cycle times when the system returns to normal.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Defective wiring or sensor • Short to ground or B+ of the terminal of ECM connector (EFD-ECM)
Enable Conditions	• Engine running			
Threshold Value	• At higher than 4.85 V			
Diagnosis Time	• 3,016ms			
Fail Safe	Fuel Cut	No	• EGR control OFF • Fuel amount limit • Auto cruise OFF	
	Fuel Limit	Yes		
	Check lamp	ON		

SPECIFICATION

Temperature (℃)	Resistance (kΩ) of terminal No ④,⑤
-20	16.0 ± 2.4
20	2.45 ± 0.24
60	0.580 ± 0.087



Sensor connector

SUDFLDTC9001L

SIGNAL CIRCUIT INSPECTION

1. Signal Voltage Inspection
   1) Leave the intake air temperature sensor connector (EFD04) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 1 of the intake air temperature harness connector and chassis ground.

      ■ Specification: Sensor signal power Approx. 1.0 V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Go to “Signal Short to Power Inspection” procedure.
2. Signal Short to Power Inspection
   1) Disconnect the intake air temperature sensor connector (EFD04) and the ECM connector(EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 1 of the intake air temperature sensor harness connector and chassis ground.

      ■ Specification: Below 0~0.1 V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Power Supply Inspection” procedure.

      NO

      ▶ Repair short to power and then go to “Verification of vehicle repair” procedure.

POWER SUPPLY INSPECTION

1. Power Supply Voltage Inspection
   1) Disconnect the intake air temperature sensor connector (EFD04).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 3 of the intake air temperature sensor harness connector and chassis ground.
      ■ Specification: ECM output power approx. 12.76V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to "Ground Circuit Inspection" procedure.

      NO

      ▶ Go to "Power Supply Short to Power Inspection" procedure.
2. Power Supply Short to Power Inspection
   1) Disconnect the intake air temperature sensor connector (EFD04) and ECM connector(EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 3 of the intake air temperature sensor harness connector and chassis ground.
      ■ Specification: Below 0~0.1 V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to "Ground Circuit Inspection" procedure.

      NO

      ▶ Repair short to power and then go to "Verification of vehicle repair" procedure.

GROUND CIRCUIT INSPECTION

1. Ground Voltage Drop Inspection
   1) Disconnect the intake air temperature sensor connector (EFD04).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage drop between the terminal 2 of the intake air temperature sensor harness connector and chassis ground.
      ■ Specification: Ground voltage drop within 200mV
   4) Is the voltage measured within specification?

      YES

      ▶ Go to "Ground Open Inspection" procedure.

      NO

      ▶ Repair the excessive resistance (poor connection) and then go to "Verification of Vehicle Repair" procedure.
2. Ground Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the intake air temperature sensor connector (EFD04) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 2 of the intake air temperature sensor harness connector and the terminal 4 of the ECM connector(EFD-ECM).
      ■ Specification: Continuity (Below 1.0Ω)
   4) Is the resistance measured within specification?

      YES

      ▶ Go to "Component Inspection" procedure.

      NO

      ▶ Repair open wiring circuit and then go to "Verification of Vehicle Repair" procedure.

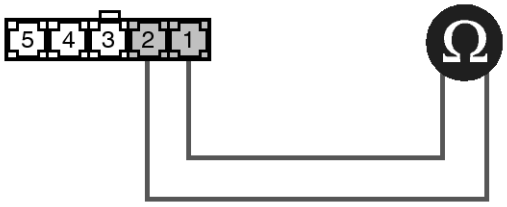
COMPONENT INSPECTION

1. Intake Air Temperature Sensor Resistance Inspection
   1) Turn the ignition OFF.
   2) Disconnect the intake air temperature sensor connector (EFD04).
   3) Measure resistance between the terminals 1 and 2 of the intake air temperature sensor.

■ SPECIFICATION :

Temperature(℃)	Resistance (kΩ) of terminal No 1,2
25	2.168

E04



Terminal 1: Intake air measure sensor signal
Terminal 2: Intake air measure sensor ground
Terminal 3: Intake air measure sensor power
Terminal 4: Intake air temperature sensor signal
Terminal 5: Intake air temperature sensor ground

SUDFLDTC9015L

4) Is the resistance measured within the specification?

YES

▶ Go to “Verification of Vehicle Repair” procedure.

NO

▶ Replace the intake air temperature sensor and then go to “Verification of Vehicle Repair” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

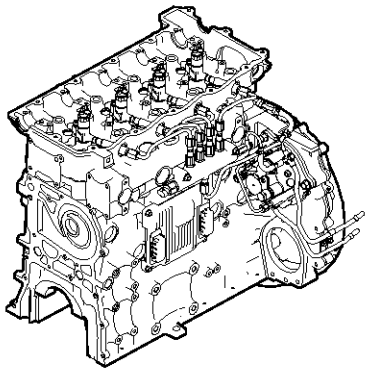
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P0107 Atmosphere Pressure Sensor Signal Too Low

COMPONENT LOCATION



SDFFL7104D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   Barometric pressure sensor (BPS) built-in in the ECM is a sensor to detect the atmospheric pressure which the vehicle is located. The barometric pressure sensor calculates air density (oxygen amount) and is used to detect precise intake air amount with intake air measure and intake air temperature sensor. If the vehicle is driven under high altitude, it plays a key role to control fuel amount correction and EGR due to the difference of air density (oxygen amount). In case of fail safe, it is controlled by 101.3 Kpa.

2. DTC DESCRIPTION

   If the output voltage is below 1.6V for 1,000ms or more at IG ON, starting, idle, the ECM judges this as a fault and DTC P0107 is set. MIL comes on when the condition continued 2 driving cycle times. MIL will go off after 3 driving cycle times when the system returns to normal. The probable cause is defective barometric pressure sensor in the ECM. When the barometric pressure sensor is defective, the ECM sets atmospheric pressure by standard value of 101.3 Kpa at IG ON, running. If the vehicle is being driven under high altitude area, black smoke may occur and engine power may decrease since the mixture of air/fuel is rich.

DTC DETECTING CONDITION

<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="6">• Poor sensor output value
• Defective barometric pressure sensor in the ECM.</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• At IG ON/ running</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• Below 1.6V</td></tr>
<tr><td>Diagnosis Time</td><td colspan="3">• 1,000.1ms or higer</td></tr>
<tr><td rowspan="3">Fail Safe</td><td>Fuel Cut</td><td>No</td><td rowspan="3">• Atmospheric pressure sets to 101. 3Kpa
• Fuel does not correct according to atmospheric pressure.</td></tr>
<tr><td>Fuel Limit</td><td>Yes</td></tr>
<tr><td>Check lamp</td><td>OFF</td></tr>
</table>

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Barometric pressure sensor” parameter on the scan tool.

NOTICE

The value of “Atmospheric pressure” varies with the altitude according to DTC detecting condition. In case of failure, be sure to check that the value of “Atmospheric pressure” is controlled by 101.3Kpa.

Parameter	Reference Value
Intake manifold pressure (At IG ON)	101 kpa
Intake manifold pressure (At idle)	101 kpa

COMPONENT INSPECTION

1. Engine ECM Component Inspection
   1) Turn the ignition key OFF.
   2) Disconnect the engine ECM(EFD-ECM).
   3) Connect the engine ECM connector(EFD-ECM) approx. 5~10 min. later.
   4) Erase the diagnostic trouble code using the scan tool.
   5) Drive the vehicle under conditions noted in failure records.
   6) Check if there is any diagnostic trouble code.
   7) Is the system okay?

   YES

   ▶ Go to the “Verification of Vehicle Repair” procedure.

   NO

   ▶ Replace the engine ECM and go to the “Verification of Vehicle Repair” procedure” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

   YES

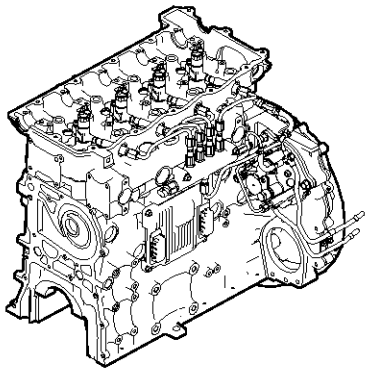
   ▶ Go to the applicable DTC procedure.

   NO

   ▶ System OK

P0108 Atmosphere Pressure Sensor Signal Too High

COMPONENT LOCATION



SDFFL7104D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   The IATS(Intake air temperature sensor) integrated with the air amount sensor and the boost pressure sensor is a thermistor type of negative characteristics which the more temperature increases the less voltage gets and it detects the air temperature entered through the engine.

   In Euro-4 diesel engine, the intake air temperature sensor is installed in the front(built-in intake air sensor) and rear(built-in boost sensor) of turbocharger so that it measures both the ambient air temperature and the air temperature passed through turbocharger and intercooler to measure more precise intake air amount.

   The ECM which received information from the sensors controls the correction of EGR and fuel amount according to intake air temperature.(In the electronic control diesel engine, it is very important for the intake air temperature sensor to measure density according to the air temperature for the exact EGR feedback control.)

2. DTC DESCRIPTION

   If the output voltage of the sensor is detected above 4.4V for more than 1,000.1ms with IG ON, at running, the ECM judges this as a fault and DTC is set. MIL comes on when the condition continued 2 driving cycle times. MIL will go off after 3 driving cycle times when the system returns to normal. The possible cause is the defective barometric pressure sensor built-in ECM. The ECM sets barometric pressure to 101.3Kpa as setting value if the barometric pressure sensor is defective.

   If the vehicle is being driven under high altitude area, black smoke may occur since fuel correction is stopped according to the atmospheric pressure and the mixture of air/fuel is rich. And the engine power is restricted.

DTC DESCRIPTION CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Poor sensor output value • Defective barometric pressure sensor in the ECM.
Enable Conditions	• At IG ON/ running			
Threshold Value	• Above 4.4V			
Diagnosis Time	• 1,000.1ms or higher			
Fail Safe	Fuel Cut	No	• Atmospheric pressure sets to 101.3Kpa • No fuel correction and engine power limit according to atmospheric pressure.	
	Fuel limit	Yes		
	Check lamp	OFF		

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Barometric pressure sensor” parameter on the scan tool.

NOTICE

The value of “Atmospheric pressure” varies with the altitude according to DTC detecting condition. In case of failure, be sure to check that the value of “Atmospheric pressure” is controlled by 101.3Kpa.

Parameter	Reference Value
Intake manifold pressure (At IG ON)	101 kpa
Intake manifold pressure (At idle)	101 kpa

COMPONENT INSPECTION

1. Engine ECM Component Inspection
   1) Turn the ignition key OFF.
   2) Disconnect the engine ECM(EFD-ECM).
   3) Connect the engine ECM connector(EFD-ECM) aprox. 5~10 min. later.
   4) Erase the diagnostic trouble code using the scan tool.
   5) Drive the vehicle under conditions noted in failure records.
   6) Check if there is any diagnostic trouble code.
   7) Is the system okay?

YES

▶ Go to the “Verification of Vehicle Repair” procedure.

NO

▶ Replace the engine ECM and go to the “Verification of Vehicle Repair” procedure” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

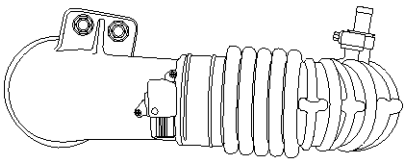
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P010A MAF Sensor Performance Invalid #2

COMPONENT LOCATION



SUDFL8100D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   Mass Air Flow Sensor(MAFS) is composed of mass air flow sensor and air temperature sensor. It measures air mass to be sucked in engine. ECM performs EGR system feed back control with the information of measured mass air flow. (The role of MAFS in diesel engine is different from gasoline engine. Fuel injection quantity is decided by MAFS signal in gasoline engine.) When the amount of EGR gas (contains no oxygen) flowing into combustion chamber increases, the air passing through MAFS (contains oxygen) decreases. Thus, with the output signal change of MAFS accompanied by EGR actuator actuation, ECM determines the amount of recirculated EGR gas quantity.

2. DTC DESCRIPTION

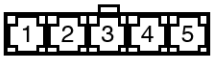
   DTC P010A is set when abnormal signal is detected from MAF sensor for more than 5,248ms. The possible causes are short or poor connection of ECM connector 12 or MAF sensor malfunction. MIL is blinking when the condition continued 2 driving cycle times. MIL will go off after 3 driving cycle times when the system returns to normal.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Defective wiring harness • MAF sensor
Enable Conditions	• Engine running			
Threshold Value	• Abnormal signal from MAF sensor			
Diagnosis Time	• 5,248ms			
Fail Safe	Fuel Cut	No	• Fuel amount limit (75% of maximum torque) • Sensor output is set to 0km/h • Auto cruise release	
	Fuel limit	Yes		
	Check lamp	OFF		

SPECIFICATION

Temperature (℃)	Resistance (kΩ) of terminal No ④,⑤
-20	16.0 ± 2.4
20	2.45 ± 0.24
60	0.580 ± 0.087



Sensor connector

SUDFLDTC9001L

SIGNAL CIRCUIT INSPECTION

1. Signal Voltage Inspection
   1) Leave the intake air temperature sensor connector (EFD04) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 1 of the intake air temperature harness connector and chassis ground.
      ■ Specification: Sensor signal power Approx. 1.0 V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Go to “Signal Open Inspection” procedure.
2. Signal Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the intake air temperature sensor connector (EFD04) and the ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 1 of the intake air temperature sensor harness connector and the terminal 12 of ECM connector.
      ■ Specification: Continuity (Below 1.0Ω)
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Signal Short to Ground Inspection” procedure.

      NO

      ▶ Repair open circuit and then go to “Verification of vehicle repair” procedure.
3. Signal Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the intake air temperature sensor connector (EFD04) and the ECM connector(EFD-ECM).
   3) Measure resistance between terminal 4 of the intake air temperature sensor harness connector and chassis ground.
      ■ Specification: Infinite
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Signal Short to Power Inspection” procedure.

      NO

      ▶ Repair short to ground and then go to

"Verification of vehicle repair" procedure.

POWER SUPPLY INSPECTION

1. Power Supply Voltage Inspection
   1) Disconnect the intake air temperature sensor connector (EFD04).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 3 of the intake air temperature sensor harness connector and chassis ground.
      ■ Specification: ECM output power approx. 12.92V
   4) Is the voltage measured within specification?
      YES
      ▶ Go to "Ground Circuit Inspection" procedure.
      NO
      ▶ Go to "Power Supply Open Inspection" procedure.
2. Power Supply Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the intake air temperature sensor connector (EFD04) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 3 of the intake air temperature sensor harness connector and the terminal 69 of ECM connector.
      ■ Specification: Continuity (Below 1.0Ω)
   4) Is the resistance measured within specification?
      YES
      ▶ Go to "Power Supply Short to Ground Inspection" procedure.
      NO
      ▶ Repair open circuit and then go to "Verification of vehicle repair" procedure.
3. Power Supply Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the intake air temperature sensor connector (EFD04) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 3 of the intake air temperature sensor harness connector and chassis ground.
      ■ Specification: Infinite
   4) Is the resistance measured within specification?
      YES
      ▶ Go to "Ground Circuit Inspection" procedure.
      NO
      ▶ Repair short to ground and then go to "Verification of vehicle repair" procedure.

GROUND CIRCUIT INSPECTION

1. Ground Voltage Drop Inspection
   1) Disconnect the intake air temperature sensor connector (EFD04).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage drop between the terminal 2 of the intake air temperature sensor harness connector and chassis ground.
      ■ Specification: Ground voltage drop within 200mV
   4) Is the voltage measured within specification?
      YES
      ▶ Go to "Ground Open Inspection" procedure.
      NO
      ▶ Repair the excessive resistance (poor connection) and then go to "Verification of Vehicle Repair" procedure.
2. Ground Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the intake air temperature sensor connector (EFD04) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 2 of the intake air temperature sensor harness connector and the terminal 4 of the ECM connector(EFD-ECM).
      ■ Specification: Continuity (Below 1.0Ω)
   4) Is the resistance measured within specification?
      YES
      ▶ Go to "Component Inspection" procedure.
      NO
      ▶ Repair open wiring circuit and then go to "Verification of Vehicle Repair" procedure.

COMPONENT INSPECTION

1. Intake Air Temperature Sensor Resistance Inspection
   1) Turn the ignition OFF.
   2) Disconnect the intake air temperature sensor connector (EFD04).
   3) Measure resistance between the terminals 1 and 2 of the intake air temperature sensor.

      ■ Specification

      Resistance : 2.168kΩ(At 25˚C)
   4) Is the resistance measured within the specification?

      YES

      ▶ Go to “Verification of Vehicle Repair” procedure.

      NO

      ▶ Replace the intake air temperature sensor and then go to “Verification of Vehicle Repair” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

   YES

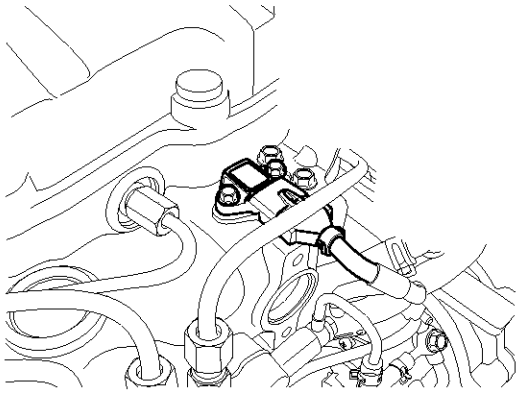
   ▶ Go to the applicable DTC procedure.

   NO

   ▶ System OK

P0112 Intake Air Temp. Sensor Signal Too Low

COMPONENT LOCATION



SDFFL7102D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   IATS(Intake air temperature sensor) is installed on the intake manifold and is built-in together with booster pressure sensor.This part employs a thermistor(NTC) which is sensitive to changes in temperature.

   The electric resistance of a thermistor decreases as the temperature increases, and increases as the temperature decreases. 5V power from ECM is supplied to the intake air temperature sensor via a resistor and the resistor and electric resistance of thermistor are changed and are converted into output signal according to air temperature entered through cylinder.

   Based on the signal, the ECM corrects fuel injection amount and injection timing.

2. DTC DESCRIPTION

   If the output voltage of the intake air temperature sensor is detected below 0.05V for more than 3,072 ms, the ECM judges this as a fault and DTC is set. Check lamp and MIL come on together when the condition continued for 2 driving cycle times. Check lamp will go off after 3 driving cycle times when the system returns to normal. The possible causes may be a defective intake air temperature sensor, faulty wiring and resistance, short to terminal 34 of ECM connector(EFD-ECM).

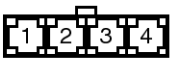
   The vehicle is being driven, but black smoke and a lack of engine power may occur since fuel correction and injection timing can not be controlled according to the intake air temperature.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Defective wiring and sensor. • GND short to the terminal 34 of the engine ECM connector(EFD-ECM).
Enable Conditions	• Engine running			
Threshold Value	• Below 0.05V			
Diagnosis Time	• 3,072ms or higher			
Fail Safe	Fuel Cut	No	Intake air temperature • IG ON: -25℃ • Engine running: 25℃	
	Fuel limit	Yes		
	Check lamp	ON		

SPECIFICATION

Temperature (℃)	Resistance (Ω) of terminal No ③, ④
-20	13,890 ~ 16,025
0	5,384 ~ 6,085
20	2,311~2,565
40	1,077~1,205
60	543~616
80	294 ~ 337
90	221 ~ 256



Sensor side connector

SUDFLDTC9018L

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Intake air temperature sensor” parameter on the scan tool.

NOTICE

The value of “Intake air temperature” varies with driving condition according to DTC detecting condition. In case of failure, be sure to check that the value of “Intake air temperature” sets to -20℃ at starting and 25℃ at idle and driving.

Parameter	Reference Value
Intake air temperature (At IG ON)	41℃
Intake air temperature (At idle)	38℃
Intake air temperature (At 1,500 rpm)	35℃
Intake air temperature (At 2,000 rpm)	34℃

SIGNAL CIRCUIT INSPECTION

1. Signal Voltage Inspection
   1) Leave the intake air temperature sensor connector (EFD14) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 3 of the intake air temperature harness connector and chassis ground.

      ■ Specification: Intake air temperature sensor signal power approx. 5V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Go to “Signal Short to Ground Inspection” procedure.
2. Signal Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the intake air temperature sensor connector (EFD14) and the ECM connector(EFD-ECM).

3) Measure resistance between terminal 3 of the intake air temperature sensor harness connector and chassis ground.
   ■ Specification: Infinite
4) Is the resistance measured within specification?
   YES
   ▶ Go to "Power Supply Inspection" procedure.
   NO
   ▶ Repair short to ground and then go to "Verification of Vehicle Repair" procedure.

POWER SUPPLY INSPECTION

1. Power Supply Voltage Inspection
   1) Disconnect the intake air temperature sensor connector (EFD14).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 2 of the intake air temperature sensor harness connector and chassis ground.
      ■ Specification: ECM output power approx. 5V
   4) Is the voltage measured within specification?
      YES
      ▶ Go to "Ground Circuit Inspection" procedure.
      NO
      ▶ Go to "Power Supply Short to Ground Inspection" procedure.
2. Power Supply Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the intake air temperature sensor connector (EFD14) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 2 of the intake air temperature sensor harness connector and chassis ground.
      ■ Specification: Infinite
   4) Is the resistance measured within specification?
      YES
      ▶ Go to "Ground Circuit Inspection" procedure.
      NO
      ▶ Repair short to ground and then go to "Verification of Vehicle Repair" procedure.

GROUND CIRCUIT INSPECTION

1. Ground Voltage Drop Inspection
   1) Disconnect the intake air temperature sensor connector (EFD14).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage drop between the terminal 4 of the intake air temperature sensor harness connector and chassis ground.
      ■ Specification: Ground voltage drop within 200mV
   4) Is the voltage measured within specification?
      YES
      ▶ Go to "Ground Open Inspection" procedure.
      NO
      ▶ Repair the excessive resistance (poor connection) and then go to "Verification of Vehicle Repair" procedure.
2. Ground Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the intake air temperature sensor connector (EFD14) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 4 of the intake air temperature sensor harness connector and the terminal 23 of the ECM connector(EFD-ECM).
      ■ Specification: Continuity (Below 1.0Ω)
   4) Is the resistance measured within specification?
      YES
      ▶ Go to "Component Inspection" procedure.
      NO
      ▶ Repair open wiring circuit and then go to "Verification of Vehicle Repair" procedure.

COMPONENT INSPECTION

1. Intake Air Temperature Sensor Resistance Inspection
   1) Turn the ignition OFF.
   2) Disconnect the intake air temperature sensor connector (EFD14).
   3) Measure resistance between the terminals 3 and 4 of the intake air temperature sensor.
   4) Is the resistance measured within the specification?

      YES

      ▶ Go to “Verification of Vehicle Repair” procedure.

      NO

      ▶ Replace the intake air temperature sensor and then go to “Verification of Vehicle Repair” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

   YES

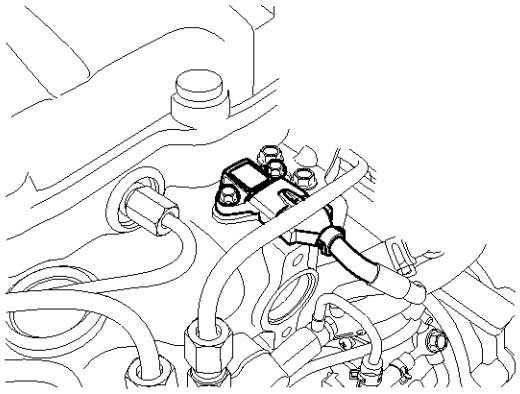
   ▶ Go to the applicable DTC procedure.

   NO

   ▶ System OK

P0113 Intake Air Temp. Sensor Signal Too High

COMPONENT LOCATION



SDFFL7102D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   IATS(Intake air temperature sensor) is installed on the intake manifold and is built-in together with booster pressure sensor.This part employs a thermistor(NTC) which is sensitive to changes in temperature.

   The electric resistance of a thermistor decreases as the temperature increases, and increases as the temperature decreases.5 V power from ECM is supplied to the intake air temperature sensor via a resistor and the resistor and electric resistance of thermistor are changed and are converted into output signal according to air temperature entered through cylinder.

   Based on the signal, the ECM corrects fuel injection amount and injection timing.

2. DTC DESCRIPTION

   If the output voltage of the intake air temperature sensor is detected above 4.85V for more than 3,072 ms, the ECM judges this as a fault and DTC is set. Check lamp and MIL come on together when the condition continued for 2 driving cycle times. Check lamp will go off after 3 driving cycle times when the system returns to normal. The possible causes may be a defective intake air temperature sensor, faulty wiring and resistance, short to terminal 34 of ECM connector(EFD-ECM).

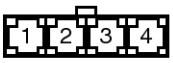
   The vehicle is being driven, but black smoke and a lack of engine power may occur since fuel correction and injection timing can not be controlled according to the intake air temperature.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Defective wiring and sensor. • Open or Power short to the terminal 34 of the engine ECM connector(EF-D-ECM).
Enable Conditions	• At IG ON/ Running			
Threshold Value	• Above 4.85V			
Diagnosis Time	• 3,072ms or higher			
Fail Safe	Fuel Cut	No	Intake air temperature • IG ON: -25℃ • Engine running: 25℃	
	Fuel limit	Yes		
	Check lamp	ON		

SPECIFICATION

Temperature (℃)	Resistance (Ω) of terminal No ③, ④
-20	13,890 ~ 16,025
0	5,384 ~ 6,085
20	2,311~2,565
40	1,077~1,205
60	543~616
80	294 ~ 337
90	221 ~ 256



Sensor side connector

SUDFLDTC9018L

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Intake air temperature sensor” parameter on the scan tool.

NOTICE

The value of “Intake air temperature” varies with driving condition according to DTC detecting condition. In case of failure, be sure to check that the value of “Intake air temperature” sets to -20℃ at starting and 25℃ at idle and driving.

Parameter	Reference Value
Intake air temperature (At IG ON)	41℃
Intake air temperature (At idle)	38℃
Intake air temperature (At 1,500 rpm)	35℃
Intake air temperature (At 2,000 rpm)	34℃

SIGNAL CIRCUIT INSPECTION

1. Signal Voltage Inspection
   1) Leave the intake air temperature sensor connector (EFD14) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 3 of the intake air temperature harness connector and chassis ground.

      ■ Specification : Intake air temperature sensor signal power approx. 5V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Go to “Signal Open Inspection” procedure.
2. Signal Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the intake air temperature sensor connector (EFD14) and the ECM connector(EFD-ECM).

3) Measure resistance between terminal 3 of the intake air temperature sensor harness connector and terminal 34 of the ECM connector(EFD-ECM).
   ■ Specification: Continuity
4) Is the resistance measured within specification?

YES

▶ Go to "Signal Short to Power Inspection" procedure.

NO

▶ Repair open circuit and then go to "Verification of Vehicle Repair" procedure.

3. Signal Short to Power Inspection
   1) Disconnect the intake air temperature sensor connector (EFD14) and the ECM connector(EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 3 of the intake air temperature sensor harness connector and chassis ground.
      ■ Specification: Below 0~0.1V
   4) Is the voltage measured within specification?

YES

▶ Go to "Power Supply Inspection" procedure.

NO

▶ Repair short to power and then go to "Verification of Vehicle Repair" procedure.

POWER SUPPLY INSPECTION

1. Power Supply Voltage Inspection
   1) Disconnect the intake air temperature sensor connector (EFD14).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 2 of the intake air temperature sensor harness connector and chassis ground.
      ■ Specification: ECM output power approx. 5V
   4) Is the voltage measured within specification?

YES

▶ Go to "Ground Circuit Inspection" procedure.

NO

▶ Go to "Power Supply Open Inspection" procedure.

2. Power Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the intake air temperature sensor connector (EFD14) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 2 of the intake air temperature sensor harness connector and terminal 48 of the engine ECM connector(EFD-ECM).
      ■ Specification: Continuity
   4) Is the resistance measured within specification?

YES

▶ Go to "Power Supply Short to Power Inspection" procedure.

NO

▶ Repair short to ground and then go to "Verification of Vehicle Repair" procedure.

3. Power Supply Short to Power Inspection
   1) Disconnect the intake air temperature sensor connector (EFD14) and ECM connector(EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 2 of the intake air temperature sensor harness connector and chassis ground.
      ■ Specification: Below 0~0.1V
   4) Is the voltage measured within specification?

YES

▶ Go to "Ground Circuit Inspection" procedure.

NO

▶ Repair short to power and then go to "Verification of Vehicle Repair" procedure.

GROUND CIRCUIT INSPECTION

1. Ground Voltage Drop Inspection
   1) Disconnect the intake air temperature sensor connector (EFD14).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage drop between the terminal 4 of the intake air temperature sensor harness connector and chassis ground.

      ■ Specification: Ground voltage drop within 200mV
   4) Is the voltage measured within specification?

      YES

      ▶ Go to "Ground Open Inspection" procedure.

      NO

      ▶ Repair the excessive resistance (poor connection) and then go to "Verification of Vehicle Repair" procedure.
2. Ground Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the intake air temperature sensor connector (EFD14) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 4 of the intake air temperature sensor harness connector and the terminal 23 of the ECM connector(EFD-ECM).

      ■ Specification: Continuity (Below 1.0Ω)
   4) Is the resistance measured within specification?

      YES

      ▶ Go to "Component Inspection" procedure.

      NO

      ▶ Repair open wiring circuit and then go to "Verification of Vehicle Repair" procedure.

COMPONENT INSPECTION

1. Intake Air Temperature Sensor Resistance Inspection
   1) Turn the ignition OFF.
   2) Disconnect the intake air temperature sensor connector (EFD14).
   3) Measure resistance between the terminals 3 and 4 of the intake air temperature sensor.

■ Specification :

Temperature (℃)	Resistance (Ω) of terminal No ③, ④
-20	13,890 ~ 16,025
0	5,384 ~ 6,085
20	2,311~2,565
40	1,077~1,205
60	543~616
80	294 ~ 337
90	221 ~ 256

   4) Is the resistance measured within the specification?

      YES

      ▶ Go to "Verification of Vehicle Repair" procedure.

      NO

      ▶ Replace the intake air temperature sensor and then go to "Verification of Vehicle Repair" procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select "Diagnostic Trouble Codes (DTCs)" mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

   YES

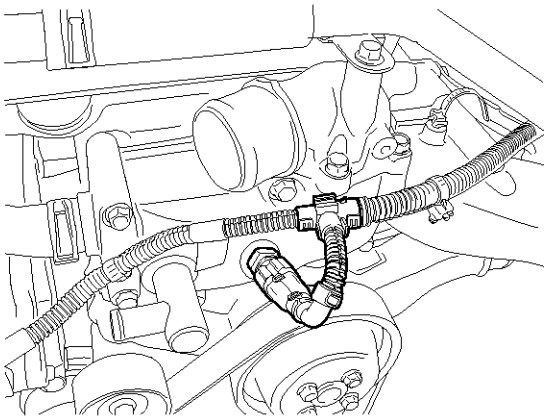
   ▶ Go to the applicable DTC procedure.

   NO

   ▶ System OK

P0116 Coolant Temp. Sensor Performance Invalid

COMPONENT LOCATION



SDFFL7103D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   ECTS(Engine Coolant Temperature Sensor) is located on coolant passage of cylinder head. The ECTS uses a thermistor whose resistance changes with the temperature. The electric resistance of the ECTS decreases as the temperature increases, and increases as the temperature decreases.

   The ECTS receives 5 voltage via resistor from ECM and resistor and thermistor are linked in series. ECM received signal from ECTS is used to control injection timing, fuel amount correction and automatic cooling fan.

   Specially the defective engine coolant temperature sensor has a great influence on the cold starting and is one of the factors to cause white smoke at starting.

2. DTC DESCRIPTION

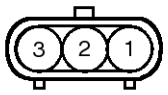
   If the output voltage of engine coolant temperature sensor is excessive than target value for more than 5,248ms, the ECM judges this as a fault and DTC is set. MIL comes on when the condition continued 2 driving cycle times. MIL will go off after 3 driving cycle times when the system returns to normal.

DTC DETECTING CONDITION

<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="5">• Defective wiring harness
• Coolant temperature sensor
• Cooling system</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• Engine running</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• The difference between target and actual value of sensor signal is excessive.</td></tr>
<tr><td>Diagnosis Time</td><td colspan="3">• 5,248ms</td></tr>
<tr><td rowspan="3">Fail Safe</td><td>Fuel Cut</td><td>No</td><td rowspan="3">• Coolant temperature sets to -20℃ at starting.
• Coolant temperature sets to 80℃ at idle and driving.
• Cooling fan operates continuously.</td></tr>
<tr><td>Fuel limit</td><td>Yes</td></tr>
<tr><td>Check lamp</td><td>OFF</td></tr>
</table>

SPECIFICATION

Temperature(℃)	Resistance (kΩ) of terminal No ①, ③
-20	15.48
0	5.79
20	2.45
40	1.148
80	0.322



Sensor connector

SUDFLDTC9021L

SIGNAL CIRCUIT INSPECTION

1. Signal Voltage Inspection
   1) Leave the coolant temperature sensor connector (EFD07) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 3 of the coolant temperature sensor harness connector and chassis ground.

      ■ Specification : Coolant temperature sensor signal power approx. 1.86V(With connecting)

      Note) Voltage value varies depending on coolant temperature.
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Go to “Signal Short to Ground Inspection” procedure.
2. Signal Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the coolant temperature sensor connector (EFD07) and the ECM connector(EFD-ECM).
   3) Measure resistance between terminal 3 of the coolant temperature sensor harness connector and chassis ground.

      ■ Specification: Infinite
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Ground Circuit Inspection” procedure.

      NO

      ▶ Repair short to ground and then go to “Verification of Vehicle Repair” procedure.

GROUND CIRCUIT INSPECTION

1. Ground Voltage Drop Inspection
   1) Disconnect the coolant temperature sensor connector (EFD07).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage drop between the terminal 1 of the coolant temperature sensor harness

connector and chassis ground.

■ Specification: Ground voltage drop within 200mV

4) Is the voltage measured within specification?

YES

▶ Go to “Ground Open Inspection” procedure.

NO

▶ Repair the excessive resistance (poor connection) and then go to “Verification of Vehicle Repair” procedure.

2. Ground Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the coolant temperature sensor connector (EFD07) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 3 of the coolant temperature sensor harness connector and the terminal 5 of the ECM connector(EFD-ECM).

      ■ Specification: Continuity (Below 1.0Ω)

   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Repair open wiring circuit and then go to “Verification of Vehicle Repair” procedure.

COMPONENT INSPECTION

1. Intake Air Temperature Sensor Resistance Inspection
   1) Turn the ignition OFF.
   2) Disconnect the coolant temperature sensor connector (EFD07).
   3) Measure resistance between the terminals 1 and 3 of the coolant temperature sensor.

■ Specification :

Temperature(℃)	Resistance (㏀) of terminal No ①, ③
-20	15.48
0	5.79
20	2.45
40	1.148
80	0.322

   4) Is the resistance measured within the specification?

      YES

      ▶ Go to “Verification of Vehicle Repair” procedure.

      NO

      ▶ Replace the coolant temperature sensor and then go to “Verification of Vehicle Repair” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

   YES

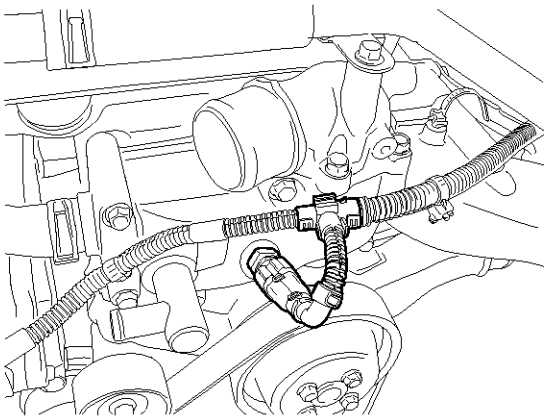
   ▶ Go to the applicable DTC procedure.

   NO

   ▶ System OK

P0117 Coolant Temp. Sensor Signal Too Low

COMPONENT LOCATION



SDFFL7103D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   ECTS(Engine Coolant Temperature Sensor) is located on coolant passage of cylinder head. The ECTS uses a thermistor whose resistance changes with the temperature. The electric resistance of the ECTS decreases as the temperature increases, and increases as the temperature decreases.

   The ECTS receives 5 voltage via resistor from ECM and resistor and thermistor are linked in series. ECM received signal from ECTS is used to control injection timing, fuel amount correction and automatic cooling fan.

   Specially the defective engine coolant temperature sensor has a great influence on the cold starting and is one of the factors to cause white smoke at starting.

2. DTC DESCRIPTION

   If the output voltage of the engine coolant temperature sensor is detected below 0.1V for 3,072ms or more, the ECM judges this as a fault and DTC is set. Check lamp and MIL come on together when the condition continued for 2 driving cycle times. Check lamp will go off after 3 driving cycle times when the system returns to normal. The possible causes are defective ECTS, faulty wiring & resistance or short to terminal 15 of ECM connector(EFD-ECM) etc.

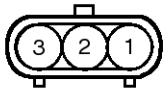
   The vehicle is being driven, but black smoke and a lack of engine power may occur since fuel correction and injection timing can not be controlled according to the engine coolant temperature.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Defective wiring and sensor. • GND short to the terminal 15 of the engine ECM connector(EFD-ECM).
Enable Conditions	• At IG ON/ Running			
Threshold Value	• Below 0.1V			
Diagnosis Time	• 3,072ms or higher			
Fail Safe	Fuel Cut	No	• Coolant temperature sets to -20℃ at starting. • Coolant temperature sets to 80℃ at idle and driving.	
	Fuel limit	Yes		
	Check lamp	ON		

SPECIFICATION

Temperature(℃)	Resistance (kΩ) of terminal No ①, ③
-20	15.48
0	5.79
20	2.45
40	1.148
80	0.322



Sensor connector

SUDFLDTC9021L

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Coolant temperature” parameter on the scan tool.

NOTICE

The value of “Coolant temperature” varies with driving condition according to DTC detecting condition. In case of failure, be sure to check that the value of “Coolant temperature” sets to -20℃ at starting and 80℃ at idle and driving.

Parameter	Reference Value
Water temperature (At IG ON)	41℃
Water temperature (At idle)	56℃

SIGNAL CIRCUIT INSPECTION

1. Signal Voltage Inspection
   1) Leave the coolant temperature sensor connector (EFD07) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 3 of the coolant temperature sensor harness connector and chassis ground.

      ■ Specification : Coolant temperature sensor signal power approx. 1.86V(With connecting)

      Note) Voltage value varies depending on coolant temperature.
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Go to “Signal Short to Ground Inspection” procedure.
2. Signal Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the coolant temperature sensor connector (EFD07) and the ECM connector(EFD-ECM).
   3) Measure resistance between terminal 3 of the coolant temperature sensor harness connector and chassis ground.

      ■ Specification: Infinite
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Ground Circuit Inspection” procedure.

      NO

      ▶ Repair short to ground and then go to “Verification of Vehicle Repair” procedure.

GROUND CIRCUIT INSPECTION

1. Ground Voltage Drop Inspection
   1) Disconnect the coolant temperature sensor connector (EFD07).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage drop between the terminal 1 of the coolant temperature sensor harness connector and chassis ground.

      ■ Specification: Ground voltage drop within 200mV
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Ground Open Inspection” procedure.

NO

▶ Repair the excessive resistance (poor connection) and then go to “Verification of Vehicle Repair” procedure.

2. Ground Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the coolant temperature sensor connector (EFD07) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 3 of the coolant temperature sensor harness connector and the terminal 5 of the ECM connector(EFD-ECM).

      ■ Specification: Continuity (Below 1.0Ω)
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Repair open wiring circuit and then go to “Verification of Vehicle Repair” procedure.

COMPONENT INSPECTION

1. Intake Air Temperature Sensor Resistance Inspection
   1) Turn the ignition OFF.
   2) Disconnect the coolant temperature sensor connector (EFD07).
   3) Measure resistance between the terminals 1 and 3 of the coolant temperature sensor.

■ Specification :

Temperature(℃)	Resistance (kΩ) of terminal No ①, ③
-20	15.48
0	5.79
20	2.45
40	1.148
80	0.322

   4) Is the resistance measured within the specification?

      YES

      ▶ Go to “Verification of Vehicle Repair” procedure.

NO

▶ Replace the coolant temperature sensor and then go to “Verification of Vehicle Repair” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

   YES

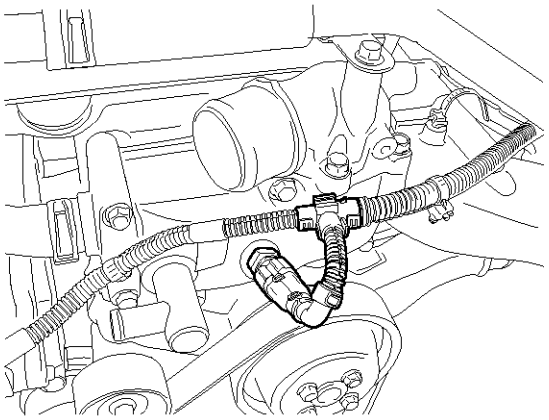
   ▶ Go to the applicable DTC procedure.

   NO

   ▶ System OK

P0118 Coolant Temp. Sensor Signal Too High

COMPONENT LOCATION



SDFFL7103D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   ECTS(Engine Coolant Temperature Sensor) is located on coolant passage of cylinder head. The ECTS uses a thermistor whose resistance changes with the temperature. The electric resistance of the ECTS decreases as the temperature increases, and increases as the temperature decreases.

   The ECTS receives 5 voltage via resistor from ECM and resistor and thermistor are linked in series. ECM received signal from ECTS is used to control injection timing, fuel amount correction and automatic cooling fan.

   Specially the defective engine coolant temperature sensor has a great influence on the cold starting and is one of the factors to cause white smoke at starting.

2. DTC DESCRIPTION

   If the output voltage of the engine coolant temperature sensor is detected above 4.92V for 2,995.9ms or more, the ECM judges this as a fault and DTC is set. Check lamp and MIL come on together when the condition continued for 2 driving cycle times. Check lamp will go off after 3 driving cycle times when the system returns to normal. The possible causes are defective ECTS, faulty wiring & resistance or open in terminal 15 of ECM connector(EFD-ECM) etc.

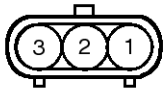
   The vehicle is being driven, but black smoke and a lack of engine power may occur since fuel correction and injection timing can not be controlled according to the engine coolant temperature.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Defective wiring and sensor. • Open or short to the terminal 15 of the engine E-CM connector(EFD-ECM).
Enable Conditions	• At IG ON/ Running			
Threshold Value	• Above 4.92V			
Diagnosis Time	• 3,072ms or higher			
Fail Safe	Fuel Cut	No	• Coolant temperature sets to -20℃ at starting. • Coolant temperature sets to 80℃ at idle and driving.	
	Fuel limit	Yes		
	Check lamp	ON		

SPECIFICATION

Temperature(℃)	Resistance (kΩ) of terminal No ①, ③
-20	15.48
0	5.79
20	2.45
40	1.148
80	0.322



Sensor connector

SUDFLDTC9021L

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Coolant temperature” parameter on the scan tool.

NOTICE

The value of “Coolant temperature” varies with driving condition according to DTC detecting condition. In case of failure, be sure to check that the value of “Coolant temperature” sets to -20℃ at starting and 80℃ at idle and driving.

Parameter	Reference Value
Water temperature (At IG ON)	56℃
Water temperature (At idle)	56℃

SIGNAL CIRCUIT INSPECTION

1. Signal Voltage Inspection
   1) Leave the coolant temperature sensor connector (EFD07) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 3 of the coolant temperature sensor harness connector and chassis ground.

      ■ Specification: Coolant temperature sensor signal power approx. 1.86V(With connecting)

      Note) Voltage value varies depending on coolant temperature.
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Go to “Signal Open Inspection” procedure.
2. Signal Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the coolant temperature sensor connector (EFD07) and the ECM connector(EFD-ECM).
   3) Measure resistance between terminal 3 of the coolant temperature sensor harness connector and terminal 15 of the engine ECM(01).

      ■ Specification: Continuity
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Signal Short to Power Inspection” procedure.

      NO

      ▶ Repair short to open circuit and then go to “Verification of Vehicle Repair” procedure.
3. Signal Short to Power Inspection
   1) Disconnect the coolant temperature sensor connector (EFD07) and the ECM connector(EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 3 of the coolant temperature sensor harness connector and chassis ground.

      ■ Specification: Below 0~0.1V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Ground Circuit Inspection” procedure.

      NO

▶ Repair short to power and then go to "Verification of Vehicle Repair" procedure.

GROUND CIRCUIT INSPECTION

1. Ground Voltage Drop Inspection
   1) Disconnect the coolant temperature sensor connector (EFD07).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage drop between the terminal 1 of the coolant temperature sensor harness connector and chassis ground.

      ■ Specification: Ground voltage drop within 200mV
   4) Is the voltage measured within specification?

      YES

      ▶ Go to "Ground Open Inspection" procedure.

      NO

      ▶ Repair the excessive resistance (poor connection) and then go to "Verification of Vehicle Repair" procedure.
2. Ground Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the coolant temperature sensor connector (EFD07) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 3 of the coolant temperature sensor harness connector and the terminal 5 of the ECM connector(EFD-ECM).

      ■ Specification: Continuity (Below 1.0Ω)
   4) Is the resistance measured within specification?

      YES

      ▶ Go to "Component Inspection" procedure.

      NO

      ▶ Repair open wiring circuit and then go to "Verification of Vehicle Repair" procedure.

COMPONENT INSPECTION

1. Intake Air Temperature Sensor Resistance Inspection
   1) Turn the ignition OFF.
   2) Disconnect the coolant temperature sensor connector (EFD07).
   3) Measure resistance between the terminals 1 and 3 of the coolant temperature sensor.

■ Specification :

Temperature(℃)	Resistance (kΩ) of terminal No ①, ③
-20	15.48
0	5.79
20	2.45
40	1.148
80	0.322

   4) Is the resistance measured within the specification?

      YES

      ▶ Go to "Verification of Vehicle Repair" procedure.

      NO

      ▶ Replace the coolant temperature sensor and then go to "Verification of Vehicle Repair" procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select "Diagnostic Trouble Codes (DTCs)" mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

   YES

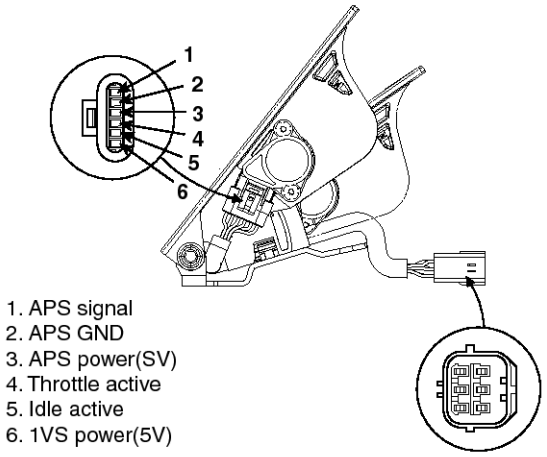
   ▶ Go to the applicable DTC procedure.

   NO

   ▶ System OK

P0120 Accel. Pedal Sensor No.1 Not Open

COMPONENT LOCATION



1. APS signal
2. APS GND
3. APS power(SV)
4. Throttle active
5. Idle active
6. 1VS power(5V)

SUDFLDTC9070L

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   Electronic control fuel injection is injected by engine control module(ECM) via factors received from various components. The accelerator pedal position sensor detects pedal position and sends signal to ECM. It is composed of two potentiometers(dual variable resistor type). Power supply is provided separately to detect acceleration condition exactly. The voltage of accelerator pedal position sensor is generated by potentiometer and the position of accelerator pedal is calculated by using characteristic curve programmed beforehand.

2. DTC DESCRIPTION

   If the accelerator pedal sensor indicates idle state when the vehicle is being accelerated(idle switch OFF) and accelerator signal is below 0.6 V(short to ground), the accelerator pedal sensor "1" outputs 0.6~1.2V and the accelerator pedal sensor "2" outputs 1.5V or more for more than 1,056ms, the ECM judges this as a fault and DTC is set. The possible causes are defective sensor, wiring problem etc.

DTC DETECTING CONDITION

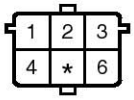
<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="6">• Defective wiring and sensor.</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• Engine running</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• Idle s/w OFF, 0.6V≤Accelerator pedal sensor “1” output voltage≤1.2V, Accelerator pedal sensor “2”≥1.5V or higher</td></tr>
<tr><td>Diagnosis Time</td><td colspan="3">• 1,056ms or higher</td></tr>
<tr><td rowspan="3">Fail Safe</td><td>Fuel Cut</td><td>No</td><td rowspan="3">• APS No.2 signal is selected.</td></tr>
<tr><td>Fuel limit</td><td>No</td></tr>
<tr><td>Check lamp</td><td>OFF</td></tr>
</table>

SPECIFICATION

Terminal resistance ①-②(Inoperative)	Terminal resistance ①-②(Operative)	Terminal resistance ①-③(Inoperative)	Terminal resistance ①-③(Operative)
Approx. 1.83㏀(Continuity)	Approx. 0.708㏀(Continuity)	Approx. 1.64㏀(Continuity)	Approx. 1.64㏀(Continuity)

Terminal resistance ②-③ (Inoperative)	Terminal resistance ②-③ (Operative)
Approx. 0.477㏀(Continuity)	Approx. 1.66㏀(Continuity)

At idle(0%)	At full throttle(100%)
0.33V	3.85V



Sensor connector

SUDFLDTC9024L

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Accelerator pedal position” parameter on the scan tool.

Parameter	Reference Value
Accel. Pos. (At IG ON)	0.0%
Accel. Pos. (At idle)	0.0%
Accel. Pos. (At 1,500 rpm)	23%
Accel. Pos. (At 2,000 rpm)	34.5%

SIGNAL CIRCUIT INSPECTION

1. Signal Voltage Inspection
   1) Leave the accelerator pedal position sensor connector (M32) and the engine ECM connector(CFD-ECM) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 2 of the accelerator pedal position sensor harness connector and chassis ground.

      ■ Specification: Accelerator pedal position sensor signal power approx. 0.68V(At IG ON)
   4) Measure voltage between terminal 47, 67 of the engine ECM connector and chassis ground.

      ■ Specification : Accelerator pedal sensor signal power approx. 0.68V(Inoperative)
   5) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Go to “Signal Open Inspection” procedure.
2. Signal Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the accelerator pedal position sensor connector (M32) and the ECM connector(CFD-ECM, EFD-ECM).
   3) Measure resistance between terminal 2 of the accelerator pedal position sensor harness connector and terminal 47, 67 of the engine ECM connector(CFD-ECM).

      ■ Specification: Continuity
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Signal Short to Power Inspection” procedure.

      NO

      ▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.
3. Signal Short to Power Inspection
   1) Disconnect the accelerator pedal position sensor connector (M32) and the ECM connector(CFD-ECM, EFD-ECM).

2) Turn the ignition ON. Leave the engine OFF.
3) Measure voltage between terminal 2 of the accelerator pedal position sensor harness connector and chassis ground.
4) Measure voltage between terminal 47, 67 of the engine ECM connector and chassis ground.
   ■ Specification: Below 0~0.1V
5) Is the voltage measured within specification?

YES

▶ Go to "Signal Short to Ground Inspection" procedure.

NO

▶ Repair short to power and then go to "Verification of Vehicle Repair" procedure.

4. Signal Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the accelerator pedal position sensor connector (M32) and the ECM connector(CFD-ECM, EFD-ECM).
   3) Measure resistance between terminal 2 of the accelerator pedal position sensor harness connector and chassis ground.
   4) Measure resistance between terminal 47, 67 of the engine ECM connector and chassis ground.
      ■ Specification: Infinite
   5) Is the resistance measured within specification?

YES

▶ Go to "Power Supply Inspection" procedure.

NO

▶ Repair short to ground and then go to "Verification of Vehicle Repair" procedure.

POWER SUPPLY INSPECTION

1. Power Supply Voltage Inspection
   1) Leave the accelerator pedal position sensor connector (M32) and the engine ECM connector(CFD-ECM) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 1 of the accelerator pedal position sensor harness connector and chassis ground.
   4) Measure voltage between terminal 50 of the engine ECM connector and chassis ground.
      ■ Specification: Accelerator pedal sensor signal power approx. 5.0V
   5) Is the voltage measured within specification?

YES

▶ Go to "Ground Circuit Inspection" procedure.

NO

▶ Go to "Power Supply Open Inspection" procedure.

2. Power Supply Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the accelerator pedal position sensor connector (M32) and the engine ECM connector(CFD-ECM).
   3) Measure resistance between the terminal 1 of the accelerator pedal position sensor harness connector and terminal 50 of the engine ECM connector(CFD-ECM).
      ■ Specification: Continuity
   4) Is the resistance measured within specification?

YES

▶ Go to "Power Supply Short to Power Inspection" procedure.

NO

▶ Repair open circuit and then go to "Verification of Vehicle Repair" procedure.

3. Power Supply Short to Power Inspection
   1) Disconnect the accelerator pedal position sensor connector (M32) and ECM connector(CFD-ECM, EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 1 of the accelerator pedal position sensor harness connector and chassis ground.
   4) Measure voltage between the terminal 50 of the engine ECM harness connector and chassis ground.
      ■ Specification: Below 0~0.1V
   5) Is the voltage measured within specification?

YES

▶ Go to "Power Supply Short to Ground Inspection" procedure.

NO

▶ Repair short to power and then go to "Verification of Vehicle Repair" procedure.

4. Power Supply Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the accelerator pedal position sensor connector (M32) and ECM connector(CFD-ECM, EFD-ECM).
   3) Measure resistance between the terminal 1 of the accelerator pedal position sensor harness connector and chassis ground.
   4) Measure resistance between the terminal 50 of the engine ECM harness connector and chassis ground.
      ■ Specification: Infinite
   5) Is the resistance measured within specification?

YES

▶ Go to "Ground Circuit Inspection" procedure.

NO

▶ Repair short to ground and then go to "Verification of Vehicle Repair" procedure.

GROUND CIRCUIT INSPECTION

1. Ground Voltage Drop Inspection
   1) Disconnect the accelerator pedal position sensor connector (M32).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage drop between the terminal 3 of the accelerator pedal position sensor harness connector and chassis ground.
      ■ Specification: Ground voltage drop within 200mV
   4) Is the voltage measured within specification?

YES

▶ Go to "Ground Open Inspection" procedure.

NO

▶ Repair the excessive resistance (poor connection) and then go to "Verification of Vehicle Repair" procedure.

2. Ground Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the accelerator pedal position sensor connector (M32) and the engine ECM connector(CFD-ECM, EFD-ECM).
   3) Measure resistance between the terminal 3 of the accelerator pedal position sensor harness connector and the terminal 45, 65 of the engine ECM connector(CFD-ECM).
      ■ Specification: Continuity (Below 1.0Ω)
   4) Is the resistance measured within specification?

YES

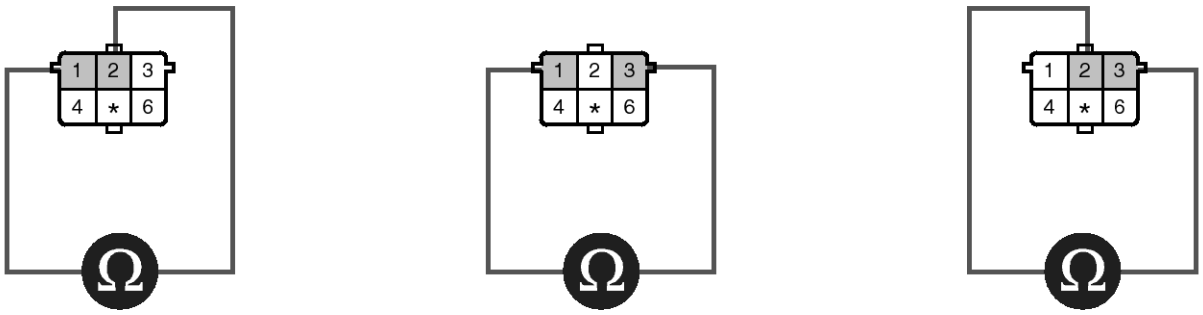
▶ Go to "Component Inspection" procedure.

NO

▶ Repair open wiring circuit and then go to "Verification of Vehicle Repair" procedure.

COMPONENT INSPECTION

1. Accelerator Pedal Position Sensor Component Inspection
   1) Turn the ignition OFF.
   2) Disconnect the accelerator pedal position sensor connector (M32).
   3) Measure resistance between the terminals ①-②, ②-③, ①-③ of the accelerator pedal position sensor.



■ Specification

Terminal resistance ①-②(Inoperative)	Terminal resistance ①-②(Operative)	Terminal resistance ①-③(Inoperative)	Terminal resistance ①-③(Operative)
Approx. 1.83㏀(Continuity)	Approx. 0.708㏀(Continuity)	Approx. 1.64㏀(Continuity)	Approx. 1.64㏀(Continuity)

Terminal resistance ②-③ (Inoperative)	Terminal resistance ②-③ (Operative)
Approx. 0.477㏀(Continuity)	Approx. 1.66㏀(Continuity)

SUDFLDTC9026L

4) Is the resistance measured within the specification?

YES

▶ Go to “Verification of Vehicle Repair” procedure.

NO

▶ Replace the accelerator pedal position sensor and then go to “Verification of Vehicle Repair” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

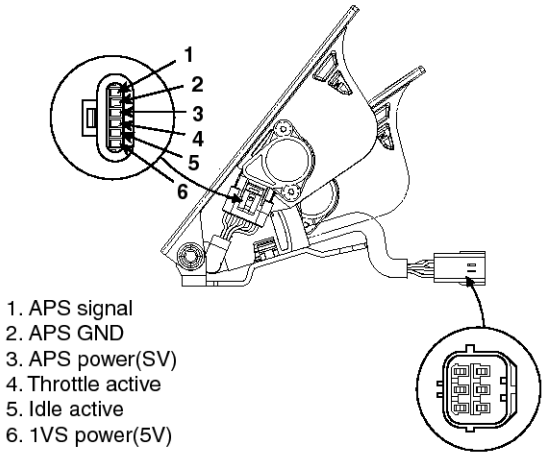
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P0121 Accel. Pedal Sensor No.1 Not Close

COMPONENT LOCATION



SUDFLDTC9070L

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   Electronic control fuel injection is injected by engine control module(ECM) via factors received from various components. The accelerator pedal position sensor detects pedal position and sends signal to ECM. It is composed of two potentiometers(dual variable resistor type). Power supply is provided separately to detect acceleration condition exactly. The voltage of accelerator pedal position sensor is generated by potentiometer and the position of accelerator pedal is calculated by using characteristic curve programmed beforehand.

2. DTC DESCRIPTION

   If the accelerator pedal sensor doesn't indicates idle state when the vehicle is not being accelerated(idle switch ON) and the accelerator pedal sensor "1" outputs 5V or more and the accelerator pedal sensor "2" outputs 0~5.0V for more than 1,056ms, the ECM judges this as a fault and DTC is set. The possible causes are defective sensor, wiring problem etc.

DTC DETECTING CONDITION

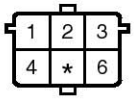
Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Defective wiring and sensor.
Enable Conditions	• Engine running			
Threshold Value	• Idle s/w ON, 0.6V≤Accelerator pedal sensor “1” output voltage≤1.2V, Accelerator pedal sensor “2”≥1.5V or higher			
Diagnosis Time	• 1,056ms or higher			
Fail Safe	Fuel Cut	No	• APS No.2 signal is selected.	
	Fuel limit	No		
	Check lamp	OFF		

SPECIFICATION

Terminal resistance ①-②(Inoperative)	Terminal resistance ①-②(Operative)	Terminal resistance ①-③(Inoperative)	Terminal resistance ①-③(Operative)
Approx. 1.83㏀(Continuity)	Approx. 0.708㏀(Continuity)	Approx. 1.64㏀(Continuity)	Approx. 1.64㏀(Continuity)

Terminal resistance ②-③ (Inoperative)	Terminal resistance ②-③ (Operative)
Approx. 0.477㏀(Continuity)	Approx. 1.66㏀(Continuity)

At idle(0%)	At full throttle(100%)
0.33V	3.85V



Sensor connector

SUDFLDTC9024L

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Accelerator pedal position” parameter on the scan tool.

Parameter	Reference Value
Accel. Pos. (At IG ON)	0.0%
Accel. Pos. (At idle)	0.0%
Accel. Pos. (At 1,500 rpm)	23%
Accel. Pos. (At 2,000 rpm)	34.5%

SIGNAL CIRCUIT INSPECTION

1. Signal Voltage Inspection
   1) Leave the accelerator pedal position sensor connector (M32) and the engine ECM connector(CFD-ECM) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 2 of the accelerator pedal position sensor harness connector and chassis ground.

      ■ Specification: Accelerator pedal position sensor signal power approx. 0.68V(At IG ON)
   4) Measure voltage between terminal 47, 67 of the engine ECM connector and chassis ground.

      ■ Specification : Accelerator pedal sensor signal power approx. 0.68V(Inoperative)
   5) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Go to “Signal Open Inspection” procedure.
2. Signal Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the accelerator pedal position sensor connector (M32) and the ECM connector(CFD-ECM, EFD-ECM).
   3) Measure resistance between terminal 2 of the accelerator pedal position sensor harness connector and terminal 47, 67 of the engine ECM connector(CFD-ECM).

      ■ Specification: Continuity
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Signal Short to Power Inspection” procedure.

      NO

      ▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.
3. Signal Short to Power Inspection
   1) Disconnect the accelerator pedal position sensor connector (M32) and the ECM connector(CFD-ECM, EFD-ECM).

2) Turn the ignition ON. Leave the engine OFF.
3) Measure voltage between terminal 2 of the accelerator pedal position sensor harness connector and chassis ground.
4) Measure voltage between terminal 47, 67 of the engine ECM connector and chassis ground.
   ■ Specification: Below 0~0.1V
5) Is the voltage measured within specification?

YES

▶ Go to "Signal Short to Ground Inspection" procedure.

NO

▶ Repair short to power and then go to "Verification of Vehicle Repair" procedure.

4. Signal Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the accelerator pedal position sensor connector (M32) and the ECM connector(CFD-ECM, EFD-ECM).
   3) Measure resistance between terminal 2 of the accelerator pedal position sensor harness connector and chassis ground.
   4) Measure resistance between terminal 47, 67 of the engine ECM connector and chassis ground.
      ■ Specification: Infinite
   5) Is the resistance measured within specification?

YES

▶ Go to "Power Supply Inspection" procedure.

NO

▶ Repair short to ground and then go to "Verification of Vehicle Repair" procedure.

POWER SUPPLY INSPECTION

1. Power Supply Voltage Inspection
   1) Leave the accelerator pedal position sensor connector (M32) and the engine ECM connector(CFD-ECM) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 1 of the accelerator pedal position sensor harness connector and chassis ground.
   4) Measure voltage between terminal 50 of the engine ECM connector and chassis ground.
      ■ Specification: Accelerator pedal sensor signal power approx. 5.0V
   5) Is the voltage measured within specification?

YES

▶ Go to "Ground Circuit Inspection" procedure.

NO

▶ Go to "Power Supply Open Inspection" procedure.

2. Power Supply Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the accelerator pedal position sensor connector (M32) and the engine ECM connector(CFD-ECM).
   3) Measure resistance between the terminal 1 of the accelerator pedal position sensor harness connector and terminal 50 of the engine ECM connector(CFD-ECM).
      ■ Specification: Continuity
   4) Is the resistance measured within specification?

YES

▶ Go to "Power Supply Short to Power Inspection" procedure.

NO

▶ Repair open circuit and then go to "Verification of Vehicle Repair" procedure.

3. Power Supply Short to Power Inspection
   1) Disconnect the accelerator pedal position sensor connector (M32) and ECM connector(CFD-ECM, EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 1 of the accelerator pedal position sensor harness connector and chassis ground.
   4) Measure voltage between the terminal 50 of the engine ECM harness connector and chassis ground.
      ■ Specification: Below 0~0.1V
   5) Is the voltage measured within specification?

YES

▶ Go to "Power Supply Short to Ground Inspection" procedure.

NO

▶ Repair short to power and then go to "Verification of Vehicle Repair" procedure.

4. Power Supply Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the accelerator pedal position sensor connector (M32) and ECM connector(CFD-ECM, EFD-ECM).
   3) Measure resistance between the terminal 1 of the accelerator pedal position sensor harness connector and chassis ground.
   4) Measure resistance between the terminal 50 of the engine ECM harness connector and chassis ground.
      ■ Specification: Infinite
   5) Is the resistance measured within specification?

YES

▶ Go to "Ground Circuit Inspection" procedure.

NO

▶ Repair short to ground and then go to "Verification of Vehicle Repair" procedure.

GROUND CIRCUIT INSPECTION

1. Ground Voltage Drop Inspection
   1) Disconnect the accelerator pedal position sensor connector (M32).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage drop between the terminal 3 of the accelerator pedal position sensor harness connector and chassis ground.
      ■ Specification: Ground voltage drop within 200mV
   4) Is the voltage measured within specification?

YES

▶ Go to "Ground Open Inspection" procedure.

NO

▶ Repair the excessive resistance (poor connection) and then go to "Verification of Vehicle Repair" procedure.

2. Ground Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the accelerator pedal position sensor connector (M32) and the engine ECM connector(CFD-ECM, EFD-ECM).
   3) Measure resistance between the terminal 3 of the accelerator pedal position sensor harness connector and the terminal 45, 65 of the engine ECM connector(CFD-ECM).
      ■ Specification: Continuity (Below 1.0Ω)
   4) Is the resistance measured within specification?

YES

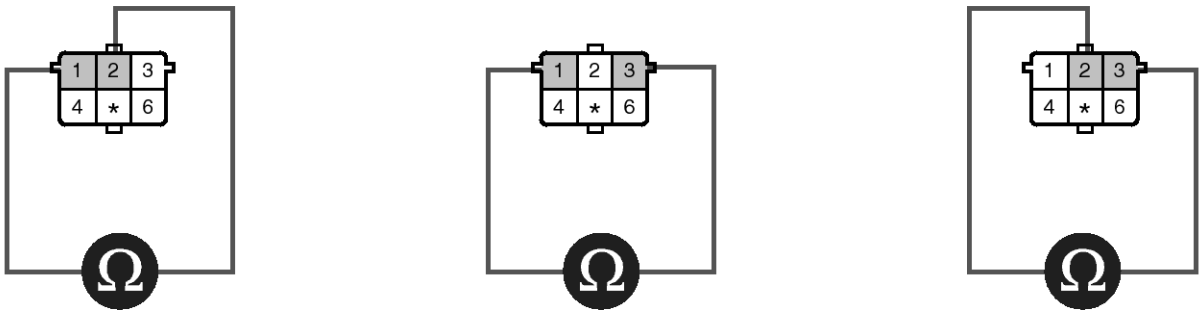
▶ Go to "Component Inspection" procedure.

NO

▶ Repair open wiring circuit and then go to "Verification of Vehicle Repair" procedure.

COMPONENT INSPECTION

1. Accelerator Pedal Position Sensor Component Inspection
   1) Turn the ignition OFF.
   2) Disconnect the accelerator pedal position sensor connector (M32).
   3) Measure resistance between the terminals ①-②, ②-③, ①-③ of the accelerator pedal position sensor.



■ Specification

Terminal resistance ①-②(Inoperative)	Terminal resistance ①-②(Operative)	Terminal resistance ①-③(Inoperative)	Terminal resistance ①-③(Operative)
Approx. 1.83㏀(Continuity)	Approx. 0.708㏀(Continuity)	Approx. 1.64㏀(Continuity)	Approx. 1.64㏀(Continuity)

Terminal resistance ②-③ (Inoperative)	Terminal resistance ②-③ (Operative)
Approx. 0.477㏀(Continuity)	Approx. 1.66㏀(Continuity)

SUDFLDTC9026L

4) Is the resistance measured within the specification?

YES

▶ Go to “Verification of Vehicle Repair” procedure.

NO

▶ Replace the accelerator pedal position sensor and then go to “Verification of Vehicle Repair” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

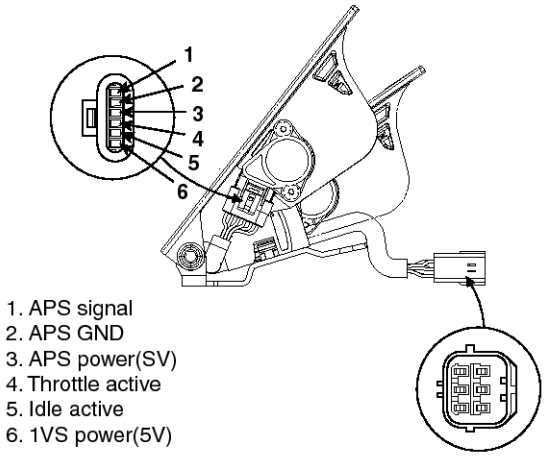
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P0122 Accel. Pedal Sensor No.1 Signal Too low

COMPONENT LOCATION



SUDFLDTC9070L

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   Electronic control fuel injection is injected by engine control module(ECM) via factors received from various components. The accelerator pedal position sensor detects pedal position and sends signal to ECM. It is composed of two potentiometers(dual variable resistor type). Power supply is provided separately to detect acceleration condition exactly. The voltage of accelerator pedal position sensor is generated by potentiometer and the position of accelerator pedal is calculated by using characteristic curve programmed beforehand.

2. DTC DESCRIPTION

   When the accelerator pedal sensor "1" outputs below 0.2V for more than 1,056ms, the ECM judges this as a fault and DTC is set. The possible causes are defective sensor, wiring problem and open in terminal 47,50 of ECM connector(CFD-ECM) etc. When the accelerator pedal sensor "1" is defective, ECM is controlled by using data of the accelerator pedal sensor "2" and the vehicle is being driven in normal condition.

DTC DETECTING CONDITION

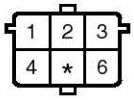
Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Defective wiring and sensor. • Open or short to ground of terminal 47, 50 of ECM connector (CFD-ECM) .
Enable Conditions	• At IG ON/ Running			
Threshold Value	• Below 0.2V			
Diagnosis Time	• 1,056ms or higher			
Fail Safe	Fuel Cut	No	• APS No.1 signal is selected.	
	Fuel limit	No		
	Check lamp	OFF		

SPECIFICATION

Terminal resistance ①-②(Inoperative)	Terminal resistance ①-②(Operative)	Terminal resistance ①-③(Inoperative)	Terminal resistance ①-③(Operative)
Approx. 1.83㏀(Continuity)	Approx. 0.708㏀(Continuity)	Approx. 1.64㏀(Continuity)	Approx. 1.64㏀(Continuity)

Terminal resistance ②-③ (Inoperative)	Terminal resistance ②-③ (Operative)
Approx. 0.477㏀(Continuity)	Approx. 1.66㏀(Continuity)

At idle(0%)	At full throttle(100%)
0.33V	3.85V



Sensor connector

SUDFLDTC9024L

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Accelerator pedal position” parameter on the scan tool.

Parameter	Reference Value
Accel. Pos. (At IG ON)	0.0%
Accel. Pos. (At idle)	0.0%
Accel. Pos. (At 1,500 rpm)	23%
Accel. Pos. (At 2,000 rpm)	34.5%

SIGNAL CIRCUIT INSPECTION

1. Signal Voltage Inspection
   1) Leave the accelerator pedal position sensor connector (M32) and the engine ECM connector(CFD-ECM) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 2 of the accelerator pedal position sensor harness connector and chassis ground.
   4) Measure voltage between terminal 47 of the engine ECM connector and chassis ground.

      ■ Specification: Accelerator pedal sensor signal power approx. 0.68V (Inoperative)

   5) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Go to “Signal Open Inspection” procedure.
2. Signal Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the accelerator pedal position sensor connector (M32) and the ECM connector(CFD-ECM, EFD-ECM).
   3) Measure resistance between terminal 2 of the accelerator pedal position sensor harness connector and terminal 47 of the engine ECM connector(CFD-ECM).

      ■ Specification: Continuity

   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Signal Short to Ground Inspection” procedure.

      NO

      ▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.
3. Signal Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the accelerator pedal position sensor connector (M32) and the ECM connector(CFD-ECM, EFD-ECM).
   3) Measure resistance between terminal 2 of the

accelerator pedal position sensor harness connector and chassis ground.

4) Measure resistance between terminal 47 of the engine ECM connector and chassis ground.

■ Specification: Infinite

5) Is the resistance measured within specification?

YES

▶ Go to "Power Supply Inspection" procedure.

NO

▶ Repair short to ground and then go to "Verification of Vehicle Repair" procedure.

POWER SUPPLY INSPECTION

1. Power Supply Voltage Inspection
   1) Leave the accelerator pedal position sensor connector (M32) and the engine ECM connector(CFD-ECM) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 1 of the accelerator pedal position sensor harness connector and chassis ground.
   4) Measure voltage between terminal 50 of the engine ECM connector and chassis ground.

      ■ Specification: Accelerator pedal sensor signal power approx. 5.0V

   5) Is the voltage measured within specification?

      YES

      ▶ Go to "Ground Circuit Inspection" procedure.

      NO

      ▶ Go to "Power Supply Open Inspection" procedure.
2. Power Supply Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the accelerator pedal position sensor connector (M32) and the engine ECM connector(CFD-ECM).
   3) Measure resistance between the terminal 1 of the accelerator pedal position sensor harness connector and terminal 50 of the engine ECM connector(CFD-ECM).

      ■ Specification: Continuity

   4) Is the resistance measured within specification?

      YES

      ▶ Go to "Power Supply Short to Ground Inspection" procedure.

      NO

      ▶ Repair open circuit and then go to "Verification of Vehicle Repair" procedure.
3. Power Supply Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the accelerator pedal position sensor connector (M32) and ECM connector(CFD-ECM, EFD-ECM).
   3) Measure resistance between the terminal 1 of the accelerator pedal position sensor harness connector and chassis ground.
   4) Measure resistance between the terminal 50 of the engine ECM harness connector and chassis ground.

      ■ Specification: Infinite

   5) Is the resistance measured within specification?

      YES

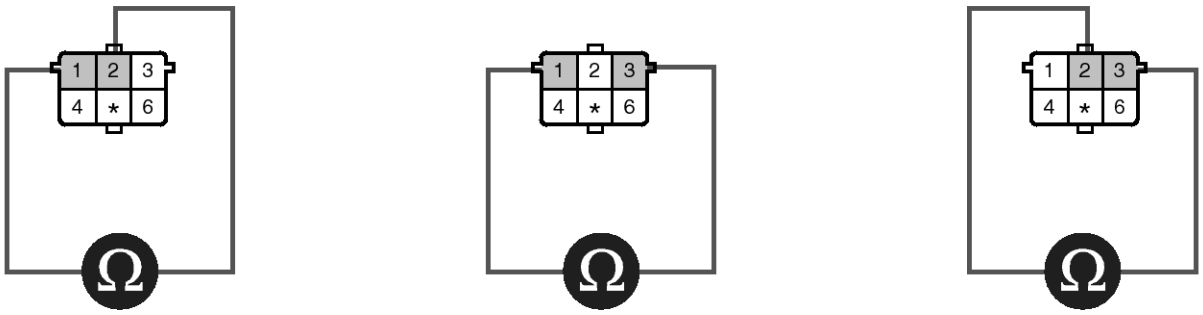
      ▶ Go to "Component Inspection" procedure.

      NO

      ▶ Repair short to ground and then go to "Verification of Vehicle Repair" procedure.

COMPONENT INSPECTION

1. Accelerator Pedal Position Sensor Component Inspection
   1) Turn the ignition OFF.
   2) Disconnect the accelerator pedal position sensor connector (M32).
   3) Measure resistance between the terminals ①-②, ②-③, ①-③ of the accelerator pedal position sensor.



■ Specification

Terminal resistance ①-②(Inoperative)	Terminal resistance ①-②(Operative)	Terminal resistance ①-③(Inoperative)	Terminal resistance ①-③(Operative)
Approx. 1.83㏀(Continuity)	Approx. 0.708㏀(Continuity)	Approx. 1.64㏀(Continuity)	Approx. 1.64㏀(Continuity)

Terminal resistance ②-③ (Inoperative)	Terminal resistance ②-③ (Operative)
Approx. 0.477㏀(Continuity)	Approx. 1.66㏀(Continuity)

SUDFLDTC9026L

4) Is the resistance measured within the specification?

YES

▶ Go to “Verification of Vehicle Repair” procedure.

NO

▶ Replace the accelerator pedal position sensor and then go to “Verification of Vehicle Repair” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

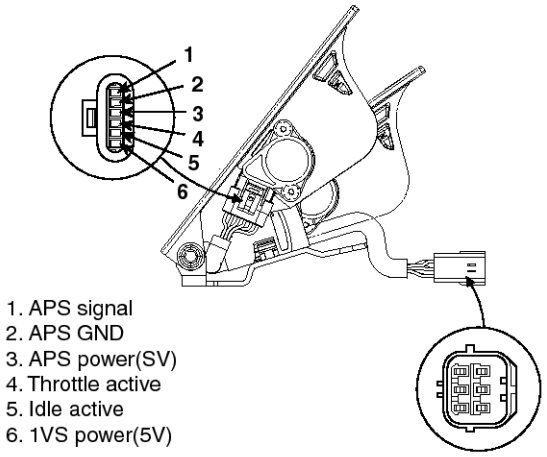
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P0123 Accel. Pedal Sensor No.1 Signal Too high

COMPONENT LOCATION



1. APS signal
2. APS GND
3. APS power(SV)
4. Throttle active
5. Idle active
6. 1VS power(5V)

SUDFLDTC9070L

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   Electronic control fuel injection is injected by engine control module(ECM) via factors received from various components.The accelerator pedal position sensor detects pedal position and sends signal to ECM. It is composed of two potentiometers(dual variable resistor type). Power supply is provided separately to detect acceleration condition exactly. The voltage of accelerator pedal position sensor is generated by potentiometer and the position of accelerator pedal is calculated by using characteristic curve programmed beforehand.

2. DTC DESCRIPTION

   When the accelerator pedal sensor "1" outputs above 4.5V for more than 528ms, the ECM judges this as a fault and DTC is set. The possible causes are defective sensor, wiring problem etc.

DTC DETECTING CONDITION

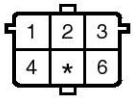
Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Defective wiring and sensor.
Enable Conditions	• At IG ON/ Running			
Threshold Value	• Above 4.5V			
Diagnosis Time	• 528ms or higher			
Fail Safe	Fuel Cut	No	• APS No.2 signal is selected.	
	Fuel limit	No		
	Check lamp	OFF		

SPECIFICATION

Terminal resistance ①-②(Inoperative)	Terminal resistance ①-②(Operative)	Terminal resistance ①-③(Inoperative)	Terminal resistance ①-③(Operative)
Approx. 1.83㏀(Continuity)	Approx. 0.708㏀(Continuity)	Approx. 1.64㏀(Continuity)	Approx. 1.64㏀(Continuity)

Terminal resistance ②-③ (Inoperative)	Terminal resistance ②-③ (Operative)
Approx. 0.477㏀(Continuity)	Approx. 1.66㏀(Continuity)

At idle(0%)	At full throttle(100%)
0.33V	3.85V



Sensor connector

SUDFLDTC9024L

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Accelerator pedal position” parameter on the scan tool.

Parameter	Reference Value
Accel. Pos. (At IG ON)	0.0%
Accel. Pos. (At idle)	0.0%
Accel. Pos. (At 1,500 rpm)	23%
Accel. Pos. (At 2,000 rpm)	34.5%

SIGNAL CIRCUIT INSPECTION

1. Signal Voltage Inspection
   1) Leave the accelerator pedal position sensor connector (M32) and the engine ECM connector(CFD-ECM) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 2 of the accelerator pedal position sensor harness connector and chassis ground.
   4) Measure voltage between terminal 47 of the engine ECM connector and chassis ground.

      ■ Specification: Accelerator pedal sensor signal power approx. 0.68V (Inoperative)
   5) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Go to “Signal Short to Power Inspection” procedure.
2. Signal Short to Power Inspection
   1) Disconnect the accelerator pedal position sensor connector (M32) and the ECM connector(CFD-ECM, EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 2 of the accelerator pedal position sensor harness connector and chassis ground.
   4) Measure voltage between terminal 47 of the engine ECM connector and chassis ground.

      ■ Specification: Below 0~0.1V
   5) Is the voltage measured within specification?

      YES

      ▶ Go to “Ground Circuit Inspection” procedure.

      NO

      ▶ Repair short to power and then go to “Verification of Vehicle Repair” procedure.

GROUND CIRCUIT INSPECTION

1. Ground Voltage Drop Inspection
   1) Disconnect the accelerator pedal position sensor connector (M32).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage drop between the terminal 3 of the accelerator pedal position sensor harness connector and chassis ground.

      ■ Specification: Ground voltage drop within 200mV
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Ground Open Inspection” procedure.

      NO

      ▶ Repair the excessive resistance (poor connection) and then go to “Verification of Vehicle Repair” procedure.
2. Ground Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the accelerator pedal position sensor connector (M32) and the engine ECM connector(CFD-ECM, EFD-ECM).
   3) Measure resistance between the terminal 3 of the accelerator pedal position sensor harness connector and the terminal 45, 65 of the engine ECM connector(CFD-ECM).

      ■ Specification: Continuity (Below 1.0Ω)
   4) Is the resistance measured within specification?

      YES

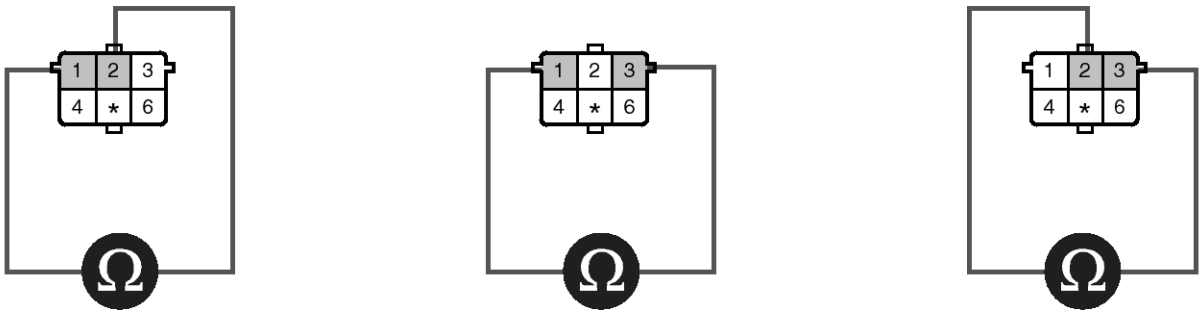
      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Repair open wiring circuit and then go to “Verification of Vehicle Repair” procedure.

COMPONENT INSPECTION

1. Accelerator Pedal Position Sensor Component Inspection
   1) Turn the ignition OFF.
   2) Disconnect the accelerator pedal position sensor connector (M32).
   3) Measure resistance between the terminals ①-②, ②-③, ①-③ of the accelerator pedal position sensor.



■ Specification

Terminal resistance ①-②(Inoperative)	Terminal resistance ①-②(Operative)	Terminal resistance ①-③(Inoperative)	Terminal resistance ①-③(Operative)
Approx. 1.83㏀(Continuity)	Approx. 0.708㏀(Continuity)	Approx. 1.64㏀(Continuity)	Approx. 1.64㏀(Continuity)

Terminal resistance ②-③ (Inoperative)	Terminal resistance ②-③ (Operative)
Approx. 0.477㏀(Continuity)	Approx. 1.66㏀(Continuity)

SUDFLDTC9026L

4) Is the resistance measured within the specification?

YES

▶ Go to “Verification of Vehicle Repair” procedure.

NO

▶ Replace the accelerator pedal position sensor and then go to “Verification of Vehicle Repair” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

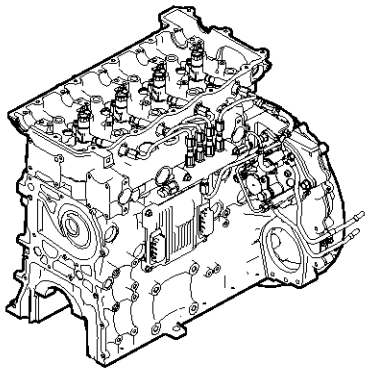
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P0182 Fuel Temp.(Pump) Sensor Signal Too Low

COMPONENT LOCATION



SDFFL7104D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   Fuel temperature sensor is installed on the right side of fuel pump. The fuel temperature sensor measures fuel temperature and sends signal to ECM. ECM corrects fuel injection amount at cold engine or hot engine by using the signal.

2. DTC DESCRIPTION

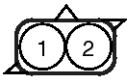
   When the fuel temperature sensor outputs below 0.1V for more than 10,112ms, the ECM judges this as a fault and DTC is set. Check lamp and MIL come on together when the condition continued for 2 driving cycle times. Check lamp will go off after 3 driving cycle times when the system returns to normal. The possible causes are defective sensor, wiring problem and short to terminal 33 of ECM connector(EFD-ECM) etc. The vehicle is being driven, but black smoke and a lack of engine power may occur since fuel correction is stopped according to the fuel temperature.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Defective wiring and sensor. • GND short to terminal 33 of ECM connector (EFD-ECM).
Enable Conditions	• Engine running			
Threshold Value	• Below 0.1V			
Diagnosis Time	• 10,112ms or higher			
Fail Safe	Fuel Cut	No	Fuel temperature • IG ON:-20℃ • Engine running: 40℃	
	Fuel limit	Yes		
	Check lamp	ON		

SPECIFICATION

Temperature(℃)	Resistance (kΩ) of terminal No ①,②
0	5.74
10	3.70
20	2.45±0.24
30	1.66
40	1.15
50	0.81
60	0.58



Sensor connector

SUDFLDTC9027L

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Fuel temperature” parameter on the scan tool.

NOTICE

The value of “Fuel temperature” varies with driving condition according to DTC detecting condition. In case of failure, be sure to check that the value of “Fuel temperature” sets to -20℃ at starting and 40℃ at idle and driving.

Parameter	Reference Value
Fuel Temp. (At IG ON)	41℃
Fuel Temp. (At idle)	42℃
Fuel Temp. (At 1,500 rpm)	41℃
Fuel Temp. (At 2,000 rpm)	40℃

SIGNAL CIRCUIT INSPECTION

1. Signal Voltage Inspection
   1) Leave the fuel temperature sensor connector (EFD16) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 1 of the fuel temperature sensor harness connector and chassis ground.

      ■ Specification: Fuel temperature sensor signal power approx. 2.5V (When connecting)

      Note) The voltage value varies depending on fuel temperature.
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Go to “Signal Short to Ground Inspection” procedure.
2. Signal Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the fuel temperature sensor connector (EFD16) and the ECM connector(EFD-ECM).
   3) Measure resistance between terminal 1 of the fuel temperature sensor harness connector and chassis ground.

      ■ Specification: Infinite
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Ground Circuit Inspection” procedure.

      NO

      ▶ Repair short to ground and then go to “Verification of Vehicle Repair” procedure.

GROUND CIRCUIT INSPECTION

1. Ground Voltage Drop Inspection
   1) Disconnect the fuel temperature sensor connector (EFD16).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage drop between the terminal 2 of the fuel temperature sensor harness connector and chassis ground.

      ■ Specification: Ground voltage drop within 200mV
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Ground Open Inspection” procedure.

      NO

      ▶ Repair the excessive resistance (poor connection) and then go to “Verification of Vehicle Repair” procedure.
2. Ground Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the fuel temperature sensor connector (EFD16) and the engine ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 2 of the fuel temperature sensor harness connector and the terminal 5 of the engine ECM connector(CFD-ECM).

      ■ Specification: Continuity (Below 1.0Ω)
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Repair open wiring circuit and then go to “Verification of Vehicle Repair” procedure.

COMPONENT INSPECTION

1. Fuel Temperature Sensor Resistance Inspection
   1) Turn the ignition OFF.
   2) Disconnect the fuel temperature sensor connector (EFD16).
   3) Measure resistance between the terminals 1 and 2 of the fuel temperature sensor connector.

■ Specification :

Temperature(℃)	Resistance (kΩ) of terminal No ①,②
0	5.74
10	3.70
20	2.45±0.24
30	1.66
40	1.15
50	0.81
60	0.58

   4) Is the resistance measured within the specification?

      YES

      ▶ Go to “Verification of Vehicle Repair” procedure.

      NO

      ▶ Replace the fuel temperature sensor and then go to “Verification of Vehicle Repair” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

   YES

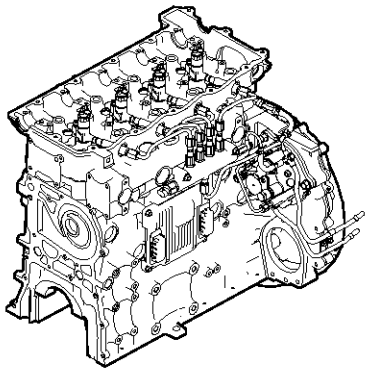
   ▶ Go to the applicable DTC procedure.

   NO

   ▶ System OK

P0183 Fuel Temp.(Pump) Sensor Signal Too High

COMPONENT LOCATION



SDFFL7104D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   Fuel temperature sensor is installed on the right side of fuel pump. The fuel temperature sensor measures fuel temperature and sends signal to ECM. ECM corrects fuel injection amount at cold engine or hot engine by using the signal.

2. DTC DESCRIPTION

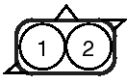
   When the fuel temperature sensor outputs above 4.85V for more than 10,112ms, the ECM judges this as a fault and DTC is set. The possible causes are defective sensor, wiring problem and open in terminal 33 of ECM connector(EFD-ECM) etc. The vehicle is being driven, but black smoke and a lack of engine power may occur since fuel correction is stopped according to the fuel temperature.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Defective wiring and sensor. • Power short to terminal 33 or open of ECM connector (EFD-ECM).
Enable Conditions	• Engine running			
Threshold Value	• Above 4.85V			
Diagnosis Time	• 10,112ms or higher			
Fail Safe	Fuel Cut	No	• Fuel temperature sets to -20℃ at starting. • Fuel temperature sets to 40℃ at idle and driving.	
	Fuel limit	Yes		
	Check lamp	ON		

SPECIFICATION

Temperature(℃)	Resistance (kΩ) of terminal No ①,②
0	5.74
10	3.70
20	2.45±0.24
30	1.66
40	1.15
50	0.81
60	0.58



Sensor connector

SUDFLDTC9027L

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Fuel temperature” parameter on the scan tool.

NOTICE

The value of “Fuel temperature” varies with driving condition according to DTC detecting condition. In case of failure, be sure to check that the value of “Fuel temperature” sets to -20℃ at starting and 40℃ at idle and driving.

Parameter	Reference Value
Fuel Temp. (At IG ON)	41℃
Fuel Temp. (At idle)	42℃
Fuel Temp. (At 1,500 rpm)	41℃
Fuel Temp. (At 2,000 rpm)	40℃

SIGNAL CIRCUIT INSPECTION

1. Signal Voltage Inspection
   1) Leave the fuel temperature sensor connector (EFD16) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 1 of the fuel temperature sensor harness connector and chassis ground.

      ■ Specification: Fuel temperature sensor signal power approx. 2.5V (When connecting)

      Note) The voltage value varies depending on fuel temperature.
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Go to “Signal Open Inspection” procedure.
2. Signal Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the fuel temperature sensor connector (EFD16) and the ECM connector(EFD-ECM).
   3) Measure resistance between terminal 1 of the fuel temperature sensor harness connector and terminal 33 of the engine ECM connector(EFD-ECM).

      ■ Specification: Continuity
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Signal Short to Power Inspection” procedure.

      NO

      ▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.
3. Signal Short to Power Inspection
   1) Disconnect the fuel temperature sensor connector (EFD16) and the ECM connector(EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 1 of the fuel temperature sensor harness connector and chassis ground.

■ Specification: Below 0~0.1V

4) Is the voltage measured within specification?

YES

▶ Go to "Ground Circuit Inspection" procedure.

NO

▶ Repair short to power and then go to "Verification of Vehicle Repair" procedure.

GROUND CIRCUIT INSPECTION

1. Ground Voltage Drop Inspection
   1) Disconnect the fuel temperature sensor connector (EFD16).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage drop between the terminal 2 of the fuel temperature sensor harness connector and chassis ground.

      ■ Specification: Ground voltage drop within 200mV

   4) Is the voltage measured within specification?

      YES

      ▶ Go to "Ground Open Inspection" procedure.

      NO

      ▶ Repair the excessive resistance (poor connection) and then go to "Verification of Vehicle Repair" procedure.
2. Ground Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the fuel temperature sensor connector (EFD16) and the engine ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 2 of the fuel temperature sensor harness connector and the terminal 5 of the engine ECM connector(CFD-ECM).

      ■ Specification: Continuity (Below 1.0Ω)

   4) Is the resistance measured within specification?

      YES

      ▶ Go to "Component Inspection" procedure.

      NO

      ▶ Repair open wiring circuit and then go to "Verification of Vehicle Repair" procedure.

COMPONENT INSPECTION

1. Fuel Temperature Sensor Resistance Inspection
   1) Turn the ignition OFF.
   2) Disconnect the fuel temperature sensor connector (EFD16).
   3) Measure resistance between the terminals 1 and 2 of the fuel temperature sensor connector.

■ Specification :

Temperature(℃)	Resistance (kΩ) of terminal No ①,②
0	5.74
10	3.70
20	2.45±0.24
30	1.66
40	1.15
50	0.81
60	0.58

   4) Is the resistance measured within the specification?

      YES

      ▶ Go to "Verification of Vehicle Repair" procedure.

      NO

      ▶ Replace the fuel temperature sensor and then go to "Verification of Vehicle Repair" procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select "Diagnostic Trouble Codes (DTCs)" mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

   YES

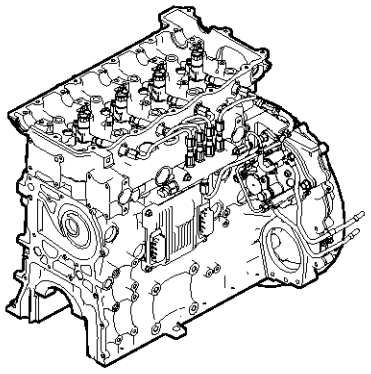
   ▶ Go to the applicable DTC procedure.

   NO

   ▶ System OK

P0192 C/Rail Pressure Sensor Signal Too Low

COMPONENT LOCATION



SDFFL7104D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   Rail pressure sensor converts fuel pressure in rail into voltage signal and sends signal to ECM. ECM uses the signal to determine fuel amount. The sensor element which converts pressure into electric signal is connected to diaphragm and is activated like an analog resistance. The resistance changes with diaphragm change of rail pressure At this time, rail pressure is converted into electric signal. The bridge circuit of diaphragm is amplified into 1.0~4.7V(0~2,300bar) and is displayed into voltage.

2. DTC DESCRIPTION

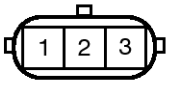
   If rail pressure sensor is detected below 0.7V for 224ms or more, ECM judges this as a fault and DTC is set. The possible causes may be faulty common rail pressure sensor, defective wiring & resistance, short to terminals 13, 32 of ECM connector(EFD-ECM) or terminal 68 open of ECM connector(EFD-ECM). The vehicle can be driven but lack of engine power will occur since ECM controls fuel amount to below 75% of maximum torque in case of fail safe.

DTC DETECTING CONDITION

<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="6">• Defective wiring and sensor.
• GND short to terminal 13 , 32 or terminal 68 open of ECM connector (EFD-ECM).</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• Engine running</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• Below 0.7V</td></tr>
<tr><td>Diagnosis Time</td><td colspan="3">• 224ms or higher</td></tr>
<tr><td rowspan="3">Fail Safe</td><td>Fuel Cut</td><td>No</td><td rowspan="3">• Fuel amount sets to below 75% of maximum torque.
• Engine output decrease</td></tr>
<tr><td>Fuel limit</td><td>Yes</td></tr>
<tr><td>Check lamp</td><td>ON</td></tr>
</table>

SPECIFICATION

Rail pressure sensor	Specification
Output voltage	Below 2.6 V (Idle state after warm-up)
Rail pressure	40 Mpa (Idle state)



Sensor connector

Component resistance	Specification(20℃)
No. 1, 2	3 kΩ
No. 1, 3	13 kΩ
No. 2, 3	16.4 kΩ

SUDFLDTC9003L

WAVEFORM

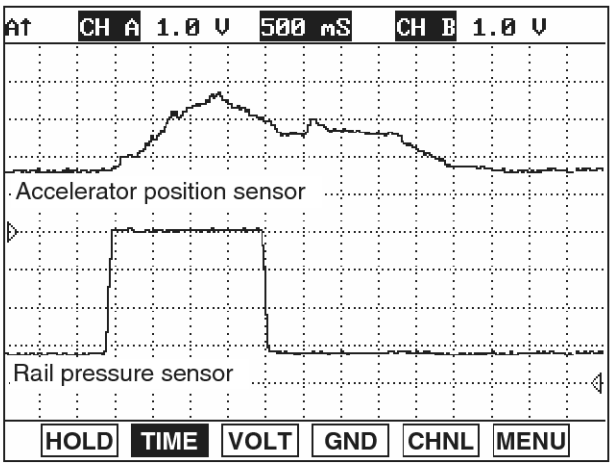


Fig. 1 Measure with oscilloscope waveform

Fig1) indicates waveform which the accelerator position sensor 1 and the rail pressure sensor are measured at the same time, can check the rail pressure sensor output at quick acceleration or deceleration.

SUDFLDTC9004L

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Rail pressure” parameter on the scan tool.

NOTICE

The value of “Rail pressure” varies with the operative condition according to DTC detecting condition. In case of fail safe, be sure to check that the value of “Rail pressure” sets to 70Mpa and the “Fuel amount” is restricted to below 75% of maximum torque.

Parameter	Reference Value
Real C/R pressure (At IG ON)	0.4 Mpa
Real C/R pressure (At idle)	31.6 Mpa
Real C/R pressure (At 1,500 rpm)	91.2 Mpa
Real C/R pressure (At 2,000 rpm)	122.5 Mpa

Start the engine and monitor the pressure change of the rail pressure sensor. The pressure of about 40Mpa is generated at hot idle (650rpm). At this time,

it is also important to check the duty of the rail pressure governor. Check that the duty of about 46.5% indicates from above service data.

This data increase with acceleration and load condition, not only the rail pressure increases up to max. 180Mpa but also the rail pressure governor duty increases up to 95%.

TROUBLESHOOTING AID

The trouble code related to poor rail pressure is necessary to diagnose high pressure fuel system and low pressure fuel system collectively

High pressure fuel system symptom: Poor high pressure of high pressure fuel pump, the poor air tightness or stuck of the ball valve seat of rail pressure governor, clogged overflow valve, the fuel leak of injector nozzle and return circuit

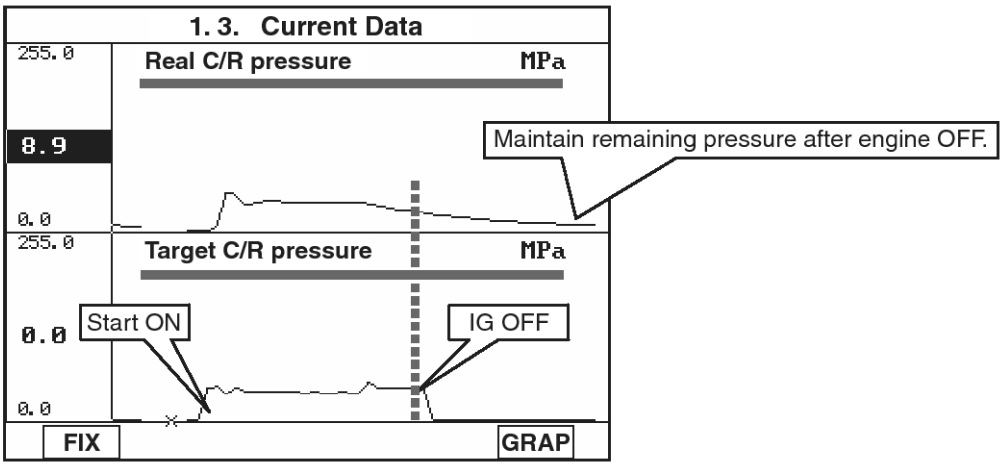
Low pressure fuel system symptom: Poor fuel supply of low pressure fuel pump, clogged fuel filter

NOTICE

Overflow valve plays a role to return fuel to the fuel tank by opening valve to protect fuel system when generating the fuel pressure in common rail with "221Mpa" or more excessively.

NOTICE

It is possible to check by turning the ignition key ON not to lose data due to impossible communication between ECM and scan tool because the main relay switches OFF at stopping the engine.



SUDFLDTC9095L

The above graph waveform indicates the pressure change of the rail pressure sensor at starting ON and OFF. It is possible to diagnose the collective fuel system by checking the condition to maintain the pressure in the common rail at stopping the engine and the time to reach about 40Mpa in the common rail.

1. It is important for the rail pressure to increase quickly at starting.
   - ▶ It is easy to diagnose the supply state of low

pressure fuel pump, the high pressure formation of high pressure fuel pump, the air tightness of rail pressure governor, the air tightness state of injector nozzle and return side.

2. It is important to maintain air tightness at below 101bar of spring tension of common rail pressure governor and to lower fuel pressure gradually at stopping the engine.

▶ It is easy to diagnose the air tightness state of rail pressure governor, nozzle and return side.

SIGNAL CIRCUIT INSPECTION

1. Signal Voltage Inspection
   1) Leave fuel pressure sensor connector (EFD13) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 2 of fuel pressure sensor harness connector and chassis ground.

      ■ Specification: Signal power approx. 1.0V (At IG ON)

      Note) The signal power may be measured differently according to rail pressure.
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Go to “Signal Short to Ground Inspection” procedure.
2. Signal Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect fuel pressure sensor connector (EFD13) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 2 of fuel pressure sensor harness connector and chassis ground.
   4) Measure resistance between the terminal 13, 32 of the engine ECM harness connector(EFD-ECM) and chassis ground.

      ■ Specification: Infinite
   5) Is the resistance measured within specification?

      YES

      ▶ Go to “Power Supply Inspection” procedure.

      NO

      ▶ Repair short to ground and then go to “Verification of Vehicle Repair” procedure.

POWER SUPPLY INSPECTION

1. Power Supply Voltage Inspection
   1) Disconnect fuel pressure sensor connector (EFD13).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 1 of fuel pressure sensor harness connector and chassis ground.

      ■ Specification: Engine ECM output power approx. 5 V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Ground Circuit Inspection” procedure.

      NO

      ▶ Go to “Power Supply Open Inspection” procedure.
2. Power Supply Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect fuel pressure sensor connector (EFD13) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 1 of fuel pressure sensor harness connector and the terminal 68 of ECM connector.

      ■ Specification: Continuity (Below 1.0Ω)
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Power Supply Short to Ground Inspection” procedure.

      NO

      ▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.
3. Power Supply Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect fuel pressure sensor connector (EFD13) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 1 of fuel pressure sensor harness connector and chassis ground.

      ■ Specification: Infinite
   4) Is the resistance measured within specification?

YES

▶ Go to “Ground Circuit Inspection” procedure.

NO

▶ Repair short to ground and then go to “Verification of Vehicle Repair” procedure.

GROUND CIRCUIT INSPECTION

1. Ground Voltage Drop Inspection
   1) Disconnect fuel pressure sensor connector (E05).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage drop between the terminal 3 of fuel pressure sensor harness connector and chassis ground.

      ■ Specification: Ground voltage drop within 200 mV
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Ground Open Inspection” procedure.

      NO

      ▶ Repair the excessive resistance (poor connection) and then go to “Verification of Vehicle Repair” procedure.
2. Ground Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect fuel pressure sensor connector (EFD13) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 3 of fuel pressure sensor harness connector and the terminal 25 of ECM(EFD-ECM).

      ■ Specification: Continuity (Below 1.0Ω)
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.

COMPONENT INSPECTION

1. Fuel Pressure Sensor Inspection
   1) Turn the ignition OFF.
   2) Leave fuel pressure sensor connector (EFD13) connected.
   3) Start the engine. Check and compare fuel pressure according to detecting condition.

      NOTICE

      The value of “rail pressure” varies with driving conditions according to DTC detecting condition. In case of fail safe, be sure to check that fuel pressure is controlled by “70 Mpa”.

Parameter	Reference Value
Real C/R pressure (At IG ON)	0.4 Mpa
Real C/R pressure (At idle)	31.5 Mpa
Real C/R pressure (At 1,500 rpm)	65.5 Mpa
Real C/R pressure (At 2,000 rpm)	65.5 Mpa

      ■ Specification :

Pressure	Output voltage
(MPa)	(V)
0	1.00
100	2.60
180	3.90
200	4.20
230	4.70

   4) Is the measured output value of fuel pressure sensor within specification?

      YES

      ▶ Go to “Verification of Vehicle Repair” procedure.

      NO

      ▶ Replace the fuel pressure sensor and then go to “Verification of Vehicle Repair” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

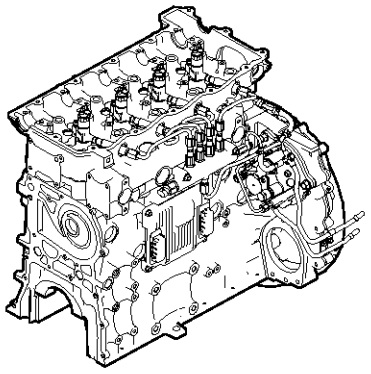
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P0193 C/Rail Pressure Sensor Signal Too High

COMPONENT LOCATION



SDFFL7104D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   Rail pressure sensor converts fuel pressure in rail into voltage signal and sends signal to ECM. ECM uses the signal to determine fuel amount. The sensor element which converts pressure into electric signal is connected to diaphragm and is activated like an analog resistance. The resistance changes with diaphragm change of rail pressure At this time, rail pressure is converted into electric signal. The bridge circuit of diaphragm is amplified into 1.0~4.7V(0~2,300bar) and is displayed into voltage.

2. DTC DESCRIPTION

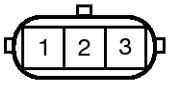
   If rail pressure sensor is detected above 4.9V for 224ms or more, ECM judges this as a fault and DTC is set. The possible causes may be faulty common rail pressure sensor, defective wiring & resistance, open in terminals 13, 25, 32 of ECM connector(EFD-ECM) and short to terminal 68. The vehicle can be driven but lack of engine power will occur since ECM controls fuel amount to below 75% of maximum torque in case of fail safe.

DTC DETECTING CONDITION

<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="6">• Defective wiring and sensor.
• Power short to terminal 68 or terminal 13, 25, 32 open of ECM connector (EFD-ECM).</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• Running</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• Above 4.9V</td></tr>
<tr><td>Diagnosis Time</td><td colspan="3">• 224ms or higher</td></tr>
<tr><td rowspan="3">Fail Safe</td><td>Fuel Cut</td><td>No</td><td rowspan="3">• Fuel amount sets to below 75% of maximum torque.
• Engine output decrease</td></tr>
<tr><td>Fuel limit</td><td>Yes</td></tr>
<tr><td>Check lamp</td><td>ON</td></tr>
</table>

SPECIFICATION

Rail pressure sensor	Specification
Output voltage	Below 2.6 V (Idle state after warm-up)
Rail pressure	40 Mpa (Idle state)



Sensor connector

Component resistance	Specification(20℃)
No. 1, 2	3 kΩ
No. 1, 3	13 kΩ
No. 2, 3	16.4 kΩ

SUDFLDTC9003L

WAVEFORM

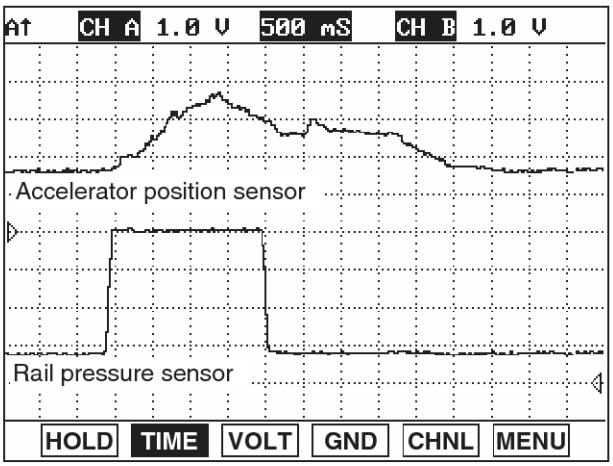


Fig. 1 Measure with oscilloscope waveform

Fig1) indicates waveform which the accelerator position sensor 1 and the rail pressure sensor are measured at the same time, can check the rail pressure sensor output at quick acceleration or deceleration.

SUDFLDTC9004L

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Rail pressure” parameter on the scan tool.

NOTICE

The value of “Rail pressure” varies with the operative condition according to DTC detecting condition. In case of fail safe, be sure to check that the value of “Rail pressure” sets to 70Mpa and the “Fuel amount” is restricted to below 75% of maximum torque.

Parameter	Reference Value
Real C/R pressure (At IG ON)	0.4 Mpa
Real C/R pressure (At idle)	31.6 Mpa
Real C/R pressure (At 1,500 rpm)	91.2 Mpa
Real C/R pressure (At 2,000 rpm)	122.5 Mpa

Start the engine and monitor the pressure change of the rail pressure sensor. The pressure of about 40Mpa is generated at hot idle (650rpm). At this time,

it is also important to check the duty of the rail pressure governor. Check that the duty of about 46.5% indicates from above service data.

This data increase with acceleration and load condition, not only the rail pressure increases up to max. 180Mpa but also the rail pressure governor duty increases up to 95%.

TROUBLESHOOTING AID

The trouble code related to poor rail pressure is necessary to diagnose high pressure fuel system and low pressure fuel system collectively

High pressure fuel system symptom: Poor high pressure of high pressure fuel pump, the poor air tightness or stuck of the ball valve seat of rail pressure governor, clogged overflow valve, the fuel leak of injector nozzle and return circuit

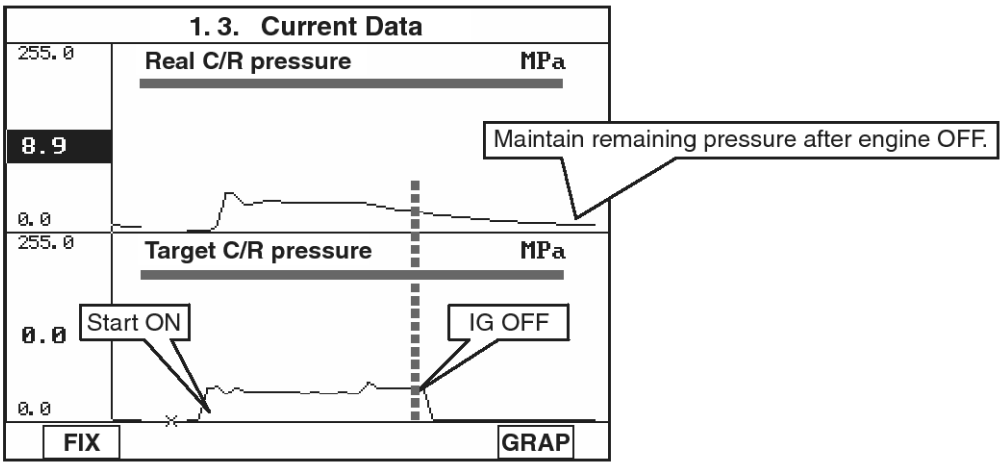
Low pressure fuel system symptom: Poor fuel supply of low pressure fuel pump, clogged fuel filter

NOTICE

Overflow valve plays a role to return fuel to the fuel tank by opening valve to protect fuel system when generating the fuel pressure in common rail with "221Mpa" or more excessively.

NOTICE

It is possible to check by turning the ignition key ON not to lose data due to impossible communication between ECM and scan tool because the main relay switches OFF at stopping the engine.



SUDFLDTC9095L

The above graph waveform indicates the pressure change of the rail pressure sensor at starting ON and OFF. It is possible to diagnose the collective fuel system by checking the condition to maintain the pressure in the common rail at stopping the engine and the time to reach about 40Mpa in the common rail.

1. It is important for the rail pressure to increase quickly at starting.
   - ▶ It is easy to diagnose the supply state of low

pressure fuel pump, the high pressure formation of high pressure fuel pump, the air tightness of rail pressure governor, the air tightness state of injector nozzle and return side.

2. It is important to maintain air tightness at below 101bar of spring tension of common rail pressure governor and to lower fuel pressure gradually at stopping the engine.

▶ It is easy to diagnose the air tightness state of rail pressure governor, nozzle and return side.

SIGNAL CIRCUIT INSPECTION

1. Signal Voltage Inspection
   1) Leave fuel pressure sensor connector (EFD13) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 2 of fuel pressure sensor harness connector and chassis ground.

      ■ Specification: Fuel pressure sensor signal power approx. 1.0V

      Note) The signal power may be measured differently according to rail pressure.
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Go to “Signal Open Inspection” procedure.
2. Signal Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect fuel pressure sensor connector (EFD13) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 2 of fuel pressure sensor harness connector and terminals 13, 32 of the engine ECM

      ■ Specification: Continuity
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Signal Short to Power Inspection” procedure.

      NO

      ▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.
3. Signal Short to Power Inspection
   1) Disconnect fuel pressure sensor connector (EFD13) and ECM connector(EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 2 of fuel pressure sensor harness connector and chassis ground.

      ■ Specification: Below 0~0.1V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Power Supply Inspection” procedure.

      NO

      ▶ Repair short to power and then go to “Verification of Vehicle Repair” procedure.

POWER SUPPLY INSPECTION

1. Power Supply Voltage Inspection
   1) Disconnect fuel pressure sensor connector (EFD13).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 1 of fuel pressure sensor harness connector and chassis ground.

      ■ Specification: Engine ECM output power approx. 5 V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Ground Circuit Inspection” procedure.

      NO

      ▶ Go to “Power Supply Short to Power Inspection” procedure.
2. Power Supply Short to Power Inspection
   1) Disconnect fuel pressure sensor connector (EFD13) and ECM connector(EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 1 of fuel pressure sensor harness connector and chassis ground.

      ■ Specification: Below 0~0.1V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Ground Circuit Inspection” procedure.

NO

▶ Repair short to power and then go to "Verification of Vehicle Repair" procedure.

GROUND CIRCUIT INSPECTION

1. Ground Voltage Drop Inspection
   1) Disconnect fuel pressure sensor connector (EFD13).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage drop between the terminal 3 of fuel pressure sensor harness connector and chassis ground.

      ■ Specification: Ground voltage drop within 200 mV
   4) Is the voltage measured within specification?

      YES

      ▶ Go to "Ground Open Inspection" procedure.

      NO

      ▶ Repair the excessive resistance (poor connection) and then go to "Verification of Vehicle Repair" procedure.
2. Ground Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect fuel pressure sensor connector (EFD13) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 3 of fuel pressure sensor harness connector and the terminal 25 of ECM(EFD-ECM).

      ■ Specification: Continuity (Below 1.0Ω)
   4) Is the resistance measured within specification?

      YES

      ▶ Go to "Component Inspection" procedure.

      NO

      ▶ Repair open circuit and then go to "Verification of Vehicle Repair" procedure.

COMPONENT INSPECTION

1. Fuel Pressure Sensor Inspection
   1) Turn the ignition OFF.
   2) Leave fuel pressure sensor connector (EFD13) connected.
   3) Start the engine. Check and compare fuel pressure according to detecting condition.

      NOTICE

      The value of "rail pressure" varies with driving conditions according to DTC detecting condition. In case of fail safe, be sure to check that fuel pressure is controlled by "70 Mpa".

Parameter	Reference Value
Real C/R pressure (At IG ON)	0.4 Mpa
Real C/R pressure (At idle)	31.5 Mpa
Real C/R pressure (At 1,500 rpm)	65.5 Mpa
Real C/R pressure (At 2,000 rpm)	65.5 Mpa

■ Specification :

Pressure	Output voltage
(MPa)	(V)
0	1.00
100	2.60
180	3.90
200	4.20
230	4.70

   4) Is the measured output value of fuel pressure sensor within specification?

      YES

      ▶ Go to "Verification of Vehicle Repair" procedure.

      NO

      ▶ Replace the fuel pressure sensor and then go to "Verification of Vehicle Repair" procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

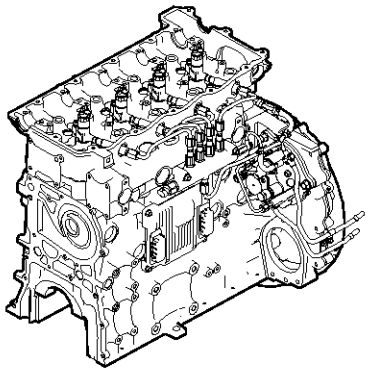
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P0194 C/Rail Pressure Sensor Signal Keeping the Middle Range

COMPONENT LOCATION



SDFFL7104D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   Rail pressure sensor converts fuel pressure in rail into voltage signal and sends signal to ECM. ECM uses the signal to determine fuel amount. The sensor element which converts pressure into electric signal is connected to diaphragm and is activated like an analog resistance. The resistance changes with diaphragm change of rail pressure At this time, rail pressure is converted into electric signal. The bridge circuit of diaphragm is amplified into 1.0~4.7V(0~2,300bar) and is displayed into voltage.

2. DTC DESCRIPTION

   Even though target rail pressure is more 10 Mpa than actual rail pressure at cranking, when voltage change of rail pressure sensor is below 0.025V or the difference between target rail pressure and actual rail pressure is more than 10 Mpa after starting, ECM judges this as a fault and DTC is set. Check lamp and MIL come on together when the condition continued for 2 driving cycle times. Check lamp will go off after 3 driving cycle times when the system returns to normal. It is related to faulty sensor output value. Check sensor output value if output value of this sensor is still the same when value of other sensors(barometric pressure sensor, intake air temperature sensor etc.) changes.

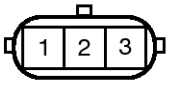
   Lack of engine power will occur since fuel amount is limited to below 40㎣/st in case of fail safe.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Sensor output value
Enable Conditions	• At IG key ON			
Threshold Value	• Target pressure-Actual pressure>10Mpa			
Diagnosis Time	• 1,216ms or higher			
Fail Safe	Fuel Cut	No	• Sensor output is controlled by EC-M target value. • Engine output decrease • Cruise release	
	Fuel limit	Yes		
	Check lamp	ON		

SPECIFICATION

Rail pressure sensor	Specification
Output voltage	Below 2.6 V (Idle state after warm-up)
Rail pressure	40 Mpa (Idle state)



Sensor connector

Component resistance	Specification(20℃)
No. 1, 2	3 kΩ
No. 1, 3	13 kΩ
No. 2, 3	16.4 kΩ

SUDFLDTC9003L

WAVEFORM

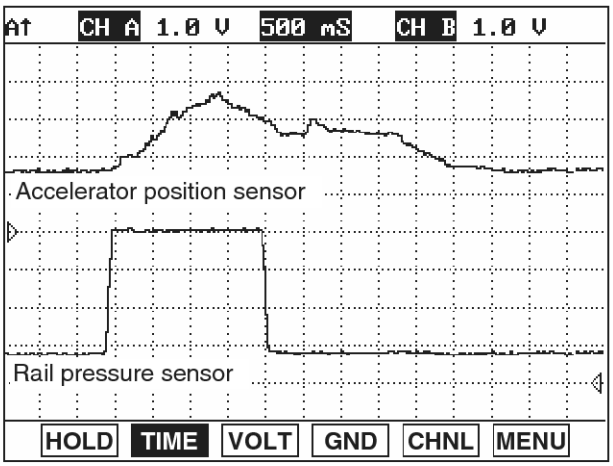


Fig. 1 Measure with oscilloscope waveform

Fig1) indicates waveform which the accelerator position sensor 1 and the rail pressure sensor are measured at the same time, can check the rail pressure sensor output at quick acceleration or deceleration.

SUDFLDTC9004L

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Rail pressure” parameter on the scan tool.

Parameter	Reference Value
Real C/R pressure (At IG ON)	0.4 Mpa
Real C/R pressure (At idle)	31.6 Mpa
Real C/R pressure (At 1,500 rpm)	91.2 Mpa
Real C/R pressure (At 2,000 rpm)	122.5 Mpa

Start the engine and monitor the pressure change of the rail pressure sensor. The pressure of about 40Mpa is generated at hot idle (650rpm). At this time, it is also important to check the duty of the rail pressure governor. Check that the duty of about 46.5% indicates from above service data.

This data increase with acceleration and load condition, not only the rail pressure increases up to max. 180Mpa but also the rail pressure governor duty increases up to 95%.

TROUBLESHOOTING AID

The trouble code related to poor rail pressure is necessary to diagnose high pressure fuel system and low pressure fuel system collectively

High pressure fuel system symptom: Poor high pressure of high pressure fuel pump, the poor air tightness or stuck of the ball valve seat of rail pressure governor, clogged overflow valve, the fuel leak of injector nozzle and return circuit

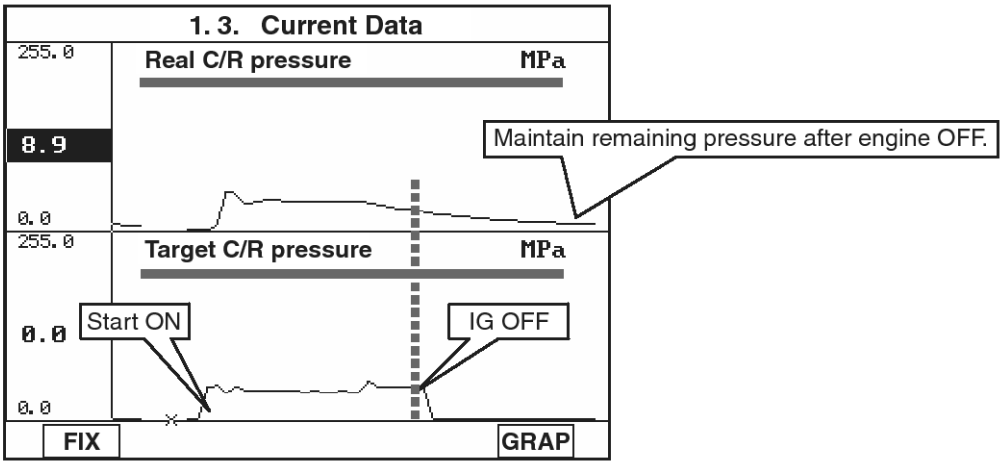
Low pressure fuel system symptom: Poor fuel supply of low pressure fuel pump, clogged fuel filter

NOTICE

Overflow valve plays a role to return fuel to the fuel tank by opening valve to protect fuel system when generating the fuel pressure in common rail with "221Mpa" or more excessively.

NOTICE

It is possible to check by turning the ignition key ON not to lose data due to impossible communication between ECM and scan tool because the main relay switches OFF at stopping the engine.



SUDFLDTC9095L

The above graph waveform indicates the pressure change of the rail pressure sensor at starting ON and OFF. It is possible to diagnose the collective fuel system by checking the condition to maintain the pressure in the common rail at stopping the engine and the time to reach about 40Mpa in the common rail.

1. It is important for the rail pressure to increase quickly at starting.

   ▶ It is easy to diagnose the supply state of low pressure fuel pump, the high pressure formation of high pressure fuel pump, the air tightness of rail pressure governor, the air tightness state of injector nozzle and return side.

2. It is important to maintain air tightness at below 101bar of spring tension of common rail pressure governor and to lower fuel pressure gradually at stopping the engine.

   ▶ It is easy to diagnose the air tightness state of rail pressure governor, nozzle and return side.

SIGNAL CIRCUIT INSPECTION

1. Signal Voltage Inspection
   1) Leave fuel pressure sensor connector (EFD13) connected.

2) Turn the ignition ON. Leave the engine OFF.
3) Measure voltage between the terminal 2 of fuel pressure sensor harness connector and chassis ground.

■ Specification: Fuel pressure sensor signal power approx. 1.0V

Note) The signal power may be measured differently according to rail pressure.

4) Is the voltage measured within specification?

YES

▶ Go to "Component Inspection" procedure.

NO

▶ Go to "Signal Open Inspection" procedure.

2. Signal Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect fuel pressure sensor connector (EFD13) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 2 of fuel pressure sensor harness connector and terminals 13, 32 of the engine ECM

   ■ Specification: Continuity

   4) Is the resistance measured within specification?

   YES

   ▶ Go to "Signal Short to Ground Inspection" procedure.

   NO

   ▶ Repair open circuit and then go to "Verification of Vehicle Repair" procedure.
3. Signal Short to Ground Inspection
   1) Disconnect fuel pressure sensor connector (EFD13) and ECM connector(EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure resistance between the terminal 2 of fuel pressure sensor harness connector and chassis ground.

   ■ Specification: Infinite

   4) Is the resistance measured within specification?

   YES

   ▶ Go to "Signal Short to Power Supply Inspection" procedure.

   NO

   ▶ Repair short to ground and then go to "Verification of Vehicle Repair" procedure.
4. Signal Short to Power Inspection
   1) Disconnect fuel pressure sensor connector (EFD13) and ECM connector(EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 2 of fuel pressure sensor harness connector and chassis ground.

   ■ Specification: Below 0~0.1V

   4) Is the voltage measured within specification?

   YES

   ▶ Go to "Power Supply Inspection" procedure.

   NO

   ▶ Repair short to power and then go to "Verification of Vehicle Repair" procedure.

POWER SUPPLY INSPECTION

1. Power Supply Voltage Inspection
   1) Disconnect fuel pressure sensor connector (EFD13).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 1 of fuel pressure sensor harness connector and chassis ground.

   ■ Specification: Engine ECM output power approx. 5 V

   4) Is the voltage measured within specification?

   YES

   ▶ Go to "Ground Circuit Inspection" procedure.

   NO

   ▶ Go to "Power Supply Open Inspection" procedure.
2. Power Supply Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect fuel pressure sensor connector (EFD13) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 1 of fuel pressure sensor harness connector and terminal 68 of the engine ECM connector(EFD-ECM).

■ Specification: Continuity

4) Is the resistance measured within specification?

YES

▶ Go to “Power Supply Short to Ground Inspection” procedure.

NO

▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.

3. Power Supply Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect fuel pressure sensor connector (EFD13) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 1 of fuel pressure sensor harness connector and chassis ground.

      ■ Specification: Infinite

   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Power Supply Short to Power Inspection” procedure.

      NO

      ▶ Repair short to ground and then go to “Verification of Vehicle Repair” procedure.

4. Power Supply Short to Power Inspection
   1) Disconnect fuel pressure sensor connector (EFD13) and ECM connector(EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 1 of fuel pressure sensor harness connector and chassis ground.

      ■ Specification: Below 0~0.1V

   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Ground Circuit Inspection” procedure.

      NO

      ▶ Repair short to power and then go to “Verification of Vehicle Repair” procedure.

GROUND CIRCUIT INSPECTION

1. Ground Voltage Drop Inspection
   1) Disconnect fuel pressure sensor connector (EFD13).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage drop between the terminal 3 of fuel pressure sensor harness connector and chassis ground.

      ■ Specification: Ground voltage drop within 200 mV

   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Ground Open Inspection” procedure.

      NO

      ▶ Repair the excessive resistance (poor connection) and then go to “Verification of Vehicle Repair” procedure.

2. Ground Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect fuel pressure sensor connector (E05) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 3 of fuel pressure sensor harness connector and the terminal 25 of ECM(EFD-ECM).

      ■ Specification: Continuity (Below 1.0Ω)

   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.

COMPONENT INSPECTION

1. Fuel Pressure Sensor Inspection
   1) Turn the ignition OFF.
   2) Leave fuel pressure sensor connector (EFD13) connected.
   3) Start the engine. Check and compare fuel pressure according to detecting condition.

      NOTICE
      The value of "rail pressure" varies with driving conditions according to DTC detecting condition. In case of fail safe, be sure to check that fuel pressure is controlled by "70 Mpa".

Parameter	Reference Value
Real C/R pressure (At IG ON)	0.4 Mpa
Real C/R pressure (At idle)	31.5 Mpa
Real C/R pressure (At 1,500 rpm)	65.5 Mpa
Real C/R pressure (At 2,000 rpm)	65.5 Mpa

■ Specification :

Pressure	Output voltage
(MPa)	(V)
0	1.00
100	2.60
180	3.90
200	4.20
230	4.70

   4) Is the measured output value of fuel pressure sensor within specification?

      YES

      ▶ Go to "Verification of Vehicle Repair" procedure.

      NO

      ▶ Replace the fuel pressure sensor and then go to "Verification of Vehicle Repair" procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select "Diagnostic Trouble Codes (DTCs)" mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

   YES

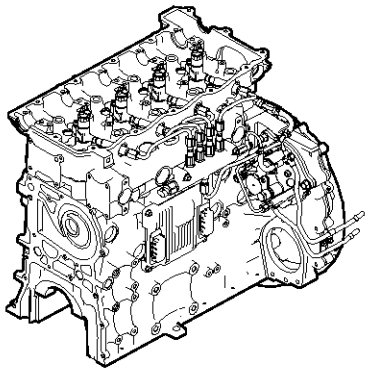
   ▶ Go to the applicable DTC procedure.

   NO

   ▶ System OK

P0195 C/Rail Pressure Sensor Signal offsef

COMPONENT LOCATION



SDFFL7104D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   Rail pressure sensor converts fuel pressure in rail into voltage signal and sends signal to ECM. ECM uses the signal to determine fuel amount. The sensor element which converts pressure into electric signal is connected to diaphragm and is activated like an analog resistance. The resistance changes with diaphragm change of rail pressure At this time, rail pressure is converted into electric signal. The bridge circuit of diaphragm is amplified into 1.0~4.7V(0~2,300bar) and is displayed into voltage.

2. DTC DESCRIPTION

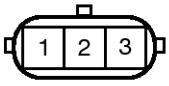
   If the difference between the coolant temperature memorized in the ECM before starting and the actual coolant temperature after starting is more than 15℃ and sensor output voltage is more than 1.25V or less than 0.75V for 2,048ms or more, ECM judges this as a fault and DTC is set. Check lamp and MIL come on together when the condition continued for 2 driving cycle times. MIL will go off after 3 driving cycle times when the system returns to normal. The fuel rail pressure is limited to 100Mpa or less.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Defective wiring harness • Sensor output value
Enable Conditions	• Engine running			
Threshold Value	• 0.75V>sensor output voltage<1.25			
Diagnosis Time	• 288ms or higher			
Fail Safe	Fuel Cut	No	Sensor output is controlled by ECM target value.	
	Fuel limit	Yes		
	Check lamp	ON		

SPECIFICATION

Rail pressure sensor	Specification
Output voltage	Below 2.6 V (Idle state after warm-up)
Rail pressure	40 Mpa (Idle state)



Sensor connector

Component resistance	Specification(20℃)
No. 1, 2	3 kΩ
No. 1, 3	13 kΩ
No. 2, 3	16.4 kΩ

SUDFLDTC9003L

WAVEFORM

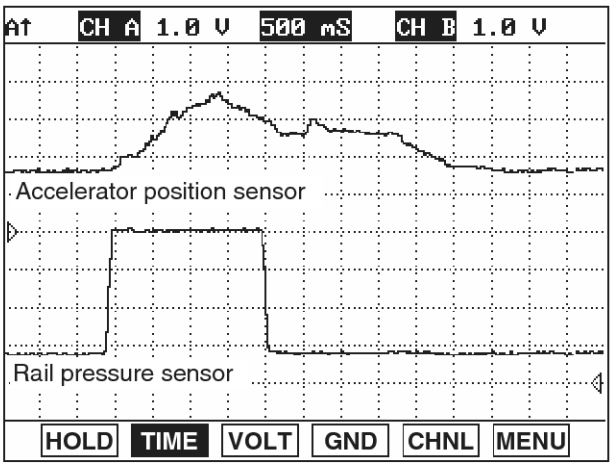


Fig. 1 Measure with oscilloscope waveform

Fig1) indicates waveform which the accelerator position sensor 1 and the rail pressure sensor are measured at the same time, can check the rail pressure sensor output at quick acceleration or deceleration.

SUDFLDTC9004L

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Rail pressure” parameter on the scan tool.

Parameter	Reference Value
Real C/R pressure (At IG ON)	0.4 Mpa
Real C/R pressure (At idle)	31.6 Mpa
Real C/R pressure (At 1,500 rpm)	91.2 Mpa
Real C/R pressure (At 2,000 rpm)	122.5 Mpa

Start the engine and monitor the pressure change of the rail pressure sensor. The pressure of about 40Mpa is generated at hot idle (650rpm). At this time, it is also important to check the duty of the rail pressure governor. Check that the duty of about 46.5% indicates from above service data.

This data increase with acceleration and load condition, not only the rail pressure increases up to max. 180Mpa but also the rail pressure governor duty increases up to 95%.

TROUBLESHOOTING AID

The trouble code related to poor rail pressure is necessary to diagnose high pressure fuel system and low pressure fuel system collectively

High pressure fuel system symptom: Poor high pressure of high pressure fuel pump, the poor air tightness or stuck of the ball valve seat of rail pressure governor, clogged overflow valve, the fuel leak of injector nozzle and return circuit

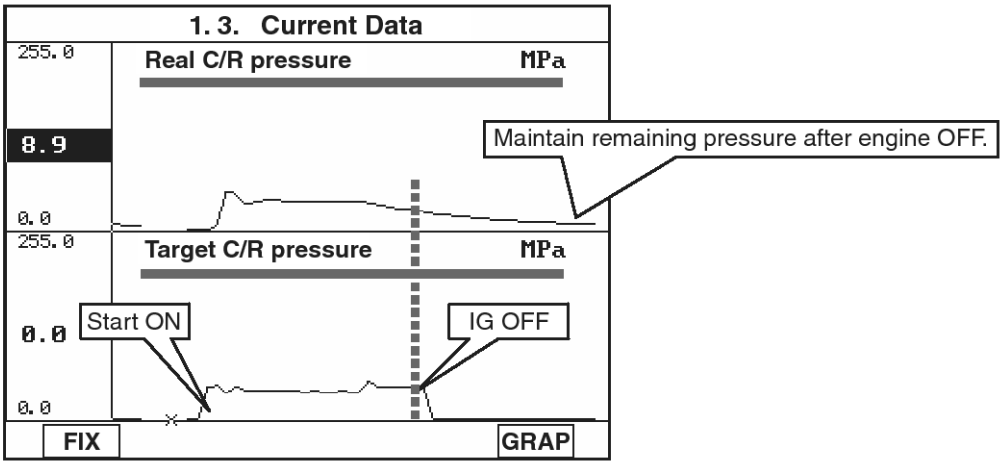
Low pressure fuel system symptom: Poor fuel supply of low pressure fuel pump, clogged fuel filter

NOTICE

Overflow valve plays a role to return fuel to the fuel tank by opening valve to protect fuel system when generating the fuel pressure in common rail with "221Mpa" or more excessively.

NOTICE

It is possible to check by turning the ignition key ON not to lose data due to impossible communication between ECM and scan tool because the main relay switches OFF at stopping the engine.



SUDFLDTC9095L

The above graph waveform indicates the pressure change of the rail pressure sensor at starting ON and OFF. It is possible to diagnose the collective fuel system by checking the condition to maintain the pressure in the common rail at stopping the engine and the time to reach about 40Mpa in the common rail.

1. It is important for the rail pressure to increase quickly at starting.

   ▶ It is easy to diagnose the supply state of low pressure fuel pump, the high pressure formation of high pressure fuel pump, the air tightness of rail pressure governor, the air tightness state of injector nozzle and return side.

2. It is important to maintain air tightness at below 101bar of spring tension of common rail pressure governor and to lower fuel pressure gradually at stopping the engine.

   ▶ It is easy to diagnose the air tightness state of rail pressure governor, nozzle and return side.

SIGNAL CIRCUIT INSPECTION

1. Signal Voltage Inspection
   1) Leave fuel pressure sensor connector (EFD13) connected.

2) Turn the ignition ON. Leave the engine OFF.
3) Measure voltage between the terminal 2 of fuel pressure sensor harness connector and chassis ground.

■ Specification: Fuel pressure sensor signal power approx. 1.0V

Note) The signal power may be measured differently according to rail pressure.

4) Is the voltage measured within specification?

YES

▶ Go to "Component Inspection" procedure.

NO

▶ Go to "Signal Open Inspection" procedure.

2. Signal Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect fuel pressure sensor connector (EFD13) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 2 of fuel pressure sensor harness connector and terminals 13, 32 of the engine ECM

   ■ Specification: Continuity

   4) Is the resistance measured within specification?

   YES

   ▶ Go to "Signal Short to Ground Inspection" procedure.

   NO

   ▶ Repair open circuit and then go to "Verification of Vehicle Repair" procedure.
3. Signal Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect fuel pressure sensor connector (EFD13) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 2 of fuel pressure sensor harness connector and chassis ground.

   ■ Specification: Infinite

   4) Is the resistance measured within specification?

   YES

   ▶ Go to "Signal Short to Power Inspection" procedure.

   NO

   ▶ Repair short to ground and then go to "Verification of Vehicle Repair" procedure.
4. Signal Short to Power Inspection
   1) Disconnect fuel pressure sensor connector (EFD13) and ECM connector(EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 2 of fuel pressure sensor harness connector and chassis ground.

   ■ Specification: Below 0~0.1V

   4) Is the voltage measured within specification?

   YES

   ▶ Go to "Power Supply Inspection" procedure.

   NO

   ▶ Repair short to power and then go to "Verification of Vehicle Repair" procedure.

POWER SUPPLY INSPECTION

1. Power Supply Voltage Inspection
   1) Disconnect fuel pressure sensor connector (EFD13).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 1 of fuel pressure sensor harness connector and chassis ground.

   ■ Specification: Engine ECM output power approx. 5 V

   4) Is the voltage measured within specification?

   YES

   ▶ Go to "Ground Circuit Inspection" procedure.

   NO

   ▶ Go to "Power Supply Open Inspection" procedure.
2. Power Supply Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect fuel pressure sensor connector (EFD13) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 1 of fuel pressure sensor harness connector and terminal 68 of the engine ECM connector(EFD-ECM).

■ Specification: Continuity

4) Is the resistance measured within specification?

YES

▶ Go to “Power Supply Short to Ground Inspection” procedure.

NO

▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.

3. Power Supply Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect fuel pressure sensor connector (EFD13) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 1 of fuel pressure sensor harness connector and chassis ground.

      ■ Specification: Infinite

   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Power Supply Short to Power Inspection” procedure.

      NO

      ▶ Repair short to ground and then go to “Verification of Vehicle Repair” procedure.
4. Power Supply Short to Power Inspection
   1) Disconnect fuel pressure sensor connector (EFD13) and ECM connector(EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 1 of fuel pressure sensor harness connector and chassis ground.

      ■ Specification: Below 0~0.1V

   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Ground Circuit Inspection” procedure.

      NO

      ▶ Repair short to power and then go to “Verification of Vehicle Repair” procedure.

GROUND CIRCUIT INSPECTION

1. Ground Voltage Drop Inspection
   1) Disconnect fuel pressure sensor connector (EFD13).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage drop between the terminal 3 of fuel pressure sensor harness connector and chassis ground.

      ■ Specification: Ground voltage drop within 200 mV

   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Ground Open Inspection” procedure.

      NO

      ▶ Repair the excessive resistance (poor connection) and then go to “Verification of Vehicle Repair” procedure.
2. Ground Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect fuel pressure sensor connector (EFD13) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 3 of fuel pressure sensor harness connector and the terminal 25 of ECM(EFD-ECM).

      ■ Specification: Continuity (Below 1.0Ω)

   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.

COMPONENT INSPECTION

1. Fuel Pressure Sensor Inspection
   1) Turn the ignition OFF.
   2) Leave fuel pressure sensor connector (EFD13) connected.
   3) Start the engine. Check and compare fuel pressure according to detecting condition.

      NOTICE

      The value of "rail pressure" varies with driving conditions according to DTC detecting condition. In case of fail safe, be sure to check that fuel pressure is controlled by "70 Mpa".

Parameter	Reference Value
Real C/R pressure (At IG ON)	0.4 Mpa
Real C/R pressure (At idle)	31.5 Mpa
Real C/R pressure (At 1,500 rpm)	65.5 Mpa
Real C/R pressure (At 2,000 rpm)	65.5 Mpa

■ Specification :

Pressure	Output voltage
(MPa)	(V)
0	1.00
100	2.60
180	3.90
200	4.20
230	4.70

   4) Is the measured output value of fuel pressure sensor within specification?

      YES

      ▶ Go to "Verification of Vehicle Repair" procedure.

      NO

      ▶ Replace the fuel pressure sensor and then go to "Verification of Vehicle Repair" procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select "Diagnostic Trouble Codes (DTCs)" mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

   YES

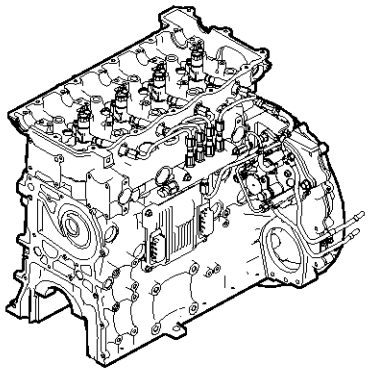
   ▶ Go to the applicable DTC procedure.

   NO

   ▶ System OK

P0196 C/Rail Pressure Sensor Signal Moment offset

COMPONENT LOCATION



SDFFL7104D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   Rail pressure sensor converts fuel pressure in rail into voltage signal and sends signal to ECM. ECM uses the signal to determine fuel amount. The sensor element which converts pressure into electric signal is connected to diaphragm and is activated like an analog resistance. The resistance changes with diaphragm change of rail pressure At this time, rail pressure is converted into electric signal. The bridge circuit of diaphragm is amplified into 1.0~4.7V(0~2,300bar) and is displayed into voltage.

2. DTC DESCRIPTION

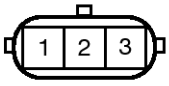
   If the coolant temperature and the fuel temperature between before and after starting are more than 7℃ and the rail pressure difference between the actual rail pressure and the previous rail pressure is less than pre-set value in the ECM, ECM judges this as a fault and DTC is set. Check lamp and MIL come on together when the condition continued for 2 driving cycle times. MIL will go off after 3 driving cycle times when the system returns to normal. The fuel rail pressure is limited to 100Mpa or less.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Defective wiring harness • Sensor output value
Enable Conditions	• Engine running			
Threshold Value	• Rail pressure difference is lower than pre-set value in the EC-M.			
Diagnosis Time	• 2,048ms or higher			
Fail Safe	Fuel Cut	No	Sensor output is controlled by ECM target value.	
	Fuel limit	Yes		
	Check lamp	ON		

SPECIFICATION

Rail pressure sensor	Specification
Output voltage	Below 2.6 V (Idle state after warm-up)
Rail pressure	40 Mpa (Idle state)



Sensor connector

Component resistance	Specification(20℃)
No. 1, 2	3 kΩ
No. 1, 3	13 kΩ
No. 2, 3	16.4 kΩ

SUDFLDTC9003L

WAVEFORM

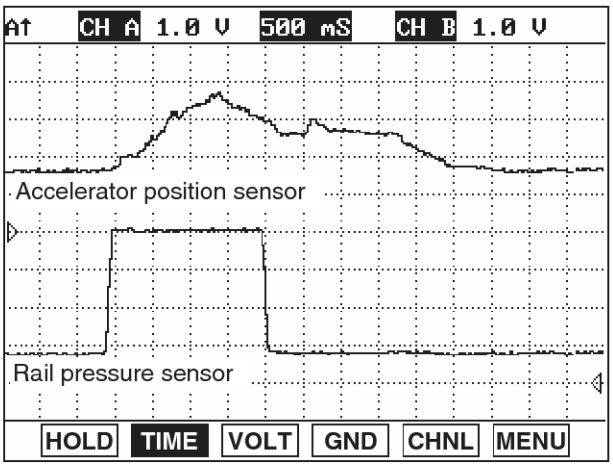


Fig. 1 Measure with oscilloscope waveform

Fig1) indicates waveform which the accelerator position sensor 1 and the rail pressure sensor are measured at the same time, can check the rail pressure sensor output at quick acceleration or deceleration.

SUDFLDTC9004L

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Rail pressure” parameter on the scan tool.

Parameter	Reference Value
Real C/R pressure (At IG ON)	0.4 Mpa
Real C/R pressure (At idle)	31.6 Mpa
Real C/R pressure (At 1,500 rpm)	91.2 Mpa
Real C/R pressure (At 2,000 rpm)	122.5 Mpa

Check “Rail pressure” at idle after warming-up from Fig.1)~2).

Start the engine and monitor the pressure change of the rail pressure sensor. The pressure of about 40Mpa is generated at hot idle (650rpm). At this time, it is also important to check the duty of the rail pressure governor. Check that the duty of about 46.5% indicates from above service data.

This data increase with acceleration and load

condition, not only the rail pressure increases up to max. 180Mpa but also the rail pressure governor duty increases up to 95%.

TROUBLESHOOTING AID

The trouble code related to poor rail pressure is necessary to diagnose high pressure fuel system and low pressure fuel system collectively

High pressure fuel system symptom: Poor high pressure of high pressure fuel pump, the poor air tightness or stuck of the ball valve seat of rail pressure governor, clogged overflow valve, the fuel leak of injector nozzle and return circuit

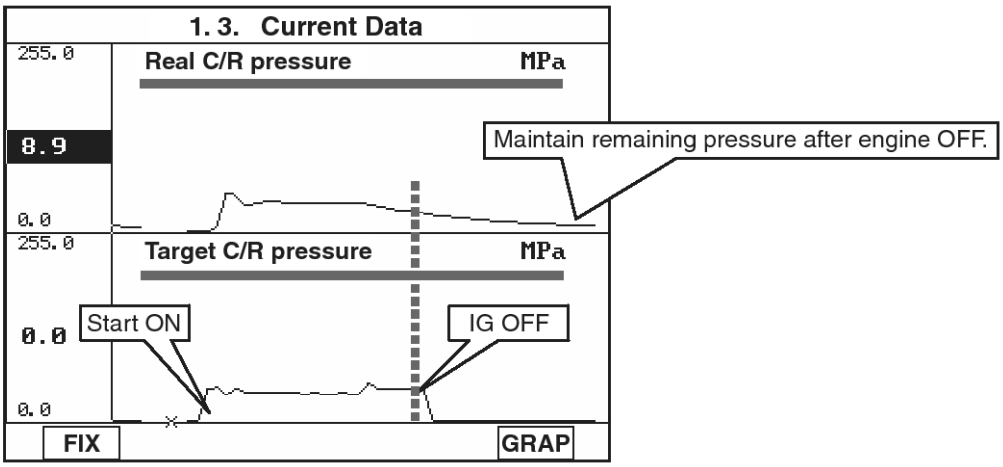
Low pressure fuel system symptom: Poor fuel supply of low pressure fuel pump, clogged fuel filter

NOTICE

Overflow valve plays a role to return fuel to the fuel tank by opening valve to protect fuel system when generating the fuel pressure in common rail with "221Mpa" or more excessively.

NOTICE

It is possible to check by turning the ignition key ON not to lose data due to impossible communication between ECM and scan tool because the main relay switches OFF at stopping the engine.



SUDFLDTC9095L

The above graph waveform indicates the pressure change of the rail pressure sensor at starting ON and OFF. It is possible to diagnose the collective fuel system by checking the condition to maintain the pressure in the common rail at stopping the engine and the time to reach about 40Mpa in the common rail.

1. It is important for the rail pressure to increase quickly at starting.

▶ It is easy to diagnose the supply state of low pressure fuel pump, the high pressure formation of high pressure fuel pump, the air tightness of rail pressure governor, the air tightness state of injector nozzle and return side.

2. It is important to maintain air tightness at below 101bar of spring tension of common rail pressure governor and to lower fuel pressure gradually at stopping the engine.

▶ It is easy to diagnose the air tightness state of rail pressure governor, nozzle and return side.

SIGNAL CIRCUIT INSPECTION

1. Signal Voltage Inspection
   1) Leave fuel pressure sensor connector (EFD13) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 2 of fuel pressure sensor harness connector and chassis ground.

      ■ Specification: Fuel pressure sensor signal power approx. 1.0V

      Note) The signal power may be measured differently according to rail pressure.
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Go to “Signal Open Inspection” procedure.
2. Signal Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect fuel pressure sensor connector (EFD13) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 2 of fuel pressure sensor harness connector and terminals 13, 32 of the engine ECM

      ■ Specification: Continuity
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Signal Short to Ground Inspection” procedure.

      NO

      ▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.
3. Signal Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect fuel pressure sensor connector (EFD13) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 2 of fuel pressure sensor harness connector and chassis ground.

      ■ Specification: Infinite
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Signal Short to Power Inspection” procedure.

      NO

      ▶ Repair short to ground and then go to “Verification of Vehicle Repair” procedure.
4. Signal Short to Power Inspection
   1) Disconnect fuel pressure sensor connector (EFD13) and ECM connector(EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 2 of fuel pressure sensor harness connector and chassis ground.

      ■ Specification: Below 0~0.1V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Power Supply Inspection” procedure.

      NO

      ▶ Repair short to power and then go to “Verification of Vehicle Repair” procedure.

POWER SUPPLY INSPECTION

1. Power Supply Voltage Inspection
   1) Disconnect fuel pressure sensor connector (EFD13).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 1 of fuel pressure sensor harness connector and chassis ground.

      ■ Specification: Engine ECM output power approx. 5 V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Ground Circuit Inspection” procedure.

      NO

      ▶ Go to “Power Supply Open Inspection” procedure.
2. Power Supply Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect fuel pressure sensor connector

(EFD13) and ECM connector(EFD-ECM).

3) Measure resistance between the terminal 1 of fuel pressure sensor harness connector and terminal 68 of the engine ECM connector(EFD-ECM).

■ Specification: Continuity

4) Is the resistance measured within specification?

YES

▶ Go to "Power Supply Short to Ground Inspection" procedure.

NO

▶ Repair open circuit and then go to "Verification of Vehicle Repair" procedure.

3. Power Supply Short to Ground Inspection

1) Turn the ignition OFF.

2) Disconnect fuel pressure sensor connector (EFD13) and ECM connector(EFD-ECM).

3) Measure resistance between the terminal 1 of fuel pressure sensor harness connector and chassis ground.

■ Specification: Infinite

4) Is the resistance measured within specification?

YES

▶ Go to "Power Supply Short to Power Inspection" procedure.

NO

▶ Repair short to ground and then go to "Verification of Vehicle Repair" procedure.

4. Power Supply Short to Power Inspection

1) Disconnect fuel pressure sensor connector (EFD13) and ECM connector(EFD-ECM).

2) Turn the ignition ON. Leave the engine OFF.

3) Measure voltage between the terminal 1 of fuel pressure sensor harness connector and chassis ground.

■ Specification: Below 0~0.1V

4) Is the voltage measured within specification?

YES

▶ Go to "Ground Circuit Inspection" procedure.

NO

▶ Repair short to power and then go to "Verification of Vehicle Repair" procedure.

GROUND CIRCUIT INSPECTION

1. Ground Voltage Drop Inspection

1) Disconnect fuel pressure sensor connector (EFD13).

2) Turn the ignition ON. Leave the engine OFF.

3) Measure voltage drop between the terminal 3 of fuel pressure sensor harness connector and chassis ground.

■ Specification: Ground voltage drop within 200 mV

4) Is the voltage measured within specification?

YES

▶ Go to "Ground Open Inspection" procedure.

NO

▶ Repair the excessive resistance (poor connection) and then go to "Verification of Vehicle Repair" procedure.

2. Ground Open Inspection

1) Turn the ignition OFF.

2) Disconnect fuel pressure sensor connector (EFD13) and ECM connector(EFD-ECM).

3) Measure resistance between the terminal 3 of fuel pressure sensor harness connector and the terminal 25 of ECM(EFD-ECM).

■ Specification: Continuity (Below 1.0Ω)

4) Is the resistance measured within specification?

YES

▶ Go to "Component Inspection" procedure.

NO

▶ Repair open circuit and then go to "Verification of Vehicle Repair" procedure.

COMPONENT INSPECTION

1. Fuel Pressure Sensor Inspection

1) Turn the ignition OFF.

2) Leave fuel pressure sensor connector (EFD13) connected.

3) Start the engine. Check and compare fuel pressure according to detecting condition.

NOTICE

The value of "rail pressure" varies with driving

conditions according to DTC detecting condition. In case of fail safe, be sure to check that fuel pressure is controlled by "70 Mpa".

Parameter	Reference Value
Real C/R pressure (At IG ON)	0.4 Mpa
Real C/R pressure (At idle)	31.5 Mpa
Real C/R pressure (At 1,500 rpm)	65.5 Mpa
Real C/R pressure (At 2,000 rpm)	65.5 Mpa

■ Specification :

Pressure	Output voltage
(MPa)	(V)
0	1.00
100	2.60
180	3.90
200	4.20
230	4.70

4) Is the measured output value of fuel pressure sensor within specification?

YES

▶ Go to "Verification of Vehicle Repair" procedure.

NO

▶ Replace the fuel pressure sensor and then go to "Verification of Vehicle Repair" procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select "Diagnostic Trouble Codes (DTCs)" mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

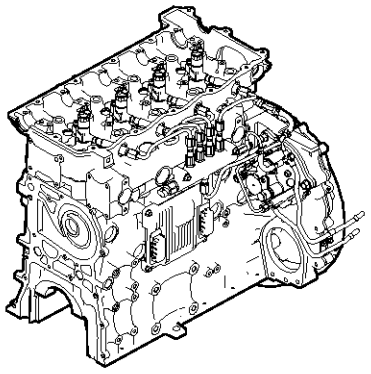
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P0201 TWV1 Output Open Load/Injector Coil Open

COMPONENT LOCATION



SDFFL7104D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   Injector carries out function to inject fuel amount calculated by ECM by making diesel spread with small particles to combustion chamber compressed with high pressure. Fuel injected generates power through combustion process. Purpose to increase fuel pressure of common rail diesel engine up to Max. 1,800 bar is to make fuel into small particles, small particles of fuel are related to smoke reduction, high power of engine, fuel consumption improvement etc. Also, hydraulic servo type is used to control fuel pressure of 1,800 bar with solenoid, injector solenoid is driven by current after increasing solenoid driving voltage up to 135V. Multi injection is possible by applying fuel injection which is not mechanic injector but electric control injector. ECM injects fuel after dividing into two stages of pilot injection and main injection and it is possible to control Injection time and injection amount independently to each cylinder. Power, torque, exhaust gas, fuel consumption improvement etc. can be optimized by controlling engine to optimum fuel injection amount.

2. DTC DESCRIPTION

   If crank rotating angle is 18,000 degrees or more due to the open in harness of injector #1, ECM judges this as a fault and DTC is set. The possible causes are open terminal 66 of ECM connector(EFD-ECM), open in injector coil, excessive resistance of injector pin, poor connection of wiring etc. Lack of engine power will occur since fuel amount is limited to below 40mm³/st in case of fail safe. There may cause damage to engine if the vehicle is driven for a long time with faulty injector.

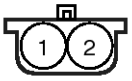
DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Current monitoring			• Terminal 66 circuit open of the engine ECM • Injector coil open • Injector pin resistance • Defective wiring
Enable Conditions	• At IG key ON/ Running			
Threshold Value	• Injector #1 circuit open			
Diagnosis Time	• Immediately			
Fail Safe	Fuel Cut	No	• Fuel amount sets to below 40㎣/st. • Engine output decrease • Cylinder balance control stop • Cruise release	
	Fuel limit	Yes		
	Check lamp	ON		

SPECIFICATION

Item	Specification
Resistance	0.45Ω(At 20℃)

Injector driving time	135V
Injector driving current	18.5A
Injector control type	Current control



Sensor connector

SUDFLDTC9030L

WAVEFORM

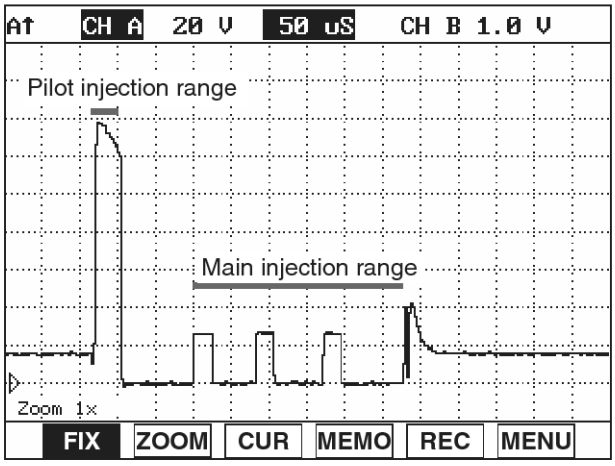


Fig. 1 Waveform of LOW side when injector operates

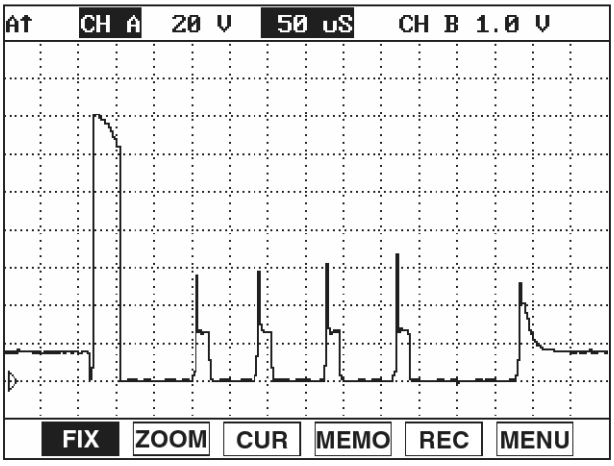


Fig. 2 Injector power waveform of HIGH side

Fig1) Waveform consists of pilot injection and main injection at LOW side.
Fig2) Injector power waveform of HIGH side

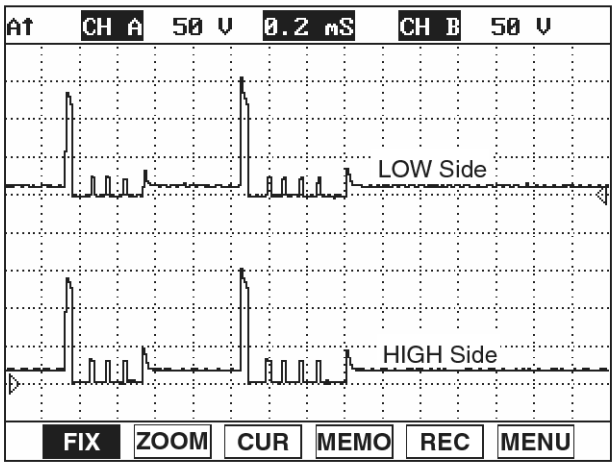


Fig. 3 Both injector waveforms of LOW/HIGH

SUDFLDTC9031L

NOTICE

When checking the injector waveform at LOW side of injector, the waveforms of Fig.1 and Fig.2 are madein turn. The waveform of Fig.2 is made when the power at the HIGH side of the injector # 1 and # 4 or the injector # 2 and # 3 which do not activate is used in common. When the injector does not activate, the waveform at HIGH side of the other injectorwhich uses the power at HIGH side in common is made.

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature.
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Fuel injection amount” parameter on the scan tool.

NOTICE

The value of “Fuel injection amount” varies with the operative condition according to DTC detecting condition. In case of fail safe, be sure to check that the value of “Injection amount” is restricted to below 40㎣/st.

■ Specification: Fuel injection amount approx. 9.0~10.5㎣/st at idle

Parameter	Reference Value
Final Fuel Q. (At IG ON)	-50.0 mm3st
Final Fuel Q. (At idle)	14.5 mm3st
Final Fuel Q. (At 1,500 rpm)	15.7 mm3st
Final Fuel Q. (At 2,000 rpm)	22.3 mm3st

POWER SUPPLY INSPECTION

1. Power Supply Voltage Inspection
   1) Leave the injector #1 connector(EFD 11-1) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 1 of injector #1 harness connector and chassis ground.
      ■ Specification: Injector #1 signal power approx. 12.86V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Go to “Power Supply Open Inspection” procedure.
2. Power Supply Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the injector #1 connector(EFD 11-1) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 1 of injector #1 harness connector and terminal 68 of the engine ECM connector(EFD-ECM).
      ■ Specification: Continuity
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Power Supply Short to Power Inspection” procedure.

      NO

      ▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.
3. Power Supply Short to Power Inspection
   1) Disconnect the injector #1 connector(EFD 11-1) and ECM connector(EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 1 of injector #1 harness connector and chassis ground.
      ■ Specification: Below 0~0.1V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Power Supply Short to Ground Inspection” procedure.

      NO

      ▶ Repair short to power and then go to “Verification of Vehicle Repair” procedure.
4. Power Supply Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the injector #1 connector(EFD 11-1) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 1 of the injector #1 harness connector and chassis ground.
      ■ Specification: Infinite
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Ground Circuit Inspection” procedure.

      NO

▶ Repair short to ground and then go to "Verification of Vehicle Repair" procedure.

GROUND CIRCUIT INSPECTION

1. Ground Voltage Drop Inspection
   1) Disconnect the injector #1 connector(EFD 11-1).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage drop between the terminal 2 of the injector #1 harness connector and chassis ground.

      ■ Specification: Ground voltage drop within 200mV
   4) Is the voltage measured within specification?

      YES

      ▶ Go to "Ground Open Inspection" procedure.

      NO

      ▶ Repair the excessive resistance (poor connection) and then go to "Verification of Vehicle Repair" procedure.
2. Ground Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the injector #1 connector(EFD 11-1) and the engine ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 2 of the injector #1 harness connector and the terminal 67 of the engine ECM connector(EFD-ECM).

      ■ Specification: Continuity (Below 1.0Ω)
   4) Is the resistance measured within specification?

      YES

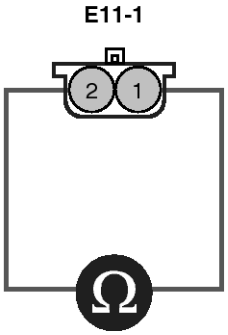
      ▶ Go to "Component Inspection" procedure.

      NO

      ▶ Repair open wiring circuit and then go to "Verification of Vehicle Repair" procedure.

COMPONENT INSPECTION

1. Injector Component Inspection
   1) Turn the ignition OFF.
   2) Disconnect the injector #1 connector(EFD 11-1).
   3) Measure resistance between the terminals 1 and 2 of the injector #1 connector.



■ SPECIFICATION

Item	Specification
Resistance	0.45 Ω (At 20℃)

SUDFLDTC9033L

4) Is the resistance measured within the specification?

YES

▶ Go to "Verification of Vehicle Repair" procedure.

NO

▶ Replace the injector and then go to "Verification of Vehicle Repair" procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select "Diagnostic Trouble Codes (DTCs)" mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

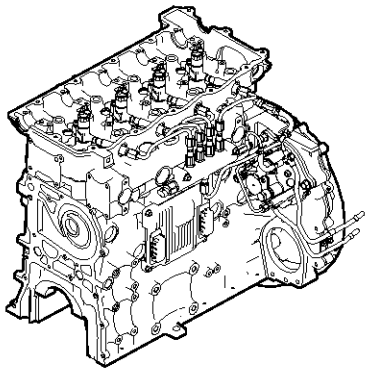
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P0202 TWV4 Output Open Load/Injector Coil Open

COMPONENT LOCATION



SDFFL7104D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   Injector carries out function to inject fuel amount calculated by ECM by making diesel spread with small particles to combustion chamber compressed with high pressure. Fuel injected generates power through combustion process. Purpose to increase fuel pressure of common rail diesel engine up to Max. 1,800 bar is to make fuel into small particles, small particles of fuel are related to smoke reduction, high power of engine, fuel consumption improvement etc. Also, hydraulic servo type is used to control fuel pressure of 1,800 bar with solenoid, injector solenoid is driven by current after increasing solenoid driving voltage up to 135V. Multi injection is possible by applying fuel injection which is not mechanic injector but electric control injector. ECM injects fuel after dividing into two stages of pilot injection and main injection and it is possible to control Injection time and injection amount independently to each cylinder. Power, torque, exhaust gas, fuel consumption improvement etc. can be optimized by controlling engine to optimum fuel injection amount.

2. DTC DESCRIPTION

   If crank rotating angle is 18,000 degrees or more due to the open in harness of injector #2, ECM judges this as a fault and DTC is set. The possible causes are open terminal 61 of ECM connector(EFD-ECM), open in injector coil, excessive resistance of injector pin, poor connection of wiring etc. Lack of engine power will occur since fuel amount is limited to below 40mm³/st in case of fail safe. There may cause damage to engine if the vehicle is driven for a long time with faulty injector.

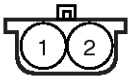
DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Current monitoring			• Terminal 61 circuit open of the engine ECM • Injector coil open • Injector pin resistance • Defective wiring
Enable Conditions	• At IG key ON/ Running			
Threshold Value	• Injector #2 circuit open			
Diagnosis Time	• Immediately			
Fail Safe	Fuel Cut	No	• Fuel amount sets to below 40㎣/st. • Engine output decrease • Cylinder balance control stop • Cruise release	
	Fuel limit	Yes		
	Check lamp	ON		

SPECIFICATION

Item	Specification
Resistance	0.45Ω(At 20℃)

Injector driving time	135V
Injector driving current	18.5A
Injector control type	Current control



Sensor connector

SUDFLDTC9030L

WAVEFORM

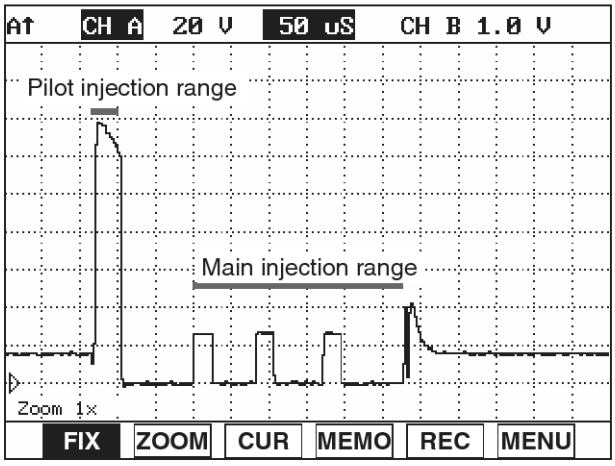


Fig. 1 Waveform of LOW side when injector operates

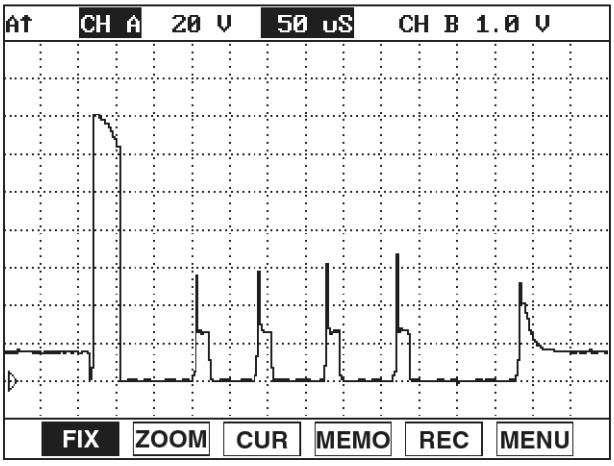


Fig. 2 Injector power waveform of HIGH side

Fig1) Waveform consists of pilot injection and main injection at LOW side.
Fig2) Injector power waveform of HIGH side

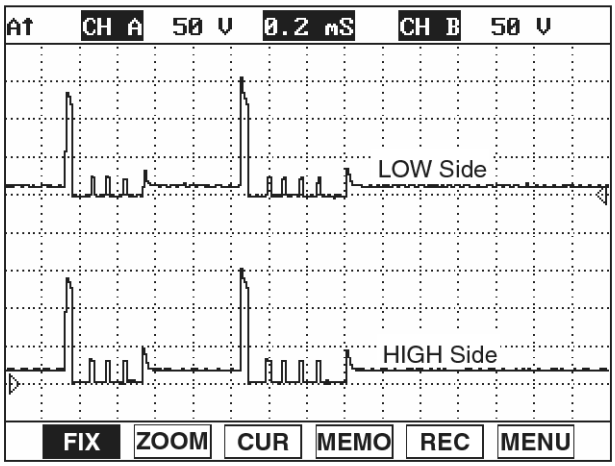


Fig. 3 Both injector waveforms of LOW/HIGH

SUDFLDTC9031L

NOTICE

When checking the injector waveform at LOW side of injector, the waveforms of Fig.1 and Fig.2 are made in turn. The waveform of Fig.2 is made when the power at the HIGH side of the injector # 1 and # 4 or the injector # 2 and # 3 which do not activate is used in common. When the injector does not activate, the waveform at HIGH side of the other injector which uses the power at HIGH side in common is made.

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature.
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Fuel injection amount” parameter on the scan tool.

NOTICE

The value of “Fuel injection amount” varies with the operative condition according to DTC detecting condition. In case of fail safe, be sure to check that the value of “Injection amount” is restricted to below 40㎣/st.

■ Specification: Fuel injection amount approx. 9.0~10.5㎣/st at idle

Parameter	Reference Value
Final Fuel Q. (At IG ON)	-50.0 mm3st
Final Fuel Q. (At idle)	14.5 mm3st
Final Fuel Q. (At 1,500 rpm)	15.7 mm3st
Final Fuel Q. (At 2,000 rpm)	22.3 mm3st

POWER SUPPLY INSPECTION

1. Power Supply Voltage Inspection
   1) Leave the injector #2 connector(EFD 11-2) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 1 of injector #2 harness connector and chassis ground.
      ■ Specification: Injector #2 signal power approx. 12.86V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Go to “Power Supply Open Inspection” procedure.
2. Power Supply Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the injector #2 connector(EFD 11-2) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 1 of injector #2 harness connector and terminal 61 of the engine ECM connector(EFD-ECM).
      ■ Specification: Continuity
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Power Supply Short to Power Inspection” procedure.

      NO

      ▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.
3. Power Supply Short to Power Inspection
   1) Disconnect the injector #2 connector(EFD 11-2) and ECM connector(EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 1 of injector #2 harness connector and chassis ground.
      ■ Specification: Below 0~0.1V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Power Supply Short to Ground Inspection” procedure.

      NO

      ▶ Repair short to power and then go to “Verification of Vehicle Repair” procedure.
4. Power Supply Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the injector #2 connector(EFD 11-2) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 1 of the injector #2 harness connector and chassis ground.
      ■ Specification: Infinite
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Ground Circuit Inspection” procedure.

      NO

▶ Repair short to ground and then go to "Verification of Vehicle Repair" procedure.

GROUND CIRCUIT INSPECTION

1. Ground Voltage Drop Inspection
   1) Disconnect the injector #2 connector(EFD 11-2).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage drop between the terminal 2 of the injector #2 harness connector and chassis ground.
      ■ Specification: Ground voltage drop within 200mV
   4) Is the voltage measured within specification?

      YES

      ▶ Go to "Ground Open Inspection" procedure.

      NO

      ▶ Repair the excessive resistance (poor connection) and then go to "Verification of Vehicle Repair" procedure.
2. Ground Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the injector #2 connector(EFD 11-2) and the engine ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 2 of the injector #2 harness connector and the terminal 43 of the engine ECM connector(EFD-ECM).
      ■ Specification: Continuity (Below 1.0Ω)
   4) Is the resistance measured within specification?

      YES

      ▶ Go to "Component Inspection" procedure.

      NO

      ▶ Repair open wiring circuit and then go to "Verification of Vehicle Repair" procedure.

COMPONENT INSPECTION

1. Injector Component Inspection
   1) Turn the ignition OFF.
   2) Disconnect the injector #2 connector(EFD 11-2).
   3) Measure resistance between the terminals 1 and 2 of the injector #2 connector.

■ **SPECIFICATION**

Item	Specification
Resistance	0.45Ω(At 20℃)

   4) Is the resistance measured within the specification?

      YES

      ▶ Go to "Verification of Vehicle Repair" procedure.

      NO

      ▶ Replace the injector and then go to "Verification of Vehicle Repair" procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select "Diagnostic Trouble Codes (DTCs)" mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

   YES

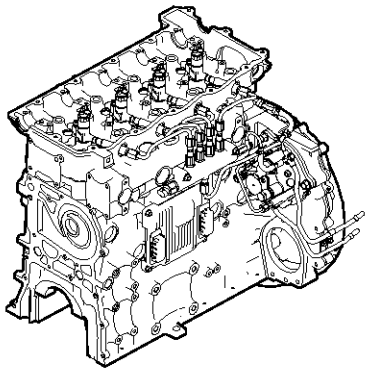
   ▶ Go to the applicable DTC procedure.

   NO

   ▶ System OK

P0203 TWV2 Output Open Load/Injector Coil Open

COMPONENT LOCATION



SDFFL7104D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   Injector carries out function to inject fuel amount calculated by ECM by making diesel spread with small particles to combustion chamber compressed with high pressure. Fuel injected generates power through combustion process. Purpose to increase fuel pressure of common rail diesel engine up to Max. 1,800 bar is to make fuel into small particles, small particles of fuel are related to smoke reduction, high power of engine, fuel consumption improvement etc. Also, hydraulic servo type is used to control fuel pressure of 1,800 bar with solenoid, injector solenoid is driven by current after increasing solenoid driving voltage up to 135V. Multi injection is possible by applying fuel injection which is not mechanic injector but electric control injector. ECM injects fuel after dividing into two stages of pilot injection and main injection and it is possible to control Injection time and injection amount independently to each cylinder. Power, torque, exhaust gas, fuel consumption improvement etc. can be optimized by controlling engine to optimum fuel injection amount.

2. DTC DESCRIPTION

   If crank rotating angle is 18,000 degrees or more due to the open in harness of injector #3, ECM judges this as a fault and DTC is set. The possible causes are open terminal 62 of ECM connector(EFD-ECM), open in injector coil, excessive resistance of injector pin, poor connection of wiring etc. Lack of engine power will occur since fuel amount is limited to below 40mm³/st in case of fail safe. There may cause damage to engine if the vehicle is driven for a long time with faulty injector.

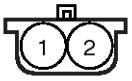
DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Current monitoring			• Terminal 62 circuit open of the engine ECM • Injector coil open • Injector pin resistance • Defective wiring
Enable Conditions	• At IG key ON/ Running			
Threshold Value	• Injector #3 circuit open			
Diagnosis Time	• Immediately			
Fail Safe	Fuel Cut	No	• Fuel amount sets to below 40㎣/st. • Engine output decrease • Cylinder balance control stop • Cruise release	
	Fuel limit	Yes		
	Check lamp	ON		

SPECIFICATION

Item	Specification
Resistance	0.45Ω(At 20℃)

Injector driving time	135V
Injector driving current	18.5A
Injector control type	Current control



Sensor connector

SUDFLDTC9030L

WAVEFORM

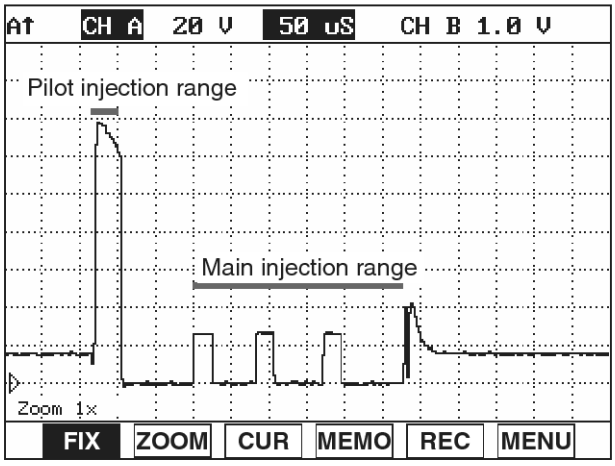


Fig. 1 Waveform of LOW side when injector operates

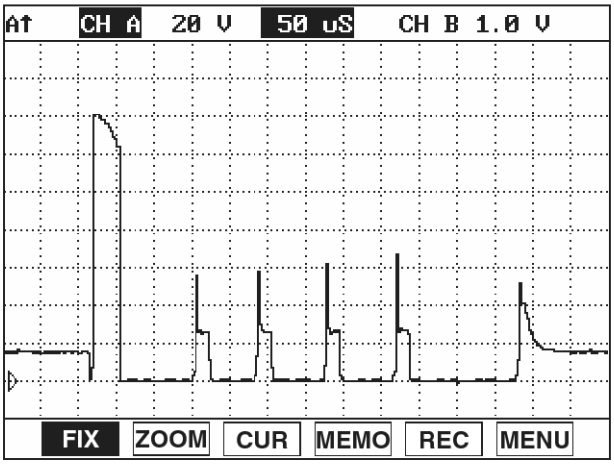


Fig. 2 Injector power waveform of HIGH side

Fig1) Waveform consists of pilot injection and main injection at LOW side.
Fig2) Injector power waveform of HIGH side

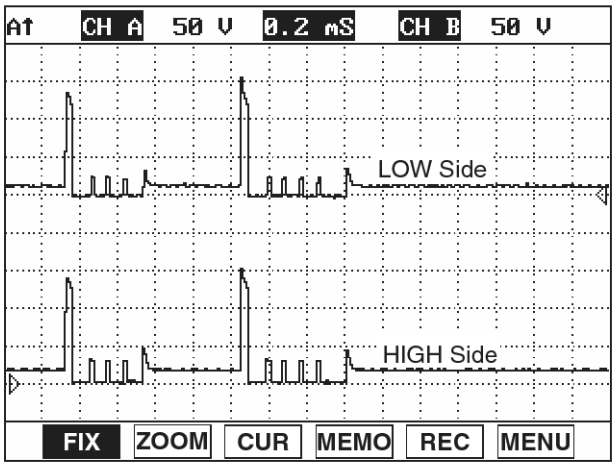


Fig. 3 Both injector waveforms of LOW/HIGH

SUDFLDTC9031L

NOTICE

When checking the injector waveform at LOW side of injector, the waveforms of Fig.1 and Fig.2 are made in turn. The waveform of Fig.2 is made when the power at the HIGH side of the injector # 1 and # 4 or the injector # 2 and # 3 which do not activate is used in common. When the injector does not activate, the waveform at HIGH side of the other injector which uses the power at HIGH side in common is made.

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature.
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Fuel injection amount” parameter on the scan tool.

NOTICE

The value of “Fuel injection amount” varies with the operative condition according to DTC detecting condition. In case of fail safe, be sure to check that the value of “Injection amount” is restricted to below 40㎣/st.

■ Specification: Fuel injection amount approx. 9.0~10.5㎣/st at idle

Parameter	Reference Value
Final Fuel Q. (At IG ON)	-50.0 mm3st
Final Fuel Q. (At idle)	14.5 mm3st
Final Fuel Q. (At 1,500 rpm)	15.7 mm3st
Final Fuel Q. (At 2,000 rpm)	22.3 mm3st

POWER SUPPLY INSPECTION

1. Power Supply Voltage Inspection
   1) Leave the injector #3 connector(EFD 11-3) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 1 of injector #3 harness connector and chassis ground.
      ■ Specification: Injector #3 signal power approx. 12.86V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Go to “Power Supply Open Inspection” procedure.
2. Power Supply Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the injector #3 connector(EFD 11-3) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 1 of injector #3 harness connector and terminal 62 of the engine ECM connector(EFD-ECM).
      ■ Specification: Continuity
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Power Supply Short to Power Inspection” procedure.

      NO

      ▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.
3. Power Supply Short to Power Inspection
   1) Disconnect the injector #3 connector(EFD 11-3) and ECM connector(EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 1 of injector #3 harness connector and chassis ground.
      ■ Specification: Below 0~0.1V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Power Supply Short to Ground Inspection” procedure.

      NO

      ▶ Repair short to power and then go to “Verification of Vehicle Repair” procedure.
4. Power Supply Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the injector #3 connector(EFD 11-3) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 1 of the injector #3 harness connector and chassis ground.
      ■ Specification: Infinite
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Ground Circuit Inspection” procedure.

      NO

▶ Repair short to ground and then go to "Verification of Vehicle Repair" procedure.

GROUND CIRCUIT INSPECTION

1. Ground Voltage Drop Inspection
   1) Disconnect the injector #3 connector(EFD 11-3).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage drop between the terminal 2 of the injector #3 harness connector and chassis ground.
      ■ Specification: Ground voltage drop within 200mV
   4) Is the voltage measured within specification?

      YES

      ▶ Go to "Ground Open Inspection" procedure.

      NO

      ▶ Repair the excessive resistance (poor connection) and then go to "Verification of Vehicle Repair" procedure.
2. Ground Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the injector #3 connector(EFD 11-3) and the engine ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 2 of the injector #3 harness connector and the terminal 63 of the engine ECM connector(EFD-ECM).
      ■ Specification: Continuity (Below 1.0Ω)
   4) Is the resistance measured within specification?

      YES

      ▶ Go to "Component Inspection" procedure.

      NO

      ▶ Repair open wiring circuit and then go to "Verification of Vehicle Repair" procedure.

COMPONENT INSPECTION

1. Injector Component Inspection
   1) Turn the ignition OFF.
   2) Disconnect the injector #3 connector(EFD 11-3).
   3) Measure resistance between the terminals 1 and 2 of the injector #3 connector.

■ **SPECIFICATION**

Item	Specification
Resistance	0.45Ω(At 20℃)

   4) Is the resistance measured within the specification?

      YES

      ▶ Go to "Verification of Vehicle Repair" procedure.

      NO

      ▶ Replace the injector and then go to "Verification of Vehicle Repair" procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select "Diagnostic Trouble Codes (DTCs)" mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

   YES

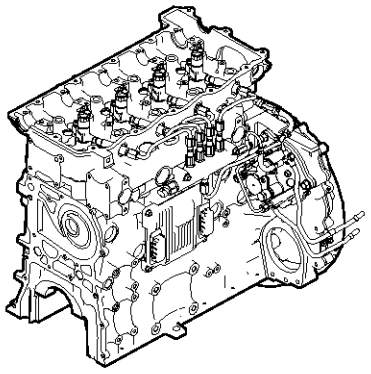
   ▶ Go to the applicable DTC procedure.

   NO

   ▶ System OK

P0204 TWV3 Output Open Load/Injector Coil Open

COMPONENT LOCATION



SDFFL7104D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   Injector carries out function to inject fuel amount calculated by ECM by making diesel spread with small particles to combustion chamber compressed with high pressure. Fuel injected generates power through combustion process. Purpose to increase fuel pressure of common rail diesel engine up to Max. 1,800 bar is to make fuel into small particles, small particles of fuel are related to smoke reduction, high power of engine, fuel consumption improvement etc. Also, hydraulic servo type is used to control fuel pressure of 1,800 bar with solenoid, injector solenoid is driven by current after increasing solenoid driving voltage up to 135V. Multi injection is possible by applying fuel injection which is not mechanic injector but electric control injector. ECM injects fuel after dividing into two stages of pilot injection and main injection and it is possible to control Injection time and injection amount independently to each cylinder. Power, torque, exhaust gas, fuel consumption improvement etc. can be optimized by controlling engine to optimum fuel injection amount.

2. DTC DESCRIPTION

   If crank rotating angle is 18,000 degrees or more due to the open in harness of injector #4, ECM judges this as a fault and DTC is set. The possible causes are open terminal 65 of ECM connector(EFD-ECM), open in injector coil, excessive resistance of injector pin, poor connection of wiring etc. Lack of engine power will occur since fuel amount is limited to below 40mm³/st in case of fail safe. There may cause damage to engine if the vehicle is driven for a long time with faulty injector.

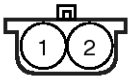
DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Current monitoring			• Terminal 65 circuit open of the engine ECM • Injector coil open • Injector pin resistance • Defective wiring
Enable Conditions	• At IG key ON/ Running			
Threshold Value	• Injector #4 circuit open			
Diagnosis Time	• Immediately			
Fail Safe	Fuel Cut	No	• Fuel amount sets to below 40㎣/st. • Engine output decrease • Cylinder balance control stop • Cruise release	
	Fuel limit	Yes		
	Check lamp	ON		

SPECIFICATION

Item	Specification
Resistance	0.45Ω(At 20℃)

Injector driving time	135V
Injector driving current	18.5A
Injector control type	Current control



Sensor connector

SUDFLDTC9030L

WAVEFORM

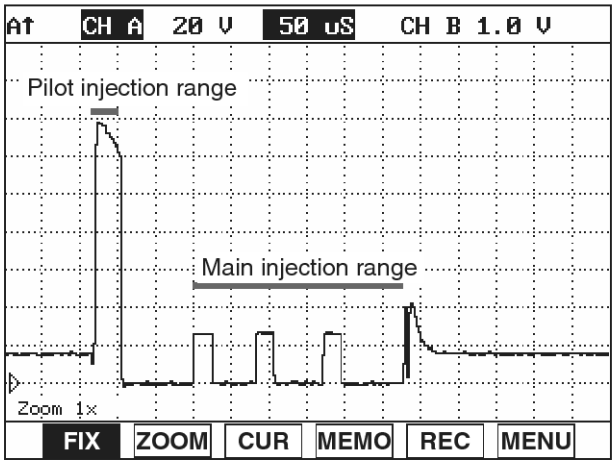


Fig. 1 Waveform of LOW side when injector operates

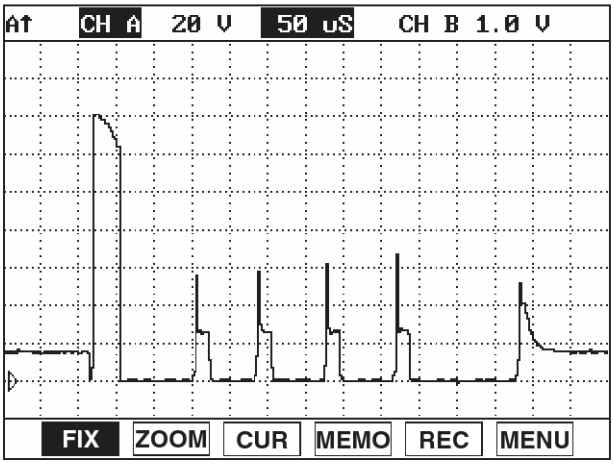


Fig. 2 Injector power waveform of HIGH side

Fig1) Waveform consists of pilot injection and main injection at LOW side.
Fig2) Injector power waveform of HIGH side

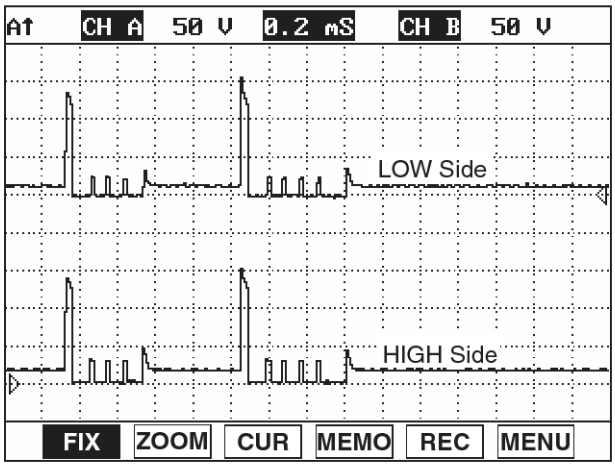


Fig. 3 Both injector waveforms of LOW/HIGH

SUDFLDTC9031L

NOTICE

When checking the injector waveform at LOW side of injector, the waveforms of Fig.1 and Fig.2 are made in turn. The waveform of Fig.2 is made when the power at the HIGH side of the injector # 1 and # 4 or the injector # 2 and # 3 which do not activate is used in common. When the injector does not activate, the waveform at HIGH side of the other injector which uses the power at HIGH side in common is made.

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature.
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Fuel injection amount” parameter on the scan tool.

NOTICE

The value of “Fuel injection amount” varies with the operative condition according to DTC detecting condition. In case of fail safe, be sure to check that the value of “Injection amount” is restricted to below 40㎣/st.

■ Specification: Fuel injection amount approx. 9.0~10.5㎣/st at idle

Parameter	Reference Value
Final Fuel Q. (At IG ON)	-50.0 mm3st
Final Fuel Q. (At idle)	14.5 mm3st
Final Fuel Q. (At 1,500 rpm)	15.7 mm3st
Final Fuel Q. (At 2,000 rpm)	22.3 mm3st

POWER SUPPLY INSPECTION

1. Power Supply Voltage Inspection
   1) Leave the injector #4 connector(EFD 11-4) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 1 of injector #4 harness connector and chassis ground.
      ■ Specification: Injector #4 signal power approx. 12.86V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Go to “Power Supply Open Inspection” procedure.
2. Power Supply Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the injector #4 connector(EFD 11-4) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 1 of injector #4 harness connector and terminal 65 of the engine ECM connector(EFD-ECM).
      ■ Specification: Continuity
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Power Supply Short to Power Inspection” procedure.

      NO

      ▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.
3. Power Supply Short to Power Inspection
   1) Disconnect the injector #4 connector(EFD 11-4) and ECM connector(EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 1 of injector #4 harness connector and chassis ground.
      ■ Specification: Below 0~0.1V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Power Supply Short to Ground Inspection” procedure.

      NO

      ▶ Repair short to power and then go to “Verification of Vehicle Repair” procedure.
4. Power Supply Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the injector #4 connector(EFD 11-4) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 1 of the injector #4 harness connector and chassis ground.
      ■ Specification: Infinite
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Ground Circuit Inspection” procedure.

      NO

▶ Repair short to ground and then go to "Verification of Vehicle Repair" procedure.

GROUND CIRCUIT INSPECTION

1. Ground Voltage Drop Inspection
   1) Disconnect the injector #4 connector(EFD 11-4).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage drop between the terminal 2 of the injector #4 harness connector and chassis ground.

      ■ Specification: Ground voltage drop within 200mV
   4) Is the voltage measured within specification?

      YES

      ▶ Go to "Ground Open Inspection" procedure.

      NO

      ▶ Repair the excessive resistance (poor connection) and then go to "Verification of Vehicle Repair" procedure.
2. Ground Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the injector #4 connector(EFD 11-4) and the engine ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 2 of the injector #4 harness connector and the terminal 47 of the engine ECM connector(EFD-ECM).

      ■ Specification: Continuity (Below 1.0Ω)
   4) Is the resistance measured within specification?

      YES

      ▶ Go to "Component Inspection" procedure.

      NO

      ▶ Repair open wiring circuit and then go to "Verification of Vehicle Repair" procedure.

COMPONENT INSPECTION

1. Injector Component Inspection
   1) Turn the ignition OFF.
   2) Disconnect the injector #4 connector(EFD 11-4).
   3) Measure resistance between the terminals 1 and 2 of the injector #4 connector.

■ SPECIFICATION

Item	Specification
Resistance	0.45Ω(At 20℃)

   4) Is the resistance measured within the specification?

      YES

      ▶ Go to "Verification of Vehicle Repair" procedure.

      NO

      ▶ Replace the injector and then go to "Verification of Vehicle Repair" procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select "Diagnostic Trouble Codes (DTCs)" mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

   YES

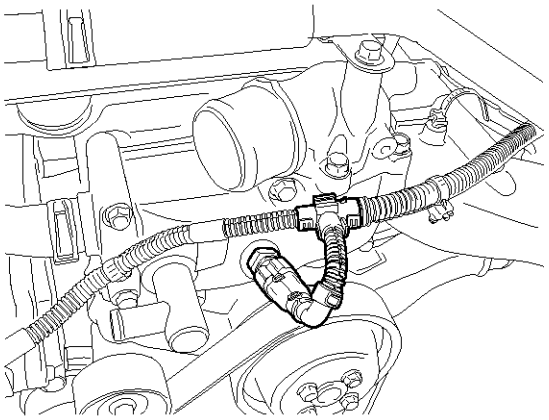
   ▶ Go to the applicable DTC procedure.

   NO

   ▶ System OK

P0217 Coolant Temp. Exceeds Upper Limit

COMPONENT LOCATION



SDFFL7103D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   ECTS(Engine Coolant Temperature Sensor) is located on coolant passage of cylinder head. The ECTS uses a thermistor whose resistance changes with the temperature. The electric resistance of the ECTS decreases as the temperature increases, and increases as the temperature decreases, that is negative characteristics. The ECTS receives 5 voltage via resistor from ECM and resistor and thermistor are linked in series. ECM received signal from ECTS is used to control injection timing, fuel amount correction and automatic cooling fan. Specially the defective engine coolant temperature sensor has a great influence on the cold starting and is one of the factors to cause white smoke at starting.

2. DTC DESCRIPTION

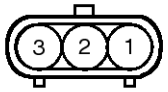
   If the output voltage of the engine coolant temperature sensor is over 115°C for 2,112ms or more, the ECM judges this as a fault and DTC is set. Check lamp and MIL come on together when the condition continued for 2 driving cycle times. Check lamp will go off after 3 driving cycle times when the system returns to normal. Fuel amount correction will not be controlled by ECM depending on engine coolant temperature but vehicle is possible to drive. Maximum engine power is limited and warning lamp comes on.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Check coolant system.
Enable Conditions	• At IG ON/ Running			
Threshold Value	• 115℃ or higher			
Diagnosis Time	• 2,112ms or higher			
Fail Safe	Fuel Cut	No	• Fuel amount sets to below 40㎣/st. • Fuel correction stop and engine power limit depending on coolant temperature	
	Fuel limit	Yes		
	Check lamp	ON		

SPECIFICATION

Temperature(℃)	Resistance (kΩ) of terminal No ①, ③
-20	15.48
0	5.79
20	2.45
40	1.148
80	0.322



Sensor connector

SUDFLDTC9021L

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature.
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Coolant temperature” parameter on the scan tool.

NOTICE

The value of “Coolant temperature” varies with driving condition according to DTC detecting condition. In case of failure, be sure to check that “Coolant temperature” indicates 115℃ or higher and “Fuel amount” sets to below 40㎜³/st.

Parameter	Reference Value
Water temperature (At IG ON)	56℃
Water temperature (At idle)	56℃

SYSTEM INSPECTION

1. Cooing System Inspection
   1) Check the fan belt tension.
   2) Check the coolant level and check for leaks.
   3) Check the radiator fin.
   4) Check the coolant for contamination or corrosion.
   5) Check the thermostat operation.
   6) Check the operation of water pump.
   7) Check the auto cooling fan for oil leak.
   8) Check the cause of overheat as possible as you can.
   9) Is the result of system check normal?

YES

▶ Go to “Verification of Vehicle Repair” procedure.

NO

▶ Repair the defective cooling system and then go to “Verification of Vehicle Repair” procedure.

※ Repeat the above cooling system check one or two times.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

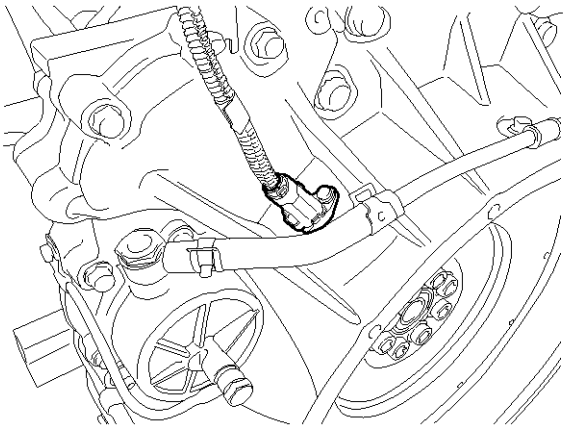
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P0219 Engine Overrun

COMPONENT LOCATION



SUDFL8231D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   The engine piston position is used for determining fuel injection timing, all pistons are connected to crankshaft via connecting rod. After the crankshaft position sensor detects piston position, it sends signal to the ECM to determine fuel injection timing and engine speed. The camshaft position sensor is used to detect the top dead center of compression stroke of each cylinder. Based on these signals, the ECM determines fuel injection timing and injection order of each cylinder.

2. DTC DESCRIPTION

   If the engine rpm is over 3,800rpm for 128 ms or more, the ECM judges this as a fault and DTC is set. Check lamp and MIL come on together when the condition continued for 2 driving cycle times. Check lamp will go off after 3 driving cycle times when the system returns to normal. In case engine rpm is over 4,000 rpm to prevent damage due to engine over speed, the fuel injection is injected partially to reduce engine rpm. If engine rpm is lower than 3,500rpm, the injection will return to normal condition. The engine system will be protected like this.

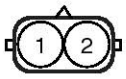
DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Check the crank position sensor.
Enable Conditions	• Engine running			
Threshold Value	• 3,800rpm or higher			
Diagnosis Time	• 128ms or higher			
Fail Safe	Fuel Cut	No	• Below 3,500rpm : Injection reactivation • Above 4,000rpm: No injection	
	Fuel limit	Yes		
	Check lamp	ON		

SPECIFICATION

Temperature(℃)	Resistance between terminals 1 and 2(Ω)
20	125±17

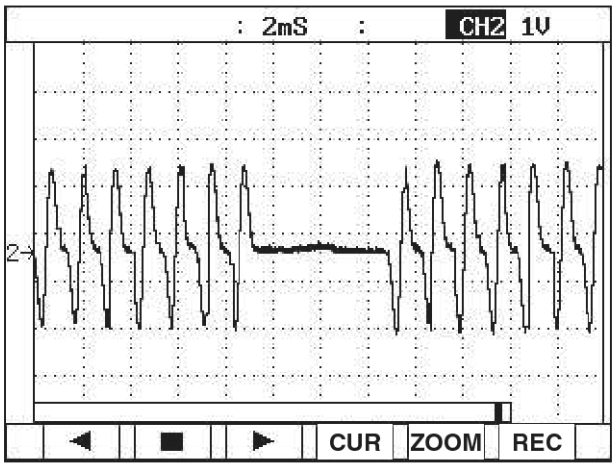
Air gap	1.50±0.5mm



Sensor connector

SUDFLDTC9037L

WAVEFORM



SUDFLDTC9096L

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature.
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Engine rpm” parameter on the scan tool.

NOTICE

The value of “Engine rpm” varies with driving condition according to DTC detecting condition. In case of failure, be sure to compare “Fuel injection amount” as the fuel injection is reactivated when the engine rpm drops to below 3,500rpm after fuel injection stops when “Engine rpm” is above 4,000rpm.

Parameter	Reference Value
Crank sensor active (At IG ON)	OFF
Crank sensor active (At idle)	ON

POWER SUPPLY INSPECTION

1. N.E Sensor(+) Voltage Inspection
   1) Leave the crank position sensor connector (EFD18) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 1 of crank position sensor harness connector and chassis ground.

      ■ Specification: ETC control module output power approx. 2.5V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Ground Circuit Inspection” procedure.

      NO

      ▶ Go to “N.E Sensor (+) Open Inspection” procedure.
2. N.E Sensor (+) Open Inspection
   1) Turn the ignition OFF.

2) Disconnect the crank position sensor connector (EFD18) and ECM connector(EFD-ECM).
3) Measure resistance between the terminal 1 of crank position sensor harness connector and terminal 29 of the engine ECM connector(EFD-ECM).
   ■ Specification: Continuity
4) Is the resistance measured within specification?

YES

▶ Go to "N.E Sensor (+) Short to Power Inspection" procedure.

NO

▶ Repair open circuit and then go to "Verification of Vehicle Repair" procedure.

3. N.E Sensor (+) Short to Power Inspection
   1) Disconnect the crank position sensor connector (EFD18) and ECM connector(EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 1 of crank position sensor harness connector and chassis ground.
      ■ Specification: Below 0~0.1V
   4) Is the voltage measured within specification?

YES

▶ Go to "Ground Circuit Inspection" procedure.

NO

▶ Repair short to power and then go to "Verification of Vehicle Repair" procedure.

GROUND CIRCUIT INSPECTION

1. N.E Sensor (-) Voltage Inspection
   1) Leave the crank position sensor connector (EFD18) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage drop between the terminal 2 of the crank position sensor harness connector and chassis ground.
      ■ Specification: ETC control module output power approx. 2.5V
   4) Is the voltage measured within specification?

YES

▶ Go to "Shield Circuit Inspection" procedure.

NO

▶ Go to "N.E Sensor (-) Open Inspection" procedure.

2. N.E Sensor (-) Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the crank position sensor connector (EFD18) and the engine ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 2 of the crank position sensor harness connector and the terminal 9 of the engine ECM connector(EFD-ECM).
      ■ Specification: Continuity (Below 1.0Ω)
   4) Is the resistance measured within specification?

YES

▶ Go to "N.E Sensor (-) Short to Power Inspection" procedure.

NO

▶ Repair open wiring circuit and then go to "Verification of Vehicle Repair" procedure.

3. N.E Sensor (-) Short to Power Inspection
   1) Disconnect the crank position sensor connector (EFD18) and the engine ECM connector(EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 2 of the crank position sensor harness connector and the chassis ground.
      ■ Specification: Below 0~0.1V
   4) Is the voltage measured within specification?

YES

▶ Go to "Shield Circuit Inspection" procedure.

NO

▶ Repair short to power and then go to "Verification of Vehicle Repair" procedure.

SHIELD CIRCUIT INSPECTION

1. Shield Short to Power Inspection
   1) Disconnect the engine ECM connector(EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage drop between the terminal 6 of

the ECM harness connector and chassis ground.

■ Specification: Shield ground power approx. 0V

4) Is the voltage measured within specification?

YES

▶ Go to "Component Inspection" procedure.

NO

▶ Go to "Shield Short to Ground Inspection" procedure.

2. Shield Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the engine ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 6 of the ECM harness connector and chassis ground.

      ■ Specification: Infinite

   4) Is the resistance measured within specification?

      YES

      ▶ Go to "Component Inspection" procedure.

      NO

      ▶ Repair short to ground and then go to "Verification of Vehicle Repair" procedure.

COMPONENT INSPECTION

1. Crank Position Sensor Resistance Inspection
   1) Turn the ignition OFF.
   2) Disconnect the crank position sensor connector (EFD18).
   3) Measure the resistance between terminals 1 and 2 of the crank position sensor.

■ Specification :

Temperature(℃)	Resistance between terminals 1 and 2(Ω)
20	125±17

   4) Is the resistance measured within specification?

      YES

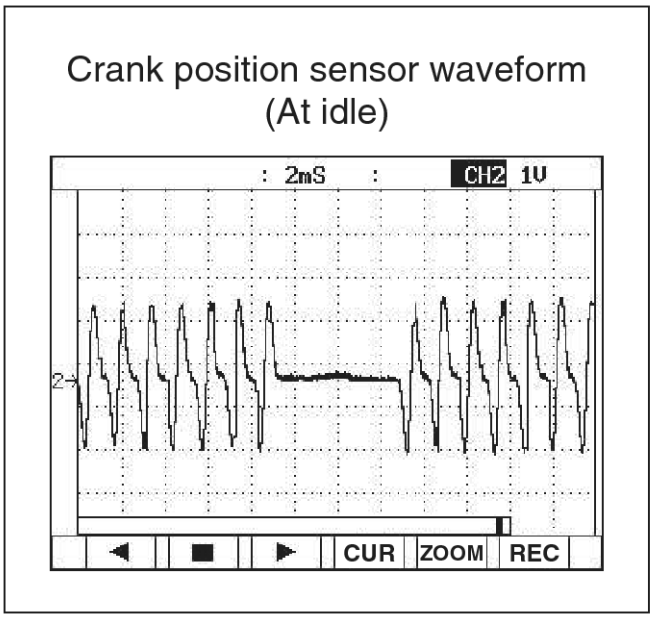
      ▶ Go to "Crank Position Sensor Waveform Inspection" procedure.

      NO

      ▶ Replace the crank position sensor and then go to "Verification of Vehicle Repair" procedure.

2. Crank Position Sensor Waveform Inspection
   1) Turn the ignition OFF.
   2) Connect the crank position sensor connector (EFD18).
   3) Connect oscilloscope probe to terminal 2 of the crank position sensor.
   4) Check that the waveform of the crank position sensor displays normally at idle.

      ■ Specification :



SUDFLDTC9069L

5) Does the waveform display normally?

YES

▶ Go to “Verification of Vehicle Repair” procedure.

NO

▶ Replace the crank position sensor and then go to “Verification of Vehicle Repair” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

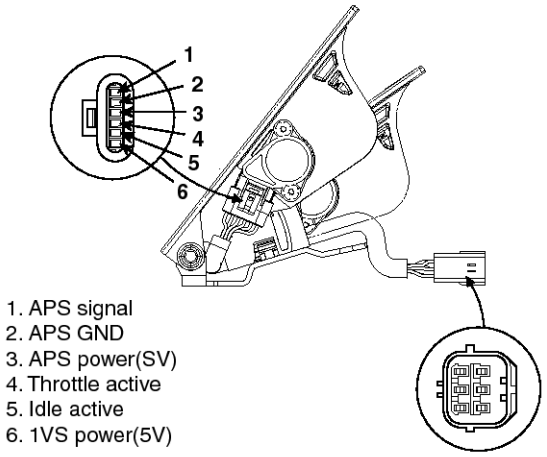
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P0220 Accel. Pedal Sensor No.2 Not Open

COMPONENT LOCATION



1. APS signal
2. APS GND
3. APS power(SV)
4. Throttle active
5. Idle active
6. 1VS power(5V)

SUDFLDTC9070L

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   The accelerator pedal position sensor detects pedal position and sends signal to ECM. It is composed of two potentiometers(dual variable resistor type). Power supply is provided separately to detect acceleration condition exactly. The voltage of accelerator pedal position sensor is generated by potentiometer and the position of accelerator pedal is calculated by using characteristic curve programmed beforehand.

2. DTC DESCRIPTION

   The accelerator pedal sensor indicates idle state in spite of idle switch OFF when the vehicle is being driven. When the accelerator pedal sensor "2" outputs 0.6~1.2V and the accelerator pedal sensor "1" outputs 1.5V or more for more than 1,056ms, the ECM judges this as a fault and DTC is set. The possible causes are defective sensor, wiring problem etc.

DTC DETECTING CONDITION

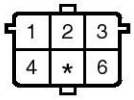
<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="6">• Defective wiring and sensor.</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• At IG ON/ Running</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• Idle s/w OFF, 0.6V≤Accelerator pedal sensor “2” output voltage≤1.2V, Accelerator pedal sensor “1”≥1.5V or higher</td></tr>
<tr><td>Diagnosis Time</td><td colspan="3">• 1,056ms or higher</td></tr>
<tr><td rowspan="3">Fail Safe</td><td>Fuel Cut</td><td>No</td><td rowspan="3">APS No.1 signal is selected.</td></tr>
<tr><td>Fuel limit</td><td>No</td></tr>
<tr><td>Check lamp</td><td>OFF</td></tr>
</table>

SPECIFICATION

Terminal resistance ①-②(Inoperative)	Terminal resistance ①-②(Operative)	Terminal resistance ①-③(Inoperative)	Terminal resistance ①-③(Operative)
Approx. 1.83㏀(Continuity)	Approx. 0.708㏀(Continuity)	Approx. 1.64㏀(Continuity)	Approx. 1.64㏀(Continuity)

Terminal resistance ②-③ (Inoperative)	Terminal resistance ②-③ (Operative)
Approx. 0.477㏀(Continuity)	Approx. 1.66㏀(Continuity)

At idle(0%)	At full throttle(100%)
0.33V	3.85V



Sensor connector

SUDFLDTC9024L

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Accelerator pedal position” parameter on the scan tool.

Parameter	Reference Value
Accel. Pos. (At IG ON)	0.0%
Accel. Pos. (At idle)	0.0%
Accel. Pos. (At 1,500 rpm)	23%
Accel. Pos. (At 2,000 rpm)	34.5%

SIGNAL CIRCUIT INSPECTION

1. Signal Voltage Inspection
   1) Leave the accelerator pedal position sensor connector (M32) and the engine ECM connector(CFD-ECM) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 2 of the accelerator pedal position sensor harness connector and chassis ground.

      ■ Specification: Accelerator pedal position sensor signal power approx. 0.68V(At IG ON)
   4) Measure voltage between terminal 47, 67 of the engine ECM connector and chassis ground.

      ■ Specification : Accelerator pedal sensor signal power approx. 0.68V(Inoperative)
   5) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Go to “Signal Open Inspection” procedure.
2. Signal Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the accelerator pedal position sensor connector (M32) and the ECM connector(CFD-ECM, EFD-ECM).
   3) Measure resistance between terminal 2 of the accelerator pedal position sensor harness connector and terminal 47, 67 of the engine ECM connector(CFD-ECM).

      ■ Specification: Continuity
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Signal Short to Power Inspection” procedure.

      NO

      ▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.
3. Signal Short to Power Inspection
   1) Disconnect the accelerator pedal position sensor connector (M32) and the ECM connector(CFD-ECM, EFD-ECM).

2) Turn the ignition ON. Leave the engine OFF.
3) Measure voltage between terminal 2 of the accelerator pedal position sensor harness connector and chassis ground.
4) Measure voltage between terminal 47, 67 of the engine ECM connector and chassis ground.
   ■ Specification: Below 0~0.1V
5) Is the voltage measured within specification?

YES

▶ Go to "Signal Short to Ground Inspection" procedure.

NO

▶ Repair short to power and then go to "Verification of Vehicle Repair" procedure.

4. Signal Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the accelerator pedal position sensor connector (M32) and the ECM connector(CFD-ECM, EFD-ECM).
   3) Measure resistance between terminal 2 of the accelerator pedal position sensor harness connector and chassis ground.
   4) Measure resistance between terminal 47, 67 of the engine ECM connector and chassis ground.
      ■ Specification: Infinite
   5) Is the resistance measured within specification?

YES

▶ Go to "Power Supply Inspection" procedure.

NO

▶ Repair short to ground and then go to "Verification of Vehicle Repair" procedure.

POWER SUPPLY INSPECTION

1. Power Supply Voltage Inspection
   1) Leave the accelerator pedal position sensor connector (M32) and the engine ECM connector(CFD-ECM) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 1 of the accelerator pedal position sensor harness connector and chassis ground.
   4) Measure voltage between terminal 50 of the engine ECM connector and chassis ground.
      ■ Specification: Accelerator pedal sensor signal power approx. 5.0V
   5) Is the voltage measured within specification?

YES

▶ Go to "Ground Circuit Inspection" procedure.

NO

▶ Go to "Power Supply Open Inspection" procedure.

2. Power Supply Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the accelerator pedal position sensor connector (M32) and the engine ECM connector(CFD-ECM).
   3) Measure resistance between the terminal 1 of the accelerator pedal position sensor harness connector and terminal 50 of the engine ECM connector(CFD-ECM).
      ■ Specification: Continuity
   4) Is the resistance measured within specification?

YES

▶ Go to "Power Supply Short to Power Inspection" procedure.

NO

▶ Repair open circuit and then go to "Verification of Vehicle Repair" procedure.

3. Power Supply Short to Power Inspection
   1) Disconnect the accelerator pedal position sensor connector (M32) and ECM connector(CFD-ECM, EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 1 of the accelerator pedal position sensor harness connector and chassis ground.
   4) Measure voltage between the terminal 50 of the engine ECM harness connector and chassis ground.
      ■ Specification: Below 0~0.1V
   5) Is the voltage measured within specification?

YES

▶ Go to "Power Supply Short to Ground Inspection" procedure.

NO

▶ Repair short to power and then go to "Verification of Vehicle Repair" procedure.

4. Power Supply Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the accelerator pedal position sensor connector (M32) and ECM connector(CFD-ECM, EFD-ECM).
   3) Measure resistance between the terminal 1 of the accelerator pedal position sensor harness connector and chassis ground.
   4) Measure resistance between the terminal 50 of the engine ECM harness connector and chassis ground.
      ■ Specification: Infinite
   5) Is the resistance measured within specification?

YES

▶ Go to "Ground Circuit Inspection" procedure.

NO

▶ Repair short to ground and then go to "Verification of Vehicle Repair" procedure.

GROUND CIRCUIT INSPECTION

1. Ground Voltage Drop Inspection
   1) Disconnect the accelerator pedal position sensor connector (M32).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage drop between the terminal 3 of the accelerator pedal position sensor harness connector and chassis ground.
      ■ Specification: Ground voltage drop within 200mV
   4) Is the voltage measured within specification?

YES

▶ Go to "Ground Open Inspection" procedure.

NO

▶ Repair the excessive resistance (poor connection) and then go to "Verification of Vehicle Repair" procedure.

2. Ground Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the accelerator pedal position sensor connector (M32) and the engine ECM connector(CFD-ECM, EFD-ECM).
   3) Measure resistance between the terminal 3 of the accelerator pedal position sensor harness connector and the terminal 45, 65 of the engine ECM connector(CFD-ECM).
      ■ Specification: Continuity (Below 1.0Ω)
   4) Is the resistance measured within specification?

YES

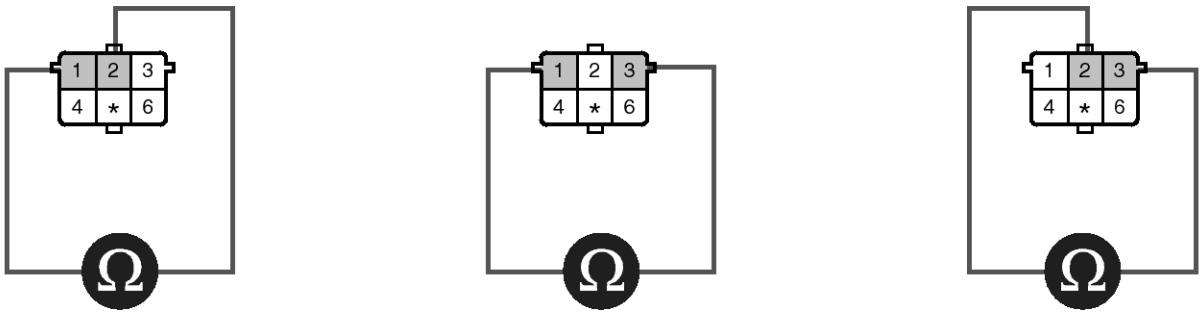
▶ Go to "Component Inspection" procedure.

NO

▶ Repair open wiring circuit and then go to "Verification of Vehicle Repair" procedure.

COMPONENT INSPECTION

1. Accelerator Pedal Position Sensor Component Inspection
   1) Turn the ignition OFF.
   2) Disconnect the accelerator pedal position sensor connector (M32).
   3) Measure resistance between the terminals ①-②, ②-③, ①-③ of the accelerator pedal position sensor.



■ Specification

Terminal resistance ①-②(Inoperative)	Terminal resistance ①-②(Operative)	Terminal resistance ①-③(Inoperative)	Terminal resistance ①-③(Operative)
Approx. 1.83㏀(Continuity)	Approx. 0.708㏀(Continuity)	Approx. 1.64㏀(Continuity)	Approx. 1.64㏀(Continuity)

Terminal resistance ②-③ (Inoperative)	Terminal resistance ②-③ (Operative)
Approx. 0.477㏀(Continuity)	Approx. 1.66㏀(Continuity)

SUDFLDTC9026L

4) Is the resistance measured within the specification?

YES

▶ Go to “Verification of Vehicle Repair” procedure.

NO

▶ Replace the accelerator pedal position sensor and then go to “Verification of Vehicle Repair” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

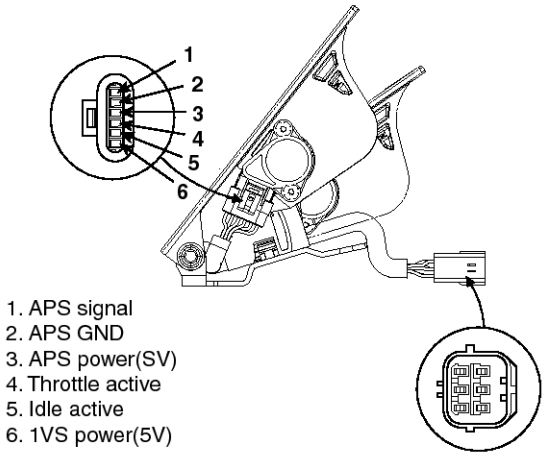
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P0221 Accel. Pedal Sensor No.2 Not Close

COMPONENT LOCATION



SUDFLDTC9070L

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   The accelerator pedal position sensor detects pedal position and sends signal to ECM. It is composed of two potentiometers(dual variable resistor type). Power supply is provided separately to detect acceleration condition exactly. The voltage of accelerator pedal position sensor is generated by potentiometer and the position of accelerator pedal is calculated by using characteristic curve programmed beforehand.

2. DTC DESCRIPTION

   The accelerator pedal sensor does not indicate idle state in spite of idle switch ON when the vehicle is not accelerated. When the accelerator pedal sensor "2" outputs above 1.5V and the accelerator pedal sensor "1" outputs 0.6~1.2V or more for more than 1,056ms, the ECM judges this as a fault and DTC is set. The possible causes are defective sensor, wiring problem etc.

DTC DETECTING CONDITION

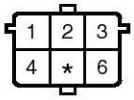
Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Defective wiring and sensor.
Enable Conditions	• At IG ON/ Running			
Threshold Value	• Idle s/w ON, Accelerator pedal sensor “2” output V ≥1.5V, 0.6 V≤Accelerator pedal sensor “1” output V ≤1.2V			
Diagnosis Time	• 1,056ms or higher			
Fail Safe	Fuel Cut	No	APS No.1 signal is selected.	
	Fuel limit	No		
	Check lamp	OFF		

SPECIFICATION

Terminal resistance ①-②(Inoperative)	Terminal resistance ①-②(Operative)	Terminal resistance ①-③(Inoperative)	Terminal resistance ①-③(Operative)
Approx. 1.83㏀(Continuity)	Approx. 0.708㏀(Continuity)	Approx. 1.64㏀(Continuity)	Approx. 1.64㏀(Continuity)

Terminal resistance ②-③ (Inoperative)	Terminal resistance ②-③ (Operative)
Approx. 0.477㏀(Continuity)	Approx. 1.66㏀(Continuity)

At idle(0%)	At full throttle(100%)
0.33V	3.85V



Sensor connector

SUDFLDTC9024L

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Accelerator pedal position” parameter on the scan tool.

Parameter	Reference Value
Accel. Pos. (At IG ON)	0.0%
Accel. Pos. (At idle)	0.0%
Accel. Pos. (At 1,500 rpm)	23%
Accel. Pos. (At 2,000 rpm)	34.5%

SIGNAL CIRCUIT INSPECTION

1. Signal Voltage Inspection
   1) Leave the accelerator pedal position sensor connector (M32) and the engine ECM connector(CFD-ECM) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 2 of the accelerator pedal position sensor harness connector and chassis ground.

      ■ Specification: Accelerator pedal position sensor signal power approx. 0.68V(At IG ON)
   4) Measure voltage between terminal 47, 67 of the engine ECM connector and chassis ground.

      ■ Specification : Accelerator pedal sensor signal power approx. 0.68V(Inoperative)
   5) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Go to “Signal Open Inspection” procedure.
2. Signal Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the accelerator pedal position sensor connector (M32) and the ECM connector(CFD-ECM, EFD-ECM).
   3) Measure resistance between terminal 2 of the accelerator pedal position sensor harness connector and terminal 47, 67 of the engine ECM connector(CFD-ECM).

      ■ Specification: Continuity
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Signal Short to Power Inspection” procedure.

      NO

      ▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.
3. Signal Short to Power Inspection
   1) Disconnect the accelerator pedal position sensor connector (M32) and the ECM connector(CFD-ECM, EFD-ECM).

2) Turn the ignition ON. Leave the engine OFF.
3) Measure voltage between terminal 2 of the accelerator pedal position sensor harness connector and chassis ground.
4) Measure voltage between terminal 47, 67 of the engine ECM connector and chassis ground.
   ■ Specification: Below 0~0.1V
5) Is the voltage measured within specification?

YES

▶ Go to "Signal Short to Ground Inspection" procedure.

NO

▶ Repair short to power and then go to "Verification of Vehicle Repair" procedure.

4. Signal Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the accelerator pedal position sensor connector (M32) and the ECM connector(CFD-ECM, EFD-ECM).
   3) Measure resistance between terminal 2 of the accelerator pedal position sensor harness connector and chassis ground.
   4) Measure resistance between terminal 47, 67 of the engine ECM connector and chassis ground.
      ■ Specification: Infinite
   5) Is the resistance measured within specification?

YES

▶ Go to "Power Supply Inspection" procedure.

NO

▶ Repair short to ground and then go to "Verification of Vehicle Repair" procedure.

POWER SUPPLY INSPECTION

1. Power Supply Voltage Inspection
   1) Leave the accelerator pedal position sensor connector (M32) and the engine ECM connector(CFD-ECM) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 1 of the accelerator pedal position sensor harness connector and chassis ground.
   4) Measure voltage between terminal 50 of the engine ECM connector and chassis ground.
      ■ Specification: Accelerator pedal sensor signal power approx. 5.0V
   5) Is the voltage measured within specification?

YES

▶ Go to "Ground Circuit Inspection" procedure.

NO

▶ Go to "Power Supply Open Inspection" procedure.

2. Power Supply Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the accelerator pedal position sensor connector (M32) and the engine ECM connector(CFD-ECM).
   3) Measure resistance between the terminal 1 of the accelerator pedal position sensor harness connector and terminal 50 of the engine ECM connector(CFD-ECM).
      ■ Specification: Continuity
   4) Is the resistance measured within specification?

YES

▶ Go to "Power Supply Short to Power Inspection" procedure.

NO

▶ Repair open circuit and then go to "Verification of Vehicle Repair" procedure.

3. Power Supply Short to Power Inspection
   1) Disconnect the accelerator pedal position sensor connector (M32) and ECM connector(CFD-ECM, EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 1 of the accelerator pedal position sensor harness connector and chassis ground.
   4) Measure voltage between the terminal 50 of the engine ECM harness connector and chassis ground.
      ■ Specification: Below 0~0.1V
   5) Is the voltage measured within specification?

YES

▶ Go to "Power Supply Short to Ground Inspection" procedure.

NO

▶ Repair short to power and then go to "Verification of Vehicle Repair" procedure.

4. Power Supply Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the accelerator pedal position sensor connector (M32) and ECM connector(CFD-ECM, EFD-ECM).
   3) Measure resistance between the terminal 1 of the accelerator pedal position sensor harness connector and chassis ground.
   4) Measure resistance between the terminal 50 of the engine ECM harness connector and chassis ground.

      ■ Specification: Infinite
   5) Is the resistance measured within specification?

      YES

      ▶ Go to "Ground Circuit Inspection" procedure.

      NO

      ▶ Repair short to ground and then go to "Verification of Vehicle Repair" procedure.

GROUND CIRCUIT INSPECTION

1. Ground Voltage Drop Inspection
   1) Disconnect the accelerator pedal position sensor connector (M32).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage drop between the terminal 3 of the accelerator pedal position sensor harness connector and chassis ground.

      ■ Specification: Ground voltage drop within 200mV
   4) Is the voltage measured within specification?

      YES

      ▶ Go to "Ground Open Inspection" procedure.

      NO

      ▶ Repair the excessive resistance (poor connection) and then go to "Verification of Vehicle Repair" procedure.
2. Ground Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the accelerator pedal position sensor connector (M32) and the engine ECM connector(CFD-ECM, EFD-ECM).
   3) Measure resistance between the terminal 3 of the accelerator pedal position sensor harness connector and the terminal 45, 65 of the engine ECM connector(CFD-ECM).

      ■ Specification: Continuity (Below 1.0Ω)
   4) Is the resistance measured within specification?

      YES

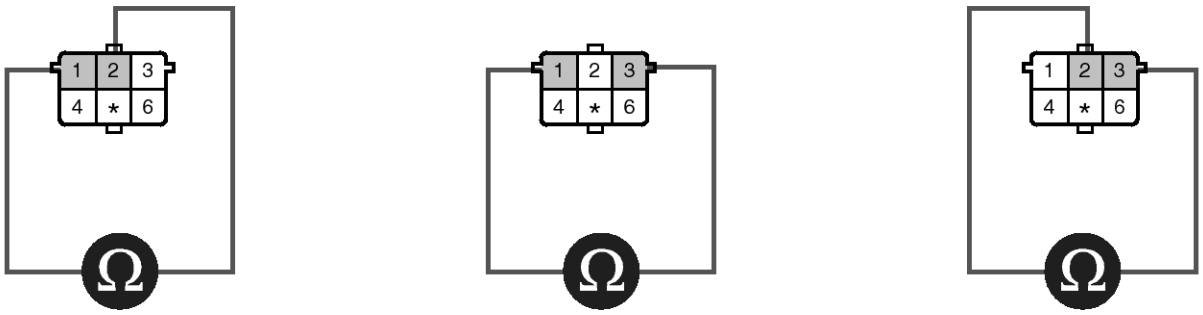
      ▶ Go to "Component Inspection" procedure.

      NO

      ▶ Repair open wiring circuit and then go to "Verification of Vehicle Repair" procedure.

COMPONENT INSPECTION

1. Accelerator Pedal Position Sensor Component Inspection
   1) Turn the ignition OFF.
   2) Disconnect the accelerator pedal position sensor connector (M32).
   3) Measure resistance between the terminals ①-②, ②-③, ①-③ of the accelerator pedal position sensor.



■ Specification

Terminal resistance ①-②(Inoperative)	Terminal resistance ①-②(Operative)	Terminal resistance ①-③(Inoperative)	Terminal resistance ①-③(Operative)
Approx. 1.83㏀(Continuity)	Approx. 0.708㏀(Continuity)	Approx. 1.64㏀(Continuity)	Approx. 1.64㏀(Continuity)

Terminal resistance ②-③ (Inoperative)	Terminal resistance ②-③ (Operative)
Approx. 0.477㏀(Continuity)	Approx. 1.66㏀(Continuity)

SUDFLDTC9026L

4) Is the resistance measured within the specification?

YES

▶ Go to “Verification of Vehicle Repair” procedure.

NO

▶ Replace the accelerator pedal position sensor and then go to “Verification of Vehicle Repair” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

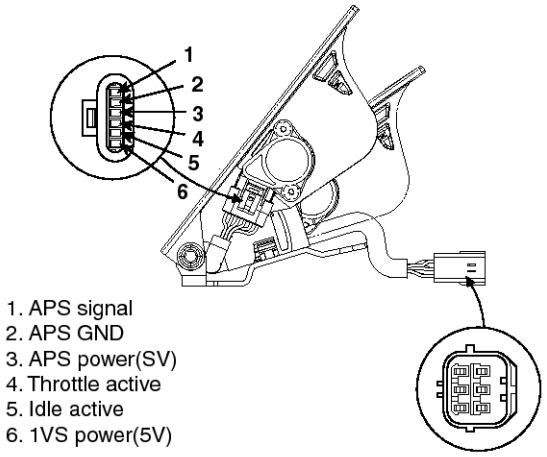
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P0222 Accel. Pedal Sensor No.2 Signal Too Low

COMPONENT LOCATION



1. APS signal
2. APS GND
3. APS power(SV)
4. Throttle active
5. Idle active
6. 1VS power(5V)

SUDFLDTC9070L

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   The accelerator pedal position sensor detects pedal position and sends signal to ECM. It is composed of two potentiometers(dual variable resistor type). Power supply is provided separately to detect acceleration condition exactly. The voltage of accelerator pedal position sensor is generated by potentiometer and the position of accelerator pedal is calculated by using characteristic curve programmed beforehand.

2. DTC DESCRIPTION

   When the accelerator pedal sensor "2" outputs below 0.2V for more than 1,056ms, the ECM judges this as a fault and DTC is set. The possible causes are defective sensor, wiring problem , open and short to terminal 67 of ECM connector(CFD-ECM). When the accelerator pedal sensor "2" is defective, ECM is controlled by using data of the accelerator pedal sensor "1" and the vehicle is possible to be driven in normal condition.

DTC DETECTING CONDITION

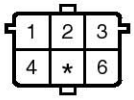
Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Defective wiring and sensor. • Open or short to ground of terminal 67 of ECM connector (CFD-ECM).
Enable Conditions	• At IG ON/ Running			
Threshold Value	• Below 0.2V			
Diagnosis Time	• 1,056ms or higher			
Fail Safe	Fuel Cut	No	APS No.1 signal is selected.	
	Fuel limit	No		
	Check lamp	OFF		

SPECIFICATION

Terminal resistance ①-②(Inoperative)	Terminal resistance ①-②(Operative)	Terminal resistance ①-③(Inoperative)	Terminal resistance ①-③(Operative)
Approx. 1.83㏀(Continuity)	Approx. 0.708㏀(Continuity)	Approx. 1.64㏀(Continuity)	Approx. 1.64㏀(Continuity)

Terminal resistance ②-③ (Inoperative)	Terminal resistance ②-③ (Operative)
Approx. 0.477㏀(Continuity)	Approx. 1.66㏀(Continuity)

At idle(0%)	At full throttle(100%)
0.33V	3.85V



Sensor connector

SUDFLDTC9024L

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Accelerator pedal position” parameter on the scan tool.

Parameter	Reference Value
Accel. Pos. (At IG ON)	0.0%
Accel. Pos. (At idle)	0.0%
Accel. Pos. (At 1,500 rpm)	23%
Accel. Pos. (At 2,000 rpm)	34.5%

SIGNAL CIRCUIT INSPECTION

1. Signal Voltage Inspection
   1) Leave the accelerator pedal position sensor connector (M32) and the engine ECM connector(CFD-ECM) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 2 of the accelerator pedal position sensor harness connector and chassis ground.

      ■ Specification: Accelerator pedal position sensor signal power approx. 0.68V (At IG ON)
   4) Measure voltage between terminal 67 of the engine ECM connector and chassis ground.

      ■ Specification: Accelerator pedal sensor signal power approx. 0.68V (Inoperative)
   5) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Go to “Signal Open Inspection” procedure.
2. Signal Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the accelerator pedal position sensor connector (M32) and the ECM connector(CFD-ECM, EFD-ECM).
   3) Measure resistance between terminal 2 of the accelerator pedal position sensor harness connector and terminal 67 of the engine ECM connector(CFD-ECM).

      ■ Specification: Continuity
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Signal Short to Ground Inspection” procedure.

      NO

      ▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.
3. Signal Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the accelerator pedal position sensor connector (M32) and the ECM

connector(CFD-ECM, EFD-ECM).

3) Measure resistance between terminal 2 of the accelerator pedal position sensor harness connector and chassis ground.
4) Measure resistance between terminal 67 of the engine ECM connector and chassis ground.
   ■ Specification: Infinite
5) Is the resistance measured within specification?

YES

▶ Go to "Power Supply Inspection" procedure.

NO

▶ Repair short to ground and then go to "Verification of Vehicle Repair" procedure.

POWER SUPPLY INSPECTION

1. Power Supply Voltage Inspection
   1) Leave the accelerator pedal position sensor connector (M32) and the engine ECM connector(CFD-ECM) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 1 of the accelerator pedal position sensor harness connector and chassis ground.
   4) Measure voltage between terminal 50 of the engine ECM connector and chassis ground.
      ■ Specification: Accelerator pedal sensor signal power approx. 5.0V
   5) Is the voltage measured within specification?

YES

▶ Go to "Ground Circuit Inspection" procedure.

NO

▶ Go to "Power Supply Open Inspection" procedure.

2. Power Supply Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the accelerator pedal position sensor connector (M32) and the engine ECM connector(CFD-ECM).
   3) Measure resistance between the terminal 1 of the accelerator pedal position sensor harness connector and terminal 50 of the engine ECM connector(CFD-ECM).
      ■ Specification: Continuity
   4) Is the resistance measured within specification?

YES

▶ Go to "Power Supply Short to Ground Inspection" procedure.

NO

▶ Repair open circuit and then go to "Verification of Vehicle Repair" procedure.

3. Power Supply Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the accelerator pedal position sensor connector (M32) and ECM connector(CFD-ECM, EFD-ECM).
   3) Measure resistance between the terminal 1 of the accelerator pedal position sensor harness connector and chassis ground.
   4) Measure resistance between the terminal 50 of the engine ECM harness connector and chassis ground.
      ■ Specification: Infinite
   5) Is the resistance measured within specification?

YES

▶ Go to "Ground Circuit Inspection" procedure.

NO

▶ Repair short to ground and then go to "Verification of Vehicle Repair" procedure.

GROUND CIRCUIT INSPECTION

1. Ground Voltage Drop Inspection
   1) Disconnect the accelerator pedal position sensor connector (M32).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage drop between the terminal 3 of the accelerator pedal position sensor harness connector and chassis ground.
      ■ Specification: Ground voltage drop within 200mV
   4) Is the voltage measured within specification?

YES

▶ Go to "Ground Open Inspection" procedure.

NO

▶ Repair the excessive resistance (poor

connection) and then go to “Verification of Vehicle Repair” procedure.

2. Ground Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the accelerator pedal position sensor connector (M32) and the engine ECM connector(CFD-ECM, EFD-ECM).
   3) Measure resistance between the terminal 3 of the accelerator pedal position sensor harness connector and the terminal 45, 65 of the engine ECM connector(CFD-ECM).
      ■ Specification: Continuity (Below 1.0Ω)
   4) Is the resistance measured within specification?

      YES

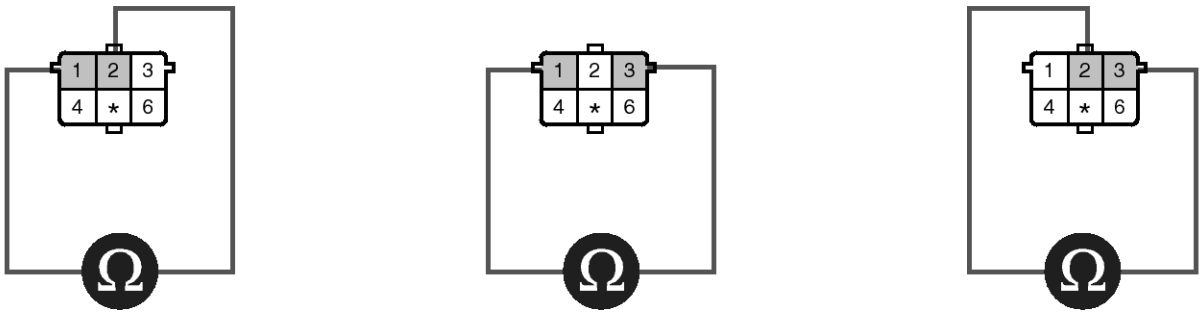
      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Repair open wiring circuit and then go to “Verification of Vehicle Repair” procedure.

COMPONENT INSPECTION

1. Accelerator Pedal Position Sensor Component Inspection
   1) Turn the ignition OFF.
   2) Disconnect the accelerator pedal position sensor connector (M32).
   3) Measure resistance between the terminals ①-②, ②-③, ①-③ of the accelerator pedal position sensor.



■ Specification

Terminal resistance ①-②(Inoperative)	Terminal resistance ①-②(Operative)	Terminal resistance ①-③(Inoperative)	Terminal resistance ①-③(Operative)
Approx. 1.83㏀(Continuity)	Approx. 0.708㏀(Continuity)	Approx. 1.64㏀(Continuity)	Approx. 1.64㏀(Continuity)

Terminal resistance ②-③ (Inoperative)	Terminal resistance ②-③ (Operative)
Approx. 0.477㏀(Continuity)	Approx. 1.66㏀(Continuity)

SUDFLDTC9026L

4) Is the resistance measured within the specification?

YES

▶ Go to “Verification of Vehicle Repair” procedure.

NO

▶ Replace the accelerator pedal position sensor and then go to “Verification of Vehicle Repair” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

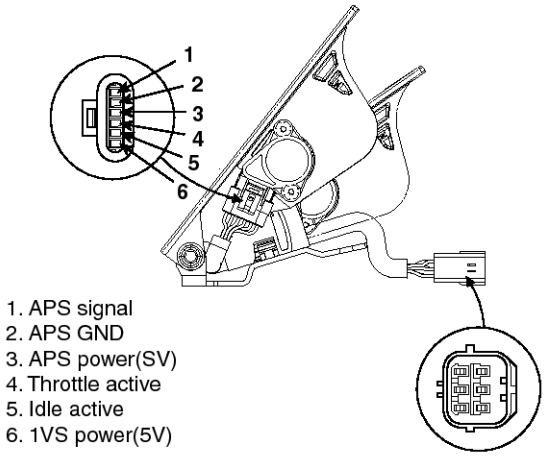
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P0223 Accel. Pedal Sensor No.2 Signal Too High

COMPONENT LOCATION



1. APS signal
2. APS GND
3. APS power(SV)
4. Throttle active
5. Idle active
6. 1VS power(5V)

SUDFLDTC9070L

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   The accelerator pedal position sensor detects pedal position and sends signal to ECM. It is composed of two potentiometers(dual variable resistor type). Power supply is provided separately to detect acceleration condition exactly. The voltage of accelerator pedal position sensor is generated by potentiometer and the position of accelerator pedal is calculated by using characteristic curve programmed beforehand.

2. DTC DESCRIPTION

   When the accelerator pedal sensor "2" outputs above 4.5V for more than 528ms, the ECM judges this as a fault and DTC is set. The possible causes are defective sensor, wiring problem etc.

DTC DETECTING CONDITION

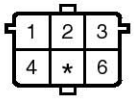
Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Defective wiring and sensor.
Enable Conditions	• At IG ON/ Running			
Threshold Value	• 4.5V or higher			
Diagnosis Time	• 528ms or higher			
Fail Safe	Fuel Cut	No	APS No.1 signal is selected.	
	Fuel limit	No		
	Check lamp	OFF		

SPECIFICATION

Terminal resistance ①-②(Inoperative)	Terminal resistance ①-②(Operative)	Terminal resistance ①-③(Inoperative)	Terminal resistance ①-③(Operative)
Approx. 1.83㏀(Continuity)	Approx. 0.708㏀(Continuity)	Approx. 1.64㏀(Continuity)	Approx. 1.64㏀(Continuity)

Terminal resistance ②-③ (Inoperative)	Terminal resistance ②-③ (Operative)
Approx. 0.477㏀(Continuity)	Approx. 1.66㏀(Continuity)

At idle(0%)	At full throttle(100%)
0.33V	3.85V



Sensor connector

SUDFLDTC9024L

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Accelerator pedal position” parameter on the scan tool.

Parameter	Reference Value
Accel. Pos. (At IG ON)	0.0%
Accel. Pos. (At idle)	0.0%
Accel. Pos. (At 1,500 rpm)	23%
Accel. Pos. (At 2,000 rpm)	34.5%

SIGNAL CIRCUIT INSPECTION

1. Signal Voltage Inspection
   1) Leave the accelerator pedal position sensor connector (M32) and the engine ECM connector(CFD-ECM) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 2 of the accelerator pedal position sensor harness connector and chassis ground.

      ■ Specification: Accelerator pedal position sensor signal power approx. 0.68V (At IG ON)
   4) Measure voltage between terminal 67 of the engine ECM connector and chassis ground.

      ■ Specification: Accelerator pedal sensor signal power approx. 0.68V (Inoperative)
   5) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Go to “Signal Short to Power Inspection” procedure.
2. Signal Short to Power Inspection
   1) Disconnect the accelerator pedal position sensor connector (M32) and the ECM connector(CFD-ECM, EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 2 of the accelerator pedal position sensor harness connector and chassis ground.
   4) Measure voltage between terminal 67 of the engine ECM connector and chassis ground.

      ■ Specification: Below 0~0.1V
   5) Is the voltage measured within specification?

      YES

      ▶ Go to “Power Supply Inspection” procedure.

      NO

      ▶ Repair short to power and then go to “Verification of Vehicle Repair” procedure.

POWER SUPPLY INSPECTION

1. Power Supply Voltage Inspection
   1) Leave the accelerator pedal position sensor connector (M32) and the engine ECM connector(CFD-ECM) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 1 of the accelerator pedal position sensor harness connector and chassis ground.
   4) Measure voltage between terminal 50 of the engine ECM connector and chassis ground.

      ■ Specification: Accelerator pedal sensor signal power approx. 5.0V
   5) Is the voltage measured within specification?

      YES

      ▶ Go to “Ground Circuit Inspection” procedure.

      NO

      ▶ Go to “Power Supply Short to Power Inspection” procedure.
2. Power Supply Short to Power Inspection
   1) Disconnect the accelerator pedal position sensor connector (M32) and ECM connector(CFD-ECM, EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 1 of the accelerator pedal position sensor harness connector and chassis ground.
   4) Measure voltage between the terminal 50 of the engine ECM harness connector and chassis ground.

      ■ Specification: Below 0~0.1V
   5) Is the voltage measured within specification?

      YES

      ▶ Go to “Ground Circuit Inspection” procedure.

      NO

      ▶ Repair short to power and then go to “Verification of Vehicle Repair” procedure.

GROUND CIRCUIT INSPECTION

1. Ground Voltage Drop Inspection
   1) Disconnect the accelerator pedal position sensor connector (M32).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage drop between the terminal 3 of the accelerator pedal position sensor harness connector and chassis ground.

      ■ Specification: Ground voltage drop within 200mV
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Ground Open Inspection” procedure.

      NO

      ▶ Repair the excessive resistance (poor connection) and then go to “Verification of Vehicle Repair” procedure.
2. Ground Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the accelerator pedal position sensor connector (M32) and the engine ECM connector(CFD-ECM, EFD-ECM).
   3) Measure resistance between the terminal 3 of the accelerator pedal position sensor harness connector and the terminal 45, 65 of the engine ECM connector(CFD-ECM).

      ■ Specification: Continuity (Below 1.0Ω)
   4) Is the resistance measured within specification?

      YES

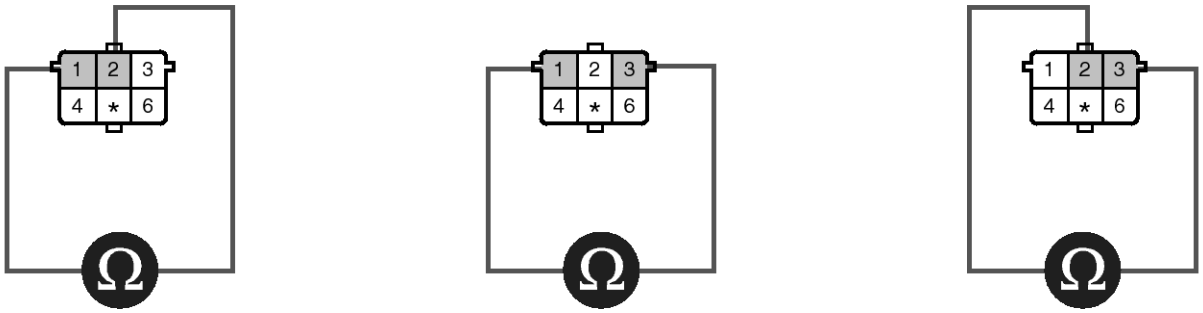
      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Repair open wiring circuit and then go to “Verification of Vehicle Repair” procedure.

COMPONENT INSPECTION

1. Accelerator Pedal Position Sensor Component Inspection
   1) Turn the ignition OFF.
   2) Disconnect the accelerator pedal position sensor connector (M32).
   3) Measure resistance between the terminals ①-②, ②-③, ①-③ of the accelerator pedal position sensor.



■ Specification

Terminal resistance ①-②(Inoperative)	Terminal resistance ①-②(Operative)	Terminal resistance ①-③(Inoperative)	Terminal resistance ①-③(Operative)
Approx. 1.83kΩ(Continuity)	Approx. 0.708kΩ(Continuity)	Approx. 1.64kΩ(Continuity)	Approx. 1.64kΩ(Continuity)

Terminal resistance ②-③ (Inoperative)	Terminal resistance ②-③ (Operative)
Approx. 0.477kΩ(Continuity)	Approx. 1.66kΩ(Continuity)

SUDFLDTC9026L

   4) Is the resistance measured within the specification?

YES

▶ Go to "Verification of Vehicle Repair" procedure.

NO

▶ Replace the accelerator pedal position sensor and then go to "Verification of Vehicle Repair" procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select "Diagnostic Trouble Codes (DTCs)" mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

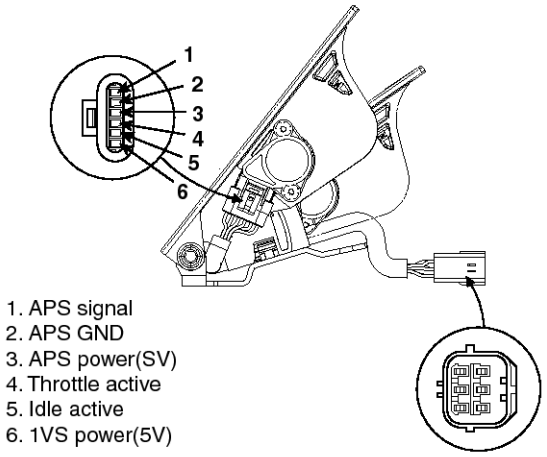
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P0225 Idle Switch Stuck Closed

COMPONENT LOCATION



SUDFLDTC9070L

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   Electronic control fuel injection is injected by engine control module(ECM) via factors received from various components. The accelerator pedal position sensor detects pedal position and sends signal to ECM. The idle switch is installed together with the accelerator pedal position sensor, the ECM controls fuel injection amount after the ECM received signal from the idle switch judges that the vehicle is under idle or acceleration.

2. DTC DESCRIPTION

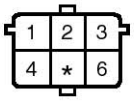
   If it will take 10,496ms or more with the condition that the idle switch is not opened even though the idle switch is depressed, the ECM judges this as a fault and DTC is set. The possible causes are switch stuck, or wiring problem etc.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Idle switch stuck • Open circuit of terminals 45 and 65 of ECM (CFD-ECM) • Power short to terminal 7 6 of ECM.
Enable Conditions	• At IG ON/ Running			
Threshold Value	• Idle switch does not open at depressing the accelerator pedal.			
Diagnosis Time	• 10,496ms or higher			
Fail Safe	Fuel Cut	No		
	Fuel limit	Yes		
	Check lamp	OFF		

SPECIFICATION

Idle switch	Specification	
	Idle (0%)	Full open (100%)
Output voltage	B+ V	0 V



Sensor connector

SUDFLDTC9040L

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Accelerator pedal position” parameter on the scan tool.

Parameter	Reference Value
Accel. Pos. (At IG ON)	0.0%
Accel. Pos. (At idle)	0.0%
Accel. Pos. (At 1,500 rpm)	23%
Accel. Pos. (At 2,000 rpm)	34.5%

SIGNAL CIRCUIT INSPECTION

1. Signal Voltage Inspection
   1) Leave the accelerator pedal position sensor connector (M32) and the engine ECM connector(CFD-ECM) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 6 of the accelerator pedal position sensor harness connector and chassis ground.

      ■ Specification:

      Idle switch signal power B+ V (When the accelerator pedal does not operate)

      Idle switch signal power approx. 0 V (When the accelerator pedal operates)
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Power Supply Inspection” procedure.

      NO

      ▶ Go to “Signal Open Inspection” procedure.
2. Signal Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the accelerator pedal position sensor connector (M32) and the ECM connector(CFD-ECM).
   3) Measure resistance between terminal 6 of the accelerator pedal position sensor harness connector and terminal 76 of the engine ECM.

      ■ Specification: Continuity
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Signal Short to Power Inspection” procedure.

      NO

      ▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.
3. Signal Short to Power Inspection
   1) Disconnect the accelerator pedal position sensor connector (M32) and the ECM connector(CFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 6 of the accelerator pedal position sensor harness connector and chassis ground.
   4) Measure voltage between terminal 76 of the engine ECM connector and chassis ground with the accelerator pedal operated.

      ■ Specification: Below 0~0.1V
   5) Is the voltage measured within specification?

      YES

      ▶ Go to “Power Supply Inspection” procedure.

NO

▶ Repair short to power and then go to "Verification of Vehicle Repair" procedure.

POWER SUPPLY INSPECTION

1. Power Supply Voltage Inspection
   1) Leave the accelerator pedal position sensor connector (M32) and the engine ECM connector(CFD-ECM) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 4 of the accelerator pedal position sensor harness connector and chassis ground.
      ■ Specification: Idle switch supply power approx. B+ V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to "Component Inspection" procedure.

      NO

      ▶ Go to "Power Supply Open Inspection" procedure.
2. Power Supply Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the fuse #12 (5A) and the accelerator pedal position sensor connector (M32).
   3) Measure resistance between the terminal 4 of the accelerator pedal position sensor harness connector (M32) and the fuse #12 (5A) terminal.
      ■ Specification: Continuity
   4) Is the resistance measured within specification?

      YES

      ▶ Go to "Power Supply Short to Power Inspection" procedure.

      NO

      ▶ Repair open circuit and then go to "Verification of Vehicle Repair" procedure.
3. Power Supply Short to Power Inspection
   1) Disconnect the accelerator pedal position sensor connector (M32) and the fuse #12 (5A).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 4 of the accelerator pedal position sensor harness connector and chassis ground.
      ■ Specification: Below 0~0.1V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to "Component Inspection" procedure.

      NO

      ▶ Repair short to power and then go to "Verification of Vehicle Repair" procedure.

COMPONENT INSPECTION

1. Accelerator Pedal Position Sensor Component Inspection
   1) Turn the ignition OFF.
   2) Disconnect the accelerator pedal position sensor connector (M32).
   3) Measure resistance between the terminals 4 and 5 of the accelerator pedal position sensor connector.

■ Specification

Resistance between terminals 4 and 6 (When the accelerator pedal does not operate)	Resistance between terminals 4 and 6 (When the accelerator pedal operates)
Continuity	Infinite

   4) Is the resistance measured within the specification?

      YES

      ▶ Go to "Verification of Vehicle Repair" procedure.

      NO

      ▶ Replace the accelerator pedal position sensor and then go to "Verification of Vehicle Repair" procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

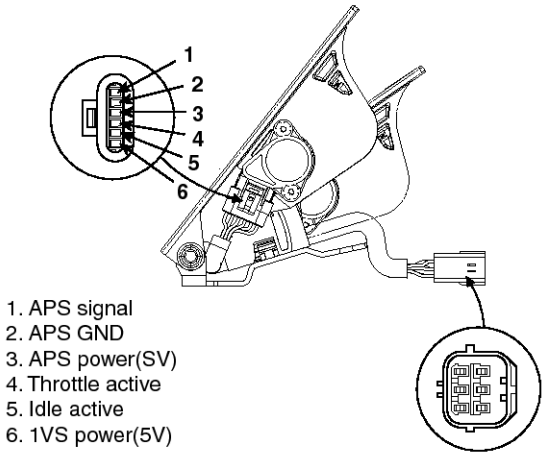
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P0226 Idle Switch Stuck Opened

COMPONENT LOCATION



1. APS signal
2. APS GND
3. APS power(SV)
4. Throttle active
5. Idle active
6. 1VS power(5V)

SUDFLDTC9070L

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   Electronic control fuel injection is injected by engine control module(ECM) via factors received from various components. The accelerator pedal position sensor detects pedal position and sends signal to ECM. The idle switch is installed together with the accelerator pedal position sensor, the ECM controls fuel injection amount after the ECM received signal from the idle switch judges that the vehicle is under idle or acceleration.

2. DTC DESCRIPTION

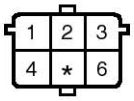
   If it takes 10,496ms or more with the condition that the idle switch is opened even though the idle switch is not depressed, the ECM judges this as a fault and DTC is set. The possible causes are switch stuck, defective ECM or wiring problem etc.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Idle switch stuck • Open circuit of terminal 7 6 of ECM
Enable Conditions	• At IG ON/ Running			
Threshold Value	• Idle switch is opened when the accelerator pedal does not de-press.			
Diagnosis Time	• 10,496ms or higher			
Fail Safe	Fuel Cut	No		
	Fuel limit	Yes		
	Check lamp	OFF		

SPECIFICATION

Idle switch	Specification	
	Idle (0%)	Full open (100%)
Output voltage	B+ V	0 V



Sensor connector

SUDFLDTC9040L

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Accelerator pedal position” parameter on the scan tool.

Parameter	Reference Value
Accel. Pos. (At IG ON)	0.0%
Accel. Pos. (At idle)	0.0%
Accel. Pos. (At 1,500 rpm)	23%
Accel. Pos. (At 2,000 rpm)	34.5%

SIGNAL CIRCUIT INSPECTION

1. Signal Voltage Inspection
   1) Leave the accelerator pedal position sensor connector (M32) and the engine ECM connector(CFD-ECM) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 6 of the accelerator pedal position sensor harness connector and chassis ground.

      ■ Specification:

      Idle switch signal power B+ V (When the accelerator pedal does not operate)

      Idle switch signal power approx. 0 V (When the accelerator pedal operates)
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Power Supply Inspection” procedure.

      NO

      ▶ Go to “Signal Open Inspection” procedure.
2. Signal Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the accelerator pedal position sensor connector (M32) and the ECM connector(CFD-ECM).
   3) Measure resistance between terminal 6 of the accelerator pedal position sensor harness connector and terminal 76 of the engine ECM.

      ■ Specification: Continuity
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Signal Short to Power Inspection” procedure.

      NO

      ▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.
3. Signal Short to Power Inspection
   1) Disconnect the accelerator pedal position sensor connector (M32) and the ECM connector(CFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 6 of the accelerator pedal position sensor harness connector and chassis ground.
   4) Measure voltage between terminal 76 of the engine ECM connector and chassis ground with the accelerator pedal operated.

      ■ Specification: Below 0~0.1V
   5) Is the voltage measured within specification?

      YES

      ▶ Go to “Power Supply Inspection” procedure.

NO

▶ Repair short to power and then go to "Verification of Vehicle Repair" procedure.

POWER SUPPLY INSPECTION

1. Power Supply Voltage Inspection
   1) Leave the accelerator pedal position sensor connector (M32) and the engine ECM connector(CFD-ECM) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 4 of the accelerator pedal position sensor harness connector and chassis ground.
      ■ Specification: Idle switch supply power approx. B+ V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to "Component Inspection" procedure.

      NO

      ▶ Go to "Power Supply Open Inspection" procedure.
2. Power Supply Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the fuse #12 (5A) and the accelerator pedal position sensor connector (M32).
   3) Measure resistance between the terminal 4 of the accelerator pedal position sensor harness connector (M32) and the fuse #12 (5A).
      ■ Specification: Continuity
   4) Is the resistance measured within specification?

      YES

      ▶ Go to "Power Supply Short to Power Inspection" procedure.

      NO

      ▶ Repair open circuit and then go to "Verification of Vehicle Repair" procedure.
3. Power Supply Short to Power Inspection
   1) Disconnect the accelerator pedal position sensor connector (M32) and the fuse #12 (5A).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 4 of the accelerator pedal position sensor harness connector and chassis ground.
      ■ Specification: Below 0~0.1V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to "Component Inspection" procedure.

      NO

      ▶ Repair short to power and then go to "Verification of Vehicle Repair" procedure.

COMPONENT INSPECTION

1. Accelerator Pedal Position Sensor Component Inspection
   1) Turn the ignition OFF.
   2) Disconnect the accelerator pedal position sensor connector (M32).
   3) Measure resistance between the terminals 4 and 5 of the accelerator pedal position sensor connector.

■ Specification

Resistance between terminals 4 and 6 (When the accelerator pedal does not operate)	Resistance between terminals 4 and 6 (When the accelerator pedal operates)
Continuity	Infinite

   4) Is the resistance measured within the specification?

      YES

      ▶ Go to "Verification of Vehicle Repair" procedure.

      NO

      ▶ Replace the accelerator pedal position sensor and then go to "Verification of Vehicle Repair" procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

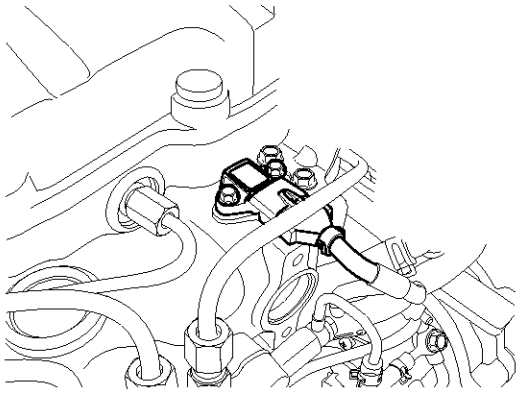
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P0237 Boost Pressure Sensor Signal Too Low

COMPONENT LOCATION



SDFFL7102D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   Engine control module(ECM) should detect the exact air amount coming into engine to determine basic fuel injection amount supplied to engine. The booster pressure sensor is used to measure air amount coming into engine indirectly and it measures pressure in the intake manifold. It delivers analogue output signal commensurate with absolute pressure according to pressure change in the intake manifold to ECM. ECM uses the signal as the basic information by calculating intake air amount together with engine revolution.

   Booster pressure sensor is installed on the intake manifold to measure pressure in the intake manifold. The intake air temperature sensor is built-in booster pressure sensor. The intake pressure sensor is composed of piezo-electricity and hybrid IC amplifying output signal of piezo-electricity. Piezo-electricity is a kind of silicon diaphragm type using piezo resistance effect, one part of it is composed of 100% vacuum chamber and the other part of it is composed of structure that the pressure of intake manifold is applied.

   Output value is obtained by silicon change according to the pressure change of intake manifold.

2. DTC DESCRIPTION

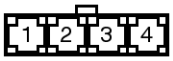
   If the output value of the booster pressure sensor is detected below 0.1V for 10,496ms, the ECM judges this as a fault and DTC is set. Check lamp and MIL come on together when the condition continued for 2 driving cycle times. Check lamp will go off after 3 driving cycle times when the system returns to normal. The probable causes are open circuit of terminal 14 of ECM connector(EFD-ECM), open or short to ground. In case of fail safe, the vehicle is possible to drive but lack of engine power and smoke will occur since engine power is limited due to fuel correction and timing stop according as intake pressure is fixed to control with 100Kpa and fuel amount is limited to below 40mm³/st.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Open or short to ground of terminal 14 of the engine ECM (EFD-ECM) • Defective booster pressure sensor
Enable Conditions	• At IG ON/ Running			
Threshold Value	• Below 0.1V			
Diagnosis Time	• 10,496ms or higher			
Fail Safe	Fuel Cut	No	• Fuel amount sets to below 40㎣/st. • Booster pressure sets to 100kpa. • Engine output power limit(Fuel correction and timing stop) • EGR control release	
	Fuel limit	Yes		
	Check lamp	ON		

SPECIFICATION

Item	Specification
Output signal	Approx. 0.94V
Intake pressure	Approx. 100kpa



Sensor connector

SUDFLDTC9042L

WAVEFORM

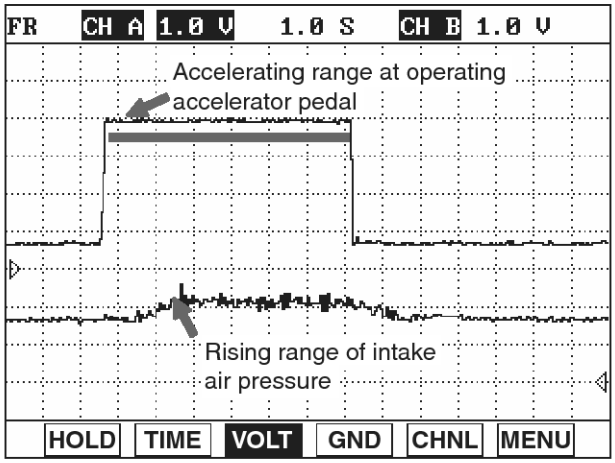


Fig. 1

The illustration above is the booster pressure sensor waveform measured while performing from idle condition to acceleration. Check that the output value increases when accelerating.

SUDFLDTC9043L

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature.
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Engine intake pressure” parameter on the scan tool.

NOTICE

The value of “Engine intake pressure” varies according to driving condition depending on DTC detecting condition. In case of fail safe, be sure to check that the output value of “Engine intake pressure” changes according as “Atmospheric pressure/ fuel pressure” changes.

Parameter	Reference Value
Intake manifold pressure (At IG ON)	101 kpa
Intake manifold pressure (At idle)	103 kpa
Intake manifold pressure (At 1,500rpm)	111 kpa
Intake manifold pressure (At 2,000rpm)	123 kpa

SIGNAL CIRCUIT INSPECTION

1. Signal Voltage Inspection
   1) Leave the booster pressure sensor connector (EFD14) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 1 of the booster pressure sensor harness connector and chassis ground.

      ■ Specification : Booster pressure sensor signal power approx. 1.17V

      Note) The voltage value varies according to intake air pressure.
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Go to “Signal Open Inspection” procedure.

2. Signal Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the booster pressure sensor connector (EFD14) and the ECM connector(EFD-ECM).
   3) Measure resistance between terminal 1 of the booster pressure sensor harness connector and terminal 14 of the engine ECM(EFD-ECM).

      ■ Specification: Continuity
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Signal Short to Ground Inspection” procedure.

      NO

      ▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.
3. Signal Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the booster pressure sensor connector (EFD14) and the ECM connector(EFD-ECM).
   3) Measure resistance between terminal 1 of the booster pressure sensor harness connector and chassis ground.

      ■ Specification: Infinite
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Power Supply Inspection” procedure.

      NO

      ▶ Repair short to ground and then go to “Verification of Vehicle Repair” procedure.

POWER SUPPLY INSPECTION

1. Power Supply Voltage Inspection
   1) Leave the booster pressure sensor connector (EFD14) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 2 of the booster pressure sensor harness connector and chassis ground.
      ■ Specification: Engine ECM output power approx. 5.1V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Ground Circuit Inspection” procedure.

      NO

      ▶ Go to “Power Supply Open Inspection” procedure.
2. Power Supply Open Inspection
   1) Turn the ignition ON.
   2) Disconnect the booster pressure sensor connector (EFD14) and the ECM connector(EFD-ECM).
   3) Measure resistance between terminal 2 of the booster pressure sensor harness connector and terminal 48 of the engine ECM(EFD-ECM).
      ■ Specification: Continuity
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Power Supply Short to Ground Inspection” procedure.

      NO

      ▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.
3. Power Supply Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the booster pressure sensor connector (EFD14) and the ECM connector(EFD-ECM).
   3) Measure resistance between terminal 2 of the booster pressure sensor harness connector and chassis ground.
      ■ Specification: Infinite
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Ground Circuit Inspection” procedure.

      NO

      ▶ Repair short to ground and then go to “Verification of Vehicle Repair” procedure.

GROUND CIRCUIT INSPECTION

1. Ground Voltage Drop Inspection
   1) Disconnect the booster pressure sensor connector (EFD14).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage drop between terminal 4 of the booster pressure sensor harness connector and chassis ground.
      ■ Specification: Ground voltage drop within 200mV
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Ground Open Inspection” procedure.

      NO

      ▶ Repair the cause of the excessive resistance (poor connection) and go to “Verification of Vehicle Repair” procedure.
2. Ground Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the booster pressure sensor connector (EFD14) and the ECM connector(EFD-ECM).
   3) Measure resistance between terminal 4 of the booster pressure sensor harness connector and terminal 23 of the engine ECM(EFD-ECM).
      ■ Specification: Continuity
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.

COMPONENT INSPECTION

1. Booster Pressure Sensor Visual Check
   1) Turn the ignition OFF.
   2) Disconnect the booster pressure sensor connector (EFD14).
   3) Check the terminal of booster pressure sensor connector for corrosion and contamination.
   4) Check the booster pressure sensor for torque and fuel leak.
   5) Is there any problem for the booster pressure sensor?

      YES

      ▶ Replace the booster pressure sensor if necessary and go to “Verification of Vehicle Repair” procedure.

      NO

      ▶ Go to “Booster Pressure Sensor Waveform Inspection” procedure.
2. Booster Pressure Sensor Waveform Inspection
   1) Turn the ignition OFF.
   2) Connect the booster pressure sensor connector (EFD14).
   3) Connect the oscilloscope probe to the terminal 1 of booster pressure sensor (EFD14).
   4) Check the waveforms of idle and accelerating condition.

      ■ Specification: Refer to “Standard waveform” of general information.
   5) Does the waveforms of booster pressure sensor display normally?

      YES

      ▶ Go to “Verification of Vehicle Repair” procedure.

      NO

      ▶ Replace the booster pressure sensor and go to “Verification of Vehicle Repair” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

   YES

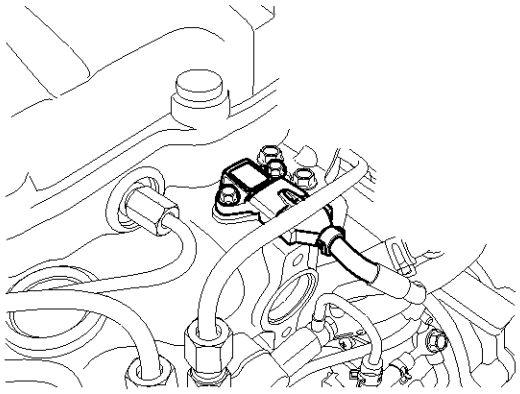
   ▶ Go to the applicable DTC procedure.

   NO

   ▶ System OK

P0238 Boost Pressure Sensor Signal Too High

COMPONENT LOCATION



SDFFL7102D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   Engine control module(ECM) should detect the exact air amount coming into engine to determine basic fuel injection amount supplied to engine. The booster pressure sensor is used to measure air amount coming into engine indirectly and it measures pressure in the intake manifold. It delivers analogue output signal commensurate with absolute pressure according to pressure change in the intake manifold to ECM. ECM uses the signal as the basic information by calculating intake air amount together with engine revolution.

   Booster pressure sensor is installed on the intake manifold to measure pressure in the intake manifold. The intake air temperature sensor is built-in booster pressure sensor. The intake pressure sensor is composed of piezo-electricity and hybrid IC amplifying output signal of piezo-electricity. Piezo-electricity is a kind of silicon diaphragm type using piezo resistance effect, one part of it is composed of 100% vacuum chamber and the other part of it is composed of structure that the pressure of intake manifold is applied.

   Output value is obtained by silicon change according to the pressure change of intake manifold.

2. DTC DESCRIPTION

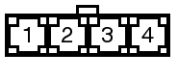
   If the output value of the booster pressure sensor is detected above 4.85V for 10,496ms, the ECM judges this as a fault and DTC is set. Check lamp and MIL come on together when the condition continued for 2 driving cycle times. Check lamp will go off after 3 driving cycle times when the system returns to normal. The probable causes are short circuit of terminal 14 of ECM connector(EFD-ECM) or sensor malfunction. In case of fail safe, the vehicle is possible to drive but lack of engine power and smoke will occur since engine power is limited due to fuel correction and timing stop according as intake pressure is fixed to control with 100Kpa and fuel amount is limited to below 40mm³/st.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Short to power of terminal 14 of the engine ECM (EF-D-ECM) • Defective booster pressure sensor
Enable Conditions	• At IG ON/ Running			
Threshold Value	• Above 4.85V			
Diagnosis Time	• 10,496ms or higher			
Fail Safe	Fuel Cut	No	• Fuel amount sets to below 40㎣/st. • Booster pressure sets to 100kpa. • Engine output power limit(Fuel correction and timing stop)	
	Fuel limit	Yes		
	Check lamp	ON		

SPECIFICATION

Item	Specification
Output signal	Approx. 0.94V
Intake pressure	Approx. 100kpa



Sensor connector

SUDFLDTC9042L

WAVEFORM

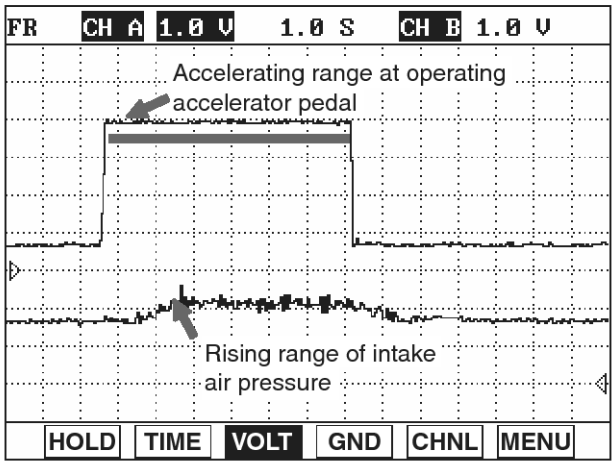


Fig. 1

The illustration above is the booster pressure sensor waveform measured while performing from idle condition to acceleration. Check that the output value increases when accelerating.

SUDFLDTC9043L

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature.
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Engine intake pressure” parameter on the scan tool.

NOTICE

The value of “Engine intake pressure” varies according to driving condition depending on DTC detecting condition. In case of fail safe, be sure to check that the output value of “Engine intake pressure” changes according as “Atmospheric pressure/ fuel pressure” changes.

Parameter	Reference Value
Intake manifold pressure (At IG ON)	101 kpa
Intake manifold pressure (At idle)	103 kpa
Intake manifold pressure (At 1,500rpm)	111 kpa
Intake manifold pressure (At 2,000rpm)	123 kpa

SIGNAL CIRCUIT INSPECTION

1. Signal Voltage Inspection
   1) Leave the booster pressure sensor connector (EFD14) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 1 of the booster pressure sensor harness connector and chassis ground.

      ■ Specification : Booster pressure sensor signal power approx. 1.17V

      Note) The voltage value varies according to intake air pressure.
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Go to “Signal Short to Power Inspection” procedure.
2. Signal Short to Power Inspection
   1) Disconnect the booster pressure sensor connector (EFD14) and the ECM connector(EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 1 of the booster pressure sensor harness connector and chassis ground.

      ■ Specification: Below 0~0.1V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Power Supply Inspection” procedure.

      NO

      ▶ Repair short to power and then go to “Verification of Vehicle Repair” procedure.

POWER SUPPLY INSPECTION

1. Power Supply Voltage Inspection
   1) Leave the booster pressure sensor connector (EFD14) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 2 of the booster pressure sensor harness connector and chassis ground.

      ■ Specification: Engine ECM output power approx. 5.1V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Ground Circuit Inspection” procedure.

      NO

      ▶ Go to “Power Supply Short to Power Inspection” procedure.
2. Power Supply Short to Power Inspection
   1) Disconnect the booster pressure sensor connector (EFD14) and the ECM connector(EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 2 of the booster pressure sensor harness connector and chassis ground.

      ■ Specification: Below 0~0.1V
   4) Is the voltage measured within specification?

      YES

▶ Go to “Ground Circuit Inspection” procedure.

NO

▶ Repair short to power and then go to “Verification of Vehicle Repair” procedure.

GROUND CIRCUIT INSPECTION

1. Ground Voltage Drop Inspection
   1) Disconnect the booster pressure sensor connector (EFD14).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage drop between terminal 4 of the booster pressure sensor harness connector and chassis ground.

      ■ Specification: Ground voltage drop within 200mV
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Ground Open Inspection” procedure.

      NO

      ▶ Repair the cause of the excessive resistance (poor connection) and go to “Verification of Vehicle Repair” procedure.
2. Ground Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the booster pressure sensor connector (EFD14) and the ECM connector(EFD-ECM).
   3) Measure resistance between terminal 4 of the booster pressure sensor harness connector and terminal 23 of the engine ECM(EFD-ECM).

      ■ Specification: Continuity
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.

COMPONENT INSPECTION

1. Booster Pressure Sensor Visual Check
   1) Turn the ignition OFF.
   2) Disconnect the booster pressure sensor connector (EFD14).
   3) Check the terminal of booster pressure sensor connector for corrosion and contamination.
   4) Check the booster pressure sensor for torque and fuel leak.
   5) Is there any problem for the booster pressure sensor?

      YES

      ▶ Replace the booster pressure sensor if necessary and go to “Verification of Vehicle Repair” procedure.

      NO

      ▶ Go to “Booster Pressure Sensor Waveform Inspection” procedure.
2. Booster Pressure Sensor Waveform Inspection
   1) Turn the ignition OFF.
   2) Connect the booster pressure sensor connector (EFD14).
   3) Connect the oscilloscope probe to the terminal 1 of booster pressure sensor (EFD14).
   4) Check the waveforms of idle and accelerating condition.

      ■ Specification: Refer to “Standard waveform” of general information.
   5) Does the waveforms of booster pressure sensor display normally?

      YES

      ▶ Go to “Verification of Vehicle Repair” procedure.

      NO

      ▶ Replace the booster pressure sensor and go to “Verification of Vehicle Repair” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

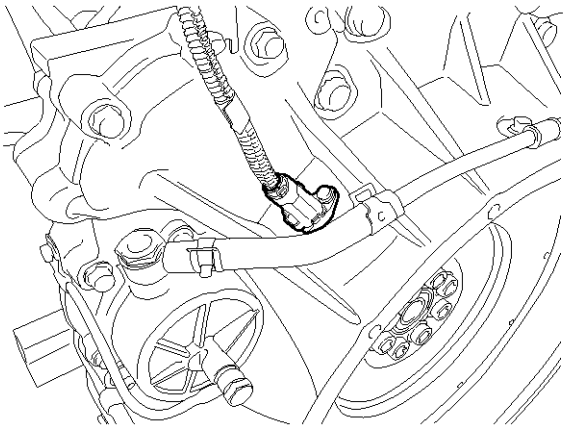
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P0335 Crank Sensor No Pulse

COMPONENT LOCATION



SUDFL8231D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   The engine piston position is used for determining fuel injection timing, all pistons are connected to crankshaft via connecting rod. After the crankshaft position sensor detects piston position, it sends signal to the ECM to determine fuel injection timing and engine speed. The camshaft position sensor is used to detect the top dead center of compression stroke of each cylinder. Based on these signals, the ECM determines fuel injection timing and injection order of each cylinder.

2. DTC DESCRIPTION

   If the number of NE pulse is detected below one time per engine one revolution(360˚CA) for 3,960 CA or more, the ECM judges this as a fault and DTC is set. Check lamp and MIL come on together when the condition continued for 2 driving cycle times. Check lamp will go off after 3 driving cycle times when the system returns to normal. The probable causes are crankshaft sensor malfunction, open or short to terminals 9 and 29 of ECM connector(EFD-ECM). The vehicle is possible to drive normally, but starting-ability is bad and exhaust brake operation to protect engine system will be stopped due to starting time delay since ECM receives signal only from pulse of camshaft position sensor(G).

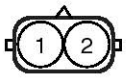
DTC DETECTING CONDITION

<table>
<tr><th>Item</th><th colspan="4">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="4">• Voltage monitoring</td><td rowspan="6">• Defective crank shaft sensor
• Open / short to terminals 9, 29 of the engine ECM(EFD-ECM)</td></tr>
<tr><td>Enable Conditions</td><td colspan="4">• Engine running</td></tr>
<tr><td>Threshold Value</td><td colspan="4">• The number of NE pulse is below one time every 360˚ CA (engine one revolution).</td></tr>
<tr><td>Diagnosis Time</td><td colspan="4">• 1,800.1 CA or higher</td></tr>
<tr><td rowspan="3">Fail Safe</td><td>Fuel Cut</td><td>No</td><td rowspan="3">• System is controlled by the pulse of camshaft position sensor.</td></tr>
<tr><td>Fuel limit</td><td>Yes</td></tr>
<tr><td>Check lamp</td><td>ON</td></tr>
</table>

SPECIFICATION

Temperature(℃)	Resistance between terminals 1 and 2(Ω)
20	125±17

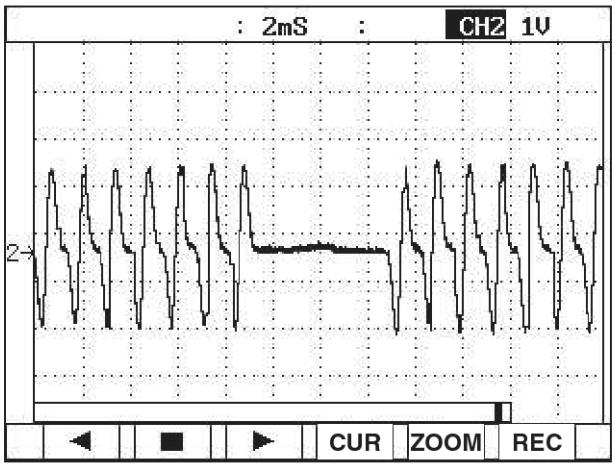
Air gap	1.50±0.5mm



Sensor connector

SUDFLDTC9037L

WAVEFORM



SUDFLDTC9096L

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature.
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Engine rpm” parameter on the scan tool.

NOTICE

The value of “Engine rpm” varies with driving condition according to DTC detecting condition. In case of failure, be sure to compare “Fuel injection amount” as the fuel injection is reactivated when the engine rpm drops to below 3,500rpm after fuel injection stops when “Engine rpm” is above 4,000rpm.

Parameter	Reference Value
Crank sensor active (At IG ON)	OFF
Crank sensor active (At idle)	ON

POWER SUPPLY INSPECTION

1. N.E Sensor (+) Voltage Inspection
   1) Leave the crank position sensor connector (EFD18) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 1 of crank position sensor harness connector and chassis ground.

      ■ Specification: ETC control module output power approx. 2.5V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Ground Circuit Inspection” procedure.

      NO

      ▶ Go to “N.E Sensor (+) Open Inspection” procedure.
2. N.E Sensor (+) Open Inspection
   1) Turn the ignition OFF.

2) Disconnect the crank position sensor connector (EFD18) and ECM connector(EFD-ECM).
3) Measure resistance between the terminal 1 of crank position sensor harness connector and terminal 29 of the engine ECM connector(EFD-ECM).
   ■ Specification: Continuity
4) Is the resistance measured within specification?

YES

▶ Go to "N.E Sensor (+) Short to Power Inspection" procedure.

NO

▶ Repair open circuit and then go to "Verification of Vehicle Repair" procedure.

3. N.E Sensor (+) Short to Power Inspection
   1) Disconnect the crank position sensor connector (EFD18) and ECM connector(EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 1 of crank position sensor harness connector and chassis ground.
      ■ Specification: Below 0~0.1V
   4) Is the voltage measured within specification?

YES

▶ Go to "N.E Sensor (+) Short to Ground Inspection" procedure.

NO

▶ Repair short to power and then go to "Verification of Vehicle Repair" procedure.

4. N.E Sensor (+) Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the crank position sensor connector (EFD18) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 1 of crank position sensor harness connector and chassis ground.
      ■ Specification: Infinite
   4) Is the resistance measured within specification?

YES

▶ Go to "Ground Circuit Inspection" procedure.

NO

▶ Repair short to ground and then go to "Verification of Vehicle Repair" procedure.

GROUND CIRCUIT INSPECTION

1. N.E Sensor (-) Voltage Inspection
   1) Leave the crank position sensor connector (EFD18) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage drop between the terminal 2 of the crank position sensor harness connector and chassis ground.
      ■ Specification: ETC control module output power approx. 2.5V
   4) Is the voltage measured within specification?

YES

▶ Go to "Shield Circuit Inspection" procedure.

NO

▶ Go to "N.E Sensor (-) Open Inspection" procedure.

2. N.E Sensor (-) Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the crank position sensor connector (EFD18) and the engine ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 2 of the crank position sensor harness connector and the terminal 9 of the engine ECM connector(EFD-ECM).
      ■ Specification: Continuity (Below 1.0Ω)
   4) Is the resistance measured within specification?

YES

▶ Go to "N.E Sensor (-) Short to Power Inspection" procedure.

NO

▶ Repair open wiring circuit and then go to "Verification of Vehicle Repair" procedure.

3. N.E Sensor (-) Short to Power Inspection
   1) Disconnect the crank position sensor connector (EFD18) and the engine ECM connector(EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.

3) Measure voltage between the terminal 2 of the crank position sensor harness connector and the chassis ground.

■ Specification: Below 0~0.1V

4) Is the voltage measured within specification?

YES

▶ Go to "N.E Sensor (-) Short to Ground Inspection" procedure.

NO

▶ Repair short to power and then go to "Verification of Vehicle Repair" procedure.

4. N.E Sensor (-) Short to Ground Inspection

1) Turn the ignition OFF.

2) Disconnect the crank position sensor connector (EFD18) and the engine ECM connector(EFD-ECM).

3) Measure resistance between the terminal 2 of the crank position sensor harness connector and the chassis ground.

■ Specification: Infinite

4) Is the resistance measured within specification?

YES

▶ Go to "Shield Circuit Inspection" procedure.

NO

▶ Repair short to ground and then go to "Verification of Vehicle Repair" procedure.

SHIELD CIRCUIT INSPECTION

1. Shield Short to Power Inspection

1) Disconnect the engine ECM connector(EFD-ECM).

2) Turn the ignition ON. Leave the engine OFF.

3) Measure voltage between the terminal 6 of the ECM harness connector and chassis ground.

■ Specification: Shield ground power approx. 0V

4) Is the voltage measured within specification?

YES

▶ Go to "Component Inspection" procedure.

NO

▶ Go to "Shield Short to Ground Inspection" procedure.

2. Shield Short to Ground Inspection

1) Turn the ignition OFF.

2) Disconnect the engine ECM connector(EFD-ECM).

3) Measure resistance between the terminal 6 of the ECM harness connector and chassis ground.

■ Specification: Infinite

4) Is the resistance measured within specification?

YES

▶ Go to "Component Inspection" procedure.

NO

▶ Repair short to ground and then go to "Verification of Vehicle Repair" procedure.

COMPONENT INSPECTION

1. Crank Position Sensor Resistance Inspection

1) Turn the ignition OFF.

2) Disconnect the crank position sensor connector (EFD18).

3) Measure the resistance between terminals 1 and 2 of the crank position sensor.

■ **Specification :**

Temperature(℃)	Resistance between terminals 1 and 2(Ω)
20	125±17

4) Is the resistance measured within specification?

YES

▶ Go to "Crank Position Sensor Waveform Inspection" procedure.

NO

▶ Replace the crank position sensor and then go to "Verification of Vehicle Repair" procedure.

2. Crank Position Sensor Waveform Inspection

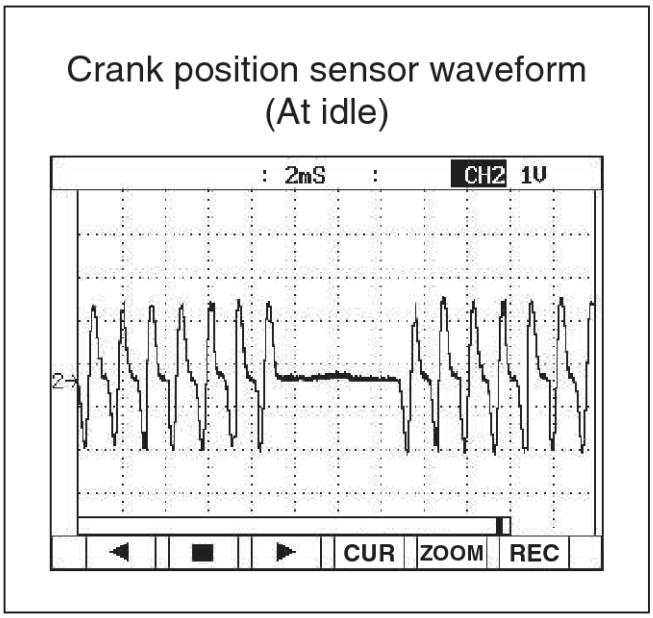
1) Turn the ignition OFF.

2) Connect the crank position sensor connector (EFD18).

3) Connect oscilloscope probe to terminal 2 of the crank position sensor.

4) Check that the waveform of the crank position sensor displays normally at idle.

■ Specification :



SUDFLDTC9069L

5) Does the waveform display normally?

YES

▶ Go to “Verification of Vehicle Repair” procedure.

NO

▶ Replace the crank position sensor and then go to “Verification of Vehicle Repair” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

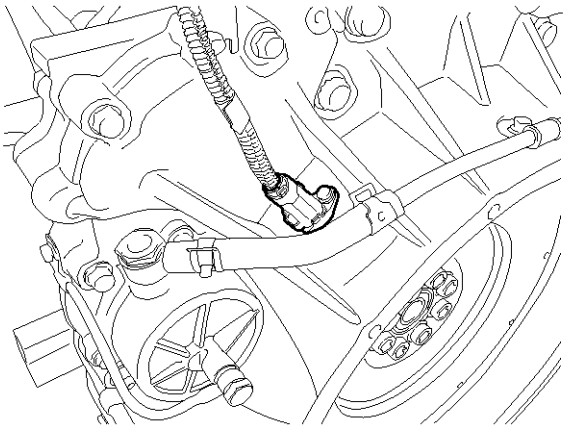
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P0336 Crankshaft Position Sensor Performance Invalid

COMPONENT LOCATION



SUDFL8231D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   The engine piston position is used for determining fuel injection timing, all pistons are connected to crankshaft via connecting rod. After the crankshaft position sensor detects piston position, it sends signal to the ECM to determine fuel injection timing and engine speed. The crankshaft position sensor is used to detect the top dead center of compression stroke of each cylinder. Based on these signals, the ECM determines fuel injection timing and injection order of each cylinder.

2. DTC DESCRIPTION

   If the number of NE pulse is detected differently or excessively one time per engine one revolution (360CA) for 3,960CA or more, the ECM judges this as a fault and DTC is set. Check lamp and MIL come on together when the condition continued for 2 driving cycle times. MIL will go off after 3 driving cycle times when the system returns to normal. The probable causes are the poor connection of crankshaft position sensor, sensor malfunction, or defect of tone wheel mounted on flywheel.

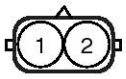
DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Defective crank shaft sensor
Enable Conditions	• Engine running			
Threshold Value	• The number of NE pulse is different or excessive one time every 360˚ CA (engine one revolution).			
Diagnosis Time	• 1,800.1 CA or higher			
Fail Safe	Fuel Cut	No	• System is controlled by the pulse of camshaft position sensor.	
	Fuel limit	No		
	Check lamp	ON		

SPECIFICATION

Temperature(℃)	Resistance between terminals 1 and 2(Ω)
20	125±17

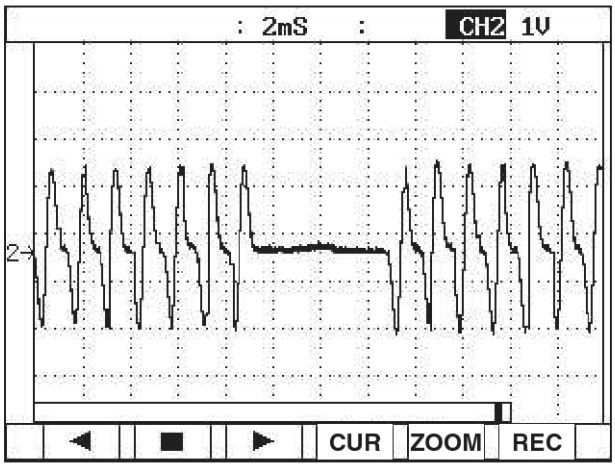
Air gap	1.50±0.5mm



Sensor connector

SUDFLDTC9037L

WAVEFORM



SUDFLDTC9096L

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature.
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Engine rpm” parameter on the scan tool.

NOTICE

The value of “Engine rpm” varies with driving condition according to DTC detecting condition. In case of failure, be sure to compare “Fuel injection amount” as the fuel injection is reactivated when the engine rpm drops to below 3,500rpm after fuel injection stops when “Engine rpm” is above 4,000rpm.

Parameter	Reference Value
Crank sensor active (At IG ON)	OFF
Crank sensor active (At idle)	ON

POWER SUPPLY INSPECTION

1. N.E Sensor (+) Voltage Inspection
   1) Leave the crank position sensor connector (EFD18) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 1 of crank position sensor harness connector and chassis ground.

      ■ Specification: ETC control module output power approx. 2.5V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Ground Circuit Inspection” procedure.

      NO

      ▶ Go to “N.E Sensor (+) Open Inspection” procedure.
2. N.E Sensor (+) Open Inspection
   1) Turn the ignition OFF.

2) Disconnect the crank position sensor connector (EFD18) and ECM connector(EFD-ECM).
3) Measure resistance between the terminal 1 of crank position sensor harness connector and terminal 29 of the engine ECM connector(EFD-ECM).
   ■ Specification: Continuity
4) Is the resistance measured within specification?

YES

▶ Go to "N.E Sensor (+) Short to Power Inspection" procedure.

NO

▶ Repair open circuit and then go to "Verification of Vehicle Repair" procedure.

3. N.E Sensor (+) Short to Power Inspection
   1) Disconnect the crank position sensor connector (EFD18) and ECM connector(EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 1 of crank position sensor harness connector and chassis ground.
      ■ Specification: Below 0~0.1V
   4) Is the voltage measured within specification?

YES

▶ Go to "N.E Sensor (+) Short to Ground Inspection" procedure.

NO

▶ Repair short to power and then go to "Verification of Vehicle Repair" procedure.

4. N.E Sensor (+) Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the crank position sensor connector (EFD18) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 1 of crank position sensor harness connector and chassis ground.
      ■ Specification: Infinite
   4) Is the resistance measured within specification?

YES

▶ Go to "Ground Circuit Inspection" procedure.

NO

▶ Repair short to ground and then go to "Verification of Vehicle Repair" procedure.

GROUND CIRCUIT INSPECTION

1. N.E Sensor (-) Voltage Inspection
   1) Leave the crank position sensor connector (EFD18) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage drop between the terminal 2 of the crank position sensor harness connector and chassis ground.
      ■ Specification: ETC control module output power approx. 2.5V
   4) Is the voltage measured within specification?

YES

▶ Go to "Shield Circuit Inspection" procedure.

NO

▶ Go to "N.E Sensor (-) Open Inspection" procedure.

2. N.E Sensor (-) Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the crank position sensor connector (EFD18) and the engine ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 2 of the crank position sensor harness connector and the terminal 9 of the engine ECM connector(EFD-ECM).
      ■ Specification: Continuity (Below 1.0Ω)
   4) Is the resistance measured within specification?

YES

▶ Go to "N.E Sensor (-) Short to Power Inspection" procedure.

NO

▶ Repair open wiring circuit and then go to "Verification of Vehicle Repair" procedure.

3. N.E Sensor (-) Short to Power Inspection
   1) Disconnect the crank position sensor connector (EFD18) and the engine ECM connector(EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.

3) Measure voltage between the terminal 2 of the crank position sensor harness connector and the chassis ground.

■ Specification: Below 0~0.1V

4) Is the voltage measured within specification?

YES

▶ Go to "N.E Sensor (-) Short to Ground Inspection" procedure.

NO

▶ Repair short to power and then go to "Verification of Vehicle Repair" procedure.

4. N.E Sensor (-) Short to Ground Inspection

1) Turn the ignition OFF.

2) Disconnect the crank position sensor connector (EFD18) and the engine ECM connector(EFD-ECM).

3) Measure resistance between the terminal 2 of the crank position sensor harness connector and the chassis ground.

■ Specification: Infinite

4) Is the resistance measured within specification?

YES

▶ Go to "Shield Circuit Inspection" procedure.

NO

▶ Repair short to ground and then go to "Verification of Vehicle Repair" procedure.

SHIELD CIRCUIT INSPECTION

1. Shield Short to Power Inspection

1) Disconnect the engine ECM connector(EFD-ECM).

2) Turn the ignition ON. Leave the engine OFF.

3) Measure voltage between the terminal 6 of the ECM harness connector and chassis ground.

■ Specification: Shield ground power approx. 0V

4) Is the voltage measured within specification?

YES

▶ Go to "Component Inspection" procedure.

NO

▶ Go to "Shield Short to Ground Inspection" procedure.

2. Shield Short to Ground Inspection

1) Turn the ignition OFF.

2) Disconnect the engine ECM connector(EFD-ECM).

3) Measure resistance between the terminal 6 of the ECM harness connector and chassis ground.

■ Specification: Infinite

4) Is the resistance measured within specification?

YES

▶ Go to "Component Inspection" procedure.

NO

▶ Repair short to ground and then go to "Verification of Vehicle Repair" procedure.

COMPONENT INSPECTION

1. Crank Position Sensor Resistance Inspection

1) Turn the ignition OFF.

2) Disconnect the crank position sensor connector (EFD18).

3) Measure the resistance between terminals 1 and 2 of the crank position sensor.

■ Specification :

Temperature(℃)	Resistance between terminals 1 and 2(Ω)
20	125±17

4) Is the resistance measured within specification?

YES

▶ Go to "Crank Position Sensor Waveform Inspection" procedure.

NO

▶ Replace the crank position sensor and then go to "Verification of Vehicle Repair" procedure.

2. Crank Position Sensor Waveform Inspection

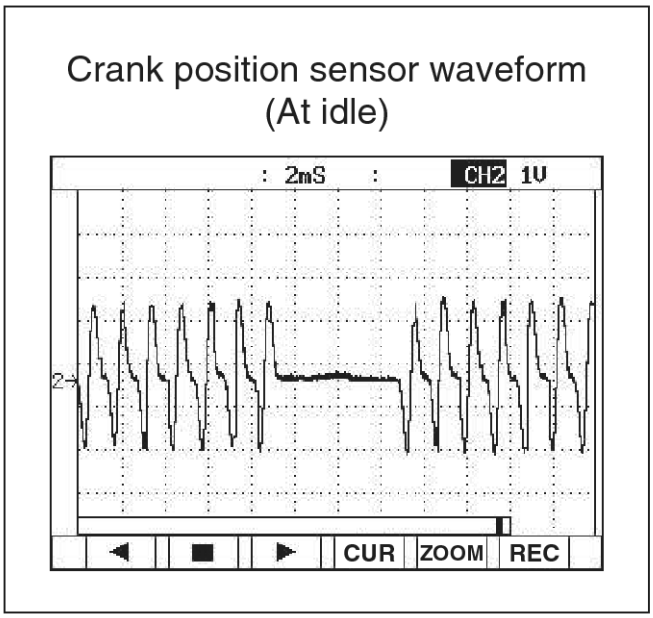
1) Turn the ignition OFF.

2) Connect the crank position sensor connector (EFD18).

3) Connect oscilloscope probe to terminal 2 of the crank position sensor.

4) Check that the waveform of the crank position sensor displays normally at idle.

■ Specification :



SUDFLDTC9069L

5) Does the waveform display normally?

YES

▶ Go to “Verification of Vehicle Repair” procedure.

NO

▶ Replace the crank position sensor and then go to “Verification of Vehicle Repair” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

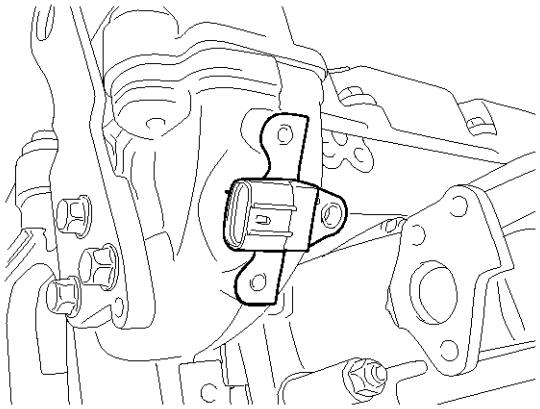
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P0340 Cam Sensor No Pulse

COMPONENT LOCATION



SDFFL7109D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   The engine piston position is used for determining fuel injection timing, all pistons are connected to camshaft via connecting rod. After the crankshaft position sensor detects piston position, it sends signal to the ECM to determine fuel injection timing and engine speed. The camshaft position sensor is used to detect the top dead center of compression stroke of each cylinder. Based on these signals, the ECM determines fuel injection timing and injection order of each cylinder.

2. DTC DESCRIPTION

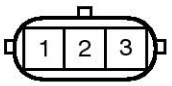
   If the number of camshaft pulse is detected below one time per engine one revolution(360˚CA) for 3,960 CA or more, the ECM judges this as a fault and DTC is set. The probable causes are camshaft sensor malfunction, open or short to terminals 8, 27 and 28 of ECM connector(EFD-ECM). The vehicle is possible to drive normally, but starting-ability is bad and exhaust brake operation to protect engine system will be stopped due to starting time delay since ECM receives signal only from pulse of crankshaft position sensor(N.E).

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Defective cam position sensor • Open/short to terminals 8 ,27,28 of the engine EC-M (EFD-ECM)
Enable Conditions	• Engine running			
Threshold Value	• The number of crankshaft pulse is below one time every 360˚ CA (engine one revolution).			
Diagnosis Time	• 3,960 CA or higher			
Fail Safe	Fuel Cut	No	• System is controlled only by the pulse of crank position sensor.	
	Fuel limit	No		
	Check lamp	ON		

SPECIFICATION

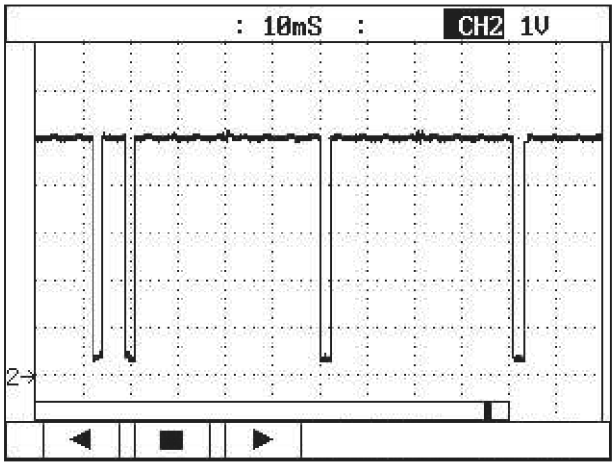
Air gap	1.0 ± 0.5 mm



Sensor connector

SUDFLDTC9045L

WAVEFORM



SUDFLDTC9071L

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature.
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Engine revolution” parameter on the scan tool.

NOTICE

The value of “Engine rpm” varies with driving condition according to DTC detecting condition. In case of failure, be sure to compare “Fuel injection amount” as the fuel injection is reactivated when the engine rpm drops to below 3,500rpm after fuel injection stops when “Engine rpm” is above 4,000rpm.

Parameter	Reference Value
Cam sensor active (At IG ON)	OFF
Cam sensor active (At idle)	ON

SIGNAL CIRCUIT INSPECTION

1. Signal Voltage Inspection
   1) Leave the cam position sensor connector (EFD03) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 3 of cam position sensor harness connector and chassis ground.

      ■ Specification: Cam position sensor signal power approx. 5V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Ground Circuit Inspection” procedure.

      NO

      ▶ Go to “Signal Open Inspection” procedure.
2. Signal Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the cam position sensor connector (EFD03) and ECM connector(EFD-ECM).

3) Measure resistance between the terminal 3 of cam position sensor harness connector and terminal 8 of the engine ECM connector(EFD-ECM).
   ■ Specification: Continuity
4) Is the resistance measured within specification?
   YES
   ▶ Go to "Signal Short to Power Inspection" procedure.
   NO
   ▶ Repair open circuit and then go to "Verification of Vehicle Repair" procedure.

3. Signal Short to Power Inspection
   1) Disconnect the cam position sensor connector (EFD03) and ECM connector(EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 3 of cam position sensor harness connector and chassis ground.
      ■ Specification: Below 0~0.1V
   4) Is the voltage measured within specification?
      YES
      ▶ Go to "Power Supply Short to Ground Inspection" procedure.
      NO
      ▶ Repair short to power and then go to "Verification of Vehicle Repair" procedure.
4. Signal Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the cam position sensor connector (EFD03) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 3 of cam position sensor harness connector and chassis ground.
      ■ Specification: Infinite
   4) Is the resistance measured within specification?
      YES
      ▶ Go to "Power Supply Inspection" procedure.
      NO
      ▶ Repair short to ground and then go to "Verification of Vehicle Repair" procedure.

POWER SUPPLY INSPECTION

1. Power Supply Voltage Inspection
   1) Disconnect the cam position sensor connector (EFD03).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 1 of cam position sensor harness connector and chassis ground.
      ■ Specification: Cam position sensor supply power approx. 5V
   4) Is the voltage measured within specification?
      YES
      ▶ Go to "Ground Circuit Inspection" procedure.
      NO
      ▶ Go to "Power Supply Open Inspection" procedure.
2. Power Supply Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the cam position sensor connector (EFD03) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 1 of cam position sensor harness connector and terminal 28 of the engine ECM connector(EFD-ECM).
      ■ Specification: Continuity
   4) Is the resistance measured within specification?
      YES
      ▶ Go to "Power Supply Short to Power Inspection" procedure.
      NO
      ▶ Repair open circuit and then go to "Verification of Vehicle Repair" procedure.
3. Power Supply Short to Power Inspection
   1) Disconnect the cam position sensor connector (EFD03) and ECM connector(EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 1 of cam position sensor harness connector and chassis ground.
      ■ Specification: Below 0~0.1V
   4) Is the voltage measured within specification?

YES

▶ Go to “Power Supply Short to Ground Inspection” procedure.

NO

▶ Repair short to power and then go to “Verification of Vehicle Repair” procedure.

4. Power Supply Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the cam position sensor connector (EFD03) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 1 of crank position sensor harness connector and chassis ground.
      ■ Specification: Infinite
   4) Is the resistance measured within specification?

YES

▶ Go to “Ground Circuit Inspection” procedure.

NO

▶ Repair short to ground and then go to “Verification of Vehicle Repair” procedure.

GROUND CIRCUIT INSPECTION

1. Ground Voltage Drop Inspection
   1) Disconnect the cam position sensor connector (EFD03).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage drop between the terminal 2 of the cam position sensor harness connector and chassis ground.
      ■ Specification: Ground voltage drop within 200mV
   4) Is the voltage measured within specification?

YES

▶ Go to “Ground Open Inspection” procedure.

NO

▶ Repair the cause of the excessive resistance (poor connection) and go to “Verification of Vehicle Repair” procedure.

2. Ground Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the cam position sensor connector (EFD03) and the engine ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 2 of the crank position sensor harness connector and the terminal 27 of the engine ECM connector(EFD-ECM).
      ■ Specification: Continuity (Below 1.0Ω)
   4) Is the resistance measured within specification?

YES

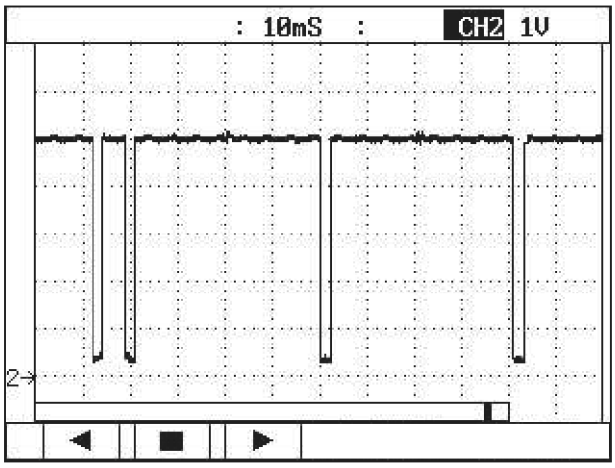
▶ Go to “Component Inspection” procedure.

NO

▶ Repair open wiring circuit and then go to “Verification of Vehicle Repair” procedure.

COMPONENT INSPECTION

1. Cam Position Sensor Waveform Inspection
   1) Turn the ignition OFF.
   2) Connect the cam position sensor connector (EFD03).
   3) Connect oscilloscope probe to terminal 1 of the cam position sensor.
   4) Check that the waveform of the crank position sensor displays normally at idle.
      ■ Specification:



SUDFLDTC9071L

5) Does the waveform display normally?

YES

▶ Go to “Verification of Vehicle Repair” procedure.

NO

▶ Replace the cam position sensor and then go to “Verification of Vehicle Repair” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

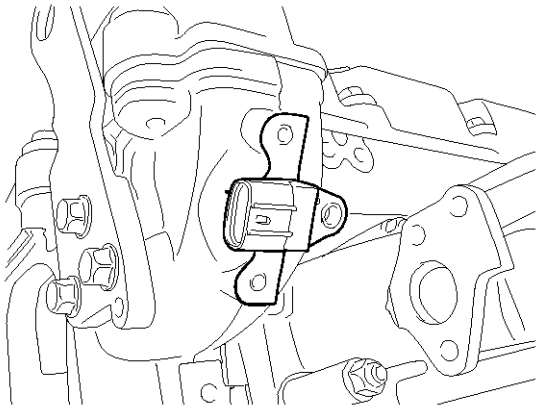
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P0341 Camshaft Position Sensor Performance Bank 1

COMPONENT LOCATION



SDFFL7109D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   The engine piston position is used for determining fuel injection timing, all pistons are connected to camshaft via connecting rod. After the crankshaft position sensor detects piston position, it sends signal to the ECM to determine fuel injection timing and engine speed. The camshaft position sensor is used to detect the top dead center of compression stroke of each cylinder. Based on these signals, the ECM determines fuel injection timing and injection order of each cylinder.

2. DTC DESCRIPTION

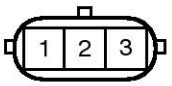
   The probable causes are momentary poor connection of camshaft position sensor, sensor malfunction or defect of tone wheel mounted on flywheel.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Poor wiring connection • Defective cam position sensor
Enable Conditions	• Engine running			
Threshold Value	• The number of camshaft pulse is different or excessive one time every 360˚CA (engine one revolution).			
Diagnosis Time	• -			
Fail Safe	Fuel Cut	No	• System is controlled only by the pulse of crank position sensor.	
	Fuel limit	No		
	Check lamp	ON		

SPECIFICATION

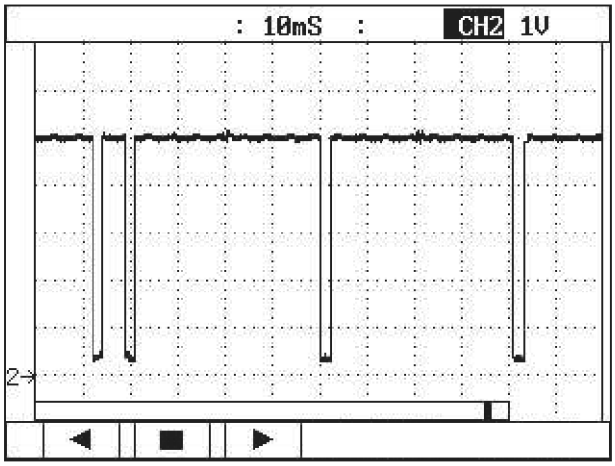
Air gap	1.0 ± 0.5 mm



Sensor connector

SUDFLDTC9045L

WAVEFORM



SUDFLDTC9071L

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature.
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Engine revolution” parameter on the scan tool.

NOTICE

The value of “Engine rpm” varies with driving condition according to DTC detecting condition. In case of failure, be sure to compare “Fuel injection amount” as the fuel injection is reactivated when the engine rpm drops to below 3,500rpm after fuel injection stops when “Engine rpm” is above 4,000rpm.

Parameter	Reference Value
Cam sensor active (At IG ON)	OFF
Cam sensor active (At idle)	ON

SIGNAL CIRCUIT INSPECTION

1. Signal Voltage Inspection
   1) Leave the cam position sensor connector (EFD03) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 3 of cam position sensor harness connector and chassis ground.

      ■ Specification: Cam position sensor signal power approx. 5V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Ground Circuit Inspection” procedure.

      NO

      ▶ Go to “Signal Open Inspection” procedure.
2. Signal Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the cam position sensor connector (EFD03) and ECM connector(EFD-ECM).

3) Measure resistance between the terminal 3 of cam position sensor harness connector and terminal 8 of the engine ECM connector(EFD-ECM).
   ■ Specification: Continuity
4) Is the resistance measured within specification?

YES

▶ Go to "Signal Short to Power Inspection" procedure.

NO

▶ Repair open circuit and then go to "Verification of Vehicle Repair" procedure.

3. Signal Short to Power Inspection
   1) Disconnect the cam position sensor connector (EFD03) and ECM connector(EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 3 of cam position sensor harness connector and chassis ground.
      ■ Specification: Below 0~0.1V
   4) Is the voltage measured within specification?

YES

▶ Go to "Power Supply Short to Ground Inspection" procedure.

NO

▶ Repair short to power and then go to "Verification of Vehicle Repair" procedure.

4. Signal Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the cam position sensor connector (EFD03) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 3 of cam position sensor harness connector and chassis ground.
      ■ Specification: Infinite
   4) Is the resistance measured within specification?

YES

▶ Go to "Power Supply Inspection" procedure.

NO

▶ Repair short to ground and then go to "Verification of Vehicle Repair" procedure.

POWER SUPPLY INSPECTION

1. Power Supply Voltage Inspection
   1) Disconnect the cam position sensor connector (EFD03).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 1 of cam position sensor harness connector and chassis ground.
      ■ Specification: Cam position sensor supply power approx. 5V
   4) Is the voltage measured within specification?

YES

▶ Go to "Ground Circuit Inspection" procedure.

NO

▶ Go to "Power Supply Open Inspection" procedure.

2. Power Supply Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the cam position sensor connector (EFD03) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 1 of cam position sensor harness connector and terminal 28 of the engine ECM connector(EFD-ECM).
      ■ Specification: Continuity
   4) Is the resistance measured within specification?

YES

▶ Go to "Power Supply Short to Power Inspection" procedure.

NO

▶ Repair open circuit and then go to "Verification of Vehicle Repair" procedure.

3. Power Supply Short to Power Inspection
   1) Disconnect the cam position sensor connector (EFD03) and ECM connector(EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 1 of cam position sensor harness connector and chassis ground.
      ■ Specification: Below 0~0.1V
   4) Is the voltage measured within specification?

YES

▶ Go to “Power Supply Short to Ground Inspection” procedure.

NO

▶ Repair short to power and then go to “Verification of Vehicle Repair” procedure.

4. Power Supply Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the cam position sensor connector (EFD03) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 1 of crank position sensor harness connector and chassis ground.
      ■ Specification: Infinite
   4) Is the resistance measured within specification?

YES

▶ Go to “Ground Circuit Inspection” procedure.

NO

▶ Repair short to ground and then go to “Verification of Vehicle Repair” procedure.

GROUND CIRCUIT INSPECTION

1. Ground Voltage Drop Inspection
   1) Disconnect the cam position sensor connector (EFD03).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage drop between the terminal 2 of the cam position sensor harness connector and chassis ground.
      ■ Specification: Ground voltage drop within 200mV
   4) Is the voltage measured within specification?

YES

▶ Go to “Ground Open Inspection” procedure.

NO

▶ Repair the cause of the excessive resistance (poor connection) and go to “Verification of Vehicle Repair” procedure.

2. Ground Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the cam position sensor connector (EFD03) and the engine ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 2 of the crank position sensor harness connector and the terminal 27 of the engine ECM connector(EFD-ECM).
      ■ Specification: Continuity (Below 1.0Ω)
   4) Is the resistance measured within specification?

YES

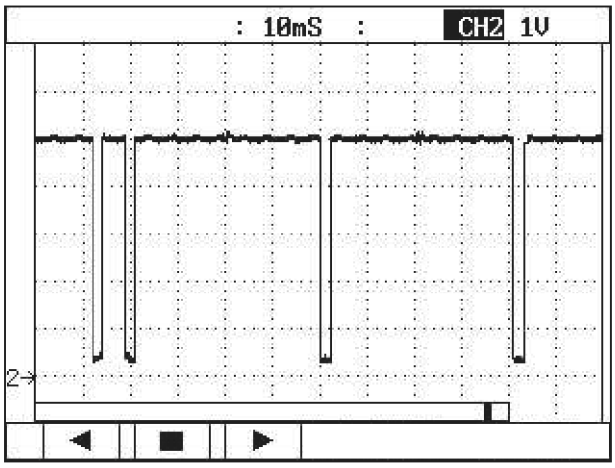
▶ Go to “Component Inspection” procedure.

NO

▶ Repair open wiring circuit and then go to “Verification of Vehicle Repair” procedure.

COMPONENT INSPECTION

1. Cam Position Sensor Waveform Inspection
   1) Turn the ignition OFF.
   2) Connect the cam position sensor connector (EFD03).
   3) Connect oscilloscope probe to terminal 1 of the cam position sensor.
   4) Check that the waveform of the crank position sensor displays normally at idle.
      ■ Specification:



SUDFLDTC9071L

5) Does the waveform display normally?

YES

▶ Go to “Verification of Vehicle Repair” procedure.

NO

▶ Replace the cam position sensor and then go to “Verification of Vehicle Repair” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

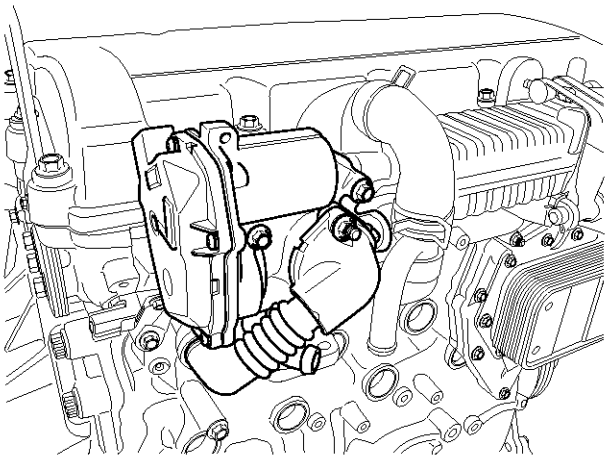
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P0401 EGR Insufficient Flow (EGR Negative Deviation)

COMPONENT LOCATION



SDFFL7101D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   Receiving ECM signal, linear solenoid type electronic EGR actuator operates EEGR valve directly. ECM performs EGR system feed back control with the information of measured mass air flow. (The role of MAFS in diesel engine is different from gasoline engine. Fuel injection quantity is decided by MAFS signal in gasoline engine.) When EGR gas (contains no oxygen) flowing into combustion chamber increases, the air passing through MAFS (contains oxygen) decreases. Thus, with the output signal change of MAFS accompanied by EEGR actuator actuation, ECM determines the amount of recirculated EGR gas quantity.

2. DTC DESCRIPTION

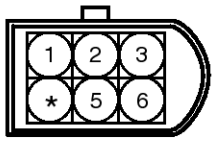
   DTC P0401 is set when actual value of EGR amount is shorter than target value for more than 5,248ms. The possible causes are EGR valve stuck, intake system air leaking or restriction, exhaust system restriction and so on.

   Check lamp comes on and MIL is blinking when the condition continued 2 driving cycle times. MIL will go off after 3 driving cycle times when the system returns to normal.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• EGR valve • Intake and exhaust system
Enable Conditions	• Engine running			
Threshold Value	• Actual value of EGR amount is shorter than target.			
Diagnosis Time	• 5,248ms			
Fail Safe	Fuel Cut	No	• EGR control released • Fuel amount limit (Below 75% of maximum torque) • Auto cruise release	
	Fuel limit	No		
	Check lamp	OFF		

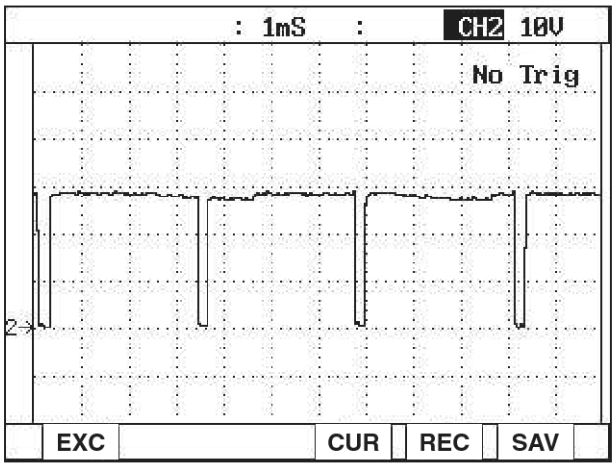
SPECIFICATION



Sensor connector

SUDFLDTC9072L

WAVEFORM



SUDFLDTC9097L

COMPONENT INSPECTION

1. EGR Valve Visual Inspection
   1) Turn the ignition OFF.
   2) Disconnect the EGR valve connector (EFD19).
   3) Check the EGR valve connector terminal for contamination or corrosion.
   4) Check the EGR valve for torque, coolant leak.
   5) Is the result of system check normal?

   YES

   ▶ Go to “EGR Valve Waveform Inspection” procedure.

   NO

   ▶ Replace the EGR valve and go to “Verification of Vehicle Repair” procedure.
2. EGR Valve Waveform Inspection
   1) Turn the ignition OFF.
   2) Connect the EGR valve connector (EFD19).
   3) Connect the oscilloscope probe to the terminal 5 of EGR valve connector (EFD19).
   4) Check the waveform of idle and accelerating condition.

   ■ Specification: Refer to “Standard Waveform” of general information.

5) Does the waveform of EGR valve display normally?

YES

▶ Go to “Verification of Vehicle Repair” procedure.

NO

▶ Go to “EGR Valve DC Motor Resistance Inspection” procedure.

3. EGR Valve DC Motor Resistance Inspection
   1) Turn the ignition OFF.
   2) Disconnect the EGR valve connector (EFD19).
   3) Measure the resistance between terminals 5 and 6 of EGR valve connector.

■ **Specification :**

Item	Specification
Resistance	Infinite

4) Is the resistance measured within specification?

YES

▶ Go to “Verification of Vehicle Repair” procedure.

NO

▶ Replace the EGR valve and go to “Verification of Vehicle Repair” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

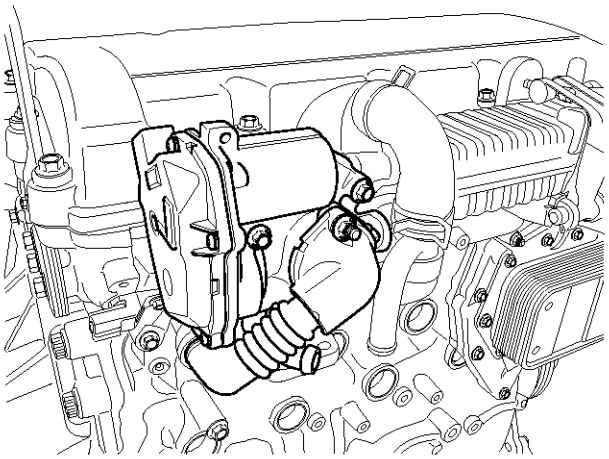
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P0403 EGR Control DC Motor Output 1, 2 Open Load, Motor Open Load

COMPONENT LOCATION



SDFFL7101D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   Receiving ECM signal, linear solenoid type electronic EGR actuator operates EEGR valve directly. ECM performs EGR system feed back control with the information of measured mass air flow. (The role of MAFS in diesel engine is different from gasoline engine. Fuel injection quantity is decided by MAFS signal in gasoline engine.) When EGR gas (contains no oxygen) flowing into combustion chamber increases, the air passing through MAFS (contains oxygen) decreases. Thus, with the output signal change of MAFS accompanied by EEGR actuator actuation, ECM determines the amount of recirculated EGR gas quantity.

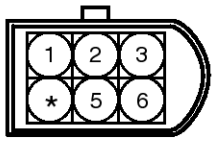
2. DTC DESCRIPTION

   If the output voltage of EGR DC motor is less than 0.1V and EGR duty target is more than 50% for 1,500ms or more, the ECM judges this as a fault and DTC is set. Check lamp and MIL come on together when the condition continued for 2 driving cycle times. MIL will go off after 3 driving cycle times when the system returns to normal. The probable causes are open EEGR actuator circuit or internal malfunction.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Open circuit of terminals 60, 80 of ECM connector (EFD-ECM) • EGR control DC motor
Enable Conditions	• Engine running			
Threshold Value	• EGR duty≥50%, Output Voltage＜0.1V			
Diagnosis Time	• 1,500ms			
Fail Safe	Fuel Cut	No	• Impossible EGR control • Fuel amount limit • Cruise release	
	Fuel limit	No		
	Check lamp	ON		

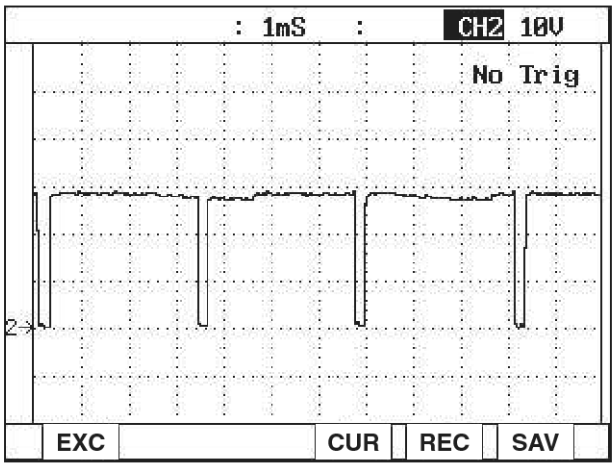
SPECIFICATION



Sensor connector

SUDFLDTC9072L

WAVEFORM



SUDFLDTC9097L

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature.
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “EGR valve” parameter on the scan tool.

Parameter	Reference Value
EGR control (At IG ON)	0%
EGR control (At idle)	0%
EGR control (At 1,500 rpm)	35%
EGR control (At 2,000 rpm)	40%

EGR VALVE DC MOTOR INSPECTION

1. EGR Valve DC Motor (LOW/HIGH) Voltage Inspection
   1) Leave the EGR valve connector (EFD19) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Check the waveform between terminals 5, 6 of EGR valve harness connector and chassis ground.

      ■ Specification: EGR valve DC motor power approx. 1.5V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Go to “EGR Valve DC Motor (LOW/HIGH) Open Inspection” procedure.

2. EGR Valve DC Motor (LOW/HIGH) Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the EGR valve connector (EFD19) and the engine ECM connector(EFD-ECM).
   3) Measure the resistance between terminal 5 of EGR valve harness connector and terminal 60 of the engine ECM connector(EFD-ECM).
   4) Measure the resistance between terminal 6 of EGR valve harness connector and terminal 80 of the engine ECM connector(EFD-ECM).

      ■ Specification: Continuity
   5) Is the resistance measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Replace open circuit and go to “Verification of Vehicle Repair” procedure.

COMPONENT INSPECTION

1. EGR Valve Visual Inspection
   1) Turn the ignition OFF.
   2) Disconnect the EGR valve connector (EFD19).
   3) Check the EGR valve connector terminal for contamination or corrosion.
   4) Check the EGR valve for torque, coolant leak.
   5) Is the result of system check normal?

      YES

      ▶ Go to “EGR Valve Waveform Inspection” procedure.

      NO

      ▶ Replace the EGR valve and go to “Verification of Vehicle Repair” procedure.
2. EGR Valve Waveform Inspection
   1) Turn the ignition OFF.
   2) Connect the EGR valve connector (EFD19).
   3) Connect the oscilloscope probe to the terminal 5 of EGR valve connector (EFD19).
   4) Check the waveform of idle and accelerating condition.

      ■ Specification: Refer to “Standard Waveform” of general information.
   5) Does the waveform of EGR valve display normally?

      YES

      ▶ Go to “Verification of Vehicle Repair” procedure.

      NO

      ▶ Go to “EGR Valve DC Motor Resistance Inspection” procedure.
3. EGR Valve DC Motor Resistance Inspection
   1) Turn the ignition OFF.
   2) Disconnect the EGR valve connector (EFD19).
   3) Measure the resistance between terminals 5 and 6 of EGR valve connector.

■ Specification :

Item	Specification
Resistance	Infinite

   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Verification of Vehicle Repair” procedure.

      NO

      ▶ Replace the EGR valve and go to “Verification of Vehicle Repair” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

   YES

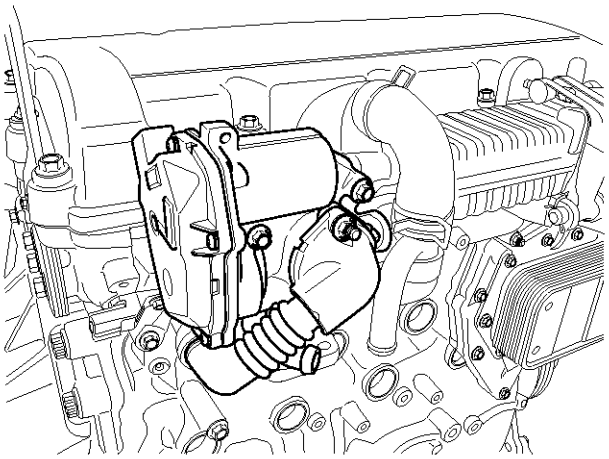
   ▶ Go to the applicable DTC procedure.

   NO

   ▶ System OK

P0404 EGR Control DC Motor Output 1, 2 Short to BATT/GND, Motor short

COMPONENT LOCATION



SDFFL7101D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   Receiving ECM signal, linear solenoid type electronic EGR actuator operates EEGR valve directly. ECM performs EGR system feed back control with the information of measured mass air flow. (The role of MAFS in diesel engine is different from gasoline engine. Fuel injection quantity is decided by MAFS signal in gasoline engine.) When EGR gas (contains no oxygen) flowing into combustion chamber increases, the air passing through MAFS (contains oxygen) decreases. Thus, with the output signal change of MAFS accompanied by EEGR actuator actuation, ECM determines the amount of recirculated EGR gas quantity.

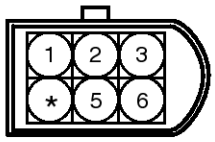
2. DTC DESCRIPTION

   If EGR duty target is less than 50% and diagnosis level in the ECM is out of preset value for 4ms or more, the ECM judges this as a fault and DTC is set. Check lamp and MIL is blinking when the condition continued for 2 driving cycle times. MIL will go off after 3 driving cycle times when the system returns to normal. The probable causes are short circuit or internal malfunction of EGR DC motor.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Current monitoring			• Power/ground short to terminals 60, 80 of ECM connector (EFD-ECM) • EGR DC motor
Enable Conditions	• Engine running			
Threshold Value	• -			
Diagnosis Time	• 4ms or higher			
Fail Safe	Fuel Cut	No	• Impossible EGR control • Fuel amount limit • Cruise release	
	Fuel limit	Yes		
	Check lamp	ON		

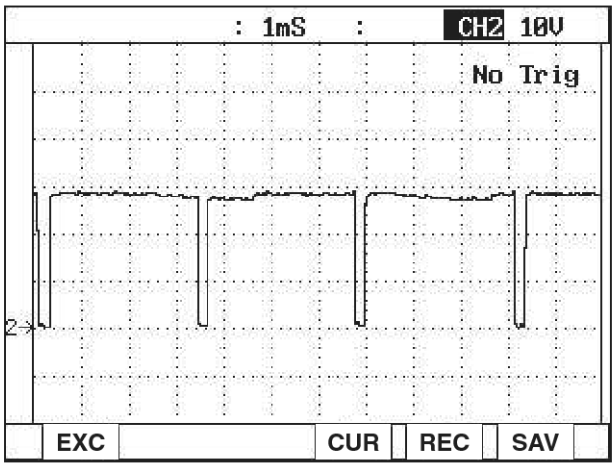
SPECIFICATION



Sensor connector

SUDFLDTC9072L

WAVEFORM



SUDFLDTC9097L

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature.
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “EGR valve” parameter on the scan tool.

Parameter	Reference Value
EGR control (At IG ON)	0%
EGR control (At idle)	0%
EGR control (At 1,500 rpm)	35%
EGR control (At 2,000 rpm)	40%

SIGNAL CIRCUIT INSPECTION

1. Signal (LOW/HIGH) Voltage Inspection
   1) Leave the EGR valve connector (EFD19) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminals 5 and 6 of EGR valve harness connector and chassis ground.

      ■ Specification: EGR valve DC motor terminal power approx. 1.5V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Go to “EGR Valve DC Motor (LOW/HIGH) Short to Power Inspection” procedure.

2. EGR Valve (LOW/HIGH) Short to Power Inspection
   1) Disconnect the EGR valve connector (EFD19) and ECM connector(EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminals 5 and 6 of EGR valve harness connector and chassis ground.
   4) ■ Specification: Below 0~0.1V
   5) Is the voltage measured within specification?

   YES

   ▶ Go to "EGR Valve (LOW/HIGH) Short to Ground Inspection" procedure.

   NO

   ▶ Repair short to power and then go to "Verification of Vehicle Repair" procedure.
3. EGR Valve (LOW/HIGH) Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the EGR valve connector (EFD19) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminals 5 and 6 of EGR valve harness connector and chassis ground.

      ■ Specification: Infinite
   4) Is the resistance measured within specification?

   YES

   ▶ Go to "Component Inspection" procedure.

   NO

   ▶ Repair short to ground and then go to "Verification of Vehicle Repair" procedure.

COMPONENT INSPECTION

1. EGR Valve Visual Inspection
   1) Turn the ignition OFF.
   2) Disconnect the EGR valve connector (EFD19).
   3) Check the EGR valve connector terminal for contamination or corrosion.
   4) Check the EGR valve for torque, coolant leak.
   5) Is the result of system check normal?

   YES

   ▶ Go to "EGR Valve Waveform Inspection" procedure.

   NO

   ▶ Replace the EGR valve and go to "Verification of Vehicle Repair" procedure.
2. EGR Valve Waveform Inspection
   1) Turn the ignition OFF.
   2) Connect the EGR valve connector (EFD19).
   3) Connect the oscilloscope probe to the terminal 5 of EGR valve connector (EFD19).
   4) Check the waveform of idle and accelerating condition.

      ■ Specification: Refer to "Standard Waveform" of general information.
   5) Does the waveform of EGR valve display normally?

   YES

   ▶ Go to "Verification of Vehicle Repair" procedure.

   NO

   ▶ Go to "EGR Valve DC Motor Resistance Inspection" procedure.
3. EGR Valve DC Motor Resistance Inspection
   1) Turn the ignition OFF.
   2) Disconnect the EGR valve connector (EFD19).
   3) Measure the resistance between terminals 5 and 6 of EGR valve connector.

■ Specification :

Item	Specification
Resistance	Infinite

   4) Is the resistance measured within specification?

   YES

   ▶ Go to "Verification of Vehicle Repair" procedure.

   NO

   ▶ Replace the EGR valve and go to "Verification of Vehicle Repair" procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

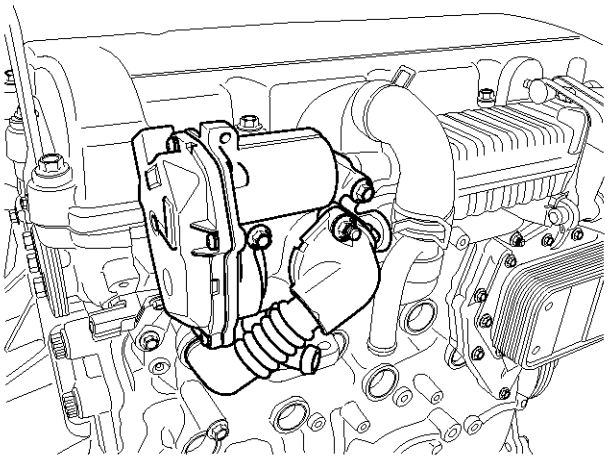
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P0405 EGR Lift Sensor1 Signal Too Low

COMPONENT LOCATION



SDFFL7101D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   Receiving ECM signal, linear solenoid type electronic EGR actuator operates EEGR valve directly. ECM performs EGR system feed back control with the information of measured mass air flow. (The role of MAFS in diesel engine is different from gasoline engine. Fuel injection quantity is decided by MAFS signal in gasoline engine.) When EGR gas (contains no oxygen) flowing into combustion chamber increases, the air passing through MAFS (contains oxygen) decreases. Thus, with the output signal change of MAFS accompanied by EEGR actuator actuation, ECM determines the amount of recirculated EGR gas quantity.

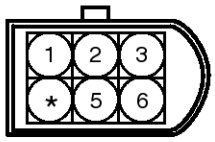
2. DTC DESCRIPTION

   If the valve position sensor output is below 0.2 V for more than 3,016 ms, the ECM judges this as a fault and DTC is set. Check lamp comes on and MIL is blinking when the condition continued 2 driving cycle times. MIL will go off after 3 driving cycle times when the system returns to normal. The probable causes are open/short to ground of EEGR actuator circuit or internal malfunction.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Short to ground of terminals 36, 48 of ECM connector (E-FD-ECM) • Wiring poor connection
Enable Conditions	• At IG ON			
Threshold Value	• When output voltage < below 0.2V			
Diagnosis Time	• 3,016ms or higher			
Fail Safe	Fuel Cut	No	• Impossible EGR control • Fuel amount limit(75% of maximum torque) • Cruise release	
	Fuel limit	Yes		
	Check lamp	ON		

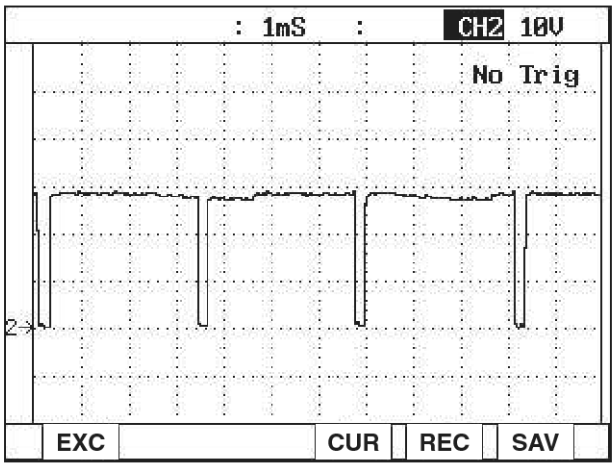
SPECIFICATION



Sensor connector

SUDFLDTC9072L

WAVEFORM



SUDFLDTC9097L

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature.
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “EGR valve” parameter on the scan tool.

Parameter	Reference Value
EGR control (At IG ON)	0%
EGR control (At idle)	0%
EGR control (At 1,500 rpm)	35%
EGR control (At 2,000 rpm)	40%

SIGNAL CIRCUIT INSPECTION

1. Lift Sensor Signal Voltage Inspection
   1) Leave the EGR valve connector (EFD19) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 2 of EGR valve harness connector and chassis ground.

      ■ Specification: EGR lift sensor signal power approx. 5V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Ground Circuit Inspection” procedure.

      NO

      ▶ Go to “Signal Short to Ground Inspection” procedure.

2. EGR Valve Lift Sensor Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the EGR valve connector (EFD19) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 2 of EGR valve harness connector and chassis ground.
   4) ■ Specification: Infinite
   5) Is the resistance measured within specification?

   YES

   ▶ Go to “Power Supply Inspection” procedure.

   NO

   ▶ Repair short to ground and then go to “Verification of Vehicle Repair” procedure.

POWER SUPPLY INSPECTION

1. Power Supply Voltage Inspection
   1) Leave the EGR valve connector (EFD19) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 1 of EGR valve harness connector and chassis ground.

      ■ Specification: EGR lift sensor signal power approx. 5V
   4) Is the voltage measured within specification?

   YES

   ▶ Go to “Ground Circuit Inspection” procedure.

   NO

   ▶ Go to “Power Supply Short to Ground Inspection” procedure.
2. Power Supply Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the EGR valve connector (EFD19) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 1 of EGR valve harness connector and chassis ground.

      ■ Specification: Infinite
   4) Is the resistance measured within specification?

   YES

   ▶ Go to “Ground Circuit Inspection” procedure.

   NO

   ▶ Repair short to ground and then go to “Verification of Vehicle Repair” procedure.

GROUND CIRCUIT INSPECTION

1. Ground Voltage Drop Inspection
   1) Disconnect the EGR valve connector (EFD19).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage drop between the terminal 3 of the EGR valve harness connector and chassis ground.

      ■ Specification: Ground voltage drop within 200mV
   4) Is the voltage measured within specification?

   YES

   ▶ Go to “Ground Open Inspection” procedure.

   NO

   ▶ Repair the cause of the excessive resistance (poor connection) and go to “Verification of Vehicle Repair” procedure.
2. Ground Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the EGR valve connector (EFD19) and the engine ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 3 of the EGR valve harness connector and the terminal 3 of the engine ECM connector(EFD-ECM).

      ■ Specification: Continuity (Below 1.0Ω)
   4) Is the resistance measured within specification?

   YES

   ▶ Go to “Component Inspection” procedure.

   NO

   ▶ Repair open wiring circuit and then go to “Verification of Vehicle Repair” procedure.

COMPONENT INSPECTION

1. EGR Valve Visual Check
   1) Turn the ignition OFF.
   2) Disconnect the EGR valve connector (EFD19).
   3) Check the terminal of EGR valve connector for corrosion and contamination.
   4) Check the EGR valve for torque and coolant leak.
   5) Is there any problem for the EGR valve?

   YES

   ▶ Replace the EGR valve if necessary and go to "Verification of Vehicle Repair" procedure.

   NO

   ▶ Go to "EGR Valve Waveform Inspection" procedure.
2. EGR Valve Waveform Inspection
   1) Turn the ignition OFF.
   2) Connect the EGR valve connector (EFD19).
   3) Connect the oscilloscope probe to the terminal 5 of EGR valve connector (EFD19).
   4) Check the waveforms of idle and accelerating condition.

      ■ Specification: Refer to "Standard waveform" of general information.
   5) Does the waveform of EGR valve display normally?

   YES

   ▶ Go to "Verification of Vehicle Repair" procedure.

   NO

   ▶ Replace the EGR valve and go to "Verification of Vehicle Repair" procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select "Diagnostic Trouble Codes (DTCs)" mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

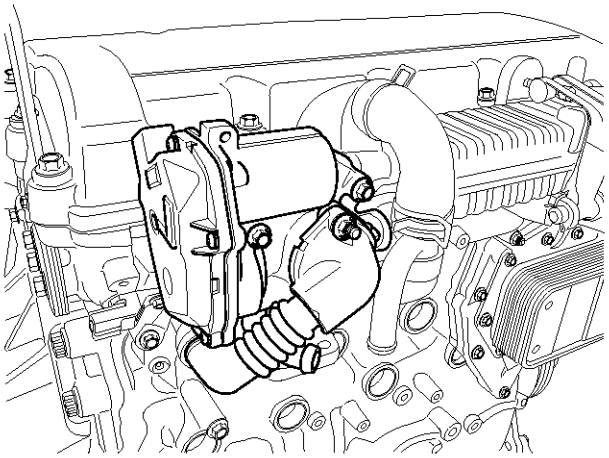
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P0406 EGR Lift Sensor1 Signal Too High

COMPONENT LOCATION



SDFFL7101D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   Receiving ECM signal, linear solenoid type electronic EGR actuator operates EEGR valve directly. ECM performs EGR system feed back control with the information of measured mass air flow. (The role of MAFS in diesel engine is different from gasoline engine. Fuel injection quantity is decided by MAFS signal in gasoline engine.) When EGR gas (contains no oxygen) flowing into combustion chamber increases, the air passing through MAFS (contains oxygen) decreases. Thus, with the output signal change of MAFS accompanied by EEGR actuator actuation, ECM determines the amount of recirculated EGR gas quantity.

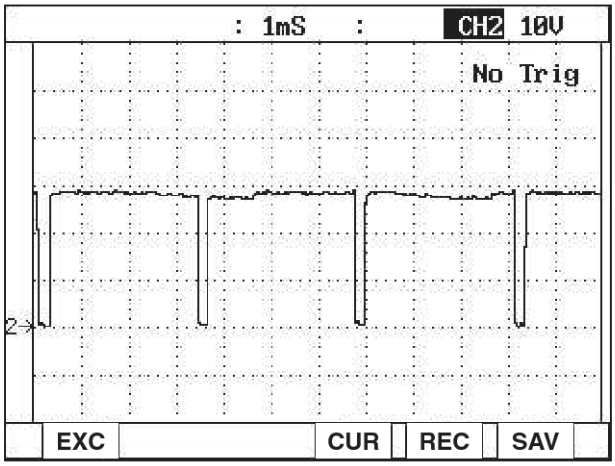
2. DTC DESCRIPTION

   If the valve position sensor output is above 4.8 V for more than 3,016 ms, the ECM judges this as a fault and DTC is set. Check lamp comes on and MIL is blinking when the condition continued 2 driving cycle times. MIL will go off after 3 driving cycle times when the system returns to normal. The probable causes are open/short to ground of EEGR actuator circuit or internal malfunction.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Current monitoring			• Open or short to power of terminals 36 of ECM connector (EFD-ECM) • Wiring poor connection
Enable Conditions	• At IG ON			
Threshold Value	• When output voltage > 4.8V or higher			
Diagnosis Time	• 3,016ms or higher			
Fail Safe	Fuel Cut	No	• Impossible EGR control • Fuel amount limit(75% of maximum torque) • Cruise release	
	Fuel limit	Yes		
	Check lamp	ON		

WAVEFORM



SUDFLDTC9097L

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature.
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “EGR valve” parameter on the scan tool.

Parameter	Reference Value
EGR control (At IG ON)	0%
EGR control (At idle)	0%
EGR control (At 1,500 rpm)	35%
EGR control (At 2,000 rpm)	40%

SIGNAL CIRCUIT INSPECTION

1. Lift Sensor Signal Voltage Inspection
   1) Leave the EGR valve connector (EFD19) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 2 of EGR valve harness connector and chassis ground.
      ■ Specification: EGR lift sensor signal power approx. 5V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Ground Circuit Inspection” procedure.

      NO

      ▶ Go to “Signal Open Inspection” procedure.
2. Signal Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the EGR valve connector (EFD19) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 2 of EGR valve harness connector and the terminal 36 of ECM connector(EFD-ECM).
   4) ■ Specification: Continuity
   5) Is the resistance measured within specification?

      YES

      ▶ Go to “EGR Valve Lift Sensor Short to Power Inspection” procedure.

      NO

      ▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.
3. EGR Valve Lift Sensor Short to Power Inspection
   1) Disconnect the EGR valve connector (EFD19) and ECM connector(EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 2 of EGR valve harness connector and the chassis ground.
      ■ Specification: Below 0~0.1V

4) Is the voltage measured within specification?

YES

▶ Go to “Power Supply Inspection” procedure.

NO

▶ Repair short to power and then go to “Verification of Vehicle Repair” procedure.

POWER SUPPLY INSPECTION

1. Power Supply Voltage Inspection
   1) Leave the EGR valve connector (EFD19) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 1 of EGR valve harness connector and chassis ground.

      ■ Specification: EGR lift sensor signal power approx. 5V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Ground Circuit Inspection” procedure.

      NO

      ▶ Go to “Power Supply Open Inspection” procedure.
2. Power Supply Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the EGR valve connector (EFD19) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 1 of EGR valve harness connector and chassis ground.

      ■ Specification: Continuity
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Power Supply Short to Power Inspection” procedure.

      NO

      ▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.
3. Power Supply Short to Power Inspection
   1) Disconnect the EGR valve connector (EFD19) and ECM connector(EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 1 of EGR valve harness connector and chassis ground.

      ■ Specification: Below 0~0.1V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Ground Circuit Inspection” procedure.

      NO

      ▶ Repair short to power and then go to “Verification of Vehicle Repair” procedure.

GROUND CIRCUIT INSPECTION

1. Ground Voltage Drop Inspection
   1) Disconnect the EGR valve connector (EFD19).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage drop between the terminal 3 of the EGR valve harness connector and chassis ground.

      ■ Specification: Ground voltage drop within 200mV
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Ground Open Inspection” procedure.

      NO

      ▶ Repair the cause of the excessive resistance (poor connection) and go to “Verification of Vehicle Repair” procedure.
2. Ground Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the EGR valve connector (EFD19) and the engine ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 3 of the EGR valve harness connector and the terminal 3 of the engine ECM connector(EFD-ECM).

      ■ Specification: Continuity (Below 1.0Ω)
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Repair open wiring circuit and then go to “Verification of Vehicle Repair” procedure.

COMPONENT INSPECTION

1. EGR Valve Visual Check
   1) Turn the ignition OFF.
   2) Disconnect the EGR valve connector (EFD19).
   3) Check the terminal of EGR valve connector for corrosion and contamination.
   4) Check the EGR valve for torque and coolant leak.
   5) Is there any problem for the EGR valve?

      YES

      ▶ Replace the EGR valve if necessary and go to "Verification of Vehicle Repair" procedure.

      NO

      ▶ Go to "EGR Valve Waveform Inspection" procedure.
2. EGR Valve Waveform Inspection
   1) Turn the ignition OFF.
   2) Connect the EGR valve connector (EFD19).
   3) Connect the oscilloscope probe to the terminal 5 of EGR valve connector (EFD19).
   4) Check the waveforms of idle and accelerating condition.

      ■ Specification: Refer to "Standard waveform" of general information.
   5) Does the waveform of EGR valve display normally?

      YES

      ▶ Go to "Verification of Vehicle Repair" procedure.

      NO

      ▶ Replace the EGR valve and go to "Verification of Vehicle Repair" procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select "Diagnostic Trouble Codes (DTCs)" mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

   YES

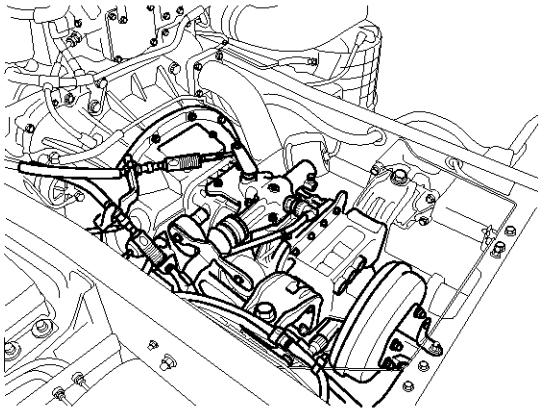
   ▶ Go to the applicable DTC procedure.

   NO

   ▶ System OK

P0501 Vehicle Speed Sensor Signal Invalid

COMPONENT LOCATION



SDFFL7116D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   Vehicle speed sensor which is hall sensor type detects vehicle speed by sensing the revolution of transmission output shaft. If the vehicle speed sensor sends signal to ECM, the signal is used not only for correction signal to calculate optimum fuel amount by comparing current engine revolution and vehicle speed but also for vehicle gauge signal and vehicle information to ETACS.

2. DTC DESCRIPTION

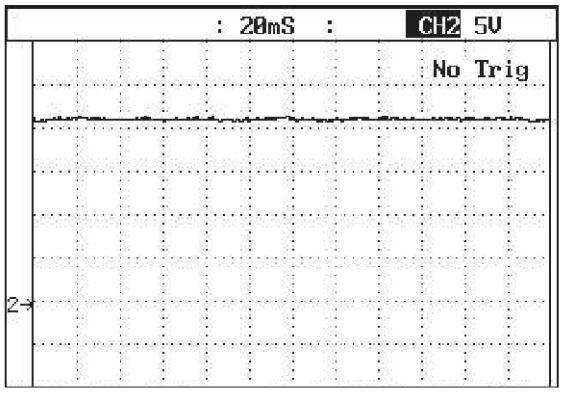
   If the sudden vehicle speed signal change is detected above 100km/h for 1,056 ms or more, the ECM judges this as a fault and DTC is set. The possible cause may be vehicle speed sensor malfunction or entry of noise to terminal 14 of ECM connector(CFD-ECM). The vehicle speed will change rapidly and it is impossible for the ECM to detect gear range. It is impossible to control PTO, if equipped.

DTC DETECTING CONDITION

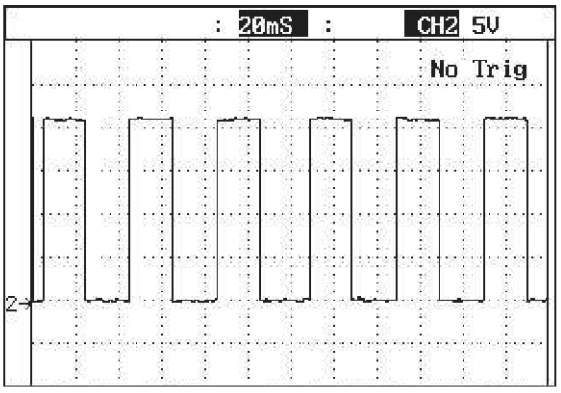
Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Defective vehicle speed sensor • Noise inflow in terminal 14 of ECM connector (CFD-ECM)
Enable Conditions	• Engine running			
Threshold Value	• Vehicle speed signal change>100km/h			
Diagnosis Time	• 1,056ms or higher			
Fail Safe	Fuel Cut	No	• Sudden change in vehicle speed • Impossible identification in gear range • PTO control stop • Cruise release	
	Fuel limit	No		
	Check lamp	ON		

WAVEFORM

Vehicle speed sensor
Waveform
(At 0km/h)



Vehicle speed sensor
Waveform
(At 20km/h)



SUDFLDTC9073L

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature.
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Vehicle speed” parameter on the scan tool.

NOTICE

It indicates such information as the stop and running of “Vehicle speed” according to DTC detecting condition. (Refer to voltage change in control information and simulation.)

Parameter	Reference Value
Vehicle speed (At IG ON)	0 Km/h
Vehicle speed (At 20 Km/h)	20 Km/h
Vehicle speed (At 40 Km/h)	40 Km/h

SIGNAL CIRCUIT INSPECTION

1. Signal Voltage Inspection
   1) Leave the vehicle speed sensor connector (C57) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 4 of vehicle speed sensor harness connector and chassis ground.

      ■ Specification: Vehicle speed sensor signal power approx. 19.2V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Ground Circuit Inspection” procedure.

      NO

      ▶ Go to “Signal Open Inspection” procedure.
2. Signal Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the vehicle speed sensor connector (C57) and ETACS connector (M56-1).
   3) Measure resistance between the terminal 4 of vehicle speed sensor harness connector and the terminal 6 of ETACS connector (M56-1).
   4) Measure resistance between the terminal 3 of ETACS harness connector (M56-3) and the terminal 14 of ECM connector(CFD-ECM).
   5) ■ Specification: Continuity
   6) Is the resistance measured within specification?

      YES

      ▶ Go to “Signal Short to Power Inspection”

procedure.

NO

▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.

3. Signal Short to Power Inspection
   1) Disconnect the vehicle speed sensor connector (C57) and ECM connector(CFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 4 of vehicle speed sensor harness connector and the chassis ground.
      ■ Specification: Below 0~0.1V
   4) Is the voltage measured within specification?

YES

▶ Go to “Power Supply Short to Ground Inspection” procedure.

NO

▶ Repair short to power and then go to “Verification of Vehicle Repair” procedure.

4. Signal Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the vehicle speed sensor connector (C57) and ECM connector(CFD-ECM).
   3) Measure resistance between the terminal 4 of vehicle speed sensor harness connector and the chassis ground.
      ■ Specification: Infinite
   4) Is the resistance measured within specification?

YES

▶ Go to “Power Supply Inspection” procedure.

NO

▶ Repair short to ground and then go to “Verification of Vehicle Repair” procedure.

POWER SUPPLY INSPECTION

1. Power Supply Voltage Inspection
   1) Leave the vehicle speed sensor connector (C57) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 2 of vehicle speed sensor harness connector and chassis ground.
      ■ Specification: Vehicle speed sensor supply power B+ V
   4) Is the voltage measured within specification?

YES

▶ Go to “Ground Circuit Inspection” procedure.

NO

▶ Go to “Power Supply Open Inspection” procedure.

2. Power Supply Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the vehicle speed sensor connector (C57) and ECM connector(CFD-ECM).
   3) Measure resistance between the terminal 2 of vehicle speed sensor harness connector and terminal of fuse #30 (10A).
      ■ Specification: Continuity
   4) Is the resistance measured within specification?

YES

▶ Go to “Ground Circuit Inspection” procedure.

NO

▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.

GROUND CIRCUIT INSPECTION

1. Ground Voltage Drop Inspection
   1) Disconnect the vehicle speed sensor connector (C57) and ECM connector(CFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage drop between the terminal 3 of the vehicle speed sensor harness connector and chassis ground.
      ■ Specification: Ground voltage drop within 200mV
   4) Is the voltage measured within specification?

YES

▶ Go to “Ground Open Inspection” procedure.

NO

▶ Repair the cause of the excessive resistance (poor connection) and go to “Verification of Vehicle Repair” procedure.

2. Ground Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the vehicle speed sensor connector (C57) and the engine ECM connector(CFD-ECM).
   3) Measure resistance between the terminal 3 of the vehicle speed sensor harness connector and ground point (G03).
      ■ Specification: Continuity (Below 1.0Ω)
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

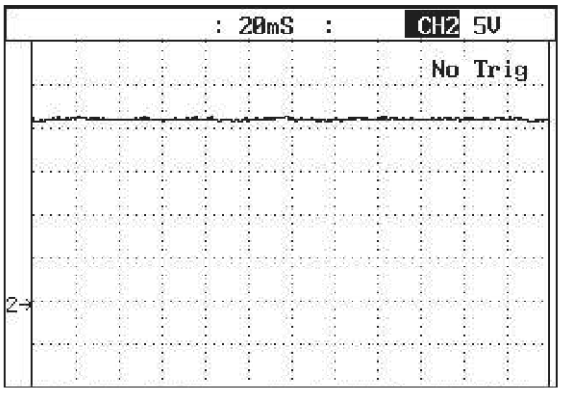
      ▶ Repair open wiring circuit and then go to “Verification of Vehicle Repair” procedure.

COMPONENT INSPECTION

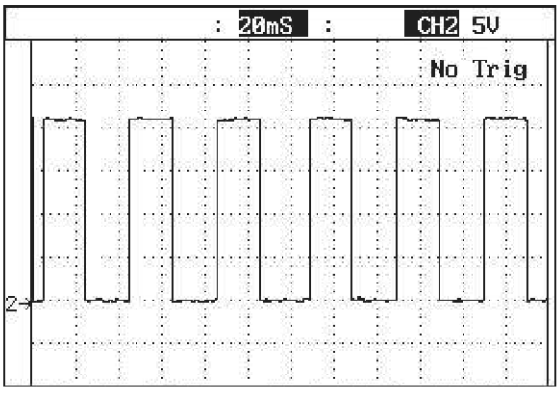
1. Vehicle Speed Sensor Waveform Inspection
   1) Turn the ignition ON. Leave the engine OFF.
   2) Connect the vehicle speed sensor connector (C57) and ECM connector(CFD-ECM).
   3) Connect oscilloscope probe to terminal 4 of the vehicle speed sensor.
   4) Check that the waveform of the vehicle speed displays normally while driving.

      ■ Specification:

Vehicle speed sensor
Waveform
(At 0km/h)



Vehicle speed sensor
Waveform
(At 20km/h)



5) Does the waveform display normally?

YES

▶ Go to “Verification of Vehicle Repair” procedure.

NO

▶ Replace the vehicle speed sensor and then go to “Verification of Vehicle Repair” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

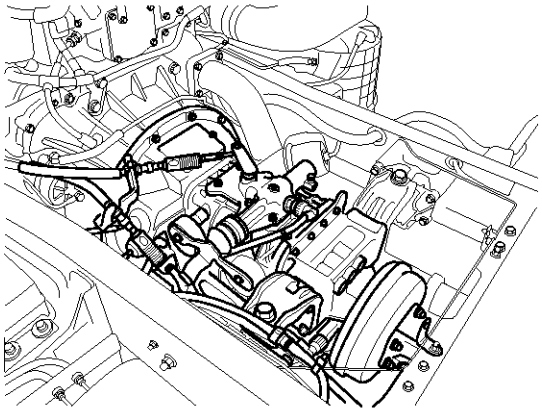
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P0502 Vehicle Speed Sensor Input Open / Short

COMPONENT LOCATION



SDFFL7116D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   Vehicle speed sensor which is hall sensor type detects vehicle speed by sensing the revolution of transmission output shaft. If the vehicle speed sensor sends signal to ECM, the signal is used not only for correction signal to calculate optimum fuel amount by comparing current engine revolution and vehicle speed but also for vehicle gauge signal and vehicle information to ETACS.

2. DTC DESCRIPTION

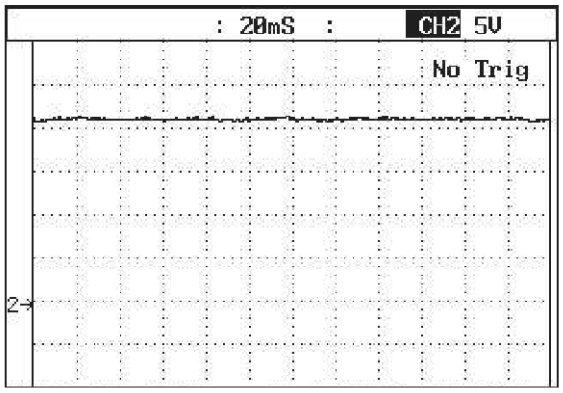
   If the no vehicle speed sensor signal while driving is detected for 1,056 ms or more to ECM, the ECM judges this as a fault and DTC is set. At this moment the following conditions should be satisfied: 1,200rpm or more of engine speed, 80°C or more of engine coolant temperature, not neutral position of gear range, 60mm³/st or more of fuel amount. The possible cause may be open or short to vehicle speed sensor or vehicle speed sensor malfunction etc. As vehicle speed signal is not input, it is impossible for ECM to detect gear range. And also it is impossible to control PTO, if equipped.

DTC DETECTING CONDITION

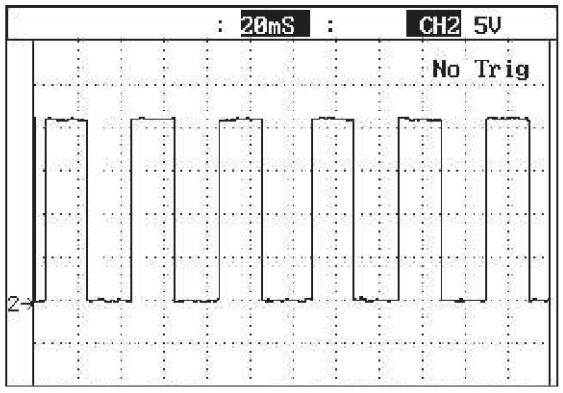
Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Defective vehicle speed sensor • Wiring open/ short
Enable Conditions	• Engine running			
Threshold Value	• Vehicle speed signal < 0.1km/h			
Diagnosis Time	• 1,056ms or higher			
Fail Safe	Fuel Cut	No	• Impossible identification in gear range • PTO control stop • Cruise release	
	Fuel limit	No		
	Check lamp	ON		

WAVEFORM

Vehicle speed sensor
Waveform
(At 0km/h)



Vehicle speed sensor
Waveform
(At 20km/h)



SUDFLDTC9073L

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature.
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Vehicle speed” parameter on the scan tool.

NOTICE
It indicates such information as the stop and running of “Vehicle speed” according to DTC detecting condition. (Refer to voltage change in control information and simulation.)

Parameter	Reference Value
Vehicle speed (At IG ON)	0 Km/h
Vehicle speed (At 20 Km/h)	20 Km/h
Vehicle speed (At 40 Km/h)	40 Km/h

SIGNAL CIRCUIT INSPECTION

1. Signal Voltage Inspection
   1) Leave the vehicle speed sensor connector (C57) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 4 of vehicle speed sensor harness connector and chassis ground.

      ■ Specification: Vehicle speed sensor signal power approx. 19.2V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Ground Circuit Inspection” procedure.

      NO

      ▶ Go to “Signal Open Inspection” procedure.
2. Signal Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the vehicle speed sensor connector (C57) and ETACS connector (M56-1).
   3) Measure resistance between the terminal 4 of vehicle speed sensor harness connector and the terminal 6 of ETACS connector (M56-1).
   4) Measure resistance between the terminal 3 of ETACS harness connector (M56-3) and the terminal 14 of ECM connector(CFD-ECM).
   5) ■ Specification: Continuity
   6) Is the resistance measured within specification?

      YES

      ▶ Go to “Signal Short to Power Inspection”

procedure.

NO

▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.

3. Signal Short to Power Inspection
   1) Disconnect the vehicle speed sensor connector (C57) and ECM connector(CFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 4 of vehicle speed sensor harness connector and the chassis ground.
      ■ Specification: Below 0~0.1V
   4) Is the voltage measured within specification?

YES

▶ Go to “Power Supply Short to Ground Inspection” procedure.

NO

▶ Repair short to power and then go to “Verification of Vehicle Repair” procedure.

4. Signal Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the vehicle speed sensor connector (C57) and ECM connector(CFD-ECM).
   3) Measure resistance between the terminal 2 of vehicle speed sensor harness connector and the chassis ground.
      ■ Specification: Infinite
   4) Is the resistance measured within specification?

YES

▶ Go to “Power Supply Inspection” procedure.

NO

▶ Repair short to ground and then go to “Verification of Vehicle Repair” procedure.

POWER SUPPLY INSPECTION

1. Power Supply Voltage Inspection
   1) Leave the vehicle speed sensor connector (C57) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 2 of vehicle speed sensor harness connector and chassis ground.
      ■ Specification: Vehicle speed sensor supply power B+ V
   4) Is the voltage measured within specification?

YES

▶ Go to “Ground Circuit Inspection” procedure.

NO

▶ Go to “Power Supply Open Inspection” procedure.

2. Power Supply Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the vehicle speed sensor connector (C57) and ECM connector(CFD-ECM).
   3) Measure resistance between the terminal 2 of vehicle speed sensor harness connector and terminal of fuse #30 (10A).
      ■ Specification: Continuity
   4) Is the resistance measured within specification?

YES

▶ Go to “Ground Circuit Inspection” procedure.

NO

▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.

GROUND CIRCUIT INSPECTION

1. Ground Voltage Drop Inspection
   1) Disconnect the vehicle speed sensor connector (C57) and ECM connector(CFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage drop between the terminal 3 of the vehicle speed sensor harness connector and chassis ground.
      ■ Specification: Ground voltage drop within 200mV
   4) Is the voltage measured within specification?

YES

▶ Go to “Ground Open Inspection” procedure.

NO

▶ Repair the cause of the excessive resistance (poor connection) and go to “Verification of Vehicle Repair” procedure.

2. Ground Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the vehicle speed sensor connector (C57) and the engine ECM connector(CFD-ECM).
   3) Measure resistance between the terminal 3 of the vehicle speed sensor harness connector and ground point (G03).
      ■ Specification: Continuity (Below 1.0Ω)
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

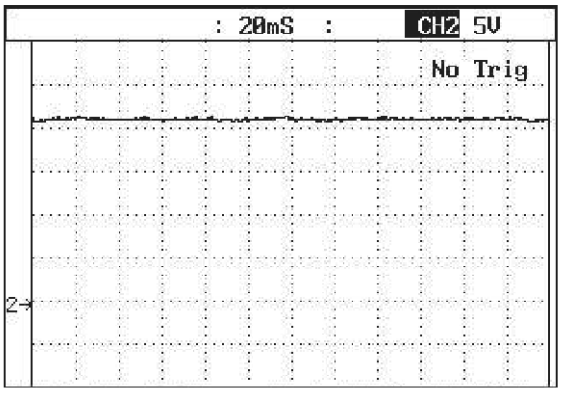
      ▶ Repair open wiring circuit and then go to “Verification of Vehicle Repair” procedure.

COMPONENT INSPECTION

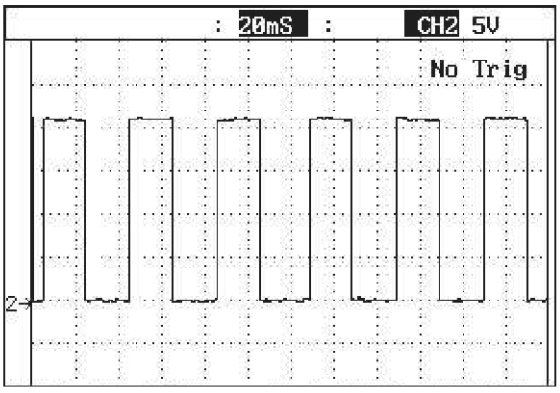
1. Vehicle Speed Sensor Waveform Inspection
   1) Turn the ignition ON. Leave the engine OFF.
   2) Connect the vehicle speed sensor connector (C57) and ECM connector(CFD-ECM).
   3) Connect oscilloscope probe to terminal 4 of the vehicle speed sensor.
   4) Check that the waveform of the vehicle speed displays normally while driving.

      ■ Specification:

Vehicle speed sensor
Waveform
(At 0km/h)



Vehicle speed sensor
Waveform
(At 20km/h)



SUDFLDTC9073L

5) Does the waveform display normally?

YES

▶ Go to “Verification of Vehicle Repair” procedure.

NO

▶ Replace the vehicle speed sensor and then go to “Verification of Vehicle Repair” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

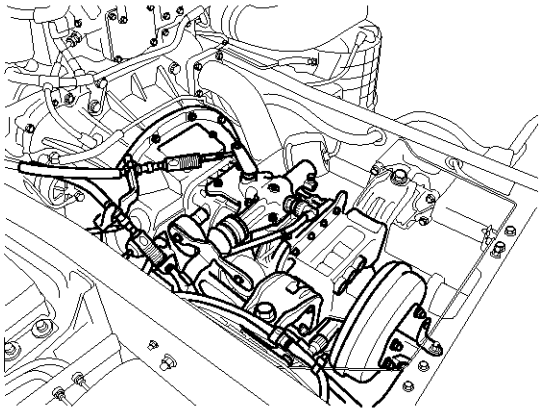
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P0503 Vehicle Speed Sensor Frequency Too High

COMPONENT LOCATION



SDFFL7116D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   Vehicle speed sensor which is hall sensor type detects vehicle speed by sensing the revolution of transmission output shaft. If the vehicle speed sensor sends signal to ECM, the signal is used not only for correction signal to calculate optimum fuel amount by comparing current engine revolution and vehicle speed but also for vehicle gauge signal and vehicle information to ETACS.

2. DTC DESCRIPTION

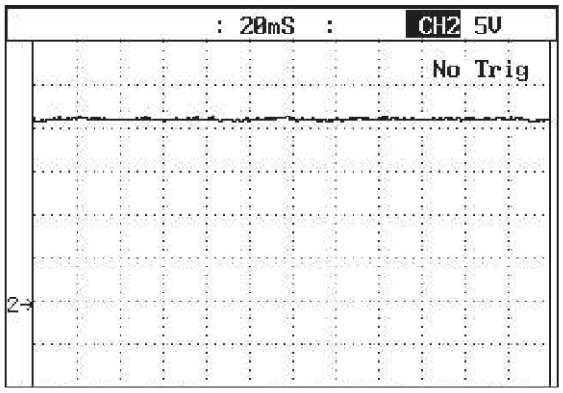
   If the vehicle speed sensor signal while driving is detected above 200km/h for 1,056 ms or more, the ECM judges this as a fault and DTC is set. The possible cause may be vehicle speed sensor malfunction or entry of noise. It is impossible for the ECM to detect gear range and to control PTO(if equipped) when vehicle speed sensor signal is detected above 200km/h.

DTC DETECTING CONDITION

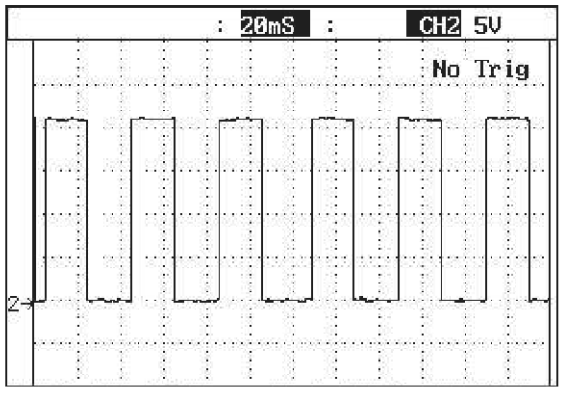
Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Defective vehicle speed sensor • Noise inflow to terminal 14 of ECM connector (CF-D-ECM)
Enable Conditions	• Engine running			
Threshold Value	• Vehicle speed signal > 200km/h			
Diagnosis Time	• 1,056ms or higher			
Fail Safe	Fuel Cut	No	• Impossible identification in gear range • PTO control stop • Cruise release	
	Fuel limit	No		
	Check lamp	ON		

WAVEFORM

Vehicle speed sensor
Waveform
(At 0km/h)



Vehicle speed sensor
Waveform
(At 20km/h)



SUDFLDTC9073L

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature.
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Vehicle speed” parameter on the scan tool.

NOTICE
It indicates such information as the stop and running of “Vehicle speed” according to DTC detecting condition. (Refer to voltage change in control information and simulation.)

Parameter	Reference Value
Vehicle speed (At IG ON)	0 Km/h
Vehicle speed (At 20 Km/h)	20 Km/h
Vehicle speed (At 40 Km/h)	40 Km/h

SIGNAL CIRCUIT INSPECTION

1. Signal Voltage Inspection
   1) Leave the vehicle speed sensor connector (C57) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 4 of vehicle speed sensor harness connector and chassis ground.
      ■ Specification: Vehicle speed sensor signal power approx. 19.2V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Ground Circuit Inspection” procedure.

      NO

      ▶ Go to “Signal Open Inspection” procedure.
2. Signal Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the vehicle speed sensor connector (C57) and ETACS connector (M56-1).
   3) Measure resistance between the terminal 4 of vehicle speed sensor harness connector and the terminal 6 of ETACS connector (M56-1).
   4) Measure resistance between the terminal 3 of ETACS harness connector (M56-3) and the terminal 14 of ECM connector(CFD-ECM).
   5) ■ Specification: Continuity
   6) Is the resistance measured within specification?

      YES

      ▶ Go to “Signal Short to Power Inspection”

procedure.

NO

▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.

3. Signal Short to Power Inspection
   1) Disconnect the vehicle speed sensor connector (C57) and ECM connector(CFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 4 of vehicle speed sensor harness connector and the chassis ground.
      ■ Specification: Below 0~0.1V
   4) Is the voltage measured within specification?

YES

▶ Go to “Power Supply Short to Ground Inspection” procedure.

NO

▶ Repair short to power and then go to “Verification of Vehicle Repair” procedure.

4. Signal Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the vehicle speed sensor connector (C57) and ECM connector(CFD-ECM).
   3) Measure resistance between the terminal 2 of vehicle speed sensor harness connector and the chassis ground.
      ■ Specification: Infinite
   4) Is the resistance measured within specification?

YES

▶ Go to “Power Supply Inspection” procedure.

NO

▶ Repair short to ground and then go to “Verification of Vehicle Repair” procedure.

POWER SUPPLY INSPECTION

1. Power Supply Voltage Inspection
   1) Leave the vehicle speed sensor connector (C57) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 2 of vehicle speed sensor harness connector and chassis ground.
      ■ Specification: Vehicle speed sensor supply power B+ V
   4) Is the voltage measured within specification?

YES

▶ Go to “Ground Circuit Inspection” procedure.

NO

▶ Go to “Power Supply Open Inspection” procedure.

2. Power Supply Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the vehicle speed sensor connector (C57) and ECM connector(CFD-ECM).
   3) Measure resistance between the terminal 2 of vehicle speed sensor harness connector and terminal of fuse #30 (10A).
      ■ Specification: Continuity
   4) Is the resistance measured within specification?

YES

▶ Go to “Ground Circuit Inspection” procedure.

NO

▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.

GROUND CIRCUIT INSPECTION

1. Ground Voltage Drop Inspection
   1) Disconnect the vehicle speed sensor connector (C57) and ECM connector(CFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage drop between the terminal 3 of the vehicle speed sensor harness connector and chassis ground.
      ■ Specification: Ground voltage drop within 200mV
   4) Is the voltage measured within specification?

YES

▶ Go to “Ground Open Inspection” procedure.

NO

▶ Repair the cause of the excessive resistance (poor connection) and go to “Verification of Vehicle Repair” procedure.

2. Ground Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the vehicle speed sensor connector (C57) and the engine ECM connector(CFD-ECM).
   3) Measure resistance between the terminal 3 of the vehicle speed sensor harness connector and ground point (G03).
      ■ Specification: Continuity (Below 1.0Ω)
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

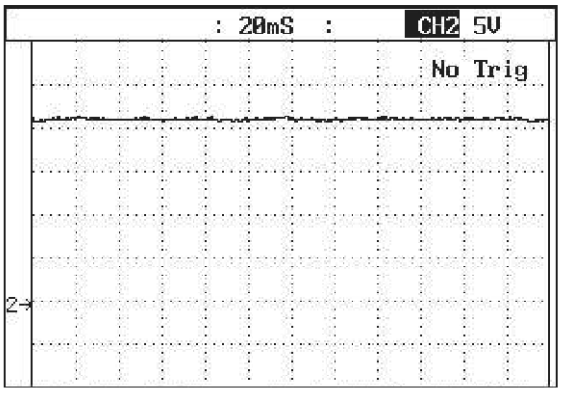
      ▶ Repair open wiring circuit and then go to “Verification of Vehicle Repair” procedure.

COMPONENT INSPECTION

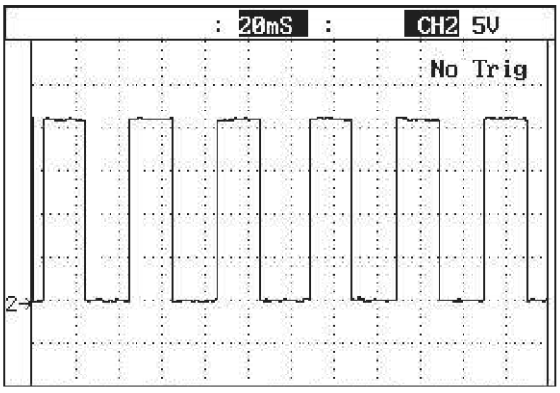
1. Vehicle Speed Sensor Waveform Inspection
   1) Turn the ignition ON. Leave the engine OFF.
   2) Connect the vehicle speed sensor connector (C57) and ECM connector(CFD-ECM).
   3) Connect oscilloscope probe to terminal 4 of the vehicle speed sensor.
   4) Check that the waveform of the vehicle speed displays normally while driving.

      ■ Specification:

Vehicle speed sensor
Waveform
(At 0km/h)



Vehicle speed sensor
Waveform
(At 20km/h)



5) Does the waveform display normally?

YES

▶ Go to “Verification of Vehicle Repair” procedure.

NO

▶ Replace the vehicle speed sensor and then go to “Verification of Vehicle Repair” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

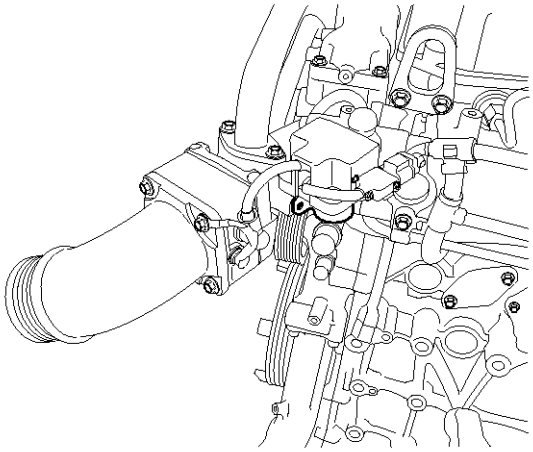
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P0541 Air Heater Monitor system Failure(LOW)

COMPONENT LOCATION



SDFFL7217D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   Air heater(glow plug) heats intake air and makes initial start ability easy and works out well for diesel fuel injection when it is low temperature. The ECM controls preheater plug through preheater plug relay and controls preheater time according to engine temperature.

2. DTC DESCRIPTION

   If the voltage is not detected to terminal 40 of ECM connector(EFD-ECM) under operation condition of glow relay #1, the ECM judges this as a fault and DTC is set. The probable causes may be open to glow relay control circuit #1, short to ground or glow relay malfunction.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Short to ground terminal 40 of ECM connector (EFD-ECM) • Check wiring harness and relay
Enable Conditions	• At IG ON			
Threshold Value	• -			
Diagnosis Time	• 6,336ms			
Fail Safe	Fuel Cut	No	• Impossible identification in gear range • PTO control stop • Cruise release	
	Fuel limit	No		
	Check lamp	ON		

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature.
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Vehicle speed” parameter on the scan tool.

Parameter	Reference Value
Air heater relay (At IG ON)	OFF
Air heater relay (At Idle)	OFF

SIGNAL CIRCUIT INSPECTION

1. Air Heater Monitoring Switch Voltage Inspection
   1) Leave the air heater monitoring & relay connector(EFD17) and the engine ECM connector(EFD-ECM) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 2 of air heater monitoring & relay harness connector and chassis ground.

      ■ Specification:

      Air heater relay signal power B^+ V (When the glow relay operates)

      Air heater relay signal power approx. 0 V (When the glow relay does not operate)
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Go to “Short to Ground Inspection” procedure.
2. Air Heater Monitoring Switch Power Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the air heater monitoring & relay connector(EFD17) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 2 of air heater monitoring harness connector and the chassis ground.
   4) ■ Specification: Infinite
   5) Is the resistance measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Repair short to ground and then go to “Verification of Vehicle Repair” procedure.

COMPONENT INSPECTION

1. Air Heater Monitoring & Relay Component Inspection
   1) Turn the ignition OFF.
   2) Connect the air heater monitoring & relay connector(EFD17).
   3) Measure the resistance between terminals 1 and 2 of the air heater monitoring & relay connector.

■ Specification

①-② resistance	17.5 Ω

   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Verification of Vehicle Repair” procedure.

      NO

      ▶ Replace the air heater monitoring & relay and then go to “Verification of Vehicle Repair” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

   YES

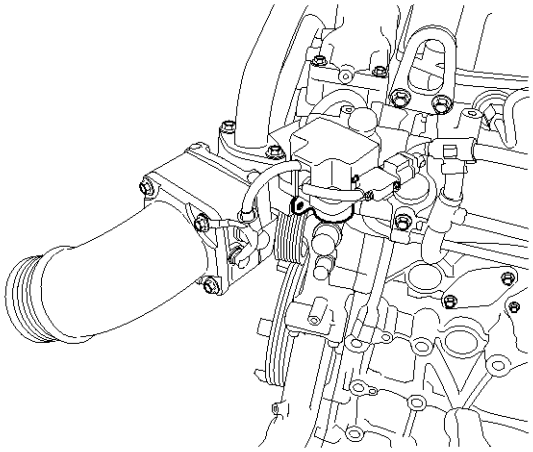
   ▶ Go to the applicable DTC procedure.

   NO

   ▶ System OK

P0542 Air Heater Monitor system Failure(HIGH)

COMPONENT LOCATION



SDFFL7217D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   Air heater(glow plug) heats intake air and makes initial start ability easy and works out well for diesel fuel injection when it is low temperature. The ECM controls preheater plug through preheater plug relay and controls preheater time according to engine temperature.

2. DTC DESCRIPTION

   If the voltage is detected to terminal 40 of ECM connector(EFD-ECM) under non-operation condition of glow relay #1, the ECM judges this as a fault and DTC is set. The probable causes may be open to glow relay control circuit #1, short to power or glow relay malfunction.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Short to power terminal 40 of ECM connector (EFD-ECM) • Check wiring harness and relay
Enable Conditions	• At IG ON			
Threshold Value	• -			
Diagnosis Time	• 6,336ms			
Fail Safe	Fuel Cut	No	• Impossible identification in gear range • PTO control stop • Cruise release	
	Fuel limit	No		
	Check lamp	ON		

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature.
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Vehicle speed” parameter on the scan tool.

Parameter	Reference Value
Air heater relay (At IG ON)	OFF
Air heater relay (At Idle)	OFF

SIGNAL CIRCUIT INSPECTION

1. Air Heater Monitoring Switch Voltage Inspection
   1) Leave the air heater monitoring & relay connector(EFD17) and the engine ECM connector(EFD-ECM) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 2 of air heater monitoring & relay harness connector and chassis ground.

      ■ Specification:

      Air heater relay signal power B+ V (When the glow relay operates)

      Air heater relay signal power approx. 0 V (When the glow relay does not operate)
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Go to “Short to Ground Inspection” procedure.
2. Air Heater Monitoring Switch Power Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the air heater monitoring & relay connector(EFD17) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 2 of air heater monitoring harness connector and the terminal 40 of the engine ECM connector(EFD-ECM).
   4) ■ Specification: Continuity
   5) Is the resistance measured within specification?

      YES

      ▶ Go to “Signal Short to Power Inspection” procedure.

      NO

      ▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.
3. Signal Short to Power Inspection
   1) Disconnect the air heater monitoring & relay connector(EFD17) and ECM connector(EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 2 of air heater monitoring harness connector and the chassis ground.

      ■ Specification: Below 0~0.1 V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Repair short to power and then go to “Verification of Vehicle Repair” procedure.

COMPONENT INSPECTION

1. Air Heater Monitoring & Relay Component Inspection
   1) Turn the ignition OFF.
   2) Connect the air heater monitoring & relay connector(EFD17).
   3) Measure the resistance between terminals 1 and 2 of the air heater monitoring & relay connector.

■ Specification

①-② resistance	17.5 Ω

   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Verification of Vehicle Repair” procedure.

      NO

      ▶ Replace the air heater monitoring & relay and then go to “Verification of Vehicle Repair” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

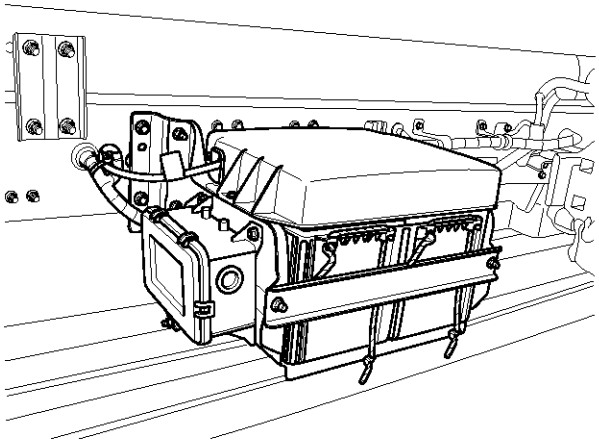
▶ Go to the applicable DTC procedure.

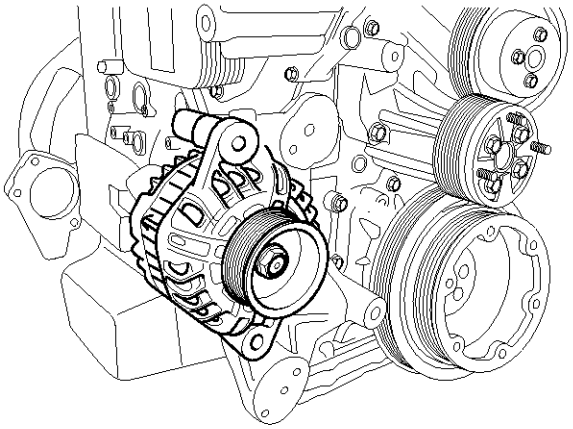
NO

▶ System OK

P0562 Vehicle System Voltage Too Low

COMPONENT LOCATION





SUDFL8327D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   The battery voltage will be fluctuated from 23.5V to 28.5V, if the battery is normal. The voltage drop at cranking will occur rapidly. The actuators such as injectors, fuel supply pump and rail sensor request the precise control and the characteristics value of the actuators changes according to battery voltage change. The ECM corrects the operation time of actuator depending on voltage change by monitoring battery voltage change to correct characteristics value of actuator according to voltage change like this.

2. DTC DESCRIPTION

   If the battery voltage is detected below 15.2V for 5,044 ms or more, the ECM judges this as a fault and DTC is set. The possible cause may be faulty charging system(Battery, alternator component and charging circuit) and wrong voltage of terminals 1,18,21,38,58 and 78 of ECM connector(CFD-ECM).

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Check battery. • Check charging circuit. • Check voltage of terminals 1, 18, 21, 38, 58, 78 of ECM connector (CFD-ECM).
Enable Conditions	• Engine running			
Threshold Value	• Output voltage <15.2			
Diagnosis Time	• 5,044ms or higher			
Fail Safe	Fuel Cut	No		
	Fuel limit	No		
	Check lamp	OFF		

SPECIFICATION

1. Regulator voltage

Regulator temperature (℃)	Voltage (V)
20~30	27.5~28.5

2. Resistance between relay terminals

85-86 (at 20℃)	30-87a	85-86 when applying power
340Ω±10%	0Ω (Continuity)	Terminal 30-87: 0 Ω (Continuity)

3. Relay connector terminal voltage (At IG ON)

Terminal 86	Terminal 87a	Terminal 30
B+ V	B+ V	B+ V

WAVEFORM

■ Specification: No-load idle state, 24.5~25.5V

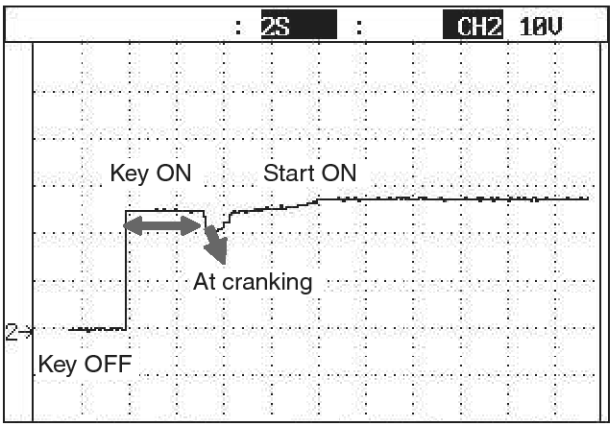


Fig. 1

Fig 1) Ignition key ON, IG key ON condition after starting
Fig 2) This is "Battery voltage" data at idle after the engine warms up. Check that voltage lowers seriously.
And check that condition below indicates.

※ Vehicle characteristics when the alternator has poor charging
1. Lamps are getting dark at idle and are getting bright at accelerating.
2. Engine rpm drops intermittently at near idle range (at low speed range) and sometimes the engine stalls.
3. The engine has poor cranking. (Warning lamps get dark extremely and have no power at cranking the engine.)
4. Charging warning lamp comes on while driving.

POWER SUPPLY INSPECTION

1. Alternator Connector Supply Power Inspection
   1) Leave the alternator connector (C39) connected.
   2) Start the engine, leave the engine ON.
   3) Measure voltage of the terminal 1 of alternator connector and chassis ground.
      ■ Specification: Charging voltage (B V)
   4) Is the voltage measured within specification?

      YES

      ▶ Go to "Verification of Vehicle Repair" procedure.

      NO

      ▶ Go to "Alternator B+ Cable Voltage Drop Inspection" procedure.
2. Alternator B+ Cable Voltage Drop Inspection
   1) Start the engine, leave the engine ON.
   2) Measure voltage between terminal B+ of alternator and terminal B+ of battery.
      (Connect terminal + of multimeter to terminal B+ of alternator, connect terminal - of multimeter to terminal - of alternator.)
      ■ Specification: Within 200mV
   3) Is the voltage drop of alternator B+ measured within specification?

      YES

      ▶ Go to "Component Inspection" procedure.

      NO

      ▶ Check the alternator B+ cable for corrosion or degradation and replace the cable if necessary.

COMPONENT INSPECTION

1. Alternator Charge Voltage Inspection
   1) Turn the ignition OFF. Leave the engine OFF.
   2) Check the belt tension to drive alternator.
   3) Check the battery terminal, fusible link and alternator B+ for looseness and corrosion
   4) Start the engine.
   5) Operate such electric systems as head lamps, heat wire and blower motor etc.
   6) Measure the battery voltage at engine 750 rpm or higher.

      ■ Specification:

Regulator temperature (℃)	Voltage (V)
20~30	27.5~28.5

   7) Is the voltage measured within specification?

      YES

      ▶ Go to "Verification of Vehicle Repair" procedure.

      NO

      ▶ Replace the regulator and then go to "Verification of Vehicle Repair" procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select "Diagnostic Trouble Codes (DTCs)" mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

   YES

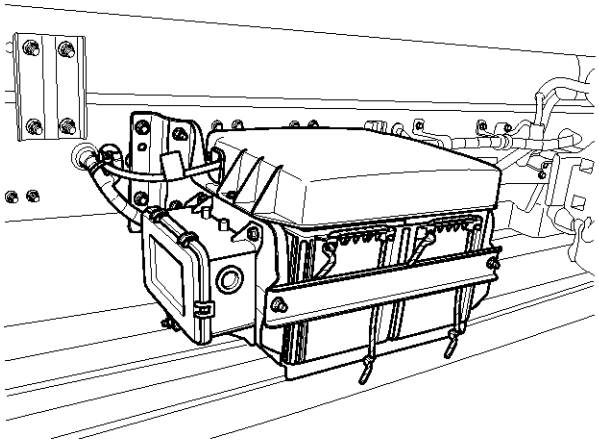
   ▶ Go to the applicable DTC procedure.

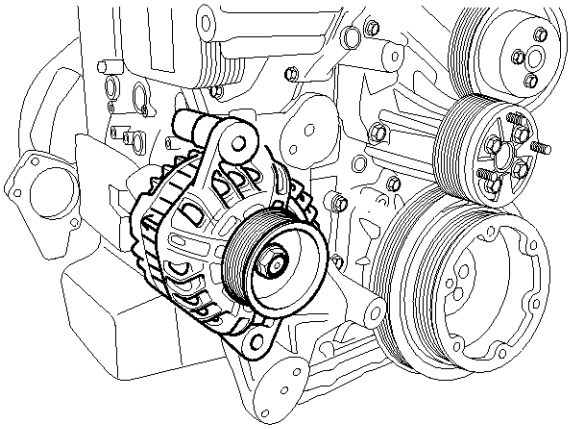
   NO

   ▶ System OK

P0563 Vehicle System Voltage Too High

COMPONENT LOCATION





SUDFL8327D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   The battery voltage will be fluctuated from 23.5V~28.5V, if the battery is normal. The voltage drop at cranking will occur rapidly. The actuators such as injectors, fuel supply pump and rail sensor request the precise control and the characteristics value of the actuators changes according to battery voltage change. The ECM corrects the operation time of actuator depending on voltage change by monitoring battery voltage change to correct characteristics value of actuator according to voltage change like this.

2. DTC DESCRIPTION

   If the battery voltage is detected above 32V for 5,044 ms or more, the ECM judges this as a fault and DTC is set. The possible cause may be faulty charging system(Battery, alternator component and charging circuit) and wrong voltage of terminals 1,18,21,38,58 and 78 of ECM connector(CFD-ECM).

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Check battery. • Check charging circuit. • Check voltage of terminals 1, 18, 21, 38, 58, 78 of EC-M connector (CFD-ECM).
Enable Conditions	• Engine running			
Threshold Value	• Output voltage >32 V			
Diagnosis Time	• 5,044ms or higher			
Fail Safe	Fuel Cut	No		
	Fuel limit	No		
	Check lamp	ON		

SPECIFICATION

1. Regulator voltage

Regulator temperature (℃)	Voltage (V)
20~30	27.5~28.5

2. Resistance between relay terminals

85-86 (at 20℃)	30-87a	85-86 when applying power
340Ω±10%	0Ω (Continuity)	Terminal 30-87: 0 Ω (Continuity)

3. Relay connector terminal voltage (At IG ON)

Terminal 86	Terminal 87a	Terminal 30
B+ V	B+ V	B+ V

WAVEFORM

■ Specification: No-load idle state, 24.5~25.5V

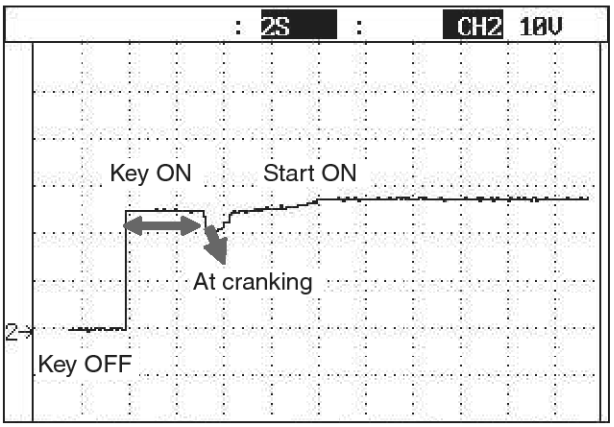


Fig. 1

Fig 1) Ignition key ON, IG key ON condition after starting
Fig 2) This is "Battery voltage" data at idle after the engine warms up. Check that voltage lowers seriously.
And check that condition below indicates.

※ Vehicle characteristics when the alternator has poor charging
1. Lamps are getting dark at idle and are getting bright at accelerating.
2. Engine rpm drops intermittently at near idle range (at low speed range) and sometimes the engine stalls.
3. The engine has poor cranking. (Warning lamps get dark extremely and have no power at cranking the engine.)
4. Charging warning lamp comes on while driving.

POWER SUPPLY INSPECTION

1. Alternator Connector Supply Power Inspection
   1) Leave the alternator connector (C39) connected.
   2) Start the engine, leave the engine ON.
   3) Measure voltage of the terminal 1 of alternator connector and chassis ground.
      ■ Specification: Charging voltage (B V)
   4) Is the voltage measured within specification?

      YES

      ▶ Go to "Verification of Vehicle Repair" procedure.

      NO

      ▶ Go to "Alternator B+ Cable Voltage Drop Inspection" procedure.
2. Alternator B+ Cable Voltage Drop Inspection
   1) Start the engine, leave the engine ON.
   2) Measure voltage between terminal B+ of alternator and terminal B+ of battery.
      (Connect terminal + of multimeter to terminal B+ of alternator, connect terminal - of multimeter to terminal - of alternator.)
      ■ Specification: Within 200mV
   3) Is the voltage drop of alternator B+ measured within specification?

      YES

      ▶ Go to "Component Inspection" procedure.

      NO

      ▶ Check the alternator B+ cable for corrosion or degradation and replace the cable if necessary.

COMPONENT INSPECTION

1. Alternator Charge Voltage Inspection
   1) Turn the ignition OFF. Leave the engine OFF.
   2) Check the belt tension to drive alternator.
   3) Check the battery terminal, fusible link and alternator B+ for looseness and corrosion
   4) Start the engine.
   5) Operate such electric systems as head lamps, heat wire and blower motor etc.
   6) Measure the battery voltage at engine 750 rpm or higher.

      ■ Specification:

Regulator temperature (℃)	Voltage (V)
20~30	27.5~28.5

   7) Is the voltage measured within specification?

      YES

      ▶ Go to "Verification of Vehicle Repair" procedure.

      NO

      ▶ Replace the regulator and then go to "Verification of Vehicle Repair" procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select "Diagnostic Trouble Codes (DTCs)" mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

   YES

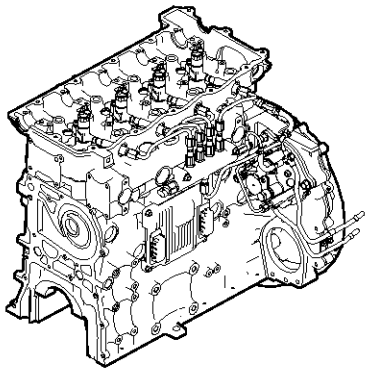
   ▶ Go to the applicable DTC procedure.

   NO

   ▶ System OK

P0601 Check Sum Error - Flash area

COMPONENT LOCATION



SDFFL7104D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   The ECM judges whether vehicle condition is good or not through algorithm check-sum. All data of algorithm check-sum is composed of combination of "0" and "1". The algorithm check-sum means that adds all values in the character row. The criteria to judge whether the ECM is good or not is sensed by comparing the stored values in the ECM and the obtained values through algorithm.

2. DTC DESCRIPTION

   If the discrepancy of check-sum is detected 3 times in a row for 96.0ms or more, the ECM judges this as a fault and DTC is set. The possible cause may be faulty CPU of ECM. In case of fail safe, it is impossible to start the engine and to control PTO(if equipped) and fuel amount is limited to below 40mm³/st.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Algorithm check			• ECM
Enable Conditions	• At IG ON			
Threshold Value	• Check sum continues to mismatch 3 times			
Diagnosis Time	• 96.0ms or higher			
Fail Safe	Fuel Cut	No	• Fuel amount sets to below 40㎣/st. • PTO control stop • Cruise control release	
	Fuel limit	Yes		
	Check lamp	ON		

TROUBLESHOOTING AID

There is no special diagnostic procedure on this diagnostic trouble code due to the internal error of ECM. Replace the ECM with new one if there is not the diagnostic trouble code any more after checking the vehicle with a known-good ECM.

COMPONENT INSPECTION

1. Turn the ignition OFF. Leave the engine OFF.
2. Remove the ECM from the vehicle.
3. Install a known-good ECM, check the system operates well.
4. Replace the ECM with new one if there is not the DTC anymore.

NOTICE

By using the scan tool when replacing the ECM, be sure to correct ECM data with the injector QR correction value (30-digit) installed to the current engine. Engine performance and exhaust gas problem can occur when the correction value marked to the injector is not input.

1. *Upgrade when replacing the ECM.*
2. *Correct the ECM data.*
   - *QR code data input*
   - *Gear ratio correction value*
   - *Final reduction ratio/ tire radius input*
   - *VIN input*

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

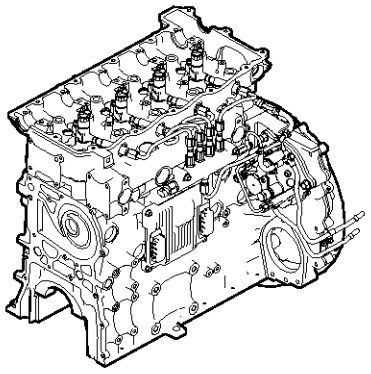
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P0602 QR Data Is Not Written

COMPONENT LOCATION



SDFFL7104D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   The ECM judges whether vehicle condition is good or not through algorithm check-sum. All data of algorithm check-sum is composed of combination of "0" and "1". The algorithm check-sum means that adds all values in the character row. The criteria to judge whether the ECM is good or not is sensed by comparing the stored values in the ECM and the obtained values through algorithm.

2. DTC DESCRIPTION

   Using EEPROM memory data, if QR correction and at least one among injectors are detected for 768.0ms or more per a day, the ECM judges this as a fault and DTC is set. Check lamp comes on and MIL is blinking when the condition continued 2 driving cycle times. MIL will go off after 3 driving cycle times when the system returns to normal. The possible cause may be mismatch between QR correction value and injector QR correction or the internal error of ECM with the scan tool. QR correction value in the upper of each injector connector should be inputted to the ECM by using the scan tool since the default value without QR correction value inputted is stored in the ECM. The engine is controlled by the previous value in case of fail safe.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• QR correction value			• ECM
Enable Conditions	• At IG ON/ running			
Threshold Value	• When QR correction using EEPROM memory data and at least one among injectors is 1			
Diagnosis Time	• 768.0ms or higher			
Fail Safe	Fuel Cut	No	• Unstable idle, lack of power • Previous value maintenance	
	Fuel limit	No		
	Check lamp	ON		

TROUBLESHOOTING AID

There is no special diagnostic procedure on this diagnostic trouble code due to the internal error of ECM. Replace the ECM with new one if there is not the diagnostic trouble code any more after checking the vehicle with a known-good ECM.

COMPONENT INSPECTION

1. Turn the ignition OFF. Leave the engine OFF.
2. Remove the ECM from the vehicle.
3. Install a known-good ECM, check the system operates well.
4. Replace the ECM with new one if there is not the DTC anymore.

NOTICE

By using the scan tool when replacing the ECM, be sure to correct ECM data with the injector QR correction value (30-digit) installed to the current engine. Engine performance and exhaust gas problem can occur when the correction value marked to the injector is not input.

1. *Upgrade when replacing the ECM.*
2. *Correct the ECM data.*
   - *QR code data input*
   - *Gear ratio correction value*
   - *Final reduction ratio/ tire radius input*
   - *VIN input*

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

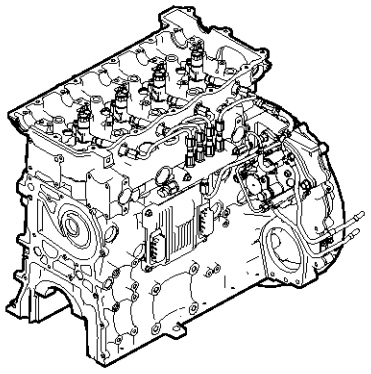
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P0603 QR Data Error

COMPONENT LOCATION



SDFFL7104D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   The ECM judges whether vehicle condition is good or not through algorithm check-sum. All data of algorithm check-sum is composed of combination of "0" and "1". The algorithm check-sum means that adds all values in the character row. The criteria to judge whether the ECM is good or not is sensed by comparing the stored values in the ECM and the obtained values through algorithm.

2. DTC DESCRIPTION

   Using EEPROM memory data, if QR correction and at least one among injectors are detected for 768.0ms or more per a day, the ECM judges this as a fault and DTC is set. Check lamp comes on and MIL is blinking when the condition continued 2 driving cycle times. MIL will go off after 3 driving cycle times when the system returns to normal. The possible cause may be mismatch between QR correction value and injector QR correction or the internal error of ECM with the scan tool. QR correction value in the upper of each injector connector should be inputted to the ECM by using the scan tool since the default value without QR correction value inputted is stored in the ECM. The engine is controlled by the previous value in case of fail safe.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• QR correction value			• ECM
Enable Conditions	• At IG ON/ running			
Threshold Value	• When QR correction using EEPROM memory data and at least one among injectors is 1			
Diagnosis Time	• 768.0ms or higher			
Fail Safe	Fuel Cut	No	• Unstable idle, lack of power • Previous value maintenance	
	Fuel limit	No		
	Check lamp	ON		

TROUBLESHOOTING AID

There is no special diagnostic procedure on this diagnostic trouble code due to the internal error of ECM. Replace the ECM with new one if there is not the diagnostic trouble code any more after checking the vehicle with a known-good ECM.

COMPONENT INSPECTION

1. Turn the ignition OFF. Leave the engine OFF.
2. Remove the ECM from the vehicle.
3. Install a known-good ECM, check the system operates well.
4. Replace the ECM with new one if there is not the DTC anymore.

NOTICE

By using the scan tool when replacing the ECM, be sure to correct ECM data with the injector QR correction value (30-digit) installed to the current engine. Engine performance and exhaust gas problem can occur when the correction value marked to the injector is not input.

1. *Upgrade when replacing the ECM.*
2. *Correct the ECM data.*
   - *QR code data input*
   - *Gear ratio correction value*
   - *Final reduction ratio/ tire radius input*
   - *VIN input*

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

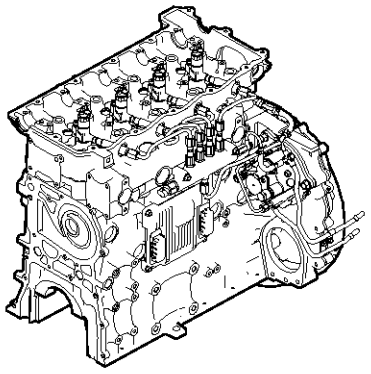
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P0604 QR Definition Error

COMPONENT LOCATION



SDFFL7104D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   The ECM judges whether vehicle condition is good or not through algorithm check-sum. All data of algorithm check-sum is composed of combination of "0" and "1". The algorithm check-sum means that adds all values in the character row. The criteria to judge whether the ECM is good or not is sensed by comparing the stored values in the ECM and the obtained values through algorithm.

2. DTC DESCRIPTION

   Using EEPROM memory data, if QR correction and at least one among injectors are detected for 768.0ms or more per a day, the ECM judges this as a fault and DTC is set. Check lamp comes on and MIL is blinking when the condition continued 2 driving cycle times. MIL will go off after 3 driving cycle times when the system returns to normal. The possible cause may be mismatch between QR correction value and injector QR correction or the internal error of ECM with the scan tool. QR correction value in the upper of each injector connector should be inputted to the ECM by using the scan tool since the default value without QR correction value inputted is stored in the ECM. The engine is controlled by the previous value in case of fail safe.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• QR correction value			• ECM
Enable Conditions	• At IG ON/ running			
Threshold Value	• When QR correction using EEPROM memory data and at least one among injectors is 1			
Diagnosis Time	• 768.0ms or higher			
Fail Safe	Fuel Cut	No	• Fuel amount sets to below 40㎟/st. • Previous value maintenance	
	Fuel limit	No		
	Check lamp	ON		

TROUBLESHOOTING AID

There is no special diagnostic procedure on this diagnostic trouble code due to the internal error of ECM. Replace the ECM with new one if there is not the diagnostic trouble code any more after checking the vehicle with a known-good ECM.

COMPONENT INSPECTION

1. Turn the ignition OFF. Leave the engine OFF.
2. Remove the ECM from the vehicle.
3. Install a known-good ECM, check the system operates well.
4. Replace the ECM with new one if there is not the DTC anymore.

NOTICE

By using the scan tool when replacing the ECM, be sure to correct ECM data with the injector QR correction value (30-digit) installed to the current engine. Engine performance and exhaust gas problem can occur when the correction value marked to the injector is not input.

1. *Upgrade when replacing the ECM.*
2. *Correct the ECM data.*
   - *QR code data input*
   - *Gear ratio correction value*
   - *Final reduction ratio/ tire radius input*
   - *VIN input*

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

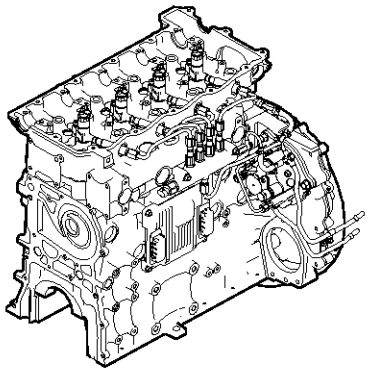
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P0606 ECM Main CPU Fault

COMPONENT LOCATION



SDFFL7104D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   ECM receives power, is activated and receives signals from the various sensors such as the crankshaft position sensor and the accelerator pedal position sensor etc. Based on the input signals, the ECM controls engine by driving injector, various solenoids and relay through comparison algorithm between micro controller and control logic stored in EEPROM. Also to improve reliability, the ECM performs diagnoses of self test of ECM itself, various sensors and actuators and informs a driver of trouble information to protect serious problem of drive ability and performs the function to shut off system to protect dangerous condition with wrong control.

2. DTC DESCRIPTION

   If RUN Pulse after Power ON Reset is detected 5 times in a row for 96.0ms when is not opposite rotation within certain set-time, the ECM judges this as a fault and DTC is set. The possible cause may be the faulty CPU in the ECM. In case of fail safe, it is impossible to start the engine and to control PTO(if equipped) and fuel amount is limited to below 40mm³/st.

DTC DETECTING CONDITION

<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• EEPROM monitoring</td><td rowspan="6">• ECM</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• At IG ON</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• When run pulse no-counter-turn continues to occur 5 times for some fixed time after power ON resets</td></tr>
<tr><td>Diagnosis Time</td><td colspan="3">• 96.0ms or higher</td></tr>
<tr><td rowspan="3">Fail Safe</td><td>Fuel Cut</td><td>No</td><td rowspan="3">• Engine stop
• PTO control stop</td></tr>
<tr><td>Fuel limit</td><td>Yes</td></tr>
<tr><td>Check lamp</td><td>ON</td></tr>
</table>

TROUBLESHOOTING AID

There is no special diagnostic procedure on this diagnostic trouble code due to the internal error of ECM. Replace the ECM with new one if there is not the diagnostic trouble code any more after checking the vehicle with a known-good ECM.

COMPONENT INSPECTION

1. Turn the ignition OFF. Leave the engine OFF.
2. Remove the ECM from the vehicle.
3. Install a known-good ECM, check the system operates well.
4. Replace the ECM with new one if there is not the DTC anymore.

NOTICE

By using the scan tool when replacing the ECM, be sure to correct ECM data with the injector QR correction value (30-digit) installed to the current engine. Engine performance and exhaust gas problem can occur when the correction value marked to the injector is not input.

1. *Upgrade when replacing the ECM.*
2. *Correct the ECM data.*
   - *QR code data input*
   - *Gear ratio correction value*
   - *Final reduction ratio/ tire radius input*
   - *VIN input*

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

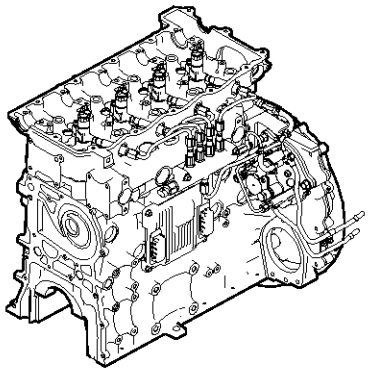
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P0607 ECM Watchdog IC Fault

COMPONENT LOCATION



SDFFL7104D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   ECM receives power, is activated and receives signals from the various sensors such as the crankshaft position sensor and the accelerator pedal position sensor etc. Based on the input signals, the ECM controls engine after driving injector, various solenoids and relay through comparison algorithm between micro controller and control logic stored in EEPROM. Also to improve reliability, the ECM performs diagnoses of self test of ECM itself, various sensors and actuators and informs a driver of trouble information to protect serious problem of drive ability and performs the function to shut off system to protect dangerous condition with wrong control.

2. DTC DESCRIPTION

   If RUN Pulse of Watchdog IC output is detected for 96.0ms or more when is not opposite rotation within 4 ms ~ 12ms, the ECM judges this as a fault and DTC is set. The possible cause may be the faulty CPU in the ECM. In case of fail safe, it is impossible to control PTO(if equipped) and fuel amount is limited to below 40mm³/st.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• EEPROM monitoring			• ECM
Enable Conditions	• At IG ON			
Threshold Value	• When the run pulse of watch dog IC output is no-counter-turn for 4~12ms or higher			
Diagnosis Time	• 96.0ms or higher			
Fail Safe	Fuel Cut	No	• Impossible startFuel amount sets t-o below 40㎣/st. • PTO control stop	
	Fuel limit	Yes		
	Check lamp	ON		

TROUBLESHOOTING AID

There is no special diagnostic procedure on this diagnostic trouble code due to the internal error of ECM. Replace the ECM with new one if there is not the diagnostic trouble code any more after checking the vehicle with a known-good ECM.

COMPONENT INSPECTION

1. Turn the ignition OFF. Leave the engine OFF.
2. Remove the ECM from the vehicle.
3. Install a known-good ECM, check the system operates well.
4. Replace the ECM with new one if there is not the DTC anymore.

NOTICE

By using the scan tool when replacing the ECM, be sure to correct ECM data with the injector QR correction value (30-digit) installed to the current engine. Engine performance and exhaust gas problem can occur when the correction value marked to the injector is not input.

1. *Upgrade when replacing the ECM.*
2. *Correct the ECM data.*
   - *QR code data input*
   - *Gear ratio correction value*
   - *Final reduction ratio/ tire radius input*
   - *VIN input*

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

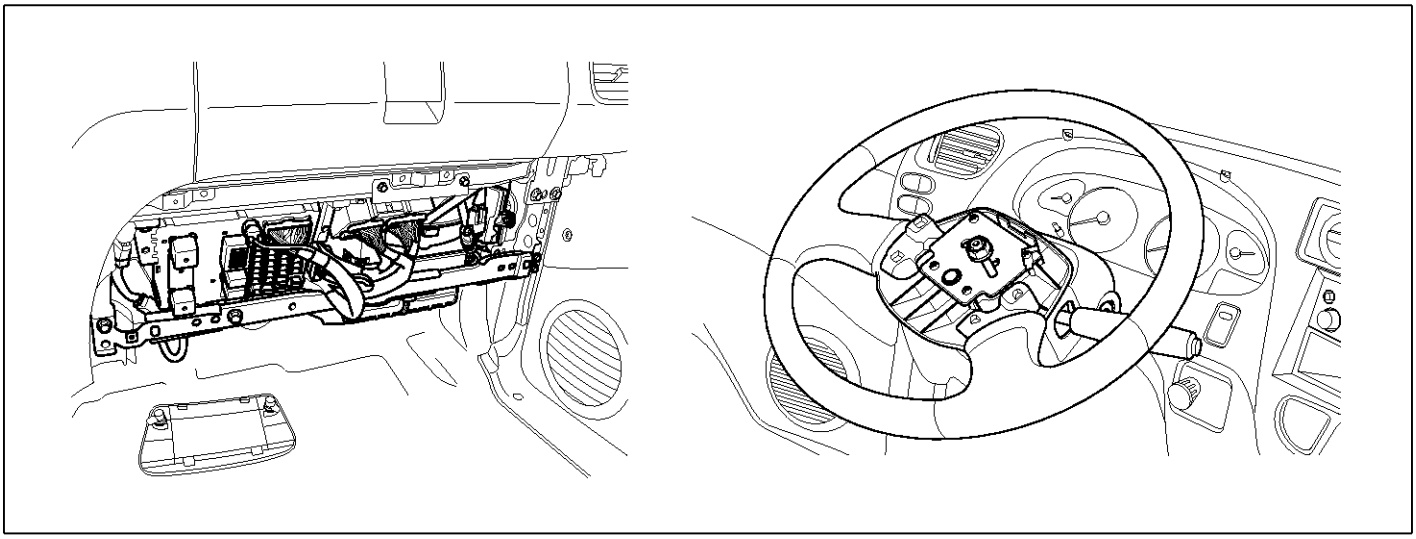
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P0615 Starter Switch Short to BATT

COMPONENT LOCATION



SUDFL8331D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   Starting system is composed of battery, start motor, solenoid switch, start switch(ignition switch), connecting wiring and battery cable etc.

   When the ignition key turns to start position, current energizes the solenoid coil of start motor.The solenoid plunger and the clutch shift lever are operating and the engine is cranked since clutch pinion is engaged with ring gear.

2. DTC DESCRIPTION

   If the voltage is detected above 0 V for 10,112 ms or more when the engine revolution is above 1,200 rpm after starting the engine. the ECM judges this as a fault and DTC is set. The probable causes may be short to battery power side of terminal 12 of ECM connector(CFD-ECM) or melted start switch. In case of fail safe, the ECM stops the engine after elapse of certain time to protect damage to the start motor.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Check the melt start switch. • Check voltage of terminal 12 of ECM (CFD-ECM).
Enable Conditions	• At IG ON/ running			
Threshold Value	• Crank position sensor > 1,200rpm			
Diagnosis Time	• 10,112ms or higher			
Fail Safe	Fuel Cut	No		
	Fuel limit	No		
	Check lamp	ON		

SPECIFICATION

1. Resistance between relay terminals

85-86 (at 20℃)	30-87a	85-86 when applying power
340Ω±10%	0Ω (Continuity)	Terminal 30-87: 0 Ω (Continuity)

2. Relay connector terminal voltage (At IG ON)

Terminal 86	Terminal 87a	Terminal 30
B+ V	B+ V	B+ V

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature.
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Start switch” parameter on the scan tool.

Parameter	Reference Value
Starter switch (At cranking)	ON
Starter switch (At IG ON)	OFF

SIGNAL CIRCUIT INSPECTION

1. Start Signal Power Inspection
   1) Leave the start relay connector (M89) connected.
   2) Turn the ignition OFF.
   3) Connect the oscilloscope probe to terminal 12 of ECM connector(CFD-ECM).
   4) Check the waveform at the ignition OFF after the vehicle maintains idle with the engine cranked.
      ■ Specification: Below 0 V after the start signal voltage (B V) detects
   5) Is the voltage measured within specification?

      YES

      ▶ Go to “Verification of Vehicle Repair” procedure.

      NO

      ▶ Go to “Signal Short to Power Inspection” procedure.
2. Signal Short to Power Inspection
   1) Disconnect the ignition fusible link (30A) and ECM connector(CFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 3 of start relay harness connector and the chassis ground.
      ■ Specification: Below 0~0.1V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Repair short to power and then go to “Verification of Vehicle Repair” procedure.

COMPONENT INSPECTION

1. Air Heater Monitoring & Relay Component Inspection
   1) Turn the ignition OFF.
   2) Connect the start relay (M89).
   3) Measure the resistance between terminals 85 and 86 of the start relay.
      ■ Specification: 325Ω±10% (20℃)
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Start Relay Component Operating Inspection” procedure.

      NO

      ▶ Replace the start relay and then go to “Verification of Vehicle Repair” procedure.
2. Start Relay Component Operating Inspection
   1) Turn the ignition OFF.
   2) Disconnect the start relay (M89).
   3) Connect B + to the terminal 85 of the start relay coil, negative (-) to 86.
   4) Measure the resistance between terminals 30 and 87a of start relay.
      ■ Specification:
      Infinite when applying power
      Continuity when cutting-off power
   5) Is the resistance measured within specification?

      YES

      ▶ Check the start switch component inspection and go to “Verification of Vehicle Repair” procedure.

      NO

▶ Replace the start relay and then go to "Verification of Vehicle Repair" procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select "Diagnostic Trouble Codes (DTCs)" mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

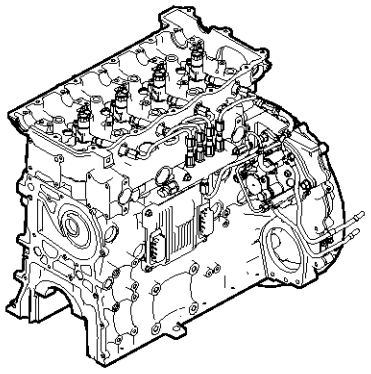
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P0627 SCV(+, -) Output Open Load/Short to GND

COMPONENT LOCATION



SDFFL7104D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   Supply control valve(SCV) is solenoid type. The ECM controls time to open/close valve, controls pump fuel amount by controlling current to be supplied to SCV to adjust target rail pressure. When the SCV is closed, fuel passage is cut off and fuel is compressed. The compressed fuel is supplied to common rail. If fuel pressure is decreased, the SCV is opened and then fuel is inhaled for next pumping. Fuel pump relay is supplied power to low fuel pump by the ECM. At the ignition key ON, the fuel pump relay works for about 1.5sec. and stops to diagnose fuel pump relay. If the engine rpm is detected above 45rpm, the ECM makes relay turn ON and feeds fuel to high pressure pump.

2. DTC DESCRIPTION

   If the SCV current duty is detected above 30% and current is detected below 500mA for 832ms or more, the ECM judges this as a fault and DTC is set. Check lamp and MIL come on together when the condition continued for 2 driving cycle times. Check lamp will go off after 3 driving cycle times when the system returns to normal. The probable causes may be short to ground of terminals 51, 52, 71 and 72 of ECM connector(EFD-ECM), open circuit in ECM or SCV wiring or pin resistance of SCV. In case of fail safe, a care should be taken due to causing a damage to common rail system. Therefore, the ECM limits engine power and abnormal high pressure is made if there is open circuit of fuel pump at starting and pressure limiter is operated etc.

DTC DETECTING CONDITION

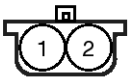
<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Current monitoring</td><td rowspan="6">• Short to ground terminal 51, 52, 71, 72 of ECM (EFD-ECM)
• Open wiring of ECM, SC-V
• SCV pin resistance</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• At IG ON</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• When SCV driving current reaches below 500mA, hardware t-arget duty value reaches 100%</td></tr>
<tr><td>Diagnosis Time</td><td colspan="3">• 832ms or higher</td></tr>
<tr><td rowspan="3">Fail Safe</td><td>Fuel Cut</td><td>No</td><td rowspan="3">• Fuel amount limit (75% of maximu-m torque)
• PTO control stop</td></tr>
<tr><td>Fuel limit</td><td>Yes</td></tr>
<tr><td>Check lamp</td><td>ON</td></tr>
</table>

SPECIFICATION

Item	Specification
Resistance	7.9±0.25Ω

SCV driving frequency	SCV control type
200 Hz	Current control

SCV driving voltage	SCV driving current
16~32 V	Below 1.29A when driving
	Below 1.16A when stopping (within 270sec.)



Sensor connector

SUDFLDTC9054L

WAVEFORM

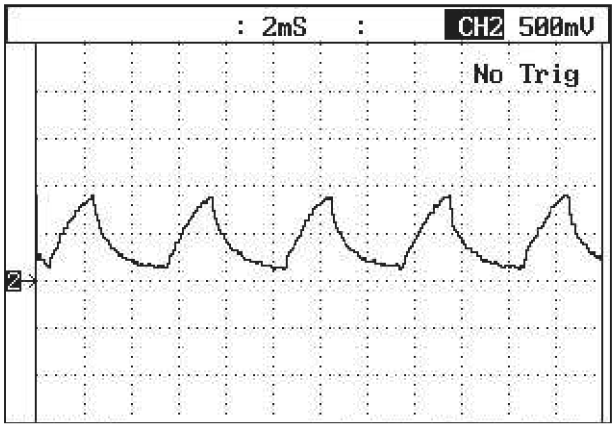


Fig. 1 Waveform at LOW side

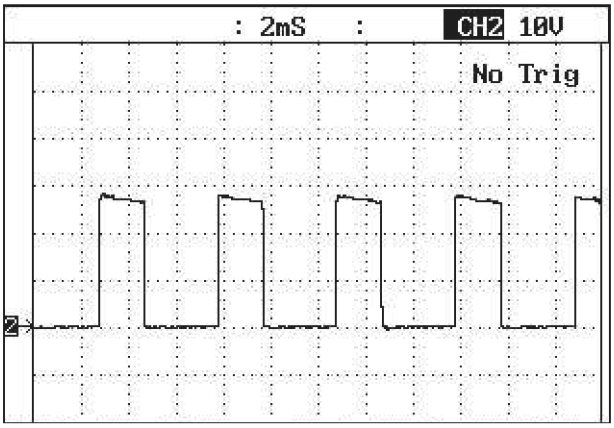


Fig. 2 Waveform at HIGH side

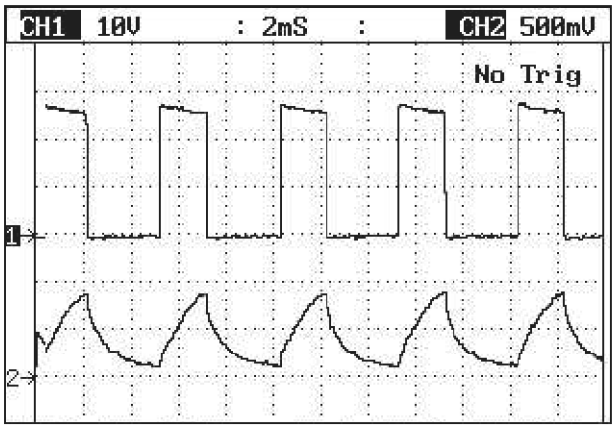


Fig. 3 Waveforms at LOW/HIGH side

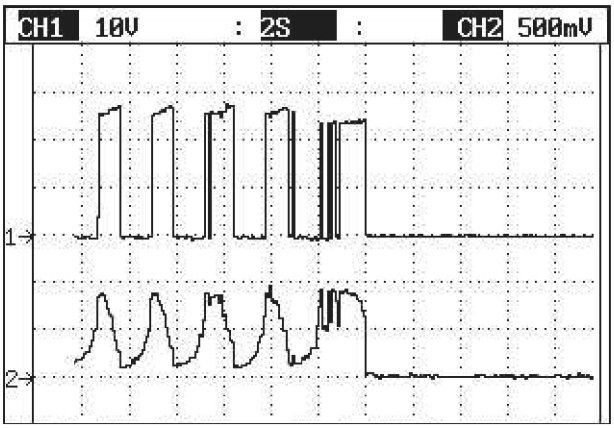


Fig. 4 Waveforms while operating for 2 sec. when the SCV valve is OFF

SUDFLDTC9055L

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature.
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Pump control duty” parameter on the scan tool.

NOTICE

The value of “Pump control duty” varies with driving condition according to DTC detecting condition. In case of failure, be sure to check that the value of “Engine output (common rail pressure limit)” is limited.

■ Specification: Pump control duty approx. 43% at idle

Parameter	Reference Value
Final pump drv. duty (At IG ON)	0.0%
Final pump drv. duty (At idle)	47.5%
Final pump drv. duty (At 1,500 rpm)	43.5%
Final pump drv. duty (At 2,000 rpm)	39.0%

SIGNAL CIRCUIT INSPECTION

1. Signal (LOW/HIGH) Voltage Inspection
   1) Leave the SCV connector (EFD15) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminals 1 and 2 of SCV harness connector and chassis ground.

      ■ Specification: SCV signal terminal 1 power approx. 0.1~0.63V(Detecting voltage fluctuation)

      ■ Specification: SCV signal terminal 2 power approx. 0~ B+V(Detecting voltage fluctuation)

      Note) It is easy to judge trouble when checking it with waveform.
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Go to “Signal (LOW/HIGH) Open Inspection” procedure.
2. Signal (LOW/HIGH) Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the SCV connector (EFD15) and the ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 1 of SCV harness connector and the terminal 51, 71 of the ECM connector(EFD-ECM).
   4) Measure resistance between the terminal 2 of SCV harness connector and the terminal 52, 72 of the ECM connector(EFD-ECM).

      ■ Specification: Continuity
   5) Is the resistance measured within specification?

      YES

      ▶ Go to “Signal (LOW/HIGH) Short to Power Inspection” procedure.

      NO

      ▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.
3. Signal (LOW/HIGH) Short to Power Inspection
   1) Disconnect the SCV connector (EFD15) and the ECM connector(EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminals 1, 2 of SCV harness connector and chassis ground.
   4) Measure voltage between the terminal 2 of SCV harness connector and the terminal 52, 72 of the ECM connector(EFD-ECM).

      ■ Specification: Below 0~0.1V
   5) Is the voltage measured within specification?

      YES

      ▶ Go to “Signal (LOW/HIGH) Short to Ground Inspection” procedure.

      NO

      ▶ Repair short to power and then go to “Verification of Vehicle Repair” procedure.
4. Signal (LOW/HIGH) Short to Ground Inspection
   1) Turn the ignition OFF
   2) Disconnect the SCV connector (EFD15) and the ECM connector(EFD-ECM).
   3) Measure resistance between the terminals 1, 2 of SCV harness connector and chassis ground.

      ■ Specification: Infinite

4) Is the resistance measured within specification?

YES

▶ Go to “Component Inspection” procedure.

NO

▶ Repair short to ground and then go to “Verification of Vehicle Repair” procedure.

COMPONENT INSPECTION

1. SCV Visual Inspection
   1) Turn the ignition OFF.
   2) Disconnect the SCV connector (EFD15).
   3) Check the terminal of SCV connector for contamination and leaks.
   4) Check the SCV for torque and fuel leaks.
   5) Is there any problem about SCV?

YES

▶ Replace the SCV if necessary and go to “Verification of Vehicle Repair” procedure.

NO

▶ Go to “SCV Waveform Inspection” procedure.

2. SCV Waveform Inspection
   1) Turn the ignition OFF.
   2) Connect the SCV connector (EFD15)
   3) Connect oscilloscope probe to terminal 2 of the SCV connector (EFD15).
   4) Check the waveform at idle and accelerating after the engine starts.

   ■ Specification: Refer to “Standard waveform” of general information.
   5) Does the waveform display normally?

YES

▶ Go to “Verification of Vehicle Repair” procedure.

NO

▶ Go to “SCV Resistance Inspection” procedure.

3. SCV Resistance Inspection
   1) Turn the ignition OFF.
   2) Disconnect the SCV connector (EFD15).
   3) Measure resistance between the terminals 1 and 2 of the SCV connector.

■ **Specification :**

Item	Specification
Resistance	7.9±0.25 Ω

   4) Is the resistance measured within the specification?

YES

▶ Go to “Verification of Vehicle Repair” procedure.

NO

▶ Replace the SCV and then go to “Verification of Vehicle Repair” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

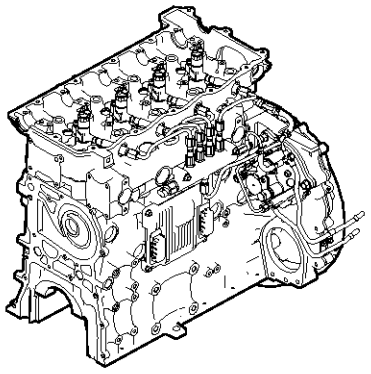
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P0629 SCV(+, -) Output Short to BATT

COMPONENT LOCATION



SDFFL7104D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   Supply control valve(SCV) is solenoid type. The ECM controls time to open/close valve, controls pump fuel amount by controlling current to be supplied to SCV to adjust target rail pressure. When the SCV is closed, fuel passage is cut off and fuel is compressed. The compressed fuel is supplied to common rail. If fuel pressure is decreased, the SCV is opened and then fuel is inhaled for next pumping. Fuel pump relay is supplied power to low fuel pump by the ECM. At the ignition key ON, the fuel pump relay works for about 1.5sec. and stops to diagnose fuel pump relay. If the engine rpm is detected above 45rpm, the ECM makes relay turn ON and feeds fuel to high pressure pump.

2. DTC DESCRIPTION

   If the SCV current duty is detected from 30% to 50 % and current is detected above 1,160mA for 832 ms or more, the ECM judges this as a fault and DTC is set. Check lamp and MIL come on together when the condition continued for 2 driving cycle times. Check lamp will go off after 3 driving cycle times when the system returns to normal. The probable causes may be short to power(16V or more) of terminals 51, 52, 71 and 72 of ECM connector(EFD-ECM), open circuit in ECM or SCV wiring. In case of fail safe, a care should be taken due to causing damage to common rail system. Therefore, the ECM limits engine power and abnormal high pressure is made if there is open circuit of fuel pump at starting and pressure limiter is operated etc.

DTC DETECTING CONDITION

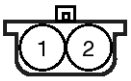
<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Current monitoring</td><td rowspan="6">• Short to power terminal 51, 52, 71, 72 of ECM (EFD-EC-M)
• SCV</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• At IG ON</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• When SCV current control target duty value reaches 0%, current reaches 1,160mA or higher</td></tr>
<tr><td>Diagnosis Time</td><td colspan="3">• 832ms or higher</td></tr>
<tr><td rowspan="3">Fail Safe</td><td>Fuel Cut</td><td>No</td><td rowspan="3">• Fuel amount limit (75% of maxi-mum torque)
• PTO control stop</td></tr>
<tr><td>Fuel limit</td><td>Yes</td></tr>
<tr><td>Check lamp</td><td>ON</td></tr>
</table>

SPECIFICATION

Item	Specification
Resistance	7.9±0.25Ω

SCV driving frequency	SCV control type
200 Hz	Current control

SCV driving voltage	SCV driving current
16~32 V	Below 1.29A when driving
	Below 1.16A when stopping (within 270sec.)



Sensor connector

SUDFLDTC9054L

WAVEFORM

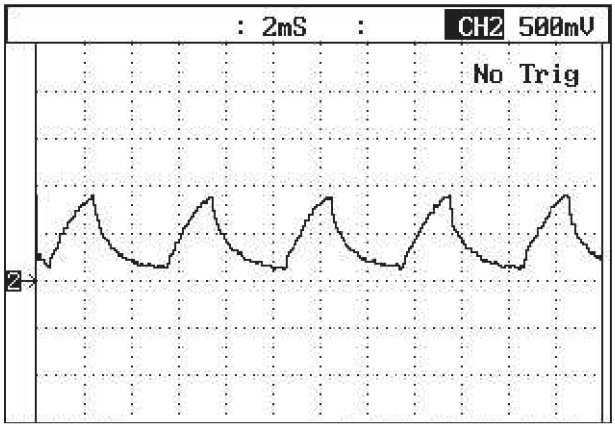


Fig. 1 Waveform at LOW side

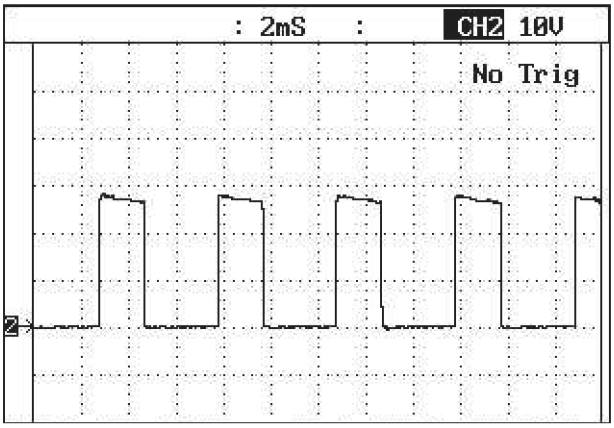


Fig. 2 Waveform at HIGH side

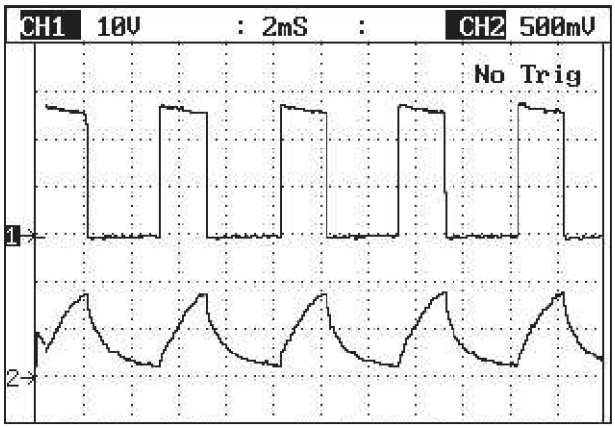


Fig. 3 Waveforms at LOW/HIGH side

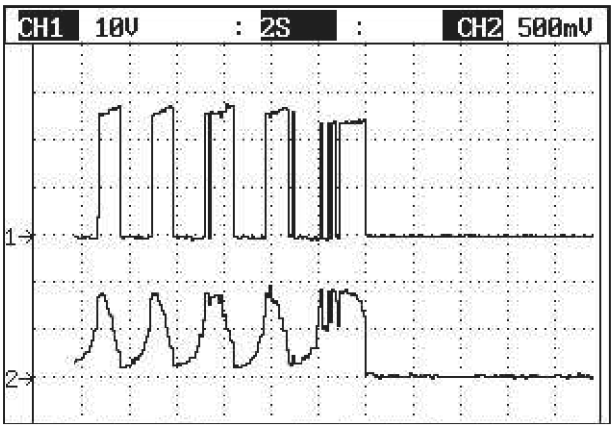


Fig. 4 Waveforms while operating for 2 sec. when the SCV valve is OFF

SUDFLDTC9055L

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature.
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Pump control duty” parameter on the scan tool.

NOTICE

The value of “Pump control duty” varies with driving condition according to DTC detecting condition. In case of failure, be sure to check that the value of “Engine output (common rail pressure limit)” is limited.

■ Specification: Pump control duty approx. 43% at idle

Parameter	Reference Value
Final pump drv. duty (At IG ON)	0.0%
Final pump drv. duty (At idle)	47.5%
Final pump drv. duty (At 1,500 rpm)	43.5%
Final pump drv. duty (At 2,000 rpm)	39.0%

SIGNAL CIRCUIT INSPECTION

1. Signal (LOW/HIGH) Voltage Inspection
   1) Leave the SCV connector (EFD15) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminals 1 and 2 of SCV harness connector and chassis ground.

      ■ Specification: SCV signal terminal 1 power approx. 0.1~0.63V(Detecting voltage fluctuation)

      ■ Specification: SCV signal terminal 2 power approx. 0~ B+V(Detecting voltage fluctuation)

      Note) It is easy to judge trouble when checking it with waveform.
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Go to “Signal (LOW/HIGH) Open Inspection” procedure.
2. Signal (LOW/HIGH) Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the SCV connector (EFD15) and the ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 1 of SCV harness connector and the terminal 51, 71 of the ECM connector(EFD-ECM).
   4) Measure resistance between the terminal 2 of SCV harness connector and the terminal 52, 72 of the ECM connector(EFD-ECM).

      ■ Specification: Continuity
   5) Is the resistance measured within specification?

      YES

      ▶ Go to “Signal (LOW/HIGH) Short to Power Inspection” procedure.

      NO

      ▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.
3. Signal (LOW/HIGH) Short to Power Inspection
   1) Disconnect the SCV connector (EFD15) and the ECM connector(EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminals 1, 2 of SCV harness connector and chassis ground.

      ■ Specification: Below 0~0.1V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Signal (LOW/HIGH) Short to Ground Inspection” procedure.

      NO

      ▶ Repair short to power and then go to “Verification of Vehicle Repair” procedure.
4. Signal (LOW/HIGH) Short to Ground Inspection
   1) Turn the ignition OFF
   2) Disconnect the SCV connector (EFD15) and the ECM connector(EFD-ECM).
   3) Measure resistance between the terminals 1, 2 of SCV harness connector and chassis ground.

      ■ Specification: Infinite
   4) Is the resistance measured within specification?

      YES

▶ Go to “Component Inspection” procedure.

NO

▶ Repair short to ground and then go to “Verification of Vehicle Repair” procedure.

COMPONENT INSPECTION

1. SCV Visual Inspection
   1) Turn the ignition OFF.
   2) Disconnect the SCV connector (EFD15).
   3) Check the terminal of SCV connector for contamination and leaks.
   4) Check the SCV for torque and fuel leaks.
   5) Is there any problem about SCV?

   YES

   ▶ Replace the SCV if necessary and go to “Verification of Vehicle Repair” procedure.

   NO

   ▶ Go to “SCV Waveform Inspection” procedure.
2. SCV Waveform Inspection
   1) Turn the ignition OFF.
   2) Connect the SCV connector (EFD15)
   3) Connect oscilloscope probe to terminal 2 of the SCV connector (EFD15).
   4) Check the waveform at idle and accelerating after the engine starts.

      ■ Specification: Refer to “Standard waveform” of general information.
   5) Does the waveform display normally?

   YES

   ▶ Go to “Verification of Vehicle Repair” procedure.

   NO

   ▶ Go to “SCV Resistance Inspection” procedure.
3. SCV Resistance Inspection
   1) Turn the ignition OFF.
   2) Disconnect the SCV connector (EFD15).
   3) Measure resistance between the terminals 1 and 2 of the SCV connector.

■ Specification :

Item	Specification
Resistance	7.9±0.25 Ω

   4) Is the resistance measured within the specification?

   YES

   ▶ Go to “Verification of Vehicle Repair” procedure.

   NO

   ▶ Replace the SCV and then go to “Verification of Vehicle Repair” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

   YES

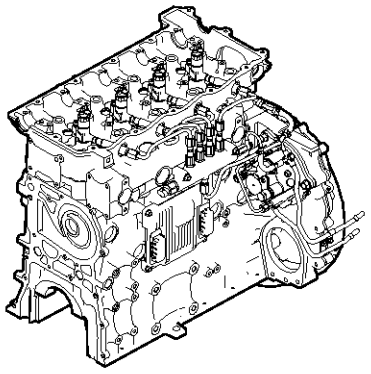
   ▶ Go to the applicable DTC procedure.

   NO

   ▶ System OK

P0642 Battery 5V Reference1 Circuit Low (VCC1L)

COMPONENT LOCATION



SDFFL7104D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   ECM receives power, is activated and receives signals from the various sensors such as the crankshaft position sensor and the rail pressure sensor etc. Based on the input signals, the ECM controls engine after driving injector, various solenoids and relay through comparison algorithm between micro controller and control logic stored in EEPROM. Also to improve reliability, the ECM performs diagnoses of self test of ECM itself, various sensors and actuators and informs a driver of trouble information to protect serious problem of drive ability and performs the function to shut off system to protect dangerous condition with wrong control.

2. DTC DESCRIPTION

   If sensor supply power 1 (5V) is detected below 2 V for more than 80 ms, the ECM judges this as a fault and DTC is set. Check lamp and MIL come on together when the condition continued for 2 driving cycle times. Check lamp will go off after 3 driving cycle times when the system returns to normal. The possible causes are short to ground of sensor power circuit or ECM internal fault.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Power supply short to ground • Ground lead wire check • ECM
Enable Conditions	• Engine running			
Threshold Value	• When 5V voltage minimum value<2V			
Diagnosis Time	• 80ms or higher			
Fail Safe	Fuel Cut	No	• Acceleration limit(30%) • Target pressure limit (70Mpa) • PTO control stop • Cruise release	
	Fuel limit	No		
	Check lamp	ON		

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature.
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Rail pressure sensor supply voltage” parameter on the scan tool.

Parameter	Reference Value
Real C/R pressure (At IG ON)	0.4 Mpa
Real C/R pressure (At idle)	31.6 Mpa
Real C/R pressure (At 1,500 rpm)	91.2 Mpa
Real C/R pressure (At 2,000 rpm)	122.5 Mpa

POWER SUPPLY INSPECTION

1. Fuel Pressure Sensor Power Supply Voltage Inspection
   1) Disconnect the fuel pressure sensor connector (EFD13).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 1 of the fuel pressure sensor harness connector and chassis ground.
      ■ Specification: ECM output power approx. 5V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Verification of Vehicle Repair” procedure.

      NO

      ▶ Go to “Fuel Pressure Sensor Power Short to Ground Inspection” procedure.
2. Fuel Pressure Sensor Power Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the fuel pressure sensor connector (EFD13) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 1 of the fuel pressure sensor harness connector and chassis ground.
      ■ Specification: Infinite
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Cam Position Sensor Power Supply Voltage Inspection” procedure.

      NO

      ▶ Repair short to ground and then go to “Verification of Vehicle Repair” procedure.
3. Cam Position Sensor Power Supply Voltage Inspection
   1) Disconnect the cam position sensor connector (EFD03).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 1 of the cam position sensor harness connector and chassis ground.
      ■ Specification: Cam position sensor supply power approx. 5V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Verification of Vehicle Repair” procedure.

      NO

      ▶ Go to “Cam Position Sensor Power Supply Short to Power Inspection” procedure.
4. Cam Position Sensor Power Supply Short to Power Inspection
   1) Disconnect the cam position sensor connector (EFD03) and ECM connector(EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure resistance between terminal 1 of the cam position sensor harness connector and chassis ground.
      ■ Specification: Infinite
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Repair short to ground and go to “Verification of Vehicle Repair” procedure.

COMPONENT INSPECTION

1. Turn the ignition OFF. Leave the engine OFF.
2. Remove the ECM from the vehicle.
3. Install a known-good ECM, check the system operates well.
4. Replace the ECM with new one if there is not the DTC anymore.

NOTICE

By using the scan tool when replacing the ECM, be sure to correct ECM data with the injector QR correction value (30-digit) installed to the current engine. Engine performance and exhaust gas problem can occur when the correction value marked to the injector is not input.

1. *Upgrade when replacing the ECM.*
2. *Correct the ECM data.*
   - *QR code data input*
   - *Gear ratio correction value*
   - *Final reduction ratio/ tire radius input*
   - *VIN input*

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

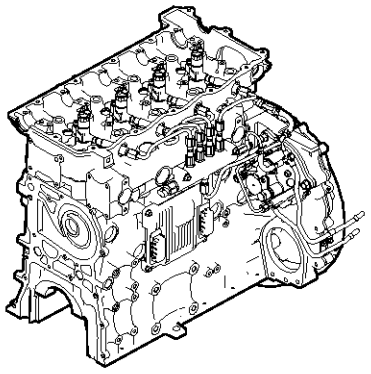
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P0643 Battery 5V Reference1 Circuit High (VCC1H)

COMPONENT LOCATION



SDFFL7104D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   ECM receives power, is activated and receives signals from the various sensors such as the crankshaft position sensor and the rail pressure sensor etc. Based on the input signals, the ECM controls engine after driving injector, various solenoids and relay through comparison algorithm between micro controller and control logic stored in EEPROM. Also to improve reliability, the ECM performs diagnoses of self test of ECM itself, various sensors and actuators and informs a driver of trouble information to protect serious problem of drive ability and performs the function to shut off system to protect dangerous condition with wrong control.

2. DTC DESCRIPTION

   If sensor supply power 1 (5V) is detected above 3 V for more than 80 ms, the ECM judges this as a fault and DTC is set. Check lamp and MIL come on together when the condition continued for 2 driving cycle times. Check lamp will go off after 3 driving cycle times when the system returns to normal. The possible causes are short to ground of sensor power circuit or ECM internal fault.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Current monitoring			• Power supply short to power • Ground lead wire check • ECM
Enable Conditions	• Engine running			
Threshold Value	• When 5V voltage minimum value>3V			
Diagnosis Time	• 80ms or higher			
Fail Safe	Fuel Cut	No	• Acceleration limit(30%) • Target pressure limit (70Mpa) • PTO control stop • Cruise release	
	Fuel limit	No		
	Check lamp	ON		

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature.
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Rail pressure sensor supply voltage” parameter on the scan tool.

Parameter	Reference Value
Real C/R pressure (At IG ON)	0.4 Mpa
Real C/R pressure (At idle)	31.6 Mpa
Real C/R pressure (At 1,500 rpm)	91.2 Mpa
Real C/R pressure (At 2,000 rpm)	122.5 Mpa

POWER SUPPLY INSPECTION

1. Fuel Pressure Sensor Power Supply Voltage Inspection
   1) Disconnect the fuel pressure sensor connector (EFD13).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 1 of the fuel pressure sensor harness connector and chassis ground.
      ■ Specification: ECM output power approx. 5V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Verification of Vehicle Repair” procedure.

      NO

      ▶ Go to “Fuel Pressure Sensor Power Short to Power Inspection” procedure.
2. Fuel Pressure Sensor Power Short to Power Inspection
   1) Disconnect the fuel pressure sensor connector (EFD13) and ECM connector(EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 1 of the fuel pressure sensor harness connector and chassis ground.
      ■ Specification: Below 0~0.1V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Ground Circuit Inspection” procedure.

      NO

      ▶ Repair short to power and then go to “Verification of Vehicle Repair” procedure.
3. Cam Position Sensor Power Supply Voltage Inspection
   1) Disconnect the cam position sensor connector (EFD03).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 1 of the cam position sensor harness connector and chassis ground.
      ■ Specification: Cam position sensor supply power approx. 5V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Verification of Vehicle Repair” procedure.

      NO

      ▶ Go to “Cam Position Sensor Power Supply Short to Power Inspection” procedure.
4. Cam Position Sensor Power Supply Short to Power Inspection
   1) Disconnect the cam position sensor connector (EFD03) and ECM connector(EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 1 of the cam position sensor harness connector and chassis ground.
      ■ Specification: Below 0~0.1V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Repair short to power and go to “Verification of Vehicle Repair” procedure.

COMPONENT INSPECTION

1. Turn the ignition OFF. Leave the engine OFF.
2. Remove the ECM from the vehicle.
3. Install a known-good ECM, check the system operates well.
4. Replace the ECM with new one if there is not the DTC anymore.

NOTICE

By using the scan tool when replacing the ECM, be sure to correct ECM data with the injector QR correction value (30-digit) installed to the current engine. Engine performance and exhaust gas problem can occur when the correction value marked to the injector is not input.

1. *Upgrade when replacing the ECM.*
2. *Correct the ECM data.*
   - *QR code data input*
   - *Gear ratio correction value*
   - *Final reduction ratio/ tire radius input*
   - *VIN input*

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

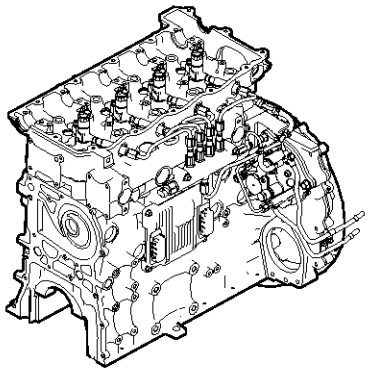
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P0652 Battery 5V Reference2 Circuit Low (VCC2L)

COMPONENT LOCATION



SDFFL7104D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   ECM receives power, is activated and receives signals from the various sensors such as the crankshaft position sensor and the rail pressure sensor etc. Based on the input signals, the ECM controls engine after driving injector, various solenoids and relay through comparison algorithm between micro controller and control logic stored in EEPROM. Also to improve reliability, the ECM performs diagnoses of self test of ECM itself, various sensors and actuators and informs a driver of trouble information to protect serious problem of drive ability and performs the function to shut off system to protect dangerous condition with wrong control.

2. DTC DESCRIPTION

   If sensor supply power 2 (5V) is detected below 2 V for more than 80 ms, the ECM judges this as a fault and DTC is set. Check lamp comes on and MIL is blinking when the condition continued 2 driving cycle times. MIL will go off after 3 driving cycle times when the system returns to normal. The possible causes are short to ground of sensor power circuit or ECM internal fault.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Power supply short to ground • Ground lead wire check • ECM
Enable Conditions	• Engine running			
Threshold Value	• When 5V voltage minimum value>3V			
Diagnosis Time	• 80ms or higher			
Fail Safe	Fuel Cut	No	• Cruise release	
	Fuel limit	No		
	Check lamp	ON		

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature.
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Booster pressure sensor power voltage” parameter on the scan tool.

Parameter	Reference Value
Intake manifold pressure (At IG ON)	101 kpa
Intake manifold pressure (At idle)	103 kpa
Intake manifold pressure (At 1,500rpm)	111 kpa
Intake manifold pressure (At 2,000rpm)	123 kpa

POWER SUPPLY INSPECTION

1. Booster Pressure Sensor Power Supply Voltage Inspection
   1) Disconnect the booster pressure sensor connector (EFD14).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 2 of the booster pressure sensor harness connector and chassis ground.
      ■ Specification: ECM output power approx. 5V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Ground Circuit Inspection” procedure.

      NO

      ▶ Go to “Booster Pressure Sensor Power Supply Short to Ground Inspection” procedure.
2. Booster Pressure Sensor Power Supply Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the booster pressure sensor connector (EFD14) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 2 of the booster pressure sensor harness connector and chassis ground.
      ■ Specification: Infinite
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Repair short to ground and then go to “Verification of Vehicle Repair” procedure.

COMPONENT INSPECTION

1. Turn the ignition OFF. Leave the engine OFF.
2. Remove the ECM from the vehicle.
3. Install a known-good ECM, check the system operates well.
4. Replace the ECM with new one if there is not the DTC anymore.

NOTICE

By using the scan tool when replacing the ECM, be sure to correct ECM data with the injector QR correction value (30-digit) installed to the current engine. Engine performance and exhaust gas problem can occur when the correction value marked to the injector is not input.

1. *Upgrade when replacing the ECM.*
2. *Correct the ECM data.*
   - *QR code data input*
   - *Gear ratio correction value*
   - *Final reduction ratio/ tire radius input*
   - *VIN input*

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

   YES

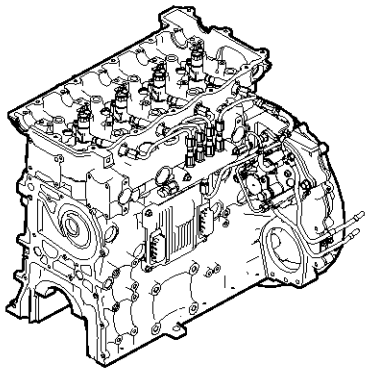
   ▶ Go to the applicable DTC procedure.

   NO

   ▶ System OK

P0653 Battery 5V Reference2 Circuit High (VCC2H)

COMPONENT LOCATION



SDFFL7104D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   ECM receives power, is activated and receives signals from the various sensors such as the crankshaft position sensor and the rail pressure sensor etc. Based on the input signals, the ECM controls engine after driving injector, various solenoids and relay through comparison algorithm between micro controller and control logic stored in EEPROM. Also to improve reliability, the ECM performs diagnoses of self test of ECM itself, various sensors and actuators and informs a driver of trouble information to protect serious problem of drive ability and performs the function to shut off system to protect dangerous condition with wrong control.

2. DTC DESCRIPTION

   If sensor supply power 2 (5V) is detected above 3 V for more than 80 ms, the ECM judges this as a fault and DTC is set. Check lamp comes on and MIL is blinking when the condition continued 2 driving cycle times. MIL will go off after 3 driving cycle times when the system returns to normal. The possible causes are short to ground of sensor power circuit or ECM internal fault.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Power supply short to power • Ground lead wire check • ECM
Enable Conditions	• Engine running			
Threshold Value	• When 5V voltage minimum value>3V			
Diagnosis Time	• 80ms or higher			
Fail Safe	Fuel Cut	No	• Cruise release	
	Fuel limit	No		
	Check lamp	ON		

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature.
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Booster pressure sensor power voltage” parameter on the scan tool.

Parameter	Reference Value
Intake manifold pressure (At IG ON)	101 kpa
Intake manifold pressure (At idle)	103 kpa
Intake manifold pressure (At 1,500rpm)	111 kpa
Intake manifold pressure (At 2,000rpm)	123 kpa

POWER SUPPLY INSPECTION

1. Booster Pressure Sensor Power Supply Voltage Inspection
   1) Disconnect the booster pressure sensor connector (EFD14).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 2 of the booster pressure sensor harness connector and chassis ground.
      ■ Specification: ECM output power approx. 5V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Ground Circuit Inspection” procedure.

      NO

      ▶ Go to “Booster Pressure Sensor Power Supply Short to Power Inspection” procedure.
2. Booster Pressure Sensor Power Supply Short to Power Inspection
   1) Disconnect the booster pressure sensor connector (EFD14) and ECM connector(EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 2 of the booster pressure sensor harness connector (EFD14) and chassis ground.
      ■ Specification: Below 0~0.1V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Repair short to power and then go to “Verification of Vehicle Repair” procedure.

COMPONENT INSPECTION

1. Turn the ignition OFF. Leave the engine OFF.
2. Remove the ECM from the vehicle.
3. Install a known-good ECM, check the system operates well.
4. Replace the ECM with new one if there is not the DTC anymore.

NOTICE

By using the scan tool when replacing the ECM, be sure to correct ECM data with the injector QR correction value (30-digit) installed to the current engine. Engine performance and exhaust gas problem can occur when the correction value marked to the injector is not input.

1. *Upgrade when replacing the ECM.*
2. *Correct the ECM data.*
   - *QR code data input*
   - *Gear ratio correction value*
   - *Final reduction ratio/ tire radius input*
   - *VIN input*

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

   YES

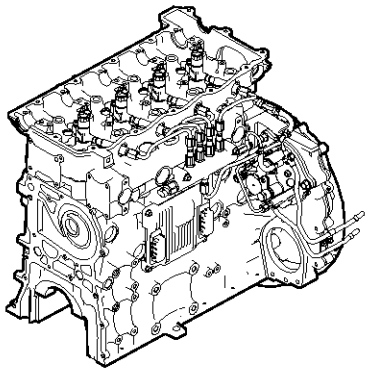
   ▶ Go to the applicable DTC procedure.

   NO

   ▶ System OK

P0698 Battery 5V Reference3 Circuit Low (VCC11L = VCC3L)

COMPONENT LOCATION



SDFFL7104D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   ECM receives power, is activated and receives signals from the various sensors such as the crankshaft position sensor and the rail pressure sensor etc. Based on the input signals, the ECM controls engine after driving injector, various solenoids and relay through comparison algorithm between micro controller and control logic stored in EEPROM. Also to improve reliability, the ECM performs diagnoses of self test of ECM itself, various sensors and actuators and informs a driver of trouble information to protect serious problem of drive ability and performs the function to shut off system to protect dangerous condition with wrong control.

2. DTC DESCRIPTION

   If sensor supply power 3 (5V) is detected below 2 V for more than 80 ms, the ECM judges this as a fault and DTC is set. Check lamp comes on and MIL is blinking when the condition continued 2 driving cycle times. MIL will go off after 3 driving cycle times when the system returns to normal. The possible causes are short to ground of sensor power circuit or ECM internal fault.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Power supply short to ground • Ground lead wire check • ECM
Enable Conditions	• Engine running			
Threshold Value	• When 5V voltage minimum value<2V			
Diagnosis Time	• 80ms or higher			
Fail Safe	Fuel Cut	No	• Acceleration limit(30%) • PTO control stop • Cruise release	
	Fuel limit	No		
	Check lamp	ON		

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature.
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Accelerator pedal sensor” parameter on the scan tool.

Parameter	Reference Value
Accel. Pos. (At IG ON)	0.0%
Accel. Pos. (At idle)	0.0%
Accel. Pos. (At 1,500 rpm)	23%
Accel. Pos. (At 2,000 rpm)	34.5%

POWER SUPPLY INSPECTION

1. Power Supply Voltage Inspection
   1) Leave the accelerator pedal position sensor connector (M32) and the engine ECM connector(CFD-ECM) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 1 of the accelerator pedal position sensor harness connector and chassis ground.
   4) Measure voltage between terminal 50 of the engine ECM connector and chassis ground.

      ■ Specification: Accelerator pedal sensor signal power approx. 5.0V
   5) Is the voltage measured within specification?

      YES

      ▶ Go to “ECM Component Inspection” procedure.

      NO

      ▶ Go to “Power Supply Short to Ground Inspection” procedure.
2. Power Supply Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the accelerator pedal position sensor connector (M32) and ECM connector(CFD-ECM, EFD-ECM).
   3) Measure resistance between the terminal 1 of the accelerator pedal position sensor harness connector and chassis ground.
   4) Measure resistance between the terminal 50 of the engine ECM harness connector and chassis ground.

      ■ Specification: Infinite
   5) Is the resistance measured within specification?

      YES

      ▶ Go to “PTO Power Supply Voltage Inspection” procedure.

      NO

      ▶ Repair short to ground and then go to “Verification of Vehicle Repair” procedure.
3. PTO Power Supply Voltage Inspection
   1) Leave the PTO connector (EC04) connected
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 7 of the PTO harness connector and chassis ground.

      ■ Specification: PTO signal power approx. 5.0V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “ECM Component Inspection” procedure.

      NO

      ▶ Go to “Power Supply Short to Ground Inspection” procedure.
4. Power Supply Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the PTO connector (EC04) and ECM connector(CFD-ECM).
   3) Measure resistance between the terminal 7 of the PTO harness connector and chassis ground.

      ■ Specification: Infinite
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “ECM Component Inspection” procedure.

      NO

      ▶ Repair short to ground and then go to “Verification of Vehicle Repair” procedure.

COMPONENT INSPECTION

1. Turn the ignition OFF. Leave the engine OFF.
2. Remove the ECM from the vehicle.
3. Install a known-good ECM, check the system operates well.
4. Replace the ECM with new one if there is not the DTC anymore.

NOTICE

By using the scan tool when replacing the ECM, be sure to correct ECM data with the injector QR correction value (30-digit) installed to the current engine. Engine performance and exhaust gas problem can occur when the correction value marked to the injector is not input.

1. *Upgrade when replacing the ECM.*
2. *Correct the ECM data.*
   - *QR code data input*
   - *Gear ratio correction value*
   - *Final reduction ratio/ tire radius input*
   - *VIN input*

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

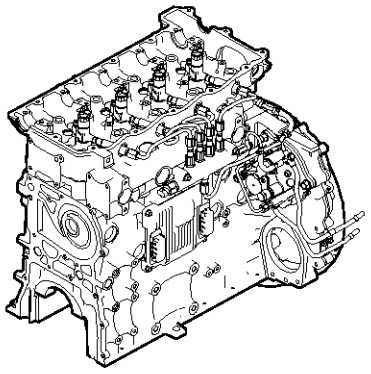
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P0699 Battery 5V Reference3 Circuit High (VCC11H = VCC3H)

COMPONENT LOCATION



SDFFL7104D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   ECM receives power, is activated and receives signals from the various sensors such as the crankshaft position sensor and the rail pressure sensor etc. Based on the input signals, the ECM controls engine after driving injector, various solenoids and relay through comparison algorithm between micro controller and control logic stored in EEPROM. Also to improve reliability, the ECM performs diagnoses of self test of ECM itself, various sensors and actuators and informs a driver of trouble information to protect serious problem of drive ability and performs the function to shut off system to protect dangerous condition with wrong control.

2. DTC DESCRIPTION

   If sensor supply power 3 (5V) is detected above 3 V for more than 80 ms, the ECM judges this as a fault and DTC is set. Check lamp and MIL come on together when the condition continued for 2 driving cycle times. Check lamp will go off after 3 driving cycle times when the system returns to normal. The possible causes are short to ground of sensor power circuit or ECM internal fault.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Power supply short to power • Ground lead wire check • ECM
Enable Conditions	• Engine running			
Threshold Value	• When 5V voltage minimum value>3V			
Diagnosis Time	• 80ms or higher			
Fail Safe	Fuel Cut	No	• Acceleration limit(30%) • PTO control stop • Cruise release	
	Fuel limit	No		
	Check lamp	ON		

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature.
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Accelerator pedal sensor” parameter on the scan tool.

Parameter	Reference Value
Accel. Pos. (At IG ON)	0.0%
Accel. Pos. (At idle)	0.0%
Accel. Pos. (At 1,500 rpm)	23%
Accel. Pos. (At 2,000 rpm)	34.5%

POWER SUPPLY INSPECTION

1. Power Supply Voltage Inspection
   1) Leave the accelerator pedal position sensor connector (M32) and the engine ECM connector(CFD-ECM) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 1 of the accelerator pedal position sensor harness connector and chassis ground.
   4) Measure voltage between terminal 50 of the engine ECM connector and chassis ground.

      ■ Specification: Accelerator pedal sensor signal power approx. 5.0V
   5) Is the voltage measured within specification?

      YES

      ▶ Go to “ECM Component Inspection” procedure.

      NO

      ▶ Go to “Power Supply Short to Power Inspection” procedure.
2. Power Supply Short to Power Inspection
   1) Disconnect the accelerator pedal position sensor connector (M32) and ECM connector(CFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 1 of the accelerator pedal position sensor harness connector and chassis ground.
   4) Measure voltage between the terminal 50 of the engine ECM harness connector and chassis ground.

      ■ Specification: Below 0~0.1V
   5) Is the voltage measured within specification?

      YES

      ▶ Go to “PTO Power Supply Power Inspection” procedure.

      NO

      ▶ Repair short to power and then go to “Verification of Vehicle Repair” procedure.
3. PTO Power Supply Power Inspection
   1) Leave the PTO connector (EC04) connected
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 7 of the PTO harness connector and chassis ground.

      ■ Specification: PTO signal power approx. 5.0V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “ECM Component Inspection” procedure.

      NO

      ▶ Go to “Power Supply Short to Ground Inspection” procedure.
4. Power Supply Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the PTO connector (EC04) and ECM connector(CFD-ECM).
   3) Measure voltage between the terminal 7 of the PTO harness connector and chassis ground.

      ■ Specification: Below 0~0.1V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “ECM Component Inspection” procedure.

      NO

      ▶ Repair short to power and then go to “Verification of Vehicle Repair” procedure.

COMPONENT INSPECTION

1. Turn the ignition OFF. Leave the engine OFF.
2. Remove the ECM from the vehicle.
3. Install a known-good ECM, check the system operates well.
4. Replace the ECM with new one if there is not the DTC anymore.

NOTICE

By using the scan tool when replacing the ECM, be sure to correct ECM data with the injector QR correction value (30-digit) installed to the current engine. Engine performance and exhaust gas problem can occur when the correction value marked to the injector is not input.

1. *Upgrade when replacing the ECM.*
2. *Correct the ECM data.*
   - *QR code data input*
   - *Gear ratio correction value*
   - *Final reduction ratio/ tire radius input*
   - *VIN input*

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

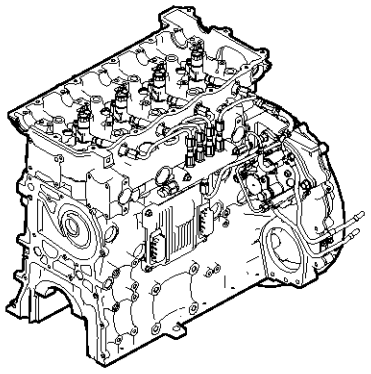
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P069E Battery 5V Reference4 Circuit Low (VCC10/12L = VCC4L)

COMPONENT LOCATION



SDFFL7104D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   ECM receives power, is activated and receives signals from the various sensors such as the crankshaft position sensor and the rail pressure sensor etc. Based on the input signals, the ECM controls engine after driving injector, various solenoids and relay through comparison algorithm between micro controller and control logic stored in EEPROM. Also to improve reliability, the ECM performs diagnoses of self test of ECM itself, various sensors and actuators and informs a driver of trouble information to protect serious problem of drive ability and performs the function to shut off system to protect dangerous condition with wrong control.

2. DTC DESCRIPTION

   If sensor supply power 4 (5V) is detected below 2 V for more than 80 ms, the ECM judges this as a fault and DTC is set. Check lamp and MIL come on together when the condition continued for 2 driving cycle times. Check lamp will go off after 3 driving cycle times when the system returns to normal. The possible causes are short to ground of sensor power circuit or ECM internal fault.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Power supply short to ground • Ground lead wire check • ECM
Enable Conditions	• Engine running			
Threshold Value	• When 5V voltage minimum value<2V			
Diagnosis Time	• 80ms or higher			
Fail Safe	Fuel Cut	No		
	Fuel limit	No		
	Check lamp	ON		

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature.
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Accelerator pedal sensor” parameter on the scan tool.

Parameter	Reference Value
Accel. Pos. (At IG ON)	0.0%
Accel. Pos. (At idle)	0.0%
Accel. Pos. (At 1,500 rpm)	23%
Accel. Pos. (At 2,000 rpm)	34.5%

POWER SUPPLY INSPECTION

1. Power Supply Voltage Inspection
   1) Leave the accelerator pedal position sensor connector (M32) and the engine ECM connector(CFD-ECM) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 1 of the accelerator pedal position sensor harness connector and chassis ground.
   4) Measure voltage between terminal 50 of the engine ECM connector and chassis ground.

      ■ Specification: Accelerator pedal sensor signal power approx. 5.0V
   5) Is the voltage measured within specification?

      YES

      ▶ Go to “ECM Component Inspection” procedure.

      NO

      ▶ Go to “Power Supply Short to Ground Inspection” procedure.
2. Power Supply Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the accelerator pedal position sensor connector (M32) and ECM connector(CFD-ECM, EFD-ECM).
   3) Measure resistance between the terminal 1 of the accelerator pedal position sensor harness connector and chassis ground.
   4) Measure resistance between the terminal 50 of the ECM connector(CFD-ECM) and chassis ground.

      ■ Specification: Infinite
   5) Is the resistance measured within specification?

      YES

      ▶ Go to “PTO Power Supply Voltage Inspection” procedure.

      NO

      ▶ Repair short to ground and then go to “Verification of Vehicle Repair” procedure.
3. PTO Power Supply Voltage Inspection
   1) Connect the PTO connector (EC04) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 7 of the PTO harness connector and chassis ground.

      ■ Specification: PTO signal power approx. 5.0V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “ECM Component Inspection” procedure.

      NO

      ▶ Go to “Power Supply Short to Ground Inspection” procedure.
4. Power Supply Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the PTO connector (EC04) and ECM connector(CFD-ECM).
   3) Measure resistance between the terminal 7 of the PTO harness connector and chassis ground.

      ■ Specification: Infinite
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “ECM Component Inspection” procedure.

      NO

      ▶ Repair short to ground and then go to “Verification of Vehicle Repair” procedure.

COMPONENT INSPECTION

1. Turn the ignition OFF. Leave the engine OFF.
2. Remove the ECM from the vehicle.
3. Install a known-good ECM, check the system operates well.
4. Replace the ECM with new one if there is not the DTC anymore.

NOTICE

By using the scan tool when replacing the ECM, be sure to correct ECM data with the injector QR correction value (30-digit) installed to the current engine. Engine performance and exhaust gas problem can occur when the correction value marked to the injector is not input.

1. *Upgrade when replacing the ECM.*
2. *Correct the ECM data.*
   - *QR code data input*
   - *Gear ratio correction value*
   - *Final reduction ratio/ tire radius input*
   - *VIN input*

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

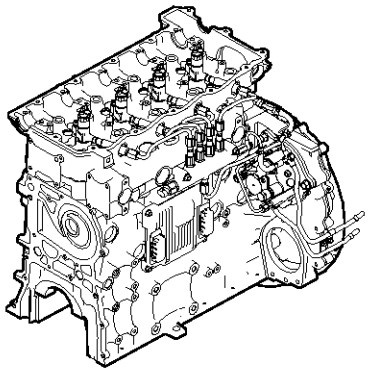
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P069F Battery 5V Reference4 Circuit High (VCC10/12H = VCC4H)

COMPONENT LOCATION



SDFFL7104D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   ECM receives power, is activated and receives signals from the various sensors such as the crankshaft position sensor and the rail pressure sensor etc. Based on the input signals, the ECM controls engine after driving injector, various solenoids and relay through comparison algorithm between micro controller and control logic stored in EEPROM. Also to improve reliability, the ECM performs diagnoses of self test of ECM itself, various sensors and actuators and informs a driver of trouble information to protect serious problem of drive ability and performs the function to shut off system to protect dangerous condition with wrong control.

2. DTC DESCRIPTION

   If sensor supply power 4 (5V) is detected above 3 V for more than 80 ms, the ECM judges this as a fault and DTC is set. Check lamp and MIL come on together when the condition continued for 2 driving cycle times. Check lamp will go off after 3 driving cycle times when the system returns to normal. The possible causes are short to power of sensor power circuit or ECM internal fault.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Power supply short to power • Ground lead wire check • ECM
Enable Conditions	• Engine running			
Threshold Value	• When 5V voltage minimum value>3V			
Diagnosis Time	• 80ms or higher			
Fail Safe	Fuel Cut	No		
	Fuel limit	No		
	Check lamp	ON		

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature.
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Accelerator pedal sensor” parameter on the scan tool.

Parameter	Reference Value
Accel. Pos. (At IG ON)	0.0%
Accel. Pos. (At idle)	0.0%
Accel. Pos. (At 1,500 rpm)	23%
Accel. Pos. (At 2,000 rpm)	34.5%

POWER SUPPLY INSPECTION

1. Power Supply Voltage Inspection
   1) Leave the accelerator pedal position sensor connector (M32) and the engine ECM connector(CFD-ECM) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 1 of the accelerator pedal position sensor harness connector and chassis ground.
   4) Measure voltage between terminal 50 of the engine ECM connector and chassis ground.

      ■ Specification: Accelerator pedal sensor signal power approx. 5.0V
   5) Is the voltage measured within specification?

      YES

      ▶ Go to “ECM Component Inspection” procedure.

      NO

      ▶ Go to “Power Supply Short to Power Inspection” procedure.
2. Power Supply Short to Power Inspection
   1) Disconnect the accelerator pedal sensor connector (M32) and ECM connector(CFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 1 of the accelerator pedal sensor harness connector and chassis ground.
   4) Measure voltage between the terminal 50 of the ECM connector(CFD-ECM) and chassis ground.

      ■ Specification: Below 0~0.1V
   5) Is the voltage measured within specification?

      YES

      ▶ Go to “PTO Power Supply Power Inspection” procedure.

      NO

      ▶ Repair short to power and then go to “Verification of Vehicle Repair” procedure.
3. PTO Power Supply Power Inspection
   1) Connect the PTO connector (EC04) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 7 of the PTO harness connector and chassis ground.

      ■ Specification: PTO signal power approx. 5.0V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “ECM Component Inspection” procedure.

      NO

      ▶ Go to “Power Supply Short to Ground Inspection” procedure.
4. Power Supply Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the PTO connector (EC04) and ECM connector(CFD-ECM).
   3) Measure voltage between the terminal 7 of the PTO harness connector and chassis ground.

      ■ Specification: Below 0~0.1V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “ECM Component Inspection” procedure.

      NO

      ▶ Repair short to ground and then go to “Verification of Vehicle Repair” procedure.

COMPONENT INSPECTION

1. Turn the ignition OFF. Leave the engine OFF.
2. Remove the ECM from the vehicle.
3. Install a known-good ECM, check the system operates well.
4. Replace the ECM with new one if there is not the DTC anymore.

NOTICE

By using the scan tool when replacing the ECM, be sure to correct ECM data with the injector QR correction value (30-digit) installed to the current engine. Engine performance and exhaust gas problem can occur when the correction value marked to the injector is not input.

1. *Upgrade when replacing the ECM.*
2. *Correct the ECM data.*
   - *QR code data input*
   - *Gear ratio correction value*
   - *Final reduction ratio/ tire radius input*
   - *VIN input*

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

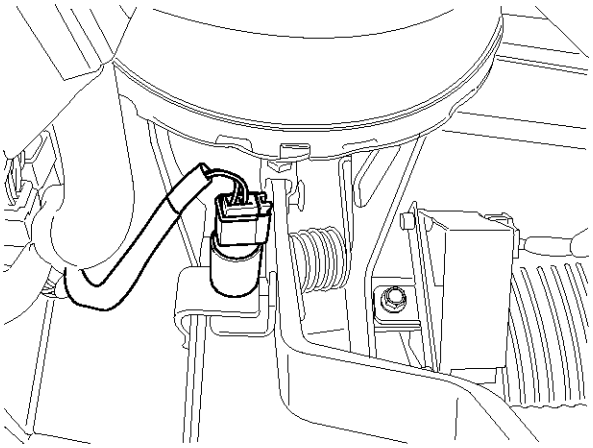
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P0704 Clutch Switch Circuit Malfunction(Manual Transmission Only)

COMPONENT LOCATION



SUDFL8354D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   The clutch is positioned between engine and transmission. The friction disc disengages flywheel and pressure plate when operating and interlocks with flywheel. If the clutch pedal is depressed, the friction disc is disengaged by clutch fork and cut off from engine power. Cutting off from torque transmission enables the gear shift to engage safely and easily. The clutch switch is installed at the upper part of clutch pedal and the ECM detects clutch state through signal of clutch switch.

2. DTC DESCRIPTION

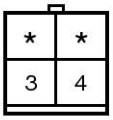
   The vehicle speed repeats from 0km/h(stop) to 80km/h(driving) and 0km/h(stop). But if the clutch switch input signal change is not detected, the ECM judges this as a fault and DTC is set. The probable causes may be short to power of terminal 55 of ECM connector(CFD-ECM), open circuit in ECM or faulty clutch switch component. In case of fail safe, it is impossible to operate the exhaust brake.

DTC DETECTING CONDITION

<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="6">• Open or short to power terminal 55 of ECM connector (CFD-ECM)
• Clutch switch component</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• Engine running</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• No clutch signal change until 0km/h (stop)→80km/h (driving) →0km/h (stop)</td></tr>
<tr><td>Diagnosis Time</td><td colspan="3">• 80ms or higher</td></tr>
<tr><td rowspan="3">Fail Safe</td><td>Fuel Cut</td><td>No</td><td rowspan="3">• PTO control stop
• Cruise release</td></tr>
<tr><td>Fuel limit</td><td>No</td></tr>
<tr><td>Check lamp</td><td>OFF</td></tr>
</table>

SPECIFICATION

Item	Specification
Resistance	0~1Ω



Sensor connector

SUDFLDTC9059L

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature.
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Clutch switch” parameter on the scan tool.

Parameter	Reference Value
Clutch switch (When operating the clutch switch)	OFF
Clutch switch (When not operating the clutch switch)	ON

SIGNAL CIRCUIT INSPECTION

1. Signal Voltage Inspection
   1) Leave the clutch switch connector (M49) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 3 of clutch switch harness connector and chassis ground.
      ■ Specification:
      Clutch switch (at OFF) signal power approx. 0V
      Clutch switch (at ON) signal power approx. B+V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Go to “Signal Open Inspection” procedure.

2. Signal Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the clutch switch connector (M49) and ECM connector(CFD-ECM).
   3) Measure resistance between the terminal 3 of clutch switch harness connector and terminal 55 of the engine ECM connector(CFD-ECM).
      ■ Specification: Continuity
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Signal Short to Power Inspection” procedure.

      NO

      ▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.

3. Signal Short to Power Inspection
   1) Disconnect the clutch switch connector (M49) and ECM connector(CFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 3 of clutch switch harness connector and chassis ground.
      ■ Specification: Below 0~0.1V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Repair short to power and then go to “Verification of Vehicle Repair” procedure.

COMPONENT INSPECTION

1. Clutch Switch Visual Inspection
   1) Turn the ignition OFF.
   2) Disconnect the clutch switch connector (M49).
   3) Check the clutch switch connector terminal for contamination or corrosion.
   4) Is the result of system check normal?

   YES

   ▶ Go to "Clutch Switch Resistance Inspection" procedure.

   NO

   ▶ Replace the clutch switch if necessary and go to "Verification of Vehicle Repair" procedure.
2. Clutch Switch Resistance Inspection
   1) Turn the ignition OFF.
   2) Disconnect the clutch switch connector (M49).
   3) Measure the resistance between terminals 3 and 4 of clutch switch connector.

■ **Specification:**

Condition	Resistance (Ω) between terminals 3 and 4
When not operating	0
When operating	Infinite

   4) Is the resistance measured within specification?

   YES

   ▶ Go to "Verification of Vehicle Repair" procedure.

   NO

   ▶ Replace the clutch switch and go to "Verification of Vehicle Repair" procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select "Diagnostic Trouble Codes (DTCs)" mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

   YES

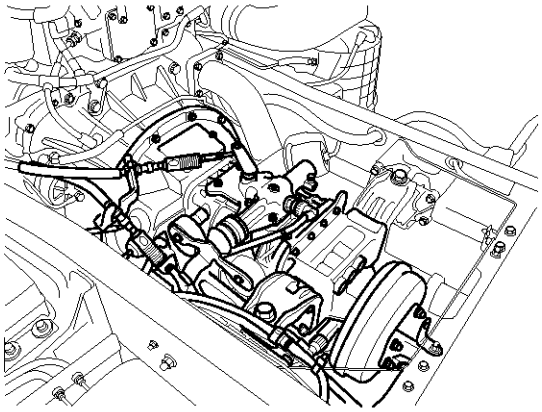
   ▶ Go to the applicable DTC procedure.

   NO

   ▶ System OK

P0850 Neutral Switch Circuit Malfunction(Manual Transmission Only)

COMPONENT LOCATION



SDFFL7116D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   The neutral switch is located in the control housing of the upper of transmission, the neutral switch sends signal to the ECM, the ECM decides fuel injection amount after the ECM judges the vehicle is in the neutral.

2. DTC DESCRIPTION

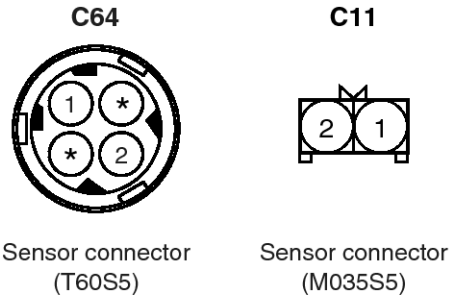
   The vehicle speed repeats from 0km/h(stop) to 80km/h(driving) and 0km/h(stop). But if the neutral switch input signal change is not detected, the ECM judges this as a fault and DTC is set. The probable causes may be short to power of terminal 11 of ECM connector(CFD-ECM), open wiring or faulty neutral switch. In case of fail safe, it is impossible to operate the exhaust brake and PTO(if equipped).

DTC DETECTING CONDITIO

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Open or short to power terminal 1 1 of ECM connector (CFD-ECM) • Neutral switch component
Enable Conditions	• Engine running			
Threshold Value	• No neutral signal change until 0km/h (stop)→80km/h (driving)→0km/h (stop)			
Diagnosis Time	• 32ms or higher			
Fail Safe	Fuel Cut	No	• PTO control stop • Cruise release	
	Fuel limit	No		
	Check lamp	OFF		

SPECIFICATION

Item	Specification
Resistance	0~1 Ω



Sensor connector (T60S5) Sensor connector (M035S5)

SUDFLDTC9062L

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature.
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Neutral switch” parameter on the scan tool.

Parameter	Reference Value
Neutral switch (When operating the neutral switch)	OFF
Neutral switch (When operating the neutral switch)	ON

SIGNAL CIRCUIT INSPECTION

1. Signal Voltage Inspection
   1) Leave the neutral switch connector C11 (C64) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 2 (1) of neutral switch harness connector and chassis ground.
      ■ Specification:
      Neutral switch (at OFF) signal power approx. 0V
      Neutral switch (at ON) signal power approx. $B^{+}V$
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Go to “Signal Open Inspection” procedure.

2. Signal Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the neutral switch connector C11 (C64) and ECM connector(CFD-ECM).
   3) Measure resistance between the terminal 2 (1) of neutral switch harness connector and terminal 11 of the engine ECM connector(CFD-ECM).
      ■ Specification: Continuity
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Signal Short to Power Inspection” procedure.

      NO

      ▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.

3. Signal Short to Power Inspection
   1) Disconnect the neutral switch connector C11 (C64) and ECM connector(CFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF and put the gear into neutral.
   3) Measure voltage between the terminal 2 (1) of neutral switch harness connector and chassis ground.
      ■ Specification: Below 0~0.1V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Repair short to power and then go to “Verification of Vehicle Repair” procedure.

COMPONENT INSPECTION

1. Neutral Switch Visual Inspection
   1) Turn the ignition OFF.
   2) Disconnect the neutral switch connector C11 (C64).
   3) Check the neutral switch connector terminal for contamination or corrosion.
   4) Is the result of system check normal?

   YES

   ▶ Go to "Neutral Switch Resistance Inspection" procedure.

   NO

   ▶ Replace the neutral switch if necessary and go to "Verification of Vehicle Repair" procedure.
2. Neutral Switch Resistance Inspection
   1) Turn the ignition OFF.
   2) Disconnect the neutral switch connector C11 (C64).
   3) Measure the resistance between terminals 2 (1) and 3 of neutral switch connector.

■ **Specification:**

Condition	Resistance (Ω) between terminals 2 and 3
When not operating	0
When operating	Infinite

   4) Is the resistance measured within specification?

   YES

   ▶ Go to "Verification of Vehicle Repair" procedure.

   NO

   ▶ Replace the neutral switch and go to "Verification of Vehicle Repair" procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select "Diagnostic Trouble Codes (DTCs)" mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

   YES

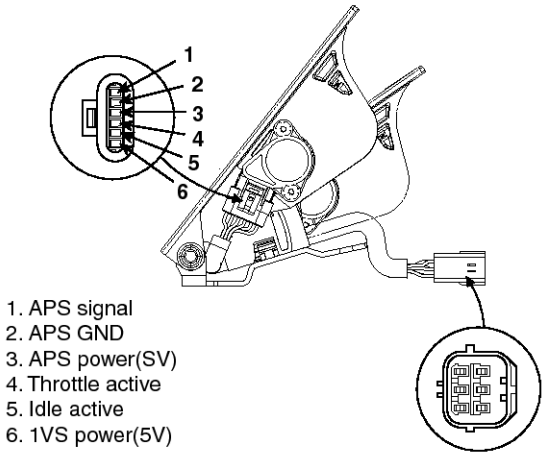
   ▶ Go to the applicable DTC procedure.

   NO

   ▶ System OK

P1120 Both Accel. Pedal Sensor Signal Invalid

COMPONENT LOCATION



SUDFLDTC9070L

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   The electronic fuel injection is accomplished by various factors in the ECM including accelerator pedal position.The accelerator pedal position sensor detects pedal position and sends signal to ECM. It is composed of two potentiometers(dual variable resistor type). Power supply is provided separately to detect acceleration condition exactly. The voltage of accelerator pedal position sensor is generated by potentiometer and the position of accelerator pedal is calculated by using characteristic curve programmed beforehand.

2. DTC DESCRIPTION

   The accelerator pedal sensor indicates idle state in spite of idle switch OFF when the vehicle is being driven. When the accelerator pedal sensors "1" and "2" have problem simultaneously for more than 528 ms, the ECM judges this as a fault and DTC is set. The possible causes are open or short to terminal 47,67 of ECM connector(CFD-ECM), defective sensor, wiring problem etc.

DTC DETECTING CONDITION

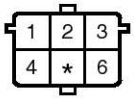
Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Open/ short to ground of terminal 47, 67 of ECM connector (CFD-ECM) • Defective wiring and sensor
Enable Conditions	• Engine running			
Threshold Value	• When the signals 1 and 2 of accelerator pedal sensor are abnormal			
Diagnosis Time	• 528ms or higher			
Fail Safe	Fuel Cut	No	• Accelerator opening signal is set to 50%.	
	Fuel limit	Yes		
	Check lamp	ON		

SPECIFICATION

Terminal resistance ①-②(Inoperative)	Terminal resistance ①-②(Operative)	Terminal resistance ①-③(Inoperative)	Terminal resistance ①-③(Operative)
Approx. 1.83㏀(Continuity)	Approx. 0.708㏀(Continuity)	Approx. 1.64㏀(Continuity)	Approx. 1.64㏀(Continuity)

Terminal resistance ②-③ (Inoperative)	Terminal resistance ②-③ (Operative)
Approx. 0.477㏀(Continuity)	Approx. 1.66㏀(Continuity)

At idle(0%)	At full throttle(100%)
0.33V	3.85V



Sensor connector

SUDFLDTC9024L

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Accelerator pedal position” parameter on the scan tool.

Parameter	Reference Value
Accel. Pos. (At IG ON)	0.0%
Accel. Pos. (At idle)	0.0%
Accel. Pos. (At 1,500 rpm)	23.0%
Accel. Pos. (At 2,000 rpm)	34.5%

SIGNAL CIRCUIT INSPECTION

1. Signal Voltage Inspection
   1) Leave the accelerator pedal position sensor connector (M32) and the engine ECM connector(CFD-ECM) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 2 of the accelerator pedal position sensor harness connector and chassis ground.

      ■ Specification: Accelerator pedal position sensor signal power approx. 0.68V(At IG ON)
   4) Measure voltage between terminal 47, 67 of the engine ECM connector and chassis ground.

      ■ Specification : Accelerator pedal sensor signal power approx. 0.68V(Inoperative)
   5) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Go to “Signal Open Inspection” procedure.
2. Signal Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the accelerator pedal position sensor connector (M32) and the ECM connector(CFD-ECM, EFD-ECM).
   3) Measure resistance between terminal 2 of the accelerator pedal position sensor harness connector and terminal 47, 67 of the engine ECM connector(CFD-ECM).

      ■ Specification: Continuity
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Signal Short to Power Inspection” procedure.

      NO

      ▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.
3. Signal Short to Power Inspection
   1) Disconnect the accelerator pedal position sensor connector (M32) and the ECM connector(CFD-ECM, EFD-ECM).

2) Turn the ignition ON. Leave the engine OFF.
3) Measure voltage between terminal 2 of the accelerator pedal position sensor harness connector and chassis ground.
4) Measure voltage between terminal 47, 67 of the engine ECM connector and chassis ground.
   ■ Specification: Below 0~0.1V
5) Is the voltage measured within specification?

YES

▶ Go to "Signal Short to Ground Inspection" procedure.

NO

▶ Repair short to power and then go to "Verification of Vehicle Repair" procedure.

4. Signal Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the accelerator pedal position sensor connector (M32) and the ECM connector(CFD-ECM, EFD-ECM).
   3) Measure resistance between terminal 2 of the accelerator pedal position sensor harness connector and chassis ground.
   4) Measure resistance between terminal 47, 67 of the engine ECM connector and chassis ground.
      ■ Specification: Infinite
   5) Is the resistance measured within specification?

YES

▶ Go to "Power Supply Inspection" procedure.

NO

▶ Repair short to ground and then go to "Verification of Vehicle Repair" procedure.

POWER SUPPLY INSPECTION

1. Power Supply Voltage Inspection
   1) Leave the accelerator pedal position sensor connector (M32) and the engine ECM connector(CFD-ECM) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 1 of the accelerator pedal position sensor harness connector and chassis ground.
   4) Measure voltage between terminal 50 of the engine ECM connector and chassis ground.
      ■ Specification: Accelerator pedal sensor signal power approx. 5.0V
   5) Is the voltage measured within specification?

YES

▶ Go to "Ground Circuit Inspection" procedure.

NO

▶ Go to "Power Supply Open Inspection" procedure.

2. Power Supply Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the accelerator pedal position sensor connector (M32) and the engine ECM connector(CFD-ECM).
   3) Measure resistance between the terminal 1 of the accelerator pedal position sensor harness connector and terminal 50 of the engine ECM connector(CFD-ECM).
      ■ Specification: Continuity
   4) Is the resistance measured within specification?

YES

▶ Go to "Power Supply Short to Power Inspection" procedure.

NO

▶ Repair open circuit and then go to "Verification of Vehicle Repair" procedure.

3. Power Supply Short to Power Inspection
   1) Disconnect the accelerator pedal position sensor connector (M32) and ECM connector(CFD-ECM, EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 1 of the accelerator pedal position sensor harness connector and chassis ground.
   4) Measure voltage between the terminal 50 of the engine ECM harness connector and chassis ground.
      ■ Specification: Below 0~0.1V
   5) Is the voltage measured within specification?

YES

▶ Go to "Power Supply Short to Ground Inspection" procedure.

NO

▶ Repair short to power and then go to "Verification of Vehicle Repair" procedure.

4. Power Supply Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the accelerator pedal position sensor connector (M32) and ECM connector(CFD-ECM, EFD-ECM).
   3) Measure resistance between the terminal 1 of the accelerator pedal position sensor harness connector and chassis ground.
   4) Measure resistance between the terminal 50 of the engine ECM harness connector and chassis ground.
      ■ Specification: Infinite
   5) Is the resistance measured within specification?

YES

▶ Go to "Ground Circuit Inspection" procedure.

NO

▶ Repair short to ground and then go to "Verification of Vehicle Repair" procedure.

GROUND CIRCUIT INSPECTION

1. Ground Voltage Drop Inspection
   1) Disconnect the accelerator pedal position sensor connector (M32).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage drop between the terminal 3 of the accelerator pedal position sensor harness connector and chassis ground.
      ■ Specification: Ground voltage drop within 200mV
   4) Is the voltage measured within specification?

YES

▶ Go to "Ground Open Inspection" procedure.

NO

▶ Repair the excessive resistance (poor connection) and then go to "Verification of Vehicle Repair" procedure.

2. Ground Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the accelerator pedal position sensor connector (M32) and the engine ECM connector(CFD-ECM, EFD-ECM).
   3) Measure resistance between the terminal 3 of the accelerator pedal position sensor harness connector and the terminal 45, 65 of the engine ECM connector(CFD-ECM).
      ■ Specification: Continuity (Below 1.0Ω)
   4) Is the resistance measured within specification?

YES

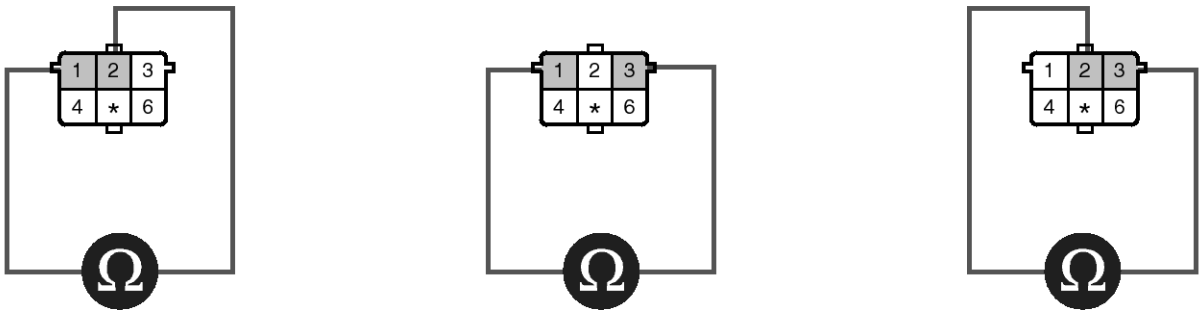
▶ Go to "Component Inspection" procedure.

NO

▶ Repair open wiring circuit and then go to "Verification of Vehicle Repair" procedure.

COMPONENT INSPECTION

1. Accelerator Pedal Position Sensor Component Inspection
   1) Turn the ignition OFF.
   2) Disconnect the accelerator pedal position sensor connector (M32).
   3) Measure resistance between the terminals ①-②, ②-③, ①-③ of the accelerator pedal position sensor.



■ Specification

Terminal resistance ①-②(Inoperative)	Terminal resistance ①-②(Operative)	Terminal resistance ①-③(Inoperative)	Terminal resistance ①-③(Operative)
Approx. 1.83㏀(Continuity)	Approx. 0.708㏀(Continuity)	Approx. 1.64㏀(Continuity)	Approx. 1.64㏀(Continuity)

Terminal resistance ②-③ (Inoperative)	Terminal resistance ②-③ (Operative)
Approx. 0.477㏀(Continuity)	Approx. 1.66㏀(Continuity)

SUDFLDTC9026L

4) Is the resistance measured within the specification?

YES

▶ Go to “Verification of Vehicle Repair” procedure.

NO

▶ Replace the accelerator pedal position sensor and then go to “Verification of Vehicle Repair” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

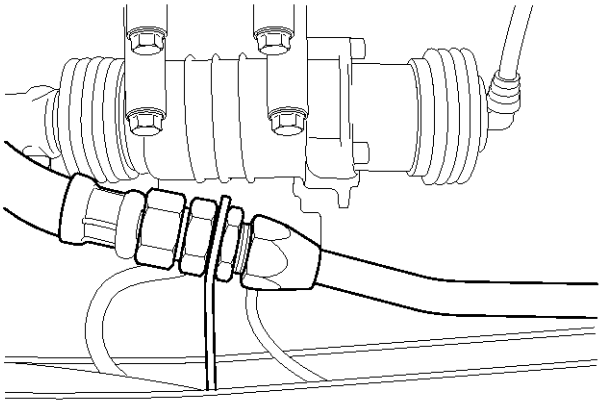
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P1132 ASC(PTO) Accel. Pedal Sensor Signal Too low

COMPONENT LOCATION



SUDFL8502D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   The remote accelerator pedal sensor has been adopted to control engine revolution in PTO mode. Using potentiometer method the remote accelerator pedal sensor changes voltage inputted to ETCM according to sensor opening. Approximate 0.2V is detected in pedal opening 0% and approx. 4.5V are detected in pedal opening 100%. ETCM calculates engine revolutions with the change amount of voltage inputted from sensor.

2. DTC DESCRIPTION

   The DTC is set when the output voltage of remote accelerator pedal sensor is below 0.2V for more than 1,056 ms. The probable causes are open or short to ground of terminals 68,71 of ECM connector(CFD-ECM), signal open and poor connection of connector. Engine revolutions are maintained at PTO basis rpm(650 rpm) when the remote accelerator pedal sensor is not operated with the remote PTO switch ON and the engine revolutions are increased gradually when the remote accelerator pedal sensor is operated.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Open or short to ground terminals 68, 71 of ECM connector (CFD-ECM) • Check the poor connection of connector
Enable Conditions	• Engine running			
Threshold Value	• Output voltage< 0.2V			
Diagnosis Time	• 1,056ms			
Fail Safe	Fuel Cut	No	• PTO control stop	
	Fuel limit	No		
	Check lamp	ON		

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature.
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Remote accelerator pedal” parameter on the scan tool.

Parameter	Reference Value
PTO switch (At IG ON)	OFF
PTO switch (At idle)	OFF

SIGNAL CIRCUIT INSPECTION

1. Signal Voltage Inspection
   1) Leave the engine PTO connector (C20) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 3 of engine PTO harness connector and chassis ground.
      ■ Specification: Engine PTO signal power approx. 0.063V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Verification of Vehicle Repair” procedure.

      NO

      ▶ Go to “Signal Short to Ground Inspection” procedure.
2. Signal Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the engine PTO connector (C20) and ECM connector(CFD-ECM).
   3) Measure resistance between the terminal 3 of engine PTO harness connector and chassis ground.
      ■ Specification: Infinite
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Power Supply Inspection” procedure.

      NO

      ▶ Repair short to ground and then go to “Verification of Vehicle Repair” procedure.

POWER SUPPLY INSPECTION

1. Power Supply Voltage Inspection
   1) Disconnect the engine PTO connector (C20).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 9 of the engine PTO harness connector and chassis ground.
      ■ Specification: Output voltage 5V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Ground Circuit Inspection” procedure.

      NO

      ▶ Go to “Power Supply Open Inspection” procedure.
2. Power Supply Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the engine PTO connector (C20) and ECM connector(CFD-ECM).
   3) Measure resistance between the terminal 9 of the engine PTO harness connector and the terminal 71 of engine ECM connector(CFD-ECM).
      ■ Specification: Continuity
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Power Supply Short to Ground Inspection” procedure.

      NO

      ▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.
3. Power Supply Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the engine PTO connector (C20) and ECM connector(CFD-ECM).
   3) Measure resistance between the terminal 9 of the PTO harness connector and chassis ground.
      ■ Specification: Infinite
   4) Is the resistance measured within specification?

YES

▶ Go to “Ground Circuit Inspection” procedure.

NO

▶ Repair short to ground and then go to “Verification of Vehicle Repair” procedure.

GROUND CIRCUIT INSPECTION

1. Ground Voltage Drop Inspection
   1) Disconnect the engine PTO connector (C20).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage drop between terminal 4 of the engine PTO harness connector and chassis ground.
      ■ Specification: Ground voltage drop within 200mV
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Ground Open Inspection” procedure.

      NO

      ▶ Repair the cause of excessive resistance (poor connection) and go to “Verification of Vehicle Repair” procedure.
2. Ground Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the engine PTO connector (C20) and ECM connector(CFD-ECM).
   3) Measure resistance between the terminal 4 of the engine PTO harness connector and the terminal 46 of engine ECM connector(CFD-ECM).
      ■ Specification: Continuity
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Verification of Vehicle Repair” procedure.

      NO

      ▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

   YES

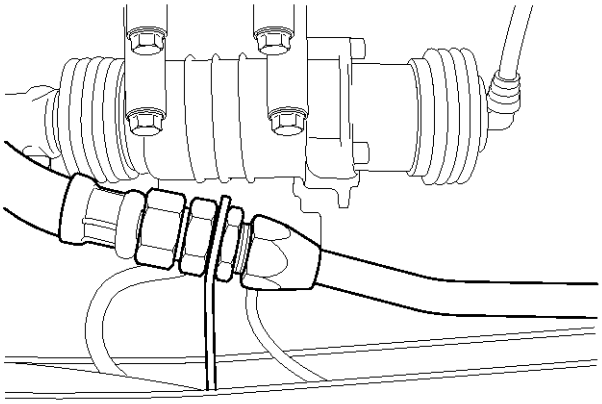
   ▶ Go to the applicable DTC procedure.

   NO

   ▶ System OK

P1133 ASC(PTO) Accel. Pedal Sensor Signal Too high

COMPONENT LOCATION



SUDFL8502D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   The remote accelerator pedal sensor has been adopted to control engine revolution in PTO mode. Using potentiometer method the remote accelerator pedal sensor changes voltage inputted to ETCM according to sensor opening. Approximate 0.2V is detected in pedal opening 0% and approx. 4.5V are detected in pedal opening 100%. ETCM calculates engine revolutions with the change amount of voltage inputted from sensor.

2. DTC DESCRIPTION

   The DTC is set when the output voltage of remote accelerator pedal sensor is above 4.5V for more than 1,056 ms. The probable causes are short to power of terminals 68,71 of ECM connector(CFD-ECM) and poor connection of connector. Engine revolutions are maintained at PTO basis rpm(650 rpm) when the remote accelerator pedal sensor is not operated with the remote PTO switch ON and the engine revolutions are increased gradually when the remote accelerator pedal sensor is operated.

DTC DETECTING CONDITION

<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="6">• Short to power of terminals 68 , 71 of ECM connector (CFD-ECM)
• Check the poor connection of connector</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• Engine running</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• Output voltage >4.5V</td></tr>
<tr><td>Diagnosis Time</td><td colspan="3">• 1,056ms</td></tr>
<tr><td rowspan="3">Fail Safe</td><td>Fuel Cut</td><td>No</td><td rowspan="3">• PTO control stop</td></tr>
<tr><td>Fuel limit</td><td>No</td></tr>
<tr><td>Check lamp</td><td>ON</td></tr>
</table>

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature.
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Remote accelerator pedal” parameter on the scan tool.

Parameter	Reference Value
PTO switch (At IG ON)	OFF
PTO switch (At idle)	OFF

SIGNAL CIRCUIT INSPECTION

1. Signal Voltage Inspection
   1) Leave the engine PTO connector (C20) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 3 of engine PTO harness connector and chassis ground.
      ■ Specification: Engine PTO signal power approx. 0.063V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Verification of Vehicle Repair” procedure.

      NO

      ▶ Go to “Signal Open Inspection” procedure.
2. Signal Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the engine PTO connector (C20) and ECM connector(CFD-ECM).
   3) Measure resistance between the terminal 3 of engine PTO harness connector and terminal 68 of ECM connector(CFD-ECM).
      ■ Specification: Continuity
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Signal Short to Power Inspection” procedure.

      NO

      ▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.
3. Signal Short to Power Inspection
   1) Turn the ignition OFF.
   2) Disconnect the engine PTO connector (C20) and ECM connector(CFD-ECM).
   3) Measure voltage between the terminal 3 of engine PTO harness connector and chassis ground.
      ■ Specification: Below 0~0.1 V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Verification of Vehicle Repair” procedure.

      NO

      ▶ Repair short to power and then go to “Verification of Vehicle Repair” procedure.

POWER SUPPLY INSPECTION

1. Power Supply Voltage Inspection
   1) Disconnect the engine PTO connector (C20).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminal 9 of the engine PTO harness connector and chassis ground.
      ■ Specification: Output voltage 5V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Ground Circuit Inspection” procedure.

      NO

      ▶ Go to “Power Supply Open Inspection” procedure.
2. Power Supply Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the engine PTO connector (C20) and ECM connector(CFD-ECM).
   3) Measure resistance between the terminal 9 of the engine PTO harness connector and the terminal 71 of engine ECM connector(CFD-ECM).
      ■ Specification: Continuity
   4) Is the resistance measured within specification?

YES

▶ Go to “Power Supply Short to Power Inspection” procedure.

NO

▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.

3. Power Supply Short to Power Inspection
   1) Turn the ignition OFF.
   2) Disconnect the engine PTO connector (C20) and ECM connector(CFD-ECM).
   3) Measure voltage between the terminal 9 of the PTO harness connector and chassis ground.
      ■ Specification: Below 0~1.0 V
   4) Is the voltage measured within specification?

YES

▶ Go to “Ground Circuit Inspection” procedure.

NO

▶ Repair short to power and then go to “Verification of Vehicle Repair” procedure.

GROUND CIRCUIT INSPECTION

1. Ground Voltage Drop Inspection
   1) Disconnect the engine PTO connector (C20).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage drop between terminal 4 of the engine PTO harness connector and chassis ground.
      ■ Specification: Ground voltage drop within 200mV
   4) Is the voltage measured within specification?

YES

▶ Go to “Ground Open Inspection” procedure.

NO

▶ Repair the cause of excessive resistance (poor connection) and go to “Verification of Vehicle Repair” procedure.

2. Ground Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the engine PTO connector (C20) and ECM connector(CFD-ECM).
   3) Measure resistance between the terminal 4 of the engine PTO harness connector and the terminal 46 of engine ECM connector(CFD-ECM).
      ■ Specification: Continuity
   4) Is the resistance measured within specification?

YES

▶ Go to “Verification of Vehicle Repair” procedure.

NO

▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

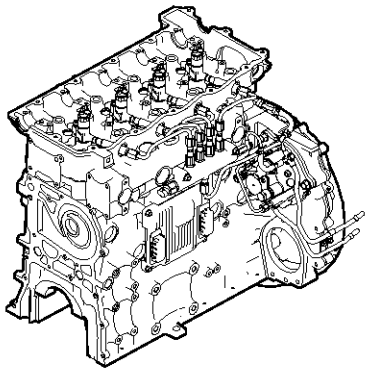
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P1190 Actual Rail Pressure Over

COMPONENT LOCATION



SDFFL7104D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   Supply control valve(SCV) is solenoid type. The ECM controls time to open/close valve, controls pump fuel amount by controlling current to be supplied to SCV to adjust target rail pressure. When the SCV is closed, fuel passage is cut off and fuel is compressed. The compressed fuel is supplied to common rail. If fuel pressure is decreased, the SCV is opened and then fuel is inhaled for next pumping. Fuel pump relay is supplied power to low fuel pump by the ECM. At the ignition key ON, the fuel pump relay works for about 1.5sec. and stops to diagnose fuel pump relay. If the engine rpm is detected above 45rpm, the ECM makes relay turn ON and feeds fuel to high pressure pump.

2. DTC DESCRIPTION

   If the difference between target fuel pressure and actual fuel pressure of the SCV is detected above 10 Mpa for 22,496 ms or more, the ECM judges this as a fault and DTC is set. The probable cause may be the SCV stuck.

DTC DETECTING CONDITION

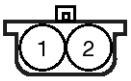
Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Check the SCV for stuck.
Enable Conditions	• At IG ON			
Threshold Value	• Actual pressure-target pressure>10Mpa			
Diagnosis Time	• 22,496ms			
Fail Safe	Fuel Cut	No		
	Fuel limit	No		
	Check lamp	ON		

SPECIFICATION

Item	Specification
Resistance	7.9±0.25Ω

SCV driving frequency	SCV control type
200 Hz	Current control

SCV driving voltage	SCV driving current
16~32 V	Below 1.29A when driving
	Below 1.16A when stopping (within 270sec.)



Sensor connector

SUDFLDTC9054L

WAVEFORM

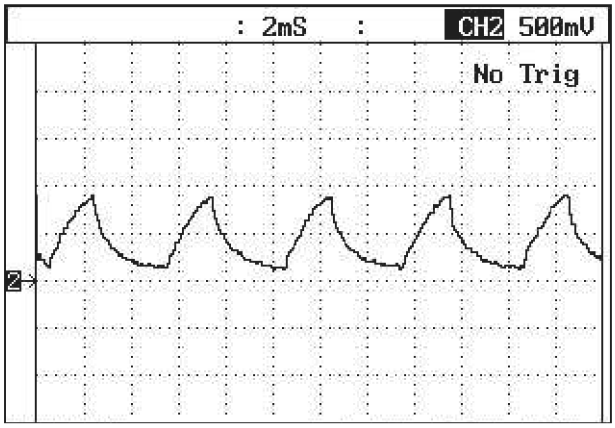


Fig. 1 Waveform at LOW side

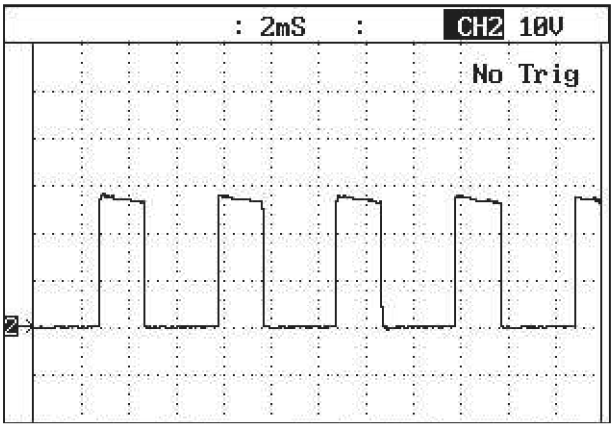


Fig. 2 Waveform at HIGH side

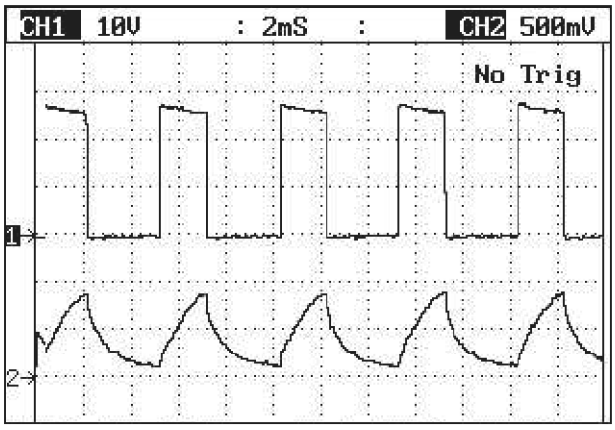


Fig. 3 Waveforms at LOW/HIGH side

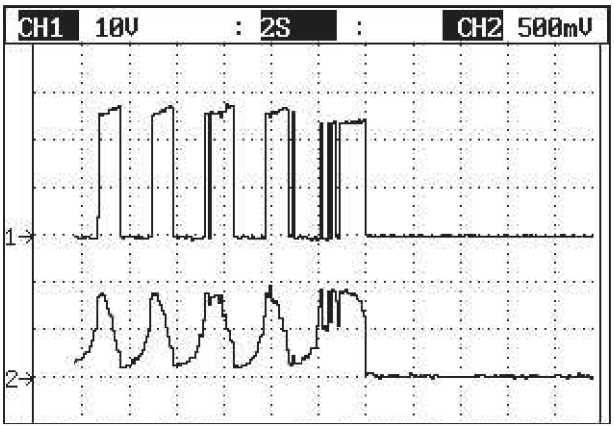


Fig. 4 Waveforms while operating for 2 sec. when the SCV valve is OFF

SUDFLDTC9055L

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature.
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Pump control duty” parameter on the scan tool.

NOTICE

The value of “Pump control duty” varies with driving condition according to DTC detecting condition. In case of failure, be sure to check that the value of “Engine output (common rail pressure limit)” is limited.

■ Specification: Pump control duty approx. 43% at idle

Parameter	Reference Value
Final pump drv. duty (At IG ON)	0.0%
Final pump drv. duty (At idle)	47.5%
Final pump drv. duty (At 1,500 rpm)	43.5%
Final pump drv. duty (At 2,000 rpm)	39.0%

SIGNAL CIRCUIT INSPECTION

1. Signal (LOW/HIGH) Voltage Inspection
   1) Leave the SCV connector (EFD15) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminals 1 and 2 of SCV harness connector and chassis ground.

      ■ Specification: SCV signal terminal 1 power approx. 0.1~0.63V(Detecting voltage fluctuation)

      ■ Specification: SCV signal terminal 2 power approx. 0~ B+V(Detecting voltage fluctuation)

      Note) It is easy to judge trouble when checking it with waveform.
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Go to “Signal (LOW/HIGH) Open Inspection” procedure.
2. Signal (LOW/HIGH) Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the SCV connector (EFD15) and the ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 1 of SCV harness connector and the terminal 51, 71 of the ECM connector(EFD-ECM).
   4) Measure resistance between the terminal 2 of SCV harness connector and the terminal 52, 72 of the ECM connector(EFD-ECM).

      ■ Specification: Continuity
   5) Is the resistance measured within specification?

      YES

      ▶ Go to “Signal (LOW/HIGH) Short to Power Inspection” procedure.

      NO

      ▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.
3. Signal (LOW/HIGH) Short to Power Inspection
   1) Disconnect the SCV connector (EFD15) and the ECM connector(EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminals 1, 2 of SCV harness connector and chassis ground.
   4) Measure voltage between the terminal 2 of SCV harness connector and the terminal 52, 72 of the ECM connector(EFD-ECM).

      ■ Specification: Below 0~0.1V
   5) Is the voltage measured within specification?

      YES

      ▶ Go to “Signal (LOW/HIGH) Short to Ground Inspection” procedure.

      NO

      ▶ Repair short to power and then go to “Verification of Vehicle Repair” procedure.
4. Signal (LOW/HIGH) Short to Ground Inspection
   1) Turn the ignition OFF
   2) Disconnect the SCV connector (EFD15) and the ECM connector(EFD-ECM).
   3) Measure resistance between the terminals 1, 2 of SCV harness connector and chassis ground.

      ■ Specification: Infinite

4) Is the resistance measured within specification?

YES

▶ Go to “Component Inspection” procedure.

NO

▶ Repair short to ground and then go to “Verification of Vehicle Repair” procedure.

COMPONENT INSPECTION

1. SCV Visual Inspection
   1) Turn the ignition OFF.
   2) Disconnect the SCV connector (EFD15).
   3) Check the terminal of SCV connector for contamination and leaks.
   4) Check the SCV for torque and fuel leaks.
   5) Is there any problem about SCV?

YES

▶ Replace the SCV if necessary and go to “Verification of Vehicle Repair” procedure.

NO

▶ Go to “SCV Waveform Inspection” procedure.

2. SCV Waveform Inspection
   1) Turn the ignition OFF.
   2) Connect the SCV connector (EFD15)
   3) Connect oscilloscope probe to terminal 2 of the SCV connector (EFD15).
   4) Check the waveform at idle and accelerating after the engine starts.

   ■ Specification: Refer to “Standard waveform” of general information.
   5) Does the waveform display normally?

YES

▶ Go to “Verification of Vehicle Repair” procedure.

NO

▶ Go to “SCV Resistance Inspection” procedure.

3. SCV Resistance Inspection
   1) Turn the ignition OFF.
   2) Disconnect the SCV connector (EFD15).
   3) Measure resistance between the terminals 1 and 2 of the SCV connector.

■ **Specification :**

Item	Specification
Resistance	7.9±0.25 Ω

   4) Is the resistance measured within the specification?

YES

▶ Go to “Verification of Vehicle Repair” procedure.

NO

▶ Replace the SCV and then go to “Verification of Vehicle Repair” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

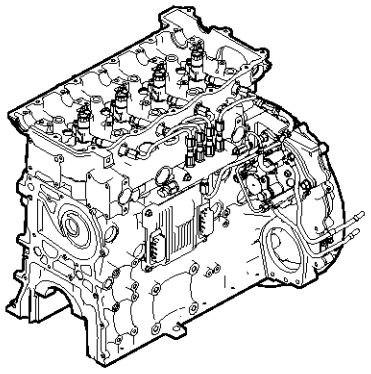
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P1218 Abnormal High Pressure Mode #3

COMPONENT LOCATION



SDFFL7104D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   Supply control valve(SCV) is solenoid type. The ECM controls time to open/close valve, controls pump fuel amount by controlling current to be supplied to SCV to adjust target rail pressure. When the SCV is closed, fuel passage is cut off and fuel is compressed. The compressed fuel is supplied to common rail. If fuel pressure is decreased, the SCV is opened and then fuel is inhaled for next pumping. Fuel pump relay is supplied power to low fuel pump by the ECM. At the ignition key ON, the fuel pump relay works for about 1.5sec. and stops to diagnose fuel pump relay. If the engine rpm is detected above 45rpm, the ECM makes relay turn ON and feeds fuel to high pressure pump.

2. DTC DESCRIPTION

   If pump pressure is more than 197Mpa for 15 seconds or 230Mpa for 3 seconds continuously, the ECM judges this as a fault and DTC is set. The probable causes may be SCV stuck, bad learning or open in SCV wiring circuit. In case of fail safe, a care should be taken due to causing damage to common rail system. Therefore, the ECM limits engine power and abnormal high pressure is made if there is open circuit of fuel pump at starting and pressure limiter is operated etc.

DTC DETECTING CONDITION

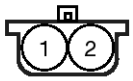
<table>
<tr><th>Item</th><th colspan="3">Detecting Condition</th><th>Possible Cause</th></tr>
<tr><td>DTC Strategy</td><td colspan="3">• Voltage monitoring</td><td rowspan="6">• Defective wiring harness
• Supply control value
• Injector</td></tr>
<tr><td>Enable Conditions</td><td colspan="3">• Cranking</td></tr>
<tr><td>Threshold Value</td><td colspan="3">• When pump pressure keeps above limit value</td></tr>
<tr><td>Diagnosis Time</td><td colspan="3">• 32ms or higher</td></tr>
<tr><td rowspan="3">Fail Safe</td><td>Fuel Cut</td><td>Yes</td><td rowspan="3">• Fuel amount limit (75% of maximum torque)</td></tr>
<tr><td>Fuel limit</td><td>No</td></tr>
<tr><td>Check lamp</td><td>OFF</td></tr>
</table>

SPECIFICATION

Item	Specification
Resistance	7.9±0.25Ω

SCV driving frequency	SCV control type
200 Hz	Current control

SCV driving voltage	SCV driving current
16~32 V	Below 1.29A when driving
	Below 1.16A when stopping (within 270sec.)



Sensor connector

SUDFLDTC9054L

WAVEFORM

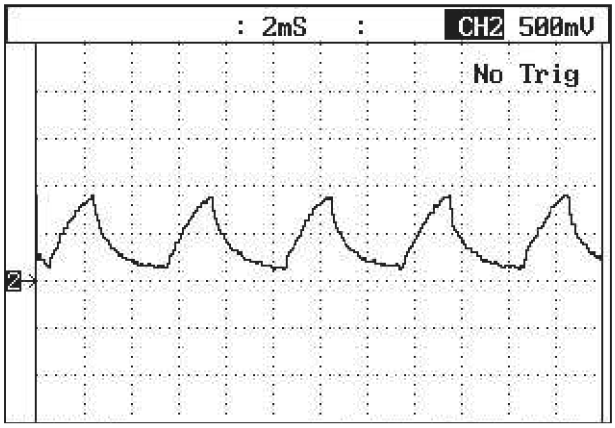


Fig. 1 Waveform at LOW side

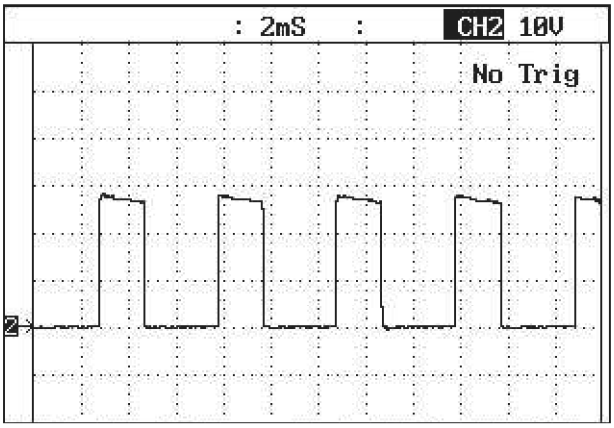


Fig. 2 Waveform at HIGH side

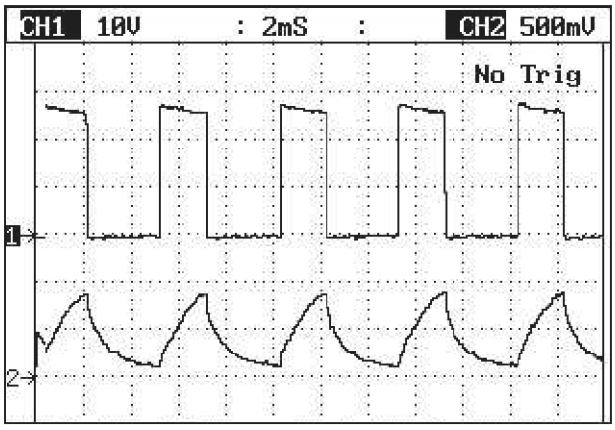


Fig. 3 Waveforms at LOW/HIGH side

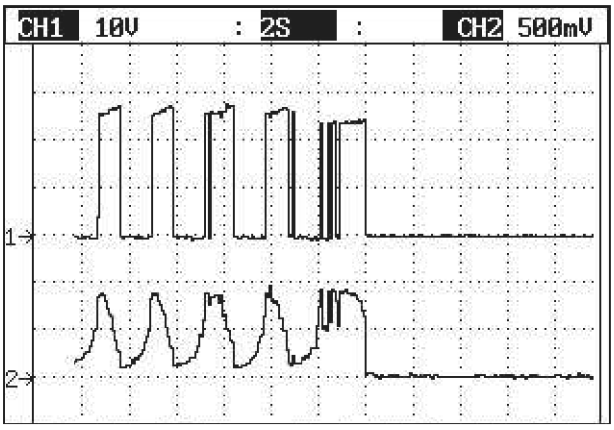


Fig. 4 Waveforms while operating for 2 sec. when the SCV valve is OFF

SUDFLDTC9055L

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature.
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Pump control duty” parameter on the scan tool.

NOTICE

The value of “Pump control duty” varies with driving condition according to DTC detecting condition. In case of failure, be sure to check that the value of “Engine output (common rail pressure limit)” is limited.

■ Specification: Pump control duty approx. 43% at idle

Parameter	Reference Value
Final pump drv. duty (At IG ON)	0.0%
Final pump drv. duty (At idle)	47.5%
Final pump drv. duty (At 1,500 rpm)	43.5%
Final pump drv. duty (At 2,000 rpm)	39.0%

SIGNAL CIRCUIT INSPECTION

1. Signal (LOW/HIGH) Voltage Inspection
   1) Leave the SCV connector (EFD15) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminals 1 and 2 of SCV harness connector and chassis ground.

      ■ Specification: SCV signal terminal 1 power approx. 0.1~0.63V(Detecting voltage fluctuation)

      ■ Specification: SCV signal terminal 2 power approx. 0~ B+V(Detecting voltage fluctuation)

      Note) It is easy to judge trouble when checking it with waveform.
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Go to “Signal (LOW/HIGH) Open Inspection” procedure.
2. Signal (LOW/HIGH) Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the SCV connector (EFD15) and the ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 1 of SCV harness connector and the terminal 51, 71 of the ECM connector(EFD-ECM).
   4) Measure resistance between the terminal 2 of SCV harness connector and the terminal 52, 72 of the ECM connector(EFD-ECM).

      ■ Specification: Continuity
   5) Is the resistance measured within specification?

      YES

      ▶ Go to “Signal (LOW/HIGH) Short to Power Inspection” procedure.

      NO

      ▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.
3. Signal (LOW/HIGH) Short to Power Inspection
   1) Disconnect the SCV connector (EFD15) and the ECM connector(EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminals 1, 2 of SCV harness connector and chassis ground.

      ■ Specification: Below 0~0.1V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Signal (LOW/HIGH) Short to Ground Inspection” procedure.

      NO

      ▶ Repair short to power and then go to “Verification of Vehicle Repair” procedure.
4. Signal (LOW/HIGH) Short to Ground Inspection
   1) Turn the ignition OFF
   2) Disconnect the SCV connector (EFD15) and the ECM connector(EFD-ECM).
   3) Measure resistance between the terminals 1, 2 of SCV harness connector and chassis ground.

      ■ Specification: Infinite
   4) Is the resistance measured within specification?

      YES

▶ Go to “Component Inspection” procedure.

NO

▶ Repair short to ground and then go to “Verification of Vehicle Repair” procedure.

COMPONENT INSPECTION

1. SCV Visual Inspection
   1) Turn the ignition OFF.
   2) Disconnect the SCV connector (EFD15).
   3) Check the terminal of SCV connector for contamination and leaks.
   4) Check the SCV for torque and fuel leaks.
   5) Is there any problem about SCV?

   YES

   ▶ Replace the SCV if necessary and go to “Verification of Vehicle Repair” procedure.

   NO

   ▶ Go to “SCV Waveform Inspection” procedure.
2. SCV Waveform Inspection
   1) Turn the ignition OFF.
   2) Connect the SCV connector (EFD15)
   3) Connect oscilloscope probe to terminal 2 of the SCV connector (EFD15).
   4) Check the waveform at idle and accelerating after the engine starts.

      ■ Specification: Refer to “Standard waveform” of general information.
   5) Does the waveform display normally?

   YES

   ▶ Go to “Verification of Vehicle Repair” procedure.

   NO

   ▶ Go to “SCV Resistance Inspection” procedure.
3. SCV Resistance Inspection
   1) Turn the ignition OFF.
   2) Disconnect the SCV connector (EFD15).
   3) Measure resistance between the terminals 1 and 2 of the SCV connector.

■ Specification :

Item	Specification
Resistance	7.9±0.25 Ω

   4) Is the resistance measured within the specification?

   YES

   ▶ Go to “Verification of Vehicle Repair” procedure.

   NO

   ▶ Replace the SCV and then go to “Verification of Vehicle Repair” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

   YES

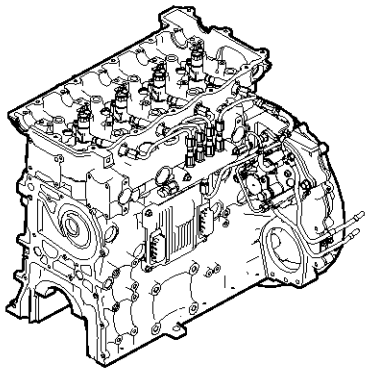
   ▶ Go to the applicable DTC procedure.

   NO

   ▶ System OK

P1219 Abnormal High Pressure Mode #1

COMPONENT LOCATION



SDFFL7104D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   Supply control valve(SCV) is solenoid type. The ECM controls time to open/close valve, controls pump fuel amount by controlling current to be supplied to SCV to adjust target rail pressure. When the SCV is closed, fuel passage is cut off and fuel is compressed. The compressed fuel is supplied to common rail. If fuel pressure is decreased, the SCV is opened and then fuel is inhaled for next pumping. Fuel pump relay is supplied power to low fuel pump by the ECM. At the ignition key ON, the fuel pump relay works for about 1.5sec. and stops to diagnose fuel pump relay. If the engine rpm is detected above 45rpm, the ECM makes relay turn ON and feeds fuel to high pressure pump.

2. DTC DESCRIPTION

   If fuel discharge amount difference among plungers are 170 ㎣/ 3 strokes for more than 500 times, the ECM judges this as a fault and DTC is set. There may be damage to high pressure plunger in the pump by forming abnormal high pressure. If abnormal high pressure in the pump is formed, the probable causes are open circuit in SCV, clogging for fuel line and fuel filter. If the DTC comes on and the reduced output and the engine stop occur, the pump assembly should be replaced.

DTC DETECTING CONDITION

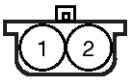
Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Pump internal defect
Enable Conditions	• Cranking			
Threshold Value	• -			
Diagnosis Time	• -			
Fail Safe	Fuel Cut	Yes	• Fuel amount limit (75% of maximum torque) • EGR release • Cruise release	
	Fuel limit	No		
	Check lamp	OFF		

SPECIFICATION

Item	Specification
Resistance	7.9±0.25Ω

SCV driving frequency	SCV control type
200 Hz	Current control

SCV driving voltage	SCV driving current
16~32 V	Below 1.29A when driving
	Below 1.16A when stopping (within 270sec.)



Sensor connector

SUDFLDTC9054L

WAVEFORM

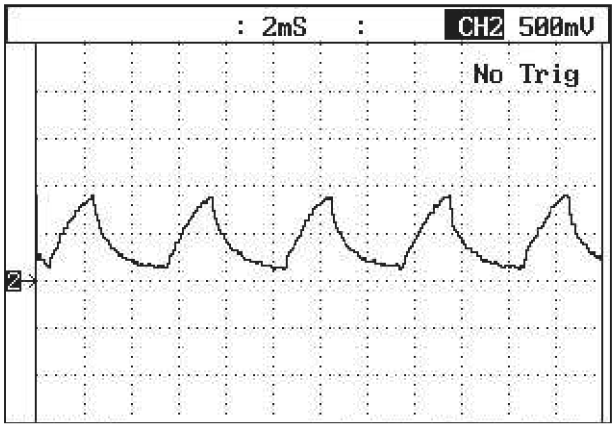


Fig. 1 Waveform at LOW side

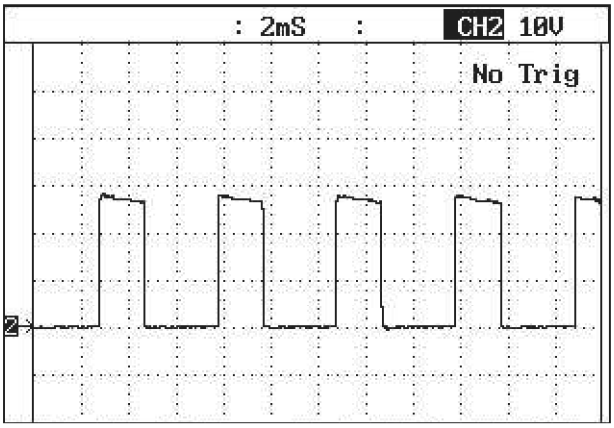


Fig. 2 Waveform at HIGH side

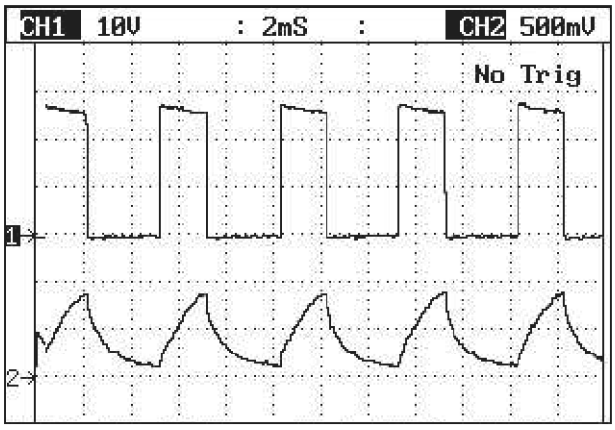


Fig. 3 Waveforms at LOW/HIGH side

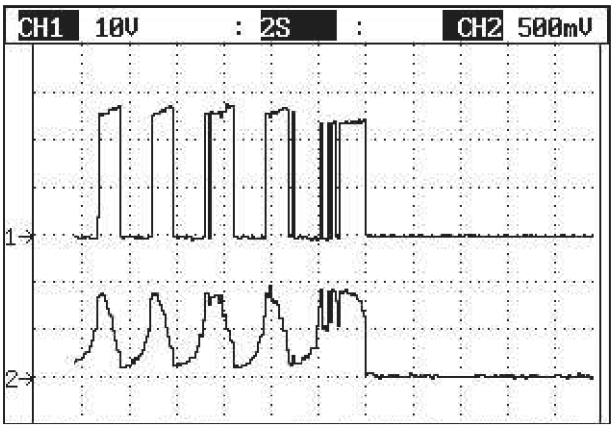


Fig. 4 Waveforms while operating for 2 sec. when the SCV valve is OFF

SUDFLDTC9055L

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature.
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Pump control duty” parameter on the scan tool.

NOTICE

The value of “Pump control duty” varies with driving condition according to DTC detecting condition. In case of failure, be sure to check that the value of “Engine output (common rail pressure limit)” is limited.

■ Specification: Pump control duty approx. 43% at idle

Parameter	Reference Value
Final pump drv. duty (At IG ON)	0.0%
Final pump drv. duty (At idle)	47.5%
Final pump drv. duty (At 1,500 rpm)	43.5%
Final pump drv. duty (At 2,000 rpm)	39.0%

COMPONENT INSPECTION

1. Fuel Supply System Visual Inspection
   1) Turn the ignition OFF.
   2) Check the fuel hose, pipe for crack, bent, deformation, degradation, and clogged etc.
   3) Check the fuel filter for clogged, damage, and contamination.
   4) Check the flower damper for damage and leak.
   5) Check fuel.
   6) Is the result of system check normal?

      YES

      ▶ Go to “Verification of Vehicle Repair” procedure.

      NO

      ▶ Repair the problem and go to “Verification of Vehicle Repair” procedure.
2. Supply Pump Inspection
   1) Turn the ignition OFF.
   2) Check the fuel pump around and the high pressure fuel supply system for fuel leak.
   3) Start the engine and check the high pressure fuel line for leak.
   4) Check the supply pump for abnormal operation sound or vibration.
   5) Is the result of system check normal?

      YES

      ▶ Go to “Verification of Vehicle Repair” procedure.

      NO

      ▶ Repair the problem and go to “Verification of Vehicle Repair” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

   YES

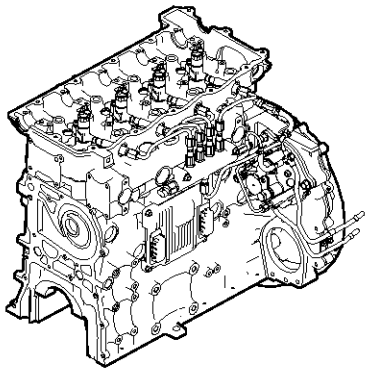
   ▶ Go to the applicable DTC procedure.

   NO

   ▶ System OK

P1221 Actual Rail Pressure Was Less Than Target Pressure

COMPONENT LOCATION



SDFFL7104D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   The rail pressure sensor should detect the instant pressure in common rail to send the voltage signal commensurate with pressure applied to the ECM.

   If fuel flows to rail pressure through rail inlet, its end part is sealed-off with sensor diaphragm. The pressurized fuel reaches diaphragm of sensor through blind hole, sensor factor(semiconductor device) to convert pressure into electric signal is connected to this diaphragm, the signal produced by the sensor amplifies the measuring signal and is input to the review circuit to send to the ECM.

   The signal plays a very important role not only to decide fuel amount and injection timing in the ECM but also to feedback rail pressure regulator to control the target fuel pressure in the ECM.

2. DTC DESCRIPTION

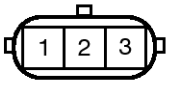
   If actual pressure of common is lower 30Mpa than target pressure for more than 6,016 ms, ECM judges this as a fault and DTC is set. The probable causes are fuel rail pressure sensor fault, fuel filter fault and fuel tank fault.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Fuel filter clogged or fuel tank • Defective fuel rail pressure sensor
Enable Conditions	• Engine running			
Threshold Value	• Target pressure-actual pressure>30Mpa			
Diagnosis Time	• 6,016ms			
Fail Safe	Fuel Cut	No	• Fuel pressure limit(60Mpa) • Fuel amount limit • EGR control stop • Cruise release	
	Fuel limit	Yes		
	Check lamp	ON		

SPECIFICATION

Rail pressure sensor	Specification
Output voltage	Below 2.6 V (Idle state after warm-up)
Rail pressure	40 Mpa (Idle state)



Sensor connector

Component resistance	Specification(20℃)
No. 1, 2	3 kΩ
No. 1, 3	13 kΩ
No. 2, 3	16.4 kΩ

SUDFLDTC9003L

WAVEFORM

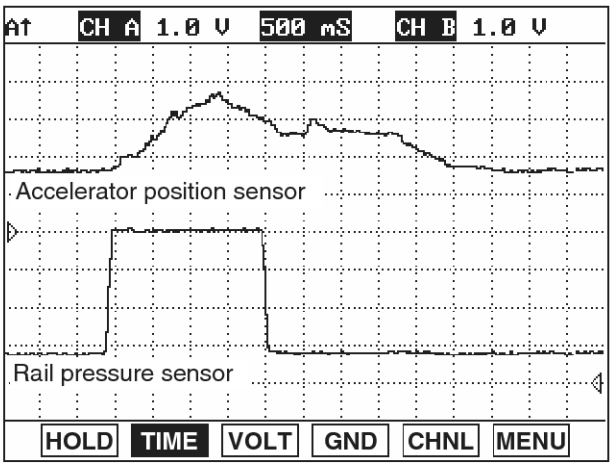


Fig. 1 Measure with oscilloscope waveform

Fig1) indicates waveform which the accelerator position sensor 1 and the rail pressure sensor are measured at the same time, can check the rail pressure sensor output at quick acceleration or deceleration.

SUDFLDTC9004L

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Rail pressure” parameter on the scan tool.

NOTICE

The value of “Rail pressure” varies with the operative condition according to DTC detecting condition. In case of fail safe, be sure to check that the value of “Rail pressure” sets to 70Mpa and the “Fuel amount” is restricted to below 70%.

Parameter	Reference Value
Real C/R pressure (At IG ON)	0.4 Mpa
Real C/R pressure (At idle)	31.6 Mpa
Real C/R pressure (At 1,500 rpm)	91.2 Mpa
Real C/R pressure (At 2,000 rpm)	122.5 Mpa

Check “Rail pressure” at idle after warming-up from Fig.1)~2).

Start the engine and monitor the pressure change of

the rail pressure sensor. The pressure of about 40Mpa is generated at hot idle (650rpm). At this time, it is also important to check the duty of the rail pressure governor. Check that the duty of about 46.5% indicates from above service data.

This data increase with acceleration and load condition, not only the rail pressure increases up to max. 180Mpa but also the rail pressure governor duty increases up to 95%.

TROUBLESHOOTING AID

The trouble code related to poor rail pressure is necessary to diagnose high pressure fuel system and low pressure fuel system collectively

High pressure fuel system symptom: Poor high pressure of high pressure fuel pump, the poor air tightness or stuck of the ball valve seat of rail pressure governor, clogged overflow valve, the fuel leak of injector nozzle and return circuit

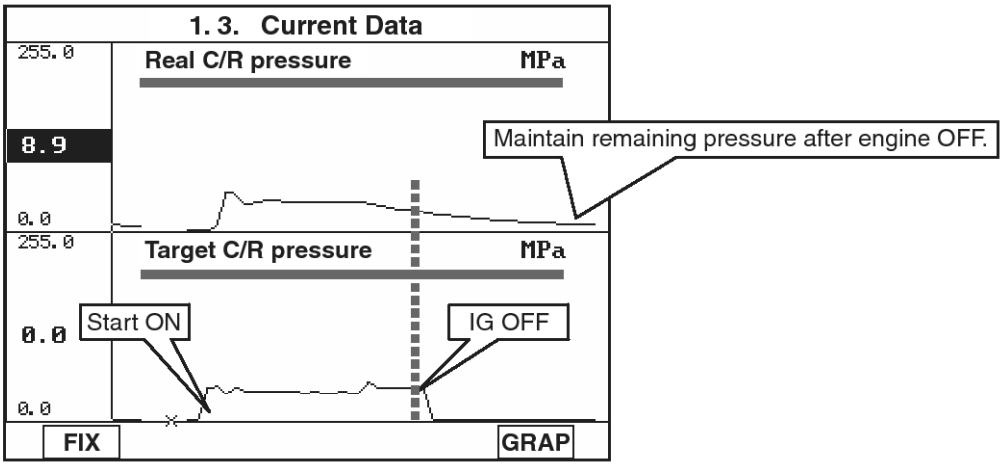
Low pressure fuel system symptom: Poor fuel supply of low pressure fuel pump, clogged fuel filter

NOTICE

Overflow valve plays a role to return fuel to the fuel tank by opening valve to protect fuel system when generating the fuel pressure in common rail with "221Mpa" or more excessively.

NOTICE

It is possible to check by turning the ignition key ON not to lose data due to impossible communication between ECM and scan tool because the main relay switches OFF at stopping the engine.



SUDFLDTC9095L

The above graph waveform indicates the pressure change of the rail pressure sensor at starting ON and OFF. It is possible to diagnose the collective fuel system by checking the condition to maintain the pressure in the common rail at stopping the engine and the time to reach about 40Mpa in the common rail.

1. It is important for the rail pressure to increase quickly at starting.

   ▶ It is easy to diagnose the supply state of low pressure fuel pump, the high pressure formation of high pressure fuel pump, the air tightness of rail pressure governor, the air tightness state of injector nozzle and return side.

2. It is important to maintain air tightness at below 101bar of spring tension of common rail pressure governor and to lower fuel pressure gradually at stopping the engine.

   ▶ It is easy to diagnose the air tightness state of rail pressure governor, nozzle and return side.

SIGNAL CIRCUIT INSPECTION

1. Signal Voltage Inspection
   1) Leave fuel pressure sensor connector (EFD13) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure the voltage between the terminal 2 of fuel pressure sensor harness connector and chassis ground.

      ■ Specification:

      Signal power: approx. 1.0V (At IG ON)

      Note) The signal power may be measured differently according to rail pressure.

   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Go to “Signal Open Inspection” procedure.

2. Signal Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect fuel pressure sensor connector (EFD13) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 2 of fuel pressure sensor harness connector and the terminal 13, 32 of ECM connector(EFD-ECM).

      ■ Specification: Continuity (Below 1.0Ω)

   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Signal Short to Ground Inspection” procedure.

      NO

      ▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.

3. Signal Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect fuel pressure sensor connector (EFD13) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 2 of fuel pressure sensor harness connector and chassis ground.

      ■ Specification: Infinite

   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Signal Short to Power Inspection” procedure.

      NO

      ▶ Repair short to ground and then go to “Verification of Vehicle Repair” procedure.

4. Signal Short to Power Inspection
   1) Disconnect fuel pressure sensor connector (EFD13) and ECM connector(EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 2 of fuel pressure sensor harness connector and chassis ground.

      ■ Specification: Below 0~0.1V

   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Power Supply Inspection” procedure.

      NO

      ▶ Repair short to power and then go to “Verification of Vehicle Repair” procedure.

POWER SUPPLY INSPECTION

1. Power Supply Voltage Inspection
   1) Disconnect fuel pressure sensor connector (EFD13).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 1 of fuel pressure sensor harness connector and chassis ground.

      ■ Specification: Engine ECM output power approx. 5 V

   4) Is the voltage measured within specification?

YES

▶ Go to “Ground Circuit Inspection” procedure.

NO

▶ Go to “Power Supply Open Inspection” procedure.

2. Power Supply Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect fuel pressure sensor connector (EFD13) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 1 of fuel pressure sensor harness connector and the terminal 68 of ECM connector.
      ■ Specification: Continuity (Below 1.0Ω)
   4) Is the resistance measured within specification?

YES

▶ Go to “Power Supply Short to Ground Inspection” procedure.

NO

▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.

3. Power Supply Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect fuel pressure sensor connector (EFD13) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 1 of fuel pressure sensor harness connector and chassis ground.
      ■ Specification: Infinite
   4) Is the resistance measured within specification?

YES

▶ Go to “Power Supply Short to Power Inspection” procedure.

NO

▶ Repair short to ground and then go to “Verification of Vehicle Repair” procedure.

4. Power Supply Short to Power Inspection
   1) Disconnect fuel pressure sensor connector (EFD13) and ECM connector(EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 1 of fuel pressure sensor harness connector and chassis ground.
      ■ Specification: Below 0~0.1 V
   4) Is the voltage measured within specification?

YES

▶ Go to “Ground Circuit Inspection” procedure.

NO

▶ Repair short to power and then go to “Verification of Vehicle Repair” procedure.

GROUND CIRCUIT INSPECTION

1. Ground Voltage Drop Inspection
   1) Disconnect fuel pressure sensor connector (EFD13).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage drop between the terminal 3 of fuel pressure sensor harness connector and chassis ground.
      ■ Specification: Ground voltage drop within 200 mV
   4) Is the voltage measured within specification?

YES

▶ Go to “Ground Open Inspection” procedure.

NO

▶ Repair the excessive resistance (poor connection) and then go to “Verification of Vehicle Repair” procedure.

2. Ground Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect fuel pressure sensor connector (EFD13) and ECM connector(EFD-ECM).
   3) Measure voltage drop between the terminal 3 of fuel pressure sensor harness connector and the terminal 25 of ECM(EFD-ECM).
      ■ Specification: Continuity (Below 1.0Ω)
   4) Is the voltage measured within specification?

YES

▶ Go to “Component Inspection” procedure.

NO

▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.

COMPONENT INSPECTION

1. Fuel Pressure Sensor Inspection
   1) Turn the ignition OFF.
   2) Leave fuel pressure sensor connector (EFD13) connected.
   3) Start the engine. Check and compare fuel pressure according to detecting condition.

      NOTICE
      The value of "rail pressure" varies with driving conditions according to DTC detecting condition. In case of fail safe, be sure to check that fuel pressure is controlled by "70 Mpa".

Parameter	Reference Value
Real C/R pressure (At IG ON)	0.4 Mpa
Real C/R pressure (At idle)	31.5 Mpa
Real C/R pressure (At 1,500 rpm)	65.5 Mpa
Real C/R pressure (At 2,000 rpm)	65.5 Mpa

■ Specification :

Pressure	Output voltage
(MPa)	(V)
0	1.00
100	2.60
180	3.90
200	4.20
230	4.70

   4) Is the measured output value of fuel pressure sensor within specification?

      YES

      ▶ Go to "Verification of Vehicle Repair" procedure.

      NO

      ▶ Replace the fuel pressure sensor and then go to "Verification of Vehicle Repair" procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select "Diagnostic Trouble Codes (DTCs)" mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

   YES

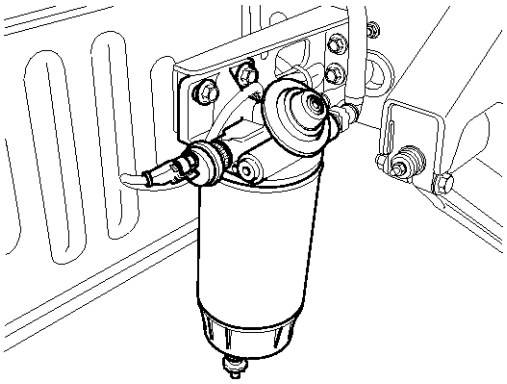
   ▶ Go to the applicable DTC procedure.

   NO

   ▶ System OK

P1222 Fuel Filter diagnosis level 1

COMPONENT LOCATION



SDFFL7117D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   If the pressure limiter detects abnormal high pressure in the common rail system, it works and plays a role to return fuel to the fuel tank to protect system. If the engine is started with SCV connector disconnected, the vehicle is driven with fuel line clogged or the engine is started without fuel in the fuel line, there is a possibility to display this code. Therefore, fuel filter should be replaced according to service interval. When the vehicle performs the initial start, be sure to try to start the engine after replacing it with a new one and feeding fuel to fuel pump by priming the pump with a priming pump.

2. DTC DESCRIPTION

   If pressure between pump and filter is detected -36 ~ -28 kPa for more than 58,256 ms, the ECM judges this as a fault and DTC is set and fuel filter warning light is blinking. The probable cause is that fuel filter is choked.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Check low pressure fuel line for clogged. • Check fuel filter for clogged. • Check that SCV connector is connected. • Defective common rail assembly
Enable Conditions	• At IG ON			
Threshold Value	• Clogged fuel filter (Pressure between pump and filter : -36~-28kPa)			
Diagnosis Time	• 58,256ms or higher			
Fail Safe	Fuel Cut	No		
	Fuel limit	Yes		
	Check lamp	OFF		

WAVEFORM

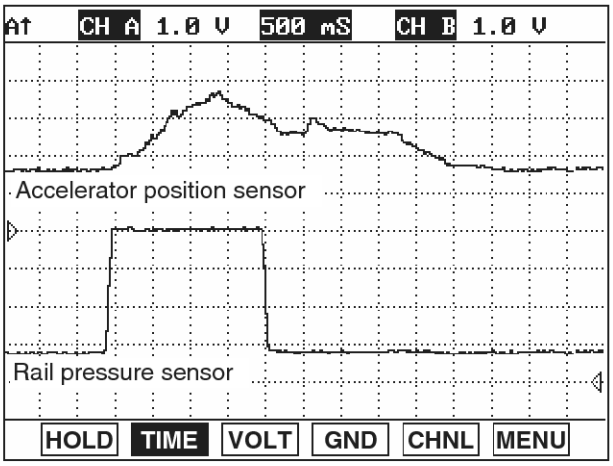


Fig. 1 Measure with oscilloscope waveform

Fig1) indicates waveform which the accelerator position sensor 1 and the rail pressure sensor are measured at the same time, can check the rail pressure sensor output at quick acceleration or deceleration.

SUDFLDTC9004L

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Rail pressure” parameter on the scan tool.

NOTICE

The value of “Rail pressure” varies with the operative condition according to DTC detecting condition. In case of fail safe, be sure to check that the value of “Rail pressure” sets to 70Mpa and the “Fuel amount” is restricted to below 63㎣/st.

Parameter	Reference Value
Real C/R pressure (At IG ON)	0.4 Mpa
Real C/R pressure (At idle)	31.6 Mpa
Real C/R pressure (At 1,500 rpm)	91.2 Mpa
Real C/R pressure (At 2,000 rpm)	122.5 Mpa

Start the engine and monitor the pressure change of the rail pressure sensor. The pressure of about 40Mpa is generated at hot idle (650rpm). At this time, it is also important to check the duty of the rail pressure governor. Check that the duty of about 46.5% indicates from above service data.

This data increase with acceleration and load condition, not only the rail pressure increases up to max. 180Mpa but also the rail pressure governor duty increases up to 95%.

TROUBLESHOOTING AID

The trouble code related to poor rail pressure is necessary to diagnose high pressure fuel system and low pressure fuel system collectively

High pressure fuel system symptom: Poor high pressure of high pressure fuel pump, the poor air tightness or stuck of the ball valve seat of rail pressure governor, clogged overflow valve, the fuel leak of injector nozzle and return circuit

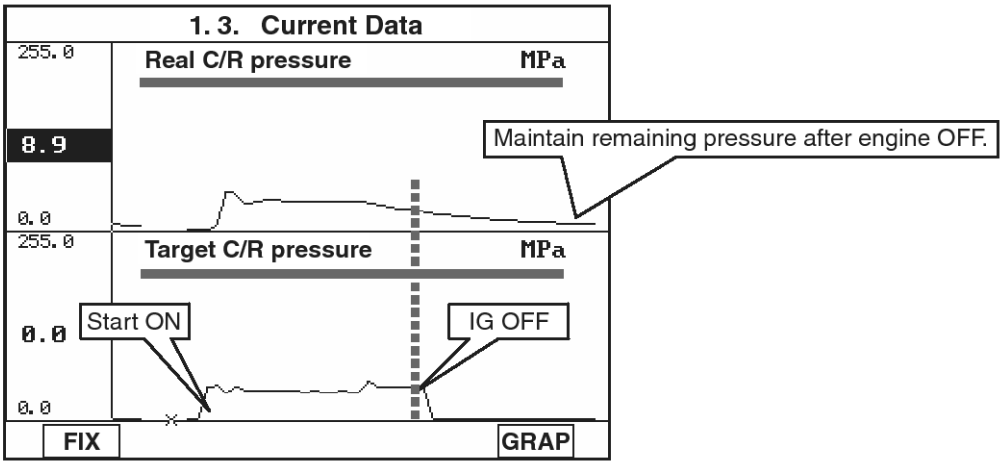
Low pressure fuel system symptom: Poor fuel supply of low pressure fuel pump, clogged fuel filter

NOTICE

Overflow valve plays a role to return fuel to the fuel tank by opening valve to protect fuel system when generating the fuel pressure in common rail with “221Mpa” or more excessively.

NOTICE

It is possible to check by turning the ignition key ON not to lose data due to impossible communication between ECM and scan tool because the main relay switches OFF at stopping the engine.



SUDFLDTC9095L

The above graph waveform indicates the pressure change of the rail pressure sensor at starting ON and OFF. It is possible to diagnose the collective fuel system by checking the condition to maintain the pressure in the common rail at stopping the engine and the time to reach about 40Mpa in the common rail.

1. It is important for the rail pressure to increase quickly at starting.

   ▶ It is easy to diagnose the supply state of low pressure fuel pump, the high pressure formation of high pressure fuel pump, the air tightness of rail pressure governor, the air tightness state of injector nozzle and return side.

2. It is important to maintain air tightness at below 101bar of spring tension of common rail pressure governor and to lower fuel pressure gradually at stopping the engine.

   ▶ It is easy to diagnose the air tightness state of rail pressure governor, nozzle and return side.

COMPONENT INSPECTION

1. Fuel Supply System Visual Inspection
   1) Turn the ignition OFF.
   2) Check the fuel hose, pipe for crack, bent, deformation, degradation, and clogged etc.
   3) Check the fuel filter for clogged, damage, and contamination.
   4) Check the common rail for defective.
   5) Check the flower damper for damage and leak.
   6) Check fuel.
   7) Is the result of system check normal?

   YES

   ▶ Go to “Verification of Vehicle Repair” procedure.

   NO

   ▶ Repair the problem and go to “Verification of Vehicle Repair” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

   YES

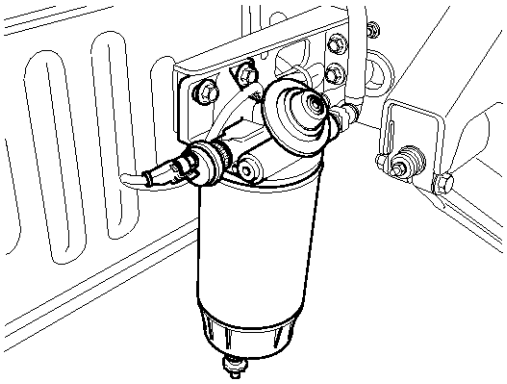
   ▶ Go to the applicable DTC procedure.

   NO

   ▶ System OK

P1223 Fuel Filter diagnosis level 2

COMPONENT LOCATION



SDFFL7117D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   If the pressure limiter detects abnormal high pressure in the common rail system, it works and plays a role to return fuel to the fuel tank to protect system. If the engine is started with SCV connector disconnected, the vehicle is driven with fuel line clogged or the engine is started without fuel in the fuel line, there is a possibility to display this code. Therefore, fuel filter should be replaced according to service interval. When the vehicle performs the initial start, be sure to try to start the engine after replacing it with a new one and feeding fuel to fuel pump by priming the pump with a priming pump.

2. DTC DESCRIPTION

   If the pressure between pump and filter is detected -36~-28kpa for 5 hours continuously or 50 times, ECM judges as a fault and DTC is set. In this case fuel amount is limited below 40㎣/st. and fuel filter warning light is blinking. The probable cause is that fuel filter is choked. After replacing the fuel filter, the ECM reset is necessary to delete the history of fault times and frequency from the ECM memory.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Check low pressure fuel line for clogged. • Check fuel filter for clogged. • Check that SCV connector is connected. • Defective common rail assembly
Enable Conditions	• At IG ON			
Threshold Value	• When fuel filter is clogged for above 5 hours or more(Pressure between pump and filter : -36~-28kPa)			
Diagnosis Time	• -			
Fail Safe	Fuel Cut	No	• Fuel amount limit(40㎣/st.) • Cruise release	
	Fuel limit	Yes		
	Check lamp	OFF		

WAVEFORM

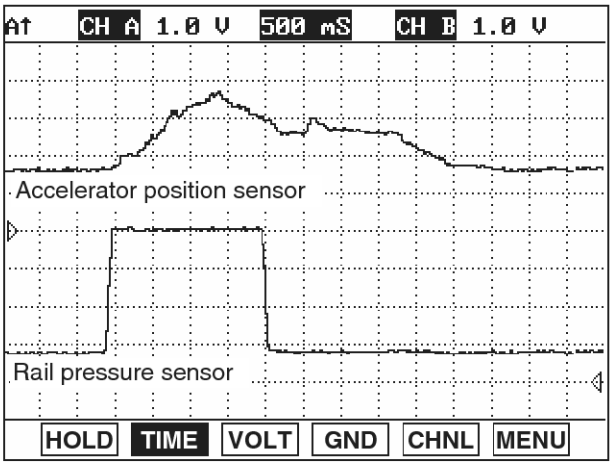


Fig. 1 Measure with oscilloscope waveform

Fig1) indicates waveform which the accelerator position sensor 1 and the rail pressure sensor are measured at the same time, can check the rail pressure sensor output at quick acceleration or deceleration.

SUDFLDTC9004L

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Rail pressure” parameter on the scan tool.

NOTICE

The value of “Rail pressure” varies with the operative condition according to DTC detecting condition. In case of fail safe, be sure to check that the value of “Rail pressure” sets to 70Mpa and the “Fuel amount” is restricted to below 63㎣/st.

Parameter	Reference Value
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Real C/R pressure (At 2,000 rpm)	122.5 Mpa

Start the engine and monitor the pressure change of the rail pressure sensor. The pressure of about 40Mpa is generated at hot idle (650rpm). At this time, it is also important to check the duty of the rail pressure governor. Check that the duty of about 46.5% indicates from above service data.

This data increase with acceleration and load condition, not only the rail pressure increases up to max. 180Mpa but also the rail pressure governor duty increases up to 95%.

TROUBLESHOOTING AID

The trouble code related to poor rail pressure is necessary to diagnose high pressure fuel system and low pressure fuel system collectively

High pressure fuel system symptom: Poor high pressure of high pressure fuel pump, the poor air tightness or stuck of the ball valve seat of rail pressure governor, clogged overflow valve, the fuel leak of injector nozzle and return circuit

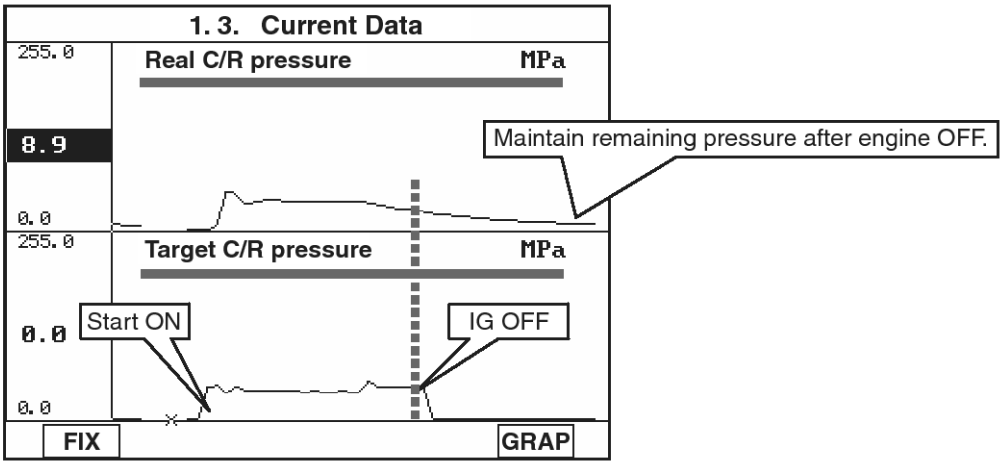
Low pressure fuel system symptom: Poor fuel supply of low pressure fuel pump, clogged fuel filter

NOTICE

Overflow valve plays a role to return fuel to the fuel tank by opening valve to protect fuel system when generating the fuel pressure in common rail with “221Mpa” or more excessively.

NOTICE

It is possible to check by turning the ignition key ON not to lose data due to impossible communication between ECM and scan tool because the main relay switches OFF at stopping the engine.



SUDFLDTC9095L

The above graph waveform indicates the pressure change of the rail pressure sensor at starting ON and OFF. It is possible to diagnose the collective fuel system by checking the condition to maintain the pressure in the common rail at stopping the engine and the time to reach about 40Mpa in the common rail.

1. It is important for the rail pressure to increase quickly at starting.

   ▶ It is easy to diagnose the supply state of low pressure fuel pump, the high pressure formation of high pressure fuel pump, the air tightness of rail pressure governor, the air tightness state of injector nozzle and return side.

2. It is important to maintain air tightness at below 101bar of spring tension of common rail pressure governor and to lower fuel pressure gradually at stopping the engine.

   ▶ It is easy to diagnose the air tightness state of rail pressure governor, nozzle and return side.

COMPONENT INSPECTION

1. Fuel Supply System Visual Inspection
   1) Turn the ignition OFF.
   2) Check the fuel hose, pipe for crack, bent, deformation, degradation, and clogged etc.
   3) Check the fuel filter for clogged, damage, and contamination.
   4) Check the common rail for defective.
   5) Check the flower damper for damage and leak.
   6) Check fuel.
   7) Is the result of system check normal?

   YES

   ▶ Go to “Verification of Vehicle Repair” procedure.

   NO

   ▶ Repair the problem and go to “Verification of Vehicle Repair” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

   YES

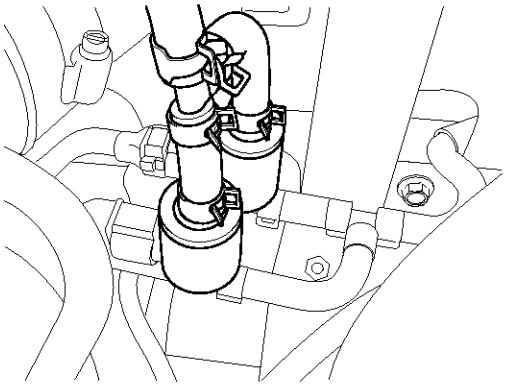
   ▶ Go to the applicable DTC procedure.

   NO

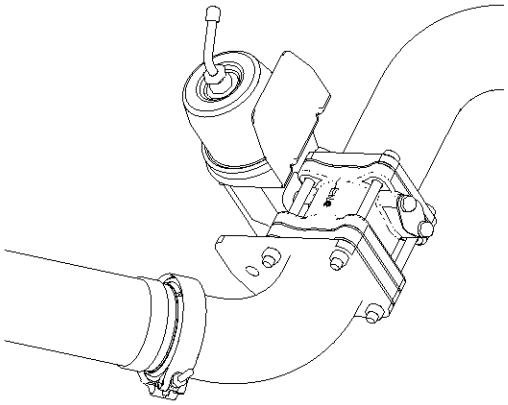
   ▶ System OK

P1231 Exhaust Brake MV1 Output Open Load/Short to GND

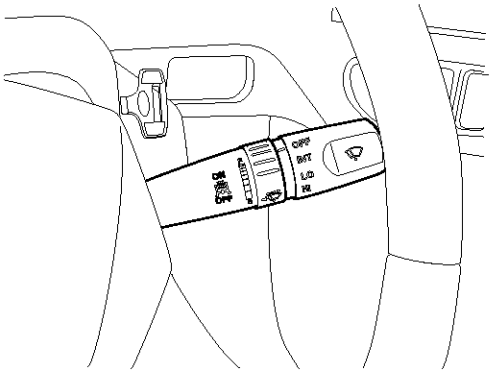
COMPONENT LOCATION



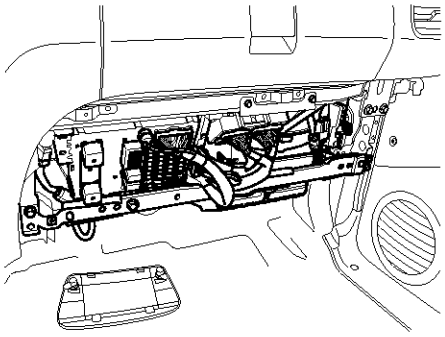
3way-valve



Exhaust brake valve



Exhaust brake switch



Exhaust brake relay

SUDFLDTC9074L

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   The exhaust brake system which is the service brake(auxiliary device) is the vacuum type to use negative pressure. The exhaust brake system is composed of exhaust brake valve in the middle of exhaust pipe, exhaust brake switch of multi-function switch, 3-way magnet valve, vacuum tank and intake shutter equipped in the intake manifold to reduce intake noise. When the exhaust brake switch is operated under exhaust brake operating conditions, if the exhaust brake valve closes butterfly valve, pressure in the exhaust pipe rises and this pressure is applied to piston head and obtains brake force. At this moment, the intake shutter is also closed. If clutch pedal, accelerator pedal or exhaust brake switch is released, the electric circuit is cut off and exhaust brake is released.

2. DTC DESCRIPTION

   Under exhaust brake non-operating conditions, if the exhaust brake is detected as operation for 3,004.5ms or more, the ECM judges this as a fault and DTC is set. The possible causes are open or short to ground of terminal 4 of ECM connector(CFD-ECM). In case of fail safe, the vehicle is possible to drive normally but the exhaust brake is not operated.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Check open of terminal 4 of ECM connector (CFD-ECM) and short to ground. • Check wiring.
Enable Conditions	• Engine running			
Threshold Value	• When exhaust brake operates under non-operation condition			
Diagnosis Time	• 3,004.5ms or higher			
Fail Safe	Fuel Cut	No		
	Fuel limit	No		
	Check lamp	OFF		

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Exhaust brake switch” parameter on the scan tool.

Parameter	Reference Value
Exhaust brake switch (When the exhaust brake switch does not operate)	OFF
Exhaust brake switch (When the exhaust brake switch operates)	ON

SIGNAL CIRCUIT INSPECTION

1. Signal Voltage Inspection
   1) Leave the exhaust brake relay (M93) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 4 of ECM connector and chassis ground.

      ■ Specification: Exhaust brake switch (at ON) signal power approx. B+ V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Go to “Signal Short Open Inspection” procedure.
2. Signal Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the junction box connector (I/P-G) including exhaust brake relay and the ECM connector(CFD-ECM).
   3) Measure resistance between the terminal 5 of junction box harness connector including exhaust brake relay and the terminal 4 of ECM connector(CFD-ECM).

      ■ Specification: Continuity
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Signal Short to Ground Inspection” procedure.

      NO

      ▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.
3. Signal Short to Ground Inspection
   1) Disconnect the junction box connector (I/P-G) including exhaust brake relay and the ECM connector(CFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF and turn the exhaust brake switch OFF.
   3) Measure resistance between the terminal 5 of junction box harness connector including exhaust brake relay and chassis ground.

      ■ Specification: Infinite
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Repair short to ground and then go to “Verification of Vehicle Repair” procedure.

COMPONENT INSPECTION

1. Exhaust Brake Relay Visual Inspection
   1) Turn the ignition OFF.
   2) Leave the exhaust brake relay connected.
   3) Check through the operation sound that the exhaust brake relay operates or not.
   4) Is there any problem about exhaust brake relay?

YES

▶ Replace the exhaust brake relay if necessary and go to “Verification of Vehicle Repair” procedure.

NO

▶ Go to “Verification of Vehicle Repair” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

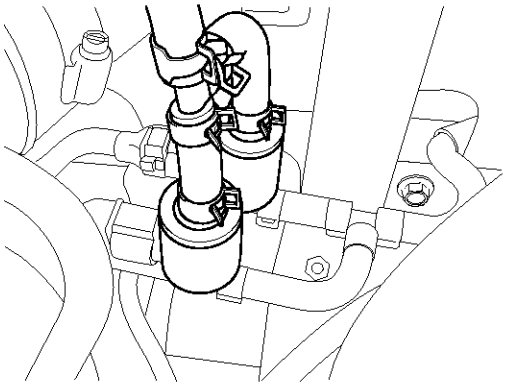
▶ Go to the applicable DTC procedure.

NO

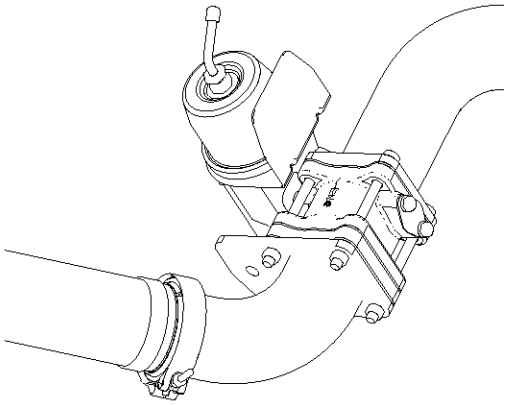
▶ System OK

P1232 Exhaust Brake MV1 Output Short to BATT

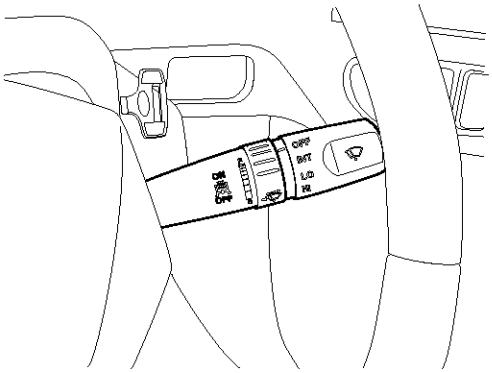
COMPONENT LOCATION



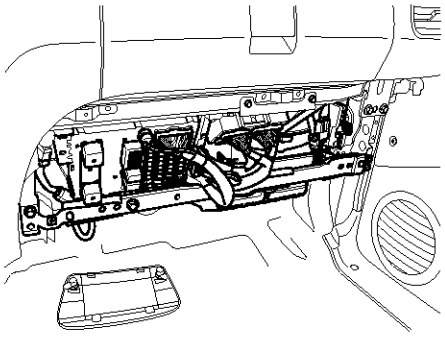
3way-valve



Exhaust brake valve



Exhaust brake switch



Exhaust brake relay

SUDFLDTC9074L

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   The exhaust brake system which is the service brake(auxiliary device) is the vacuum type to use negative pressure. The exhaust brake system is composed of exhaust brake valve in the middle of exhaust pipe, exhaust brake switch of multi-function switch, 3-way magnet valve, vacuum tank and intake shutter equipped in the intake manifold to reduce intake noise. When the exhaust brake switch is operated under exhaust brake operating conditions, if the exhaust brake valve closes butterfly valve, pressure in the exhaust pipe rises and this pressure is applied to piston head and obtains brake force. At this moment, the intake shutter is also closed. If clutch pedal, accelerator pedal or exhaust brake switch is released, the electric circuit is cut off and exhaust brake is released.

2. DTC DESCRIPTION

   Under exhaust brake operation conditions, if the exhaust brake is detected as non-operation for 3,004.5ms or more, the ECM judges this as a fault and DTC is set. The possible causes are short to terminal 4 of ECM connector(CFD-ECM) and short to power. In case of fail safe, the vehicle is possible to drive normally but the exhaust brake is not operated.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Check short to power terminal 4 of ECM connector (CFD-ECM)
Enable Conditions	• Engine running			
Threshold Value	• When exhaust brake does not operate under operation condition			
Diagnosis Time	• 3,004.5ms or higher			
Fail Safe	Fuel Cut	No	• Exhaust brake stop • Normal operation	
	Fuel limit	No		
	Check lamp	OFF		

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Exhaust brake switch” parameter on the scan tool.

Parameter	Reference Value
Exhaust brake switch (When the exhaust brake switch does not operate)	OFF
Exhaust brake switch (When the exhaust brake switch operates)	ON

SIGNAL CIRCUIT INSPECTION

1. Signal Voltage Inspection
   1) Leave the exhaust brake relay (M93) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 4 of ECM connector and chassis ground.

      ■ Specification:

      Exhaust brake switch (at OFF) signal power approx. 0 V

      Exhaust brake switch (at ON) signal power approx. B+ V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Go to “Signal Short to Power Inspection” procedure.
2. Signal Short to Power Inspection
   1) Disconnect the junction box connector (I/P-G) including exhaust brake relay and the ECM connector(CFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF and turn the exhaust brake switch OFF.
   3) Measure voltage between the terminal 5 of junction box harness connector including exhaust brake relay and chassis ground.

      ■ Specification: Below 0~0.1V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Repair short to power and then go to “Verification of Vehicle Repair” procedure.

COMPONENT INSPECTION

1. Exhaust Brake Relay Visual Inspection
   1) Turn the ignition OFF.
   2) Leave the exhaust brake relay connected.
   3) Check through the operation sound that the exhaust brake relay operates or not.
   4) Is there any problem about exhaust brake relay?

   YES

   ▶ Replace the exhaust brake relay if necessary and go to “Verification of Vehicle Repair” procedure.

   NO

   ▶ Go to “Verification of Vehicle Repair” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

   YES

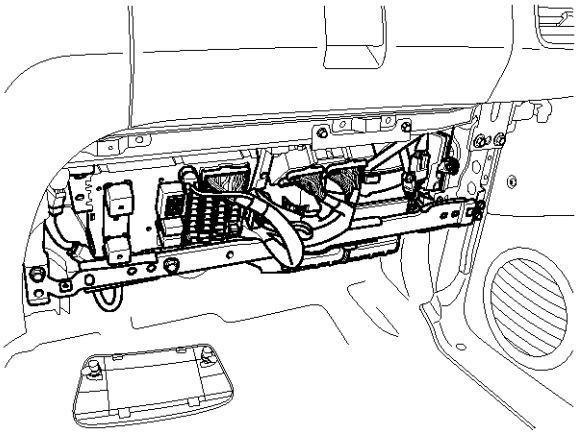
   ▶ Go to the applicable DTC procedure.

   NO

   ▶ System OK

P1383 Air Heater[Glow Relay] Output Open Load/Short to BATT

COMPONENT LOCATION



SUDFL8388D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   Preheater plug(glow plug) heats intake air and makes initial start ability easy and works out well for diesel fuel injection when it is low temperature. The ECM controls preheater plug through preheater plug relay and controls preheater time according to engine temperature.

2. DTC DESCRIPTION

   If the glow relay operation is detected for 3,000.2ms under non-operation condition of glow relay, the ECM judges this as a fault and DTC is set. The probable causes may be short to terminal 24(power) of ECM connector(CFD-ECM) or glow relay malfunction.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Check air heater. • Check short to power terminal 24 of ECM connector (CFD-ECM).
Enable Conditions	• At IG ON			
Threshold Value	• When the air heater operates under non-operating condition			
Diagnosis Time	• 3,000.2ms or higher			
Fail Safe	Fuel Cut	No		
	Fuel limit	No		
	Check lamp	OFF		

SPECIFICATION

1. Resistance between relay terminals

85-86 (at 20℃)	30-87a	85-86 when applyi-ng power
340Ω±10%	0Ω (Continuity)	Terminal 30-87: 0Ω (Continuity)

2. Relay connector terminal voltage (At IG ON)

Terminal 86	Terminal 87a	Terminal 30
B+ V	B+ V	B+ V

POWER SUPPLY INSPECTION

1. Power Supply Voltage Inspection
   1) Disconnect the junction box connector (I/P-G) including glow relay.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage of terminal 8 of the junction box (I/P-G) including glow relay.

      ■ Specification: Glow relay control power approx. B+ V

      Note) B+V power detection, approx. 0.4V power detection about 50 sec. later
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Go to “Power Supply Short to Power Inspection” procedure.
2. Power Supply Short to Power Inspection
   1) Disconnect the junction box connector (I/P-F) including glow relay and ECM connector(CFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 8 of the junction box connector (I/P-F) including glow relay and chassis ground.
   4) Measure voltage between the terminal 24 of the engine ECM connector(CFD-ECM) and chassis ground.

      ■ Specification: Below 0~0.1V
   5) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Repair short to power and then go to “Verification of Vehicle Repair” procedure.

COMPONENT INSPECTION

1. Glow Relay Component Resistance Inspection
   1) Turn the ignition OFF.
   2) Disconnect the junction box connector (I/P-F, I/P-D) including glow relay.
   3) Measure the resistance between the terminal 8 of junction box connector (I/P-F) including glow relay and the terminal 14 of junction box connector (I/P-D).

      ■ Specification: 400Ω ±10% (at 20℃)
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Glow Relay Component Operating Inspection” procedure.

      NO

      ▶ Replace the glow relay and go to “Verification of Vehicle Repair” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

   YES

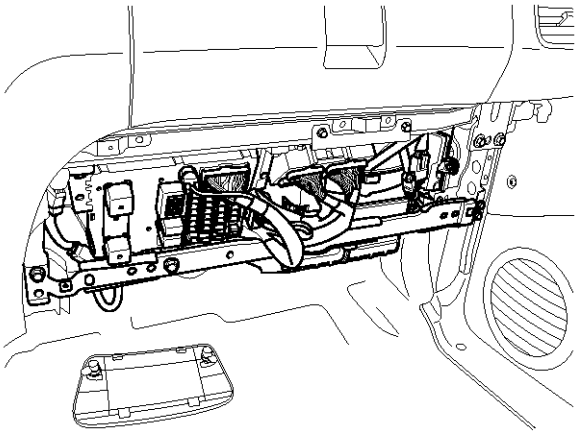
   ▶ Go to the applicable DTC procedure.

   NO

   ▶ System OK

P1384 Air Heater[Glow Relay] Output Short to GND

COMPONENT LOCATION



SUDFL8388D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   Preheater plug(glow plug) heats intake air and makes initial start ability easy and works out well for diesel fuel injection when it is low temperature. The ECM controls preheater plug through preheater plug relay and controls preheater time according to engine temperature.

2. DTC DESCRIPTION

   If the glow relay operation is not detected for 3,000.2ms under operation condition of glow relay, the ECM judges this as a fault and DTC is set. The probable causes may be open in terminal 24 of ECM connector(CFD-ECM), short to ground or glow relay malfunction.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Check air heater. • Check open of terminal 24 and short to ground of ECM connector (CF-D-ECM).
Enable Conditions	• At IG ON			
Threshold Value	• When the air heater does not operate under operating condition			
Diagnosis Time	• 3,000.2ms or higher			
Fail Safe	Fuel Cut	No		
	Fuel limit	No		
	Check lamp	OFF		

SPECIFICATION

1. Resistance between relay terminals

85-86 (at 20℃)	30-87a	85-86 when applying power
340Ω±10%	0Ω (Continuity)	Terminal 30-87: 0 Ω (Continuity)

2. Relay connector terminal voltage (At IG ON)

Terminal 86	Terminal 87a	Terminal 30
B+ V	B+ V	B+ V

POWER SUPPLY INSPECTION

1. Power Supply Voltage Inspection
   1) Disconnect the junction box connector (I/P-G) including glow relay.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage of terminal 8 of the junction box (I/P-G) including glow relay.

      ■ Specification: Glow relay control power approx. B+ V

      Note) B+V power detection, approx. 0.4V power detection about 50 sec. later
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Go to “Power Supply Open Inspection” procedure.
2. Power Supply Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the junction box connector (I/P-F) including glow relay and ECM connector(CFD-ECM).
   3) Measure resistance between the terminal 8 of the junction box connector (I/P-F) connector including glow relay and chassis ground.

      ■ Specification: Continuity
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Power Supply Short to Ground Inspection” procedure.

      NO

      ▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.
3. Power Supply Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the junction box connector (I/P-F) including glow relay and ECM connector(CFD-ECM).
   3) Measure resistance between the terminal 8 of the junction box connector (I/P-F) including glow relay and chassis ground.
   4) Measure resistance between the terminal 24 of the ECM connector(CFD-ECM) and chassis ground.

      ■ Specification: Infinite
   5) Is the resistance measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Repair short to ground and then go to “Verification of Vehicle Repair” procedure.

COMPONENT INSPECTION

1. Glow Relay Component Resistance Inspection
   1) Turn the ignition OFF.
   2) Disconnect the junction box connector (I/P-F, I/P-D) including glow relay.
   3) Measure the resistance between the terminal 8 of junction box connector (I/P-F) including glow relay and the terminal 14 of junction box connector (I/P-D).

      ■ Specification: 400Ω ±10% (at 20℃)
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Glow Relay Component Operating Inspection” procedure.

      NO

      ▶ Replace the glow relay and go to “Verification of Vehicle Repair” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

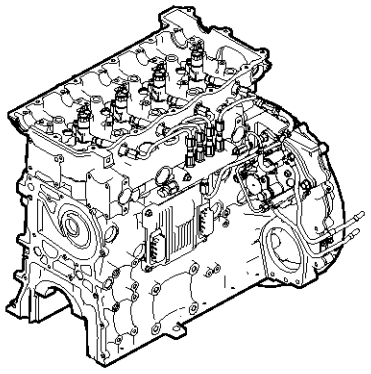
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P1616 Main Relay Diagnostics

COMPONENT LOCATION



SDFFL7104D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   The main relay works when the ignition turns on and supplies battery power to the ECM. It has function to supply battery power to various switches and actuators and to cut off battery power through junction box. When the ignition key is on, the main relay is operated and controls various solenoid, relay, switch as well as the ECM. Therefore, the main relay should be checked in detail. And it prevents danger due to wrong control and has function to cut off power to protect system.

2. DTC DESCRIPTION

   Even when ignition key turns off, if the main relay is operated and voltage of 16V or more is detected to terminal 1,18,21,38,58 and 78 of ECM(CFD-ECM) for 2,112 ms or more, the ECM judges this as a fault and DTC is set. The probable causes may be short to battery of terminal 1,18,21,38,58 and 78 of ECM connector(CFD-ECM) and melted in main relay.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Check main relay. • Short to power terminal 1, 18, 21, 38, 58, 78 of ECM connector (CFD-ECM)
Enable Conditions	• At IG ON/ running			
Threshold Value	• When the main relay operates even after the engine OFF			
Diagnosis Time	• 2,112ms or higher			
Fail Safe	Fuel Cut	No		
	Fuel limit	No		
	Check lamp	OFF		

SPECIFICATION

1. Resistance between relay terminals

85-86 (at 20℃)	30-87a	85-86 when applying power
340Ω±10%	0Ω (Continuity)	Terminal 30-87: 0Ω (Continuity)

2. Relay connector terminal voltage (At IG ON)

Terminal 86	Terminal 87a	Terminal 30
B+ V	B+ V	B+ V

MONITOR SCAN TOOL DATA

1. Self Diagnosis Inspection
   1) Turn the ignition OFF. Leave the engine OFF.
   2) Connect the self diagnosis communication cable to the connector (M72).
   3) Turn the ignition ON.
   4) Select the system to diagnose and press ENTER.
2. Does it work well?

YES

▶ Go to "Power Supply Voltage Inspection" procedure.

NO

▶ Turn the ignition OFF. And disconnect the scan tool and repeat 2 or 3 times as the above procedure. If the same symptom occurs go to "Power Supply Voltage Inspection" procedure.

POWER SUPPLY INSPECTION

1. Engine ECM Relay Power Supply Voltage Inspection
   1) Disconnect the engine ECM relay (M91).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between terminals 86 and 30 of the engine ECM relay harness connector.

      ■ Specification: Engine ECM relay battery power B+ V
   4) Measure the voltage of terminals 1, 18, 21, 38, 58, 78 of engine ECM connector(CFD-ECM).

      ■ Specification: Engine ECM battery power approx. 0.8V
   5) Is the voltage measured within specification?

YES

▶ Go to "Engine ECM Power Supply voltage Inspection" procedure if the result is above B+ V.

NO

▶ Go to "Engine ECM Relay Power Supply Open Inspection" procedure if the result is below 0 V. And go to "Engine ECM Relay Power Supply Short to Power Inspection" if the result is below B+ V.

2. Engine ECM Power Supply Voltage Inspection
   1) Leave the engine ECM relay (M91) connected.
   2) Disconnect the engine ECM connector(CFD-ECM).
   3) Using the jump wire, ground terminals 3, 23 to chassis.
   4) Turn the ignition ON. Leave the engine OFF.
   5) Measure voltage between terminals 1, 18, 21, 38, 58, 78 of the engine ECM connector(CFD-ECM) and chassis ground.

      ■ Specification: Battery power B+ V
   6) Is the voltage measured within specification?

YES

▶ Go to "Ground Circuit Inspection" procedure.

NO

▶ Go to "Engine ECM Relay Power Supply Open Inspection" procedure if the result is below 0 V. And go to "Engine ECM Relay Power Supply Short to Power Inspection" if the result is below 0~ B+ V.

3. Engine ECM Relay Power Supply Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the engine ECM relay (M91) and the ECM connector(CFD-ECM).
   3) Disconnect the fuse #20 (20A) and measure the resistance between the terminal of fuse #20 and terminals 30, 86 of ECM relay harness connector.
   4) Measure the resistance between the terminal 85 of engine ECM relay harness connector (M91) and the terminals 3, 23 of ECM connector(CFD-ECM).
   5) Measure the resistance between the terminal 87 of engine ECM relay harness connector (M91) and the terminals 1, 18, 21, 38, 58, 78 of ECM connector(CFD-ECM).

      ■ Specification: Continuity

6) Is the resistance measured within specification?

YES

▶ Go to “Engine ECM Relay Power Supply Short to Power Inspection” procedure.

NO

▶ Repair open circuit and go to “Verification of Vehicle Repair” procedure.

4. Engine ECM Relay Power Supply Short to Power Inspection
   1) Disconnect the engine ECM relay (M91) and the ECM connector(CFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure the voltage between the terminals 30, 86 of engine ECM relay harness connector (M91) and chassis ground.
   4) Measure the voltage between the terminals 1, 18, 21, 38, 58, 78 of ECM connector(CFD-ECM) and chassis ground.
      ■ Specification: Below 0~0.1V
   5) Is the voltage measured within specification?

YES

▶ Go to “Ground Circuit Inspection” procedure.

NO

▶ Repair short to power and go to “Verification of Vehicle Repair” procedure.

GROUND CIRCUIT INSPECTION

1. Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the engine ECM relay (M91) and the ECM connector(CFD-ECM).
   3) Measure the resistance between terminal 85 of the engine ECM relay harness connector and chassis ground.
      ■ Specification: Infinite
   4) Is the resistance measured within specification?

YES

▶ Go to “Engine ECM Ground Inspection” procedure if the result is above B+ V.

NO

▶ Repair short to ground and the poor connection and then go to “Verification of Vehicle Repair” procedure.

2. Engine ECM Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the engine ECM relay (M91) and the engine ECM connector(CFD-ECM).
   3) Measure the resistance between terminals 3, 23 of the engine ECM connector(CFD-ECM) and chassis ground.
      ■ Specification: Infinite
   4) Is the resistance measured within specification?

YES

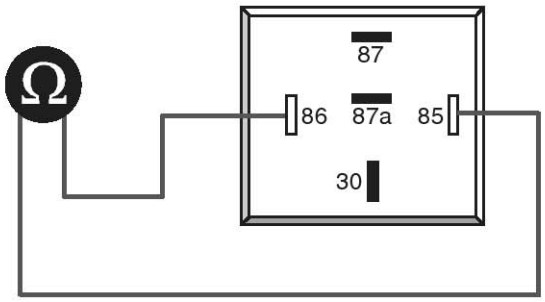
▶ Go to “Component Inspection” procedure.

NO

▶ Repair short to ground and the poor connection and then go to “Verification of Vehicle Repair” procedure.

COMPONENT INSPECTION

1. Engine ECM Relay Component Resistance Inspection
   1) Turn the ignition OFF.
   2) Disconnect the engine ECM relay (M91).
   3) Measure the resistance between terminals 85 and 86 of the engine ECM relay.



SUDFLDTC9075L

■ Specification: 340Ω±10% (at 20℃)

4) Is the resistance measured within specification?

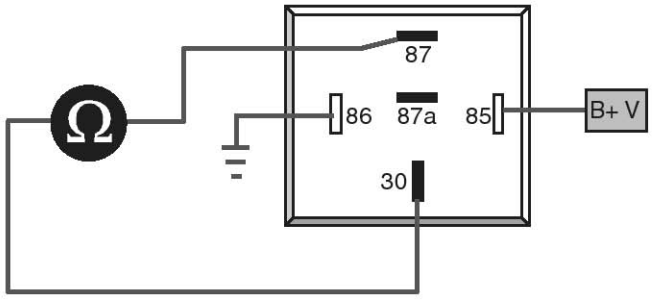
YES

▶ Go to "Engine ECM Relay Component Operating Inspection" procedure.

NO

▶ Replace the engine ECM relay and go to "Verification of Vehicle Repair" procedure.

2. Engine ECM Relay Component Operating Inspection
   1) Turn the ignition OFF.
   2) Disconnect the engine ECM relay (M91).
   3) Connect the terminal 85 of engine ECM relay to B+ power, terminal 86 to negative (-).
   4) Measure the resistance between the terminals 30 and 86 of engine ECM relay.



SUDFLDTC9076L

■ Specification :

Infinite (When supplying power)

Continuity (When cutting off power)

5) Is the resistance measured within specification?

YES

▶ Go to “Verification of Vehicle Repair” procedure.

NO

▶ Replace the engine ECM relay and go to “Verification of Vehicle Repair” procedure.

Note) Repeat the above operating inspection two or three times.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

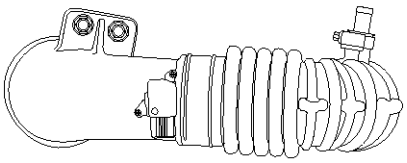
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P1642 MAF Sensor's Power Supply Failure Short to BATT

COMPONENT LOCATION



SUDFL8100D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   Mass Air Flow Sensor(MAFS) is composed of mass air flow sensor and air temperature sensor. It measures air mass to be sucked in engine. ECM performs EGR system feed back control with the information of measured mass air flow. (The role of MAFS in diesel engine is different from gasoline engine. Fuel injection quantity is decided by MAFS signal in gasoline engine.) When the amount of EGR gas (contains no oxygen) flowing into combustion chamber increases, the air passing through MAFS (contains oxygen) decreases. Thus, with the output signal change of MAFS accompanied by EGR actuator actuation, ECM determines the amount of recirculated EGR gas quantity.

2. DTC DESCRIPTION

   If it stops to supply power with MAFS, the ECM judges this as a fault and DTC is set. Check lamp comes on and MIL is blinking when the condition continued 2 driving cycle times. MIL will go off after 3 driving cycle times when the system returns to normal. The probable cause is short to power of terminal 69 of ECM connector(EFD-ECM). The vehicle is being driven, but black smoke and a lack of engine power may occur since fuel correction and injection timing can not be controlled according to the intake air temperature.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Defective wiring and sensor • Power short to terminal 69 of ECM connector (EFD-ECM)
Enable Conditions	• At IG ON			
Threshold Value	• MAF input voltage>16 • MAF output voltage>2.5V			
Diagnosis Time	• 264ms			
Fail Safe	Fuel Cut	No	• Fuel amount limit (75% of maximum torque) • EGR control stop • Cruise release	
	Fuel limit	Yes		
	Check lamp	ON		

SIGNAL CIRCUIT INSPECTION

1. Signal Voltage Inspection
   1) Leave the air temperature sensor connector (EFD04) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 1 of air temperature sensor harness connector and chassis ground.

      ■ Specification: Air temperature sensor signal power approx. 1 V

      Note) The voltage value is different according to intake air temperature.
   4) Is the voltage measured within specification?

      YES

      ▶ Go to "Component Inspection" procedure.

      NO

      ▶ Go to "Signal Short to Power Inspection" procedure.
2. Signal Short to Power Inspection
   1) Disconnect the air temperature sensor connector (EFD04) and the ECM connector(CFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 4 of air temperature sensor harness connector and chassis ground.

      ■ Specification: Below 0~0.1V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to "Power Supply Inspection" procedure.

      NO

      ▶ Repair short to power and then go to "Verification of Vehicle Repair" procedure.

POWER SUPPLY INSPECTION

1. Power Supply Voltage Inspection
   1) Disconnect the air temperature sensor connector (EFD04).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 3 of air temperature sensor harness connector and chassis ground.

      ■ Specification: Engine ECM output power approx. 12.72 V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to "Ground Circuit Inspection" procedure.

      NO

      ▶ Go to "Power Supply Short to Power Inspection" procedure.
2. Power Supply Short to Power Inspection
   1) Disconnect the air temperature sensor connector (EFD04) and the ECM connector(EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 3 of air temperature sensor harness connector and chassis ground.

      ■ Specification: Below 0~0.1V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to "Ground Circuit Inspection" procedure.

      NO

▶ Repair short to power and then go to "Verification of Vehicle Repair" procedure.

GROUND CIRCUIT INSPECTION

1. Ground Voltage Drop Inspection
   1) Disconnect the intake air temperature sensor connector (EFD04).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage drop between the terminal 2 of the intake air temperature sensor harness connector and chassis ground.
      ■ Specification: Ground voltage drop within 200mV
   4) Is the voltage measured within specification?

      YES

      ▶ Go to "Ground Open Inspection" procedure.

      NO

      ▶ Repair the excessive resistance (poor connection) and then go to "Verification of Vehicle Repair" procedure.
2. Ground Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the intake air temperature sensor connector (EFD04) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 2 of the intake air temperature sensor harness connector and the terminal 4 of the ECM connector(EFD-ECM).
      ■ Specification: Continuity (Below 1.0Ω)
   4) Is the resistance measured within specification?

      YES

      ▶ Go to "Component Inspection" procedure.

      NO

      ▶ Repair open wiring circuit and then go to "Verification of Vehicle Repair" procedure.

COMPONENT INSPECTION

1. Intake Air Temperature Sensor Resistance Inspection
   1) Turn the ignition OFF.
   2) Disconnect the intake air temperature sensor connector (EFD04).
   3) Measure resistance between the terminals 1 and 2 of the intake air temperature sensor.

■ SPECIFICATION :

Temperature(℃)	Resistance (kΩ) of terminal No 1,2
25	2.168

   4) Is the resistance measured within the specification?

      YES

      ▶ Go to "Verification of Vehicle Repair" procedure.

      NO

      ▶ Replace the intake air temperature sensor and then go to "Verification of Vehicle Repair" procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select "Diagnostic Trouble Codes (DTCs)" mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

   YES

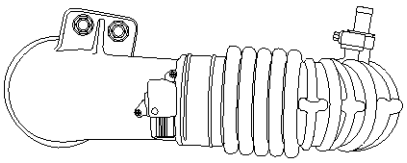
   ▶ Go to the applicable DTC procedure.

   NO

   ▶ System OK

P1643 MAF Sensor's Power Supply Failure Short to GND

COMPONENT LOCATION



SUDFL8100D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   Mass Air Flow Sensor(MAFS) is composed of mass air flow sensor and air temperature sensor. It measures air mass to be sucked in engine. ECM performs EGR system feed back control with the information of measured mass air flow. (The role of MAFS in diesel engine is different from gasoline engine. Fuel injection quantity is decided by MAFS signal in gasoline engine.) When the amount of EGR gas (contains no oxygen) flowing into combustion chamber increases, the air passing through MAFS (contains oxygen) decreases. Thus, with the output signal change of MAFS accompanied by EGR actuator actuation, ECM determines the amount of recirculated EGR gas quantity.

2. DTC DESCRIPTION

   If it stops to supply power with MAFS, the ECM judges this as a fault and DTC is set. Check lamp comes on and MIL is blinking when the condition continued 2 driving cycle times. MIL will go off after 3 driving cycle times when the system returns to normal. The probable cause is short to ground of terminal 69 of ECM connector(EFD-ECM). The vehicle is being driven, but black smoke and a lack of engine power may occur since fuel correction and injection timing can not be controlled according to the intake air temperature.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Defective wiring and sensor • Power short to terminal 69 of ECM connector (EFD-EC-M)
Enable Conditions	• At IG ON			
Threshold Value	• MAF input voltage>16 • MAF output voltage<0.7V			
Diagnosis Time	• 264ms			
Fail Safe	Fuel Cut	No	• Fuel amount limit (75% of maximum torque) • EGR control stop • Cruise release	
	Fuel limit	Yes		
	Check lamp	ON		

SIGNAL CIRCUIT INSPECTION

1. Signal Voltage Inspection
   1) Leave the air temperature sensor connector (EFD04) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 1 of air temperature sensor harness connector and chassis ground.
      ■ Specification: Air temperature sensor signal power approx. 1 V
      Note) The voltage value is different according to intake air temperature.
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Go to “Signal Open Inspection” procedure.
2. Signal Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the air temperature sensor connector (EFD04) and the ECM connector(EFD-ECM).
   3) Measure the resistance between the terminal 1 of air temperature sensor harness connector and terminal 12 of engine ECM connector(EFD-ECM).
      ■ Specification: Continuity
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Signal Short to Ground Inspection” procedure.

      NO

      ▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.
3. Signal Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the air temperature sensor connector (EFD04) and the ECM connector(EFD-ECM).
   3) Measure the resistance between the terminal 1 of air temperature sensor harness connector and chassis ground.
      ■ Specification: Infinite
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Signal Short to Power Inspection” procedure.

      NO

      ▶ Repair short to ground and then go to “Verification of Vehicle Repair” procedure.

POWER SUPPLY INSPECTION

1. Power Supply Voltage Inspection
   1) Disconnect the air temperature sensor connector (EFD04).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 3 of air temperature sensor harness connector and chassis ground.
      ■ Specification: Engine ECM output power approx. 12.72 V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Ground Circuit Inspection” procedure.

      NO

      ▶ Go to “Power Supply Open Inspection” procedure.
2. Power Supply Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the air temperature sensor connector (EFD04) and the ECM connector(EFD-ECM).
   3) Measure the resistance between the terminal 3 of air temperature sensor harness connector and the terminal 69 of engine ECM connector(EFD-ECM).
      ■ Specification: Continuity
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Power Supply Short to Ground Inspection” procedure.

      NO

      ▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.
3. Power Supply Short to Ground Inspection
   1) Turn the ignition OFF.

2) Disconnect the air temperature sensor connector (EFD04) and the ECM connector(EFD-ECM).
3) Measure the resistance between the terminal 3 of air temperature sensor harness connector and chassis ground.
   ■ Specification: Infinite
4) Is the resistance measured within specification?

YES

▶ Go to "Ground Circuit Inspection" procedure.

NO

▶ Repair short to ground and then go to "Verification of Vehicle Repair" procedure.

GROUND CIRCUIT INSPECTION

1. Ground Voltage Drop Inspection
   1) Disconnect the intake air temperature sensor connector (EFD04).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage drop between the terminal 2 of the intake air temperature sensor harness connector and chassis ground.
      ■ Specification: Ground voltage drop within 200mV
   4) Is the voltage measured within specification?

YES

▶ Go to "Ground Open Inspection" procedure.

NO

▶ Repair the excessive resistance (poor connection) and then go to "Verification of Vehicle Repair" procedure.

2. Ground Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the intake air temperature sensor connector (EFD04) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 2 of the intake air temperature sensor harness connector and the terminal 4 of the ECM connector(EFD-ECM).
      ■ Specification: Continuity (Below 1.0Ω)
   4) Is the resistance measured within specification?

YES

▶ Go to "Component Inspection" procedure.

NO

▶ Repair open wiring circuit and then go to "Verification of Vehicle Repair" procedure.

COMPONENT INSPECTION

1. Intake Air Temperature Sensor Resistance Inspection
   1) Turn the ignition OFF.
   2) Disconnect the intake air temperature sensor connector (EFD04).
   3) Measure resistance between the terminals 1 and 2 of the intake air temperature sensor.

■ SPECIFICATION :

Temperature(℃)	Resistance (kΩ) of terminal No 1,2
25	2.168

   4) Is the resistance measured within the specification?

YES

▶ Go to "Verification of Vehicle Repair" procedure.

NO

▶ Replace the intake air temperature sensor and then go to "Verification of Vehicle Repair" procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select "Diagnostic Trouble Codes (DTCs)" mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

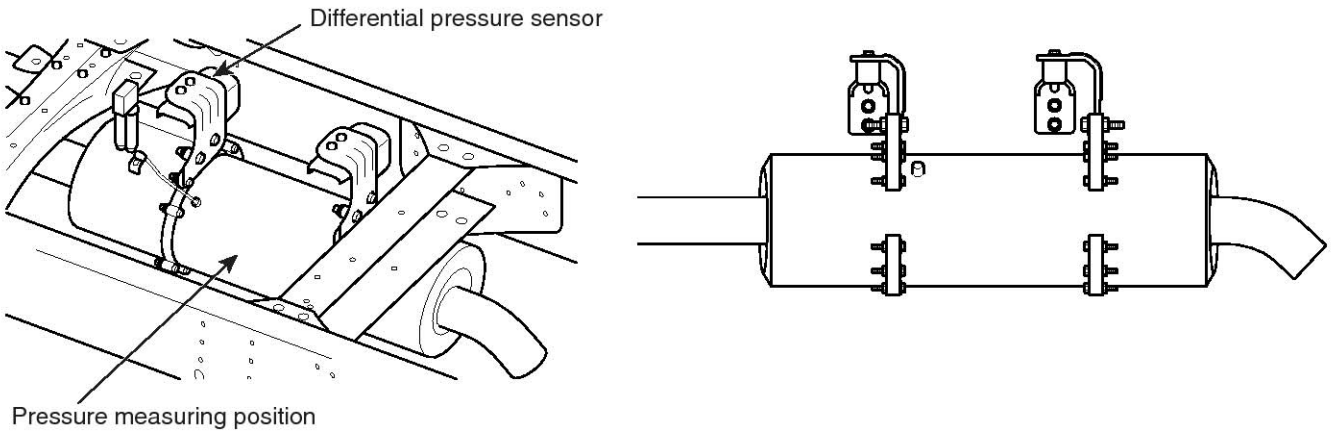
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P2002 PMC Removal Diagnosis

COMPONENT LOCATION



SUDFLDTC9099L

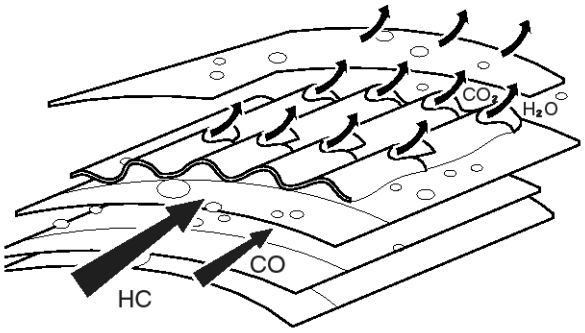
DIAGNOSTIC TROUBLE CODE DESCRIPTION

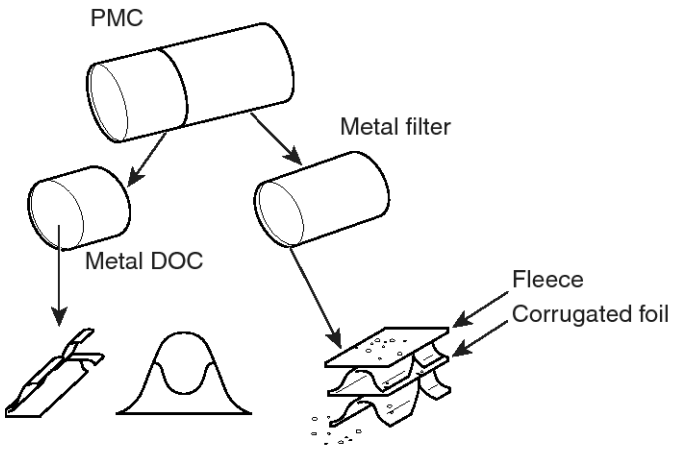
1. GENERAL DESCRIPTION

   PMC (Particulate matter catalyst) consists of metal DOC and metal filter.

   Metal DOC purifies the CO, HC, SOF and converts NO into NO_2 .

   Metal filter oxidizes (neutral regenerating at 200~400℃) the soot which gathered in the fleece by using NO_2 that is converted in the metal DOC.





SUDFLDTC9100L

2. DTC DESCRIPTION

   P2002 is set when regeneration lasts more than specified duration.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• PMC
Enable Conditions	• Engine running			
Threshold Value	• Regeneration duration lasts more than the specified duration.			
Diagnosis Time	• 5,248ms			
Fail Safe	Fuel Cut	No		
	Fuel limit	Yes		
	Check lamp	ON		

TROUBLESHOOTING AID

There is no special diagnostic procedure on this diagnostic trouble due to the internal error of PMC itself.

Replace the PMC with a new one if there is not the diagnostic trouble code any more after checking the vehicle with a known good PMC.

COMPONENT INSPECTION

1. Turn the ignition OFF. Leave the engine OFF.
2. Remove the PMC from the vehicle.
3. Install a known good PMC, check that the system operates well.
4. Replace the PMC with a new one if there is not the DTC any more.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

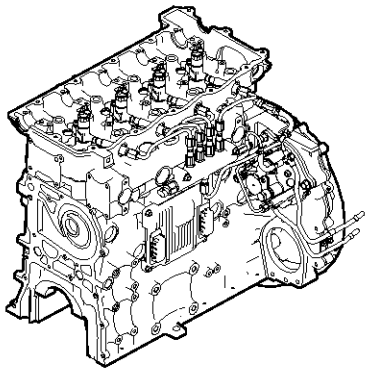
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P2146 COM1 Output Open Load (Both TWV 1 and TWV 3 Open Load)

COMPONENT LOCATION



SDFFL7104D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   Injector carries out function to inject fuel amount calculated by ECM by making diesel spread with small particles to combustion chamber compressed with high pressure. Fuel injected generates power through combustion process. Purpose to increase fuel pressure of common rail diesel engine up to Max. 1,800 bar is to make fuel into small particles, small particles of fuel are related to smoke reduction, high power of engine, fuel consumption improvement etc. Also, hydraulic servo type is used to control fuel pressure of 1,800 bar with solenoid, injector solenoid is driven by current after increasing solenoid driving voltage up to 135V. Multi injection is possible by applying fuel injection which is not mechanic injector but electric control injector. ECM injects fuel after dividing into two stages of pilot injection and main injection and it is possible to control injection time and injection amount independently to each cylinder. Power, torque, exhaust gas, fuel consumption improvement etc. can be optimized by controlling engine to optimum fuel injection amount.

2. DTC DESCRIPTION

   If open states in injector #1 and injector #4 are detected for more than 6,000 degrees of crank rotating angle, ECM judges this as a fault and DTC is set. The possible causes are open in terminal 47, 65, 66, 67 of ECM connector(EFD-ECM) and wiring problem etc. Lack of engine power will occur since fuel amount is limited to below 40mm³/st in case of fail safe. There may cause damage to engine if the vehicle is driven for a long time with faulty injector.

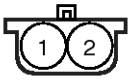
DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Open circuit of terminals 47, 65, 66, 67 of ECM connector (EFD-ECM) • Defective wiring
Enable Conditions	• Engine running			
Threshold Value	• When injector #1 and #4 circuits are open			
Diagnosis Time	• 6,000˚ CA or higher			
Fail Safe	Fuel Cut	No	• Fuel amount sets to below 40㎟/st. • Cylinder balancing control stop • Cruise release	
	Fuel limit	Yes		
	Check lamp	ON		

SPECIFICATION

Item	Specification
Resistance	0.45Ω(At 20℃)

Injector driving time	135V
Injector driving current	18.5A
Injector control type	Current control



Sensor connector

SUDFLDTC9030L

WAVEFORM

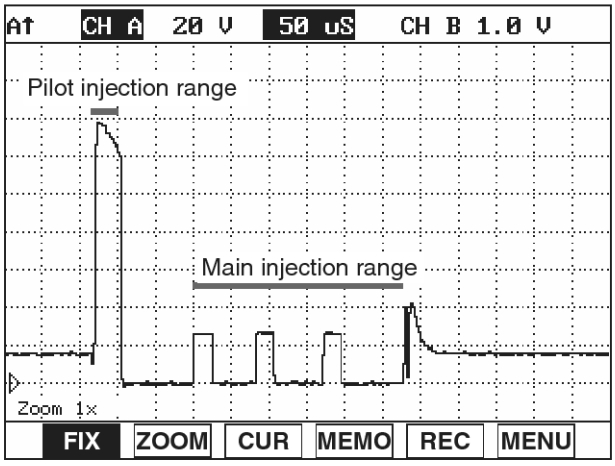


Fig. 1 Waveform of LOW side when injector operates

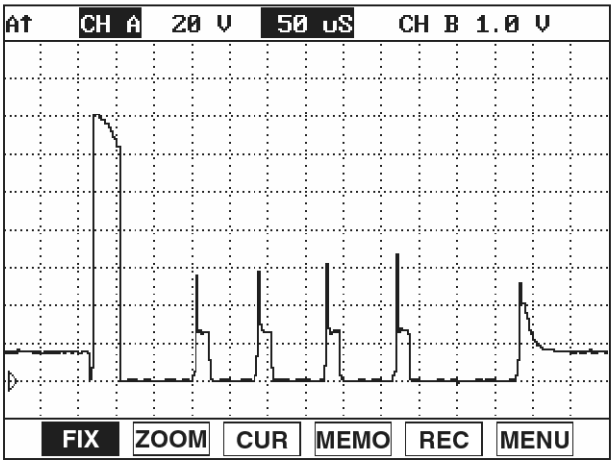


Fig. 2 Injector power waveform of HIGH side

Fig1) Waveform consists of pilot injection and main injection at LOW side.
Fig2) Injector power waveform of HIGH side

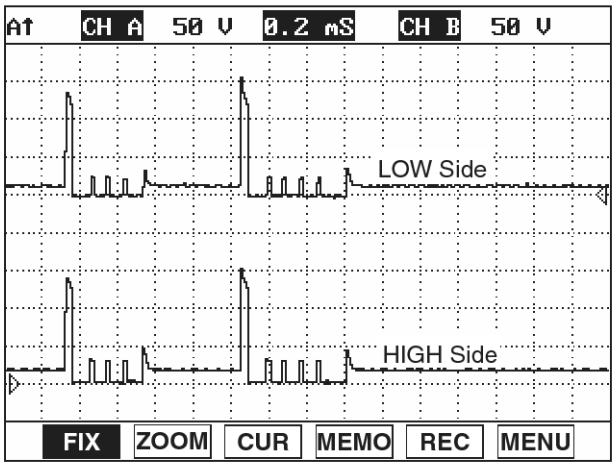


Fig. 3 Both injector waveforms of LOW/HIGH

SUDFLDTC9031L

NOTICE

When checking the injector waveform at LOW side of injector, the waveforms of Fig.1 and Fig.2 are made in turn. The waveform of Fig.2 is made when the power at the HIGH side of the injector # 1 and # 4 or the injector # 2 and # 3 which do not activate is used in common. When the injector does not activate, the waveform at HIGH side of the other injector which uses the power at HIGH side in common is made.

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature.
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Fuel injection amount” parameter on the scan tool.

NOTICE

The value of “Fuel injection amount” varies with the operative condition according to DTC detecting condition. In case of fail safe, be sure to check that the value of “Injection amount” is restricted to below 40㎣/st.

■ Specification: Fuel injection amount approx. 9.0～10.5㎣/st at idle

Parameter	Reference Value
Final Fuel Q. (At IG ON)	-50.0 mm3st
Final Fuel Q. (At idle)	14.5 mm3st
Final Fuel Q. (At 1,500 rpm)	15.7 mm3st
Final Fuel Q. (At 2,000 rpm)	22.3 mm3st

POWER SUPPLY INSPECTION

1. Power Supply Voltage Inspection
   1) Leave the injector #1, #4 connector(EFD 11-1, 4) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 1 of injector #1, #4 harness connector and chassis ground.

      ■ Specification: Injector #1, #4 signal power approx. 12.82 V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Go to “Power Supply Open Inspection” procedure.
2. Power Supply Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the injector #1, #4 connector(EFD 11-1, 4) and the ECM connector(EFD-ECM).
   3) Measure the resistance between the terminal 2 of injector #1, #4 harness connector and the terminals 65, 65 of engine ECM connector(EFD-ECM).

      ■ Specification: Continuity
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Power Supply Short to Ground Inspection” procedure.

      NO

      ▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.
3. Power Supply Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the injector #1, #4 connector(EFD 11-1, 4) and the ECM connector(EFD-ECM).
   3) Measure the resistance between the terminal 1 of injector #1, #4 harness connector and chassis ground.

      ■ Specification: Infinite
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Ground Circuit Inspection” procedure.

      NO

      ▶ Repair short to ground and then go to “Verification of Vehicle Repair” procedure.

GROUND CIRCUIT INSPECTION

1. Ground Voltage Drop Inspection
   1) Disconnect the injector #1, #4 connector(EFD 11-1, 4).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage drop between the terminal 2 of injector #1, #4 harness connector and chassis ground.

      ■ Specification: Ground voltage drop within 200mV
   4) Is the voltage drop measured within specification?

      YES

▶ Go to “Ground Open Inspection” procedure.

NO

▶ Repair the cause of excessive resistance (poor connection) and go to “Verification of Vehicle Repair” procedure.

2. Ground Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the injector #1, #4 connector(EFD 11-1, 4) and the ECM connector(EFD-ECM).
   3) Measure the resistance between the terminal 2 of injector #1, #4 harness connector and the terminals 47, 67 of engine ECM connector(EFD-ECM).
      ■ Specification: Continuity
   4) Is the resistance measured within specification?

YES

▶ Go to “Component Inspection” procedure.

NO

▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.

COMPONENT INSPECTION

1. Injector Component Inspection
   1) Turn the ignition OFF.
   2) Disconnect the injector #1, #4 connector(EFD 11-1, 4).
   3) Measure resistance between the terminals 1 and 2 of injectors #1, #4 connector.

■ Specification

Item	Specification
Resistance	0.45Ω(at 20℃)

   4) Is the resistance measured within specification?

YES

▶ Go to “Verification of Vehicle Repair” procedure.

NO

▶ Replace the injector and go to “Verification of Vehicle Repair” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

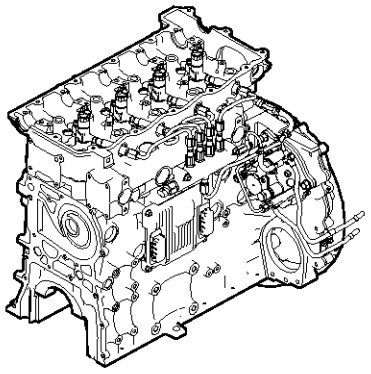
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P2147 COM1 Output Short to GND (TWV 1 or 3 Output Short to GND)

COMPONENT LOCATION



SDFFL7104D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   Injector carries out function to inject fuel amount calculated by ECM by making diesel spread with small particles to combustion chamber compressed with high pressure. Fuel injected generates power through combustion process. Purpose to increase fuel pressure of common rail diesel engine up to Max. 1,800 bar is to make fuel into small particles, small particles of fuel are related to smoke reduction, high power of engine, fuel consumption improvement etc. Also, hydraulic servo type is used to control fuel pressure of 1,800 bar with solenoid, injector solenoid is driven by current after increasing solenoid driving voltage up to 135V. Multi injection is possible by applying fuel injection which is not mechanic injector but electric control injector. ECM injects fuel after dividing into two stages of pilot injection and main injection and it is possible to control injection time and injection amount independently to each cylinder. Power, torque, exhaust gas, fuel consumption improvement etc. can be optimized by controlling engine to optimum fuel injection amount.

2. DTC DESCRIPTION

   If ground short states in injector #1 and injector #4 are detected for more than 2,880 degrees of crank rotating angle, ECM judges this as a fault and DTC is set. The possible causes are short to ground in terminal 47, 67 of ECM connector(EFD-ECM) and wiring problem etc. Lack of engine power will occur since fuel amount is limited to below 40mm³/st in case of fail safe. There may cause damage to engine if the vehicle is driven for a long time with faulty injector.

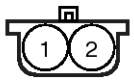
DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Short to ground of terminals 47, 67 of ECM connector (EFD-ECM) • Defective wiring
Enable Conditions	• Engine running			
Threshold Value	• When the circuits of injector #1 and #4 are short to GND at driving circuit			
Diagnosis Time	• 2,880˚ CA or higher			
Fail Safe	Fuel Cut	No	• Fuel amount sets to below 40㎣/st. • Cylinder balancing control stop • Cruise release	
	Fuel limit	Yes		
	Check lamp	ON		

SPECIFICATION

Item	Specification
Resistance	0.45Ω(At 20℃)

Injector driving time	135V
Injector driving current	18.5A
Injector control type	Current control



Sensor connector

SUDFLDTC9030L

WAVEFORM

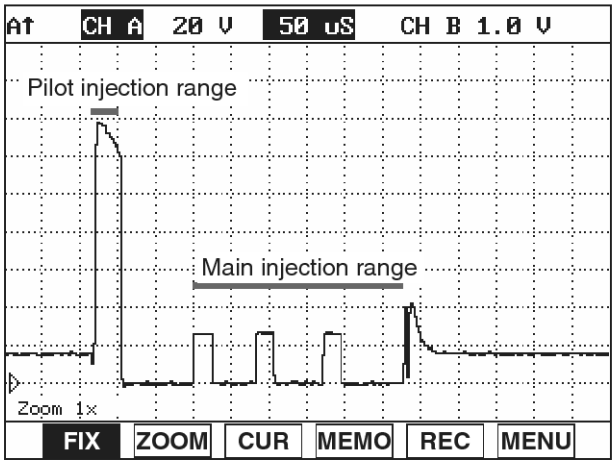


Fig. 1 Waveform of LOW side when injector operates

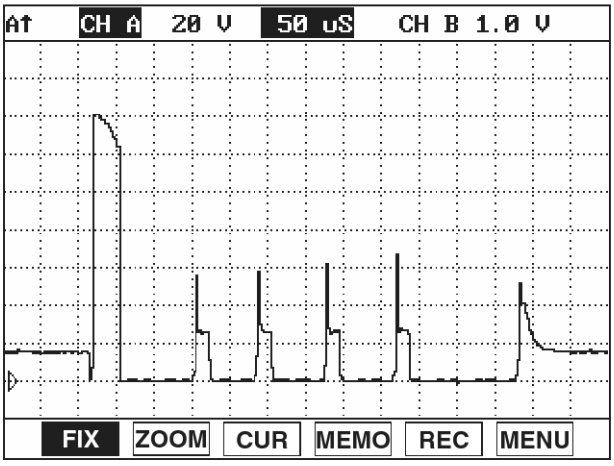


Fig. 2 Injector power waveform of HIGH side

Fig1) Waveform consists of pilot injection and main injection at LOW side.
Fig2) Injector power waveform of HIGH side

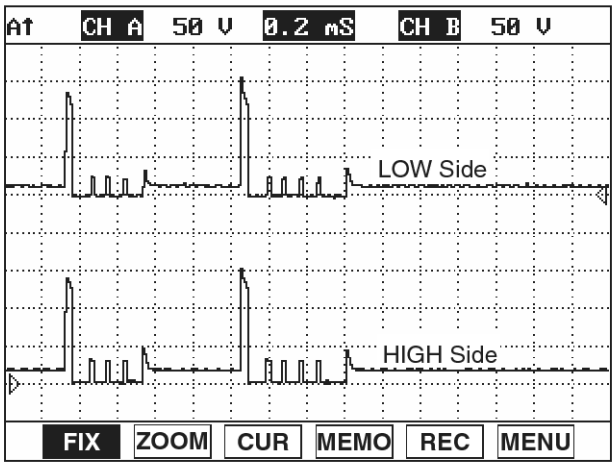


Fig. 3 Both injector waveforms of LOW/HIGH

SUDFLDTC9031L

NOTICE

When checking the injector waveform at LOW side of injector, the waveforms of Fig.1 and Fig.2 are made in turn. The waveform of Fig.2 is made when the power at the HIGH side of the injector # 1 and # 4 or the injector # 2 and # 3 which do not activate is used in common. When the injector does not activate, the waveform at HIGH side of the other injector which uses the power at HIGH side in common is made.

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature.
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Fuel injection amount” parameter on the scan tool.

NOTICE

The value of “Fuel injection amount” varies with the operative condition according to DTC detecting condition. In case of fail safe, be sure to check that the value of “Injection amount” is restricted to below 40㎣/st.

■ Specification: Fuel injection amount approx. 9.0～10.5㎣/st at idle

Parameter	Reference Value
Final Fuel Q. (At IG ON)	-50.0 mm3st
Final Fuel Q. (At idle)	14.5 mm3st
Final Fuel Q. (At 1,500 rpm)	15.7 mm3st
Final Fuel Q. (At 2,000 rpm)	22.3 mm3st

POWER SUPPLY INSPECTION

1. Power Supply Voltage Inspection
   1) Leave the injector #1, #4 connector(EFD 11-1, 4) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 1 of injector #1, #4 harness connector and chassis ground.

      ■ Specification: Injector #1, #4 signal power approx. 12.82 V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Go to “Power Supply Open Inspection” procedure.
2. Power Supply Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the injector #1, #4 connector(EFD 11-1, 4) and the ECM connector(EFD-ECM).
   3) Measure the resistance between the terminal 2 of injector #1, #4 harness connector and the terminals 65, 65 of engine ECM connector(EFD-ECM).

      ■ Specification: Continuity
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Power Supply Short to Ground Inspection” procedure.

      NO

      ▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.
3. Power Supply Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the injector #1, #4 connector(EFD 11-1, 4) and the ECM connector(EFD-ECM).
   3) Measure the resistance between the terminal 1 of injector #1, #4 harness connector and chassis ground.

      ■ Specification: Infinite
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Ground Circuit Inspection” procedure.

      NO

      ▶ Repair short to ground and then go to “Verification of Vehicle Repair” procedure.

GROUND CIRCUIT INSPECTION

1. Ground Voltage Drop Inspection
   1) Disconnect the injector #1, #4 connector(EFD 11-1, 4).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage drop between the terminal 2 of injector #1, #4 harness connector and chassis ground.

      ■ Specification: Ground voltage drop within 200mV
   4) Is the voltage drop measured within specification?

      YES

▶ Go to “Ground Open Inspection” procedure.

NO

▶ Repair the cause of excessive resistance (poor connection) and go to “Verification of Vehicle Repair” procedure.

2. Ground Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the injector #1, #4 connector(EFD 11-1, 4) and the ECM connector(EFD-ECM).
   3) Measure the resistance between the terminal 2 of injector #1, #4 harness connector and the terminals 47, 67 of engine ECM connector(EFD-ECM).
      ■ Specification: Continuity
   4) Is the resistance measured within specification?

YES

▶ Go to “Component Inspection” procedure.

NO

▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.

COMPONENT INSPECTION

1. Injector Component Inspection
   1) Turn the ignition OFF.
   2) Disconnect the injector #1, #4 connector(EFD 11-1, 4).
   3) Measure resistance between the terminals 1 and 2 of injectors #1, #4 connector.

■ Specification

Item	Specification
Resistance	0.45Ω(at 20℃)

   4) Is the resistance measured within specification?

YES

▶ Go to “Verification of Vehicle Repair” procedure.

NO

▶ Replace the injector and go to “Verification of Vehicle Repair” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

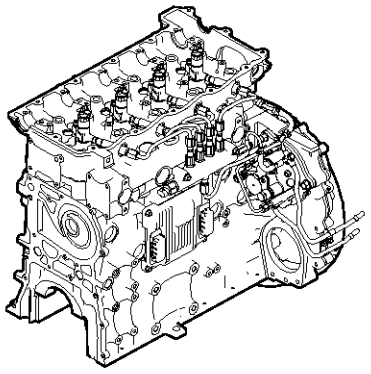
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P2148 COM1 Output Short to BATT (TWV 1 or 3 Output Short to BATT)

COMPONENT LOCATION



SDFFL7104D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   Injector carries out function to inject fuel amount calculated by ECM by making diesel spread with small particles to combustion chamber compressed with high pressure. Fuel injected generates power through combustion process. Purpose to increase fuel pressure of common rail diesel engine up to Max. 1,800 bar is to make fuel into small particles, small particles of fuel are related to smoke reduction, high power of engine, fuel consumption improvement etc. Also, hydraulic servo type is used to control fuel pressure of 1,800 bar with solenoid, injector solenoid is driven by current after increasing solenoid driving voltage up to 135V. Multi injection is possible by applying fuel injection which is not mechanic injector but electric control injector. ECM injects fuel after dividing into two stages of pilot injection and main injection and it is possible to control injection time and injection amount independently to each cylinder. Power, torque, exhaust gas, fuel consumption improvement etc. can be optimized by controlling engine to optimum fuel injection amount.

2. DTC DESCRIPTION

   If power short states in injector #1 and injector #4 are detected for more than 2,880 degrees of crank rotating angle, ECM judges this as a fault and DTC is set. The possible causes are short to terminal 47,67(power) of ECM connector(EFD-ECM) and wiring problem etc. Lack of engine power will occur since fuel amount is limited to below 40mm³/st in case of fail safe. There may cause damage to engine if the vehicle is driven for a long time with faulty injector.

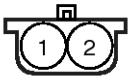
DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Short to B+ of terminals 47, 67 of ECM connector (EFD-ECM) • Defective wiring
Enable Conditions	• Engine running			
Threshold Value	• When the circuits of injector #1 and #4 are short to power			
Diagnosis Time	• 2,880˚ CA or higher			
Fail Safe	Fuel Cut	No	• Fuel amount sets to below 40㎟/st. • Cylinder balancing control stop • Cruise release	
	Fuel limit	Yes		
	Check lamp	ON		

SPECIFICATION

Item	Specification
Resistance	0.45Ω(At 20℃)

Injector driving time	135V
Injector driving current	18.5A
Injector control type	Current control



Sensor connector

SUDFLDTC9030L

WAVEFORM

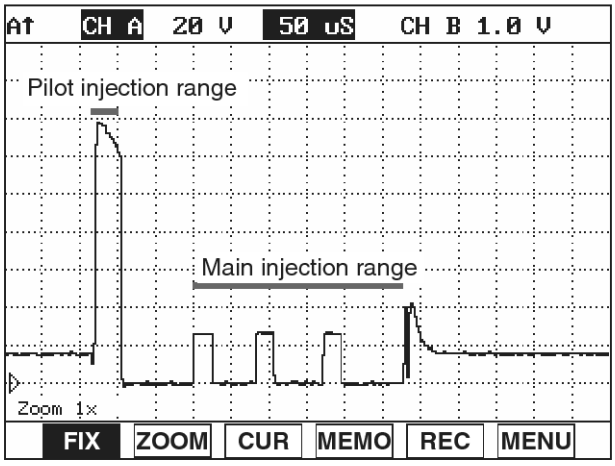


Fig. 1 Waveform of LOW side when injector operates

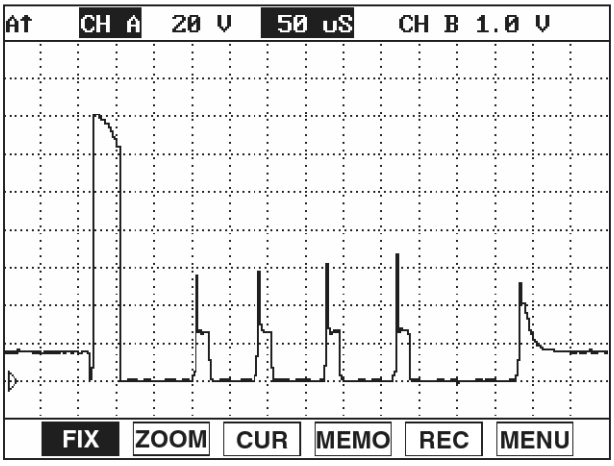


Fig. 2 Injector power waveform of HIGH side

Fig1) Waveform consists of pilot injection and main injection at LOW side.
Fig2) Injector power waveform of HIGH side

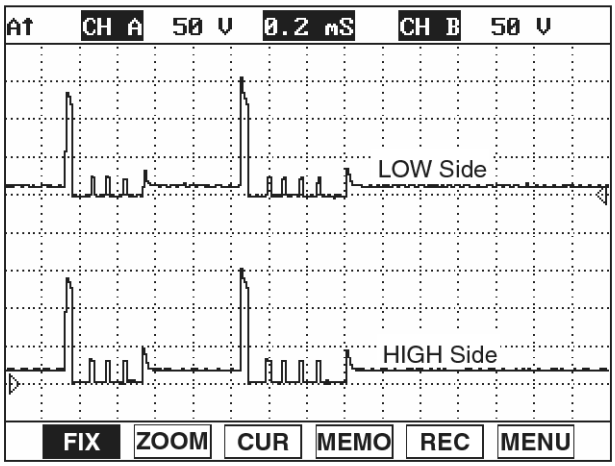


Fig. 3 Both injector waveforms of LOW/HIGH

SUDFLDTC9031L

NOTICE

When checking the injector waveform at LOW side of injector, the waveforms of Fig.1 and Fig.2 are made in turn. The waveform of Fig.2 is made when the power at the HIGH side of the injector # 1 and # 4 or the injector # 2 and # 3 which do not activate is used in common. When the injector does not activate, the waveform at HIGH side of the other injector which uses the power at HIGH side in common is made.

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature.
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Fuel injection amount” parameter on the scan tool.

NOTICE

The value of “Fuel injection amount” varies with the operative condition according to DTC detecting condition. In case of fail safe, be sure to check that the value of “Injection amount” is restricted to below 40㎣/st.

■ Specification: Fuel injection amount approx. 9.0~10.5㎣/st at idle

Parameter	Reference Value
Final Fuel Q. (At IG ON)	-50.0 mm3st
Final Fuel Q. (At idle)	14.5 mm3st
Final Fuel Q. (At 1,500 rpm)	15.7 mm3st
Final Fuel Q. (At 2,000 rpm)	22.3 mm3st

POWER SUPPLY INSPECTION

1. Power Supply Voltage Inspection
   1) Leave the injector #1, #4 connector(EFD 11-1, 4) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 1 of injector #1, #4 harness connector and chassis ground.

      ■ Specification: Injector #1, #4 signal power approx. 12.82 V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Go to “Power Supply Short to Power Inspection” procedure.
2. Power Supply Short to Power Inspection
   1) Disconnect the injector #1, #4 connector(EFD 11-1, 4) and the ECM connector(EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure the voltage between the terminal 2 of injector #1, #4 harness connector and chassis ground

      ■ Specification: Below 0~0.1V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Ground Circuit Inspection” procedure.

      NO

      ▶ Repair short to power and then go to “Verification of Vehicle Repair” procedure.

GROUND CIRCUIT INSPECTION

1. Ground Voltage Drop Inspection
   1) Disconnect the injector #1, #4 connector(EFD 11-1, 4).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage drop between the terminal 2 of injector #1, #4 harness connector and chassis ground.

      ■ Specification: Ground voltage drop within 200mV
   4) Is the voltage drop measured within specification?

      YES

      ▶ Go to “Ground Open Inspection” procedure.

      NO

      ▶ Repair the cause of excessive resistance (poor connection) and go to “Verification of Vehicle Repair” procedure.
2. Ground Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the injector #1, #4 connector(EFD 11-1, 4) and the ECM connector(EFD-ECM).
   3) Measure the resistance between the terminal 2 of injector #1, #4 harness connector and the terminals 47, 67 of engine ECM connector(EFD-ECM).

      ■ Specification: Continuity

4) Is the resistance measured within specification?

YES

▶ Go to “Component Inspection” procedure.

NO

▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.

COMPONENT INSPECTION

1. Injector Component Inspection
   1) Turn the ignition OFF.
   2) Disconnect the injector #1, #4 connector(EFD 11-1, 4).
   3) Measure resistance between the terminals 1 and 2 of injectors #1, #4 connector.

■ Specification

Item	Specification
Resistance	0.45Ω(at 20℃)

4) Is the resistance measured within specification?

YES

▶ Go to “Verification of Vehicle Repair” procedure.

NO

▶ Replace the injector and go to “Verification of Vehicle Repair” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

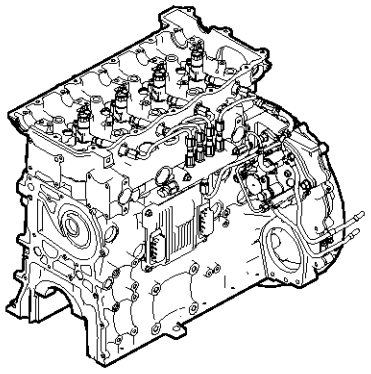
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P2149 COM2 Output Open Load (Both TWV 2 and TWV 4 Open Load)

COMPONENT LOCATION



SDFFL7104D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   Injector carries out function to inject fuel amount calculated by ECM by making diesel spread with small particles to combustion chamber compressed with high pressure. Fuel injected generates power through combustion process. Purpose to increase fuel pressure of common rail diesel engine up to Max. 1,800 bar is to make fuel into small particles, small particles of fuel are related to smoke reduction, high power of engine, fuel consumption improvement etc. Also, hydraulic servo type is used to control fuel pressure of 1,800 bar with solenoid, injector solenoid is driven by current after increasing solenoid driving voltage up to 135V. Multi injection is possible by applying fuel injection which is not mechanic injector but electric control injector. ECM injects fuel after dividing into two stages of pilot injection and main injection and it is possible to control injection time and injection amount independently to each cylinder. Power, torque, exhaust gas, fuel consumption improvement etc. can be optimized by controlling engine to optimum fuel injection amount.

2. DTC DESCRIPTION

   If open states in injectors #2 and #3 are detected for more than 6,000 degrees of crank rotating angle, ECM judges this as a fault and DTC is set. The possible causes are open in terminal 43, 61, 62, 63 of ECM connector(EFD-ECM) and wiring problem etc. Lack of engine power will occur since fuel amount is limited to below 40mm³/st in case of fail safe. There may cause damage to engine if the vehicle is driven for a long time with faulty injector.

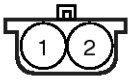
DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Open circuit of terminals 43, 61, 62, 63 of ECM connector (EFD-ECM) • Defective wiring
Enable Conditions	• Engine running			
Threshold Value	• When the circuits of injector #2 and #3 are open			
Diagnosis Time	• 6,000˚ CA or higher			
Fail Safe	Fuel Cut	No	• Fuel amount sets to below 40㎟/st. • Cylinder balancing control stop • Cruise release	
	Fuel limit	Yes		
	Check lamp	ON		

SPECIFICATION

Item	Specification
Resistance	0.45Ω(At 20℃)

Injector driving time	135V
Injector driving current	18.5A
Injector control type	Current control



Sensor connector

SUDFLDTC9030L

WAVEFORM

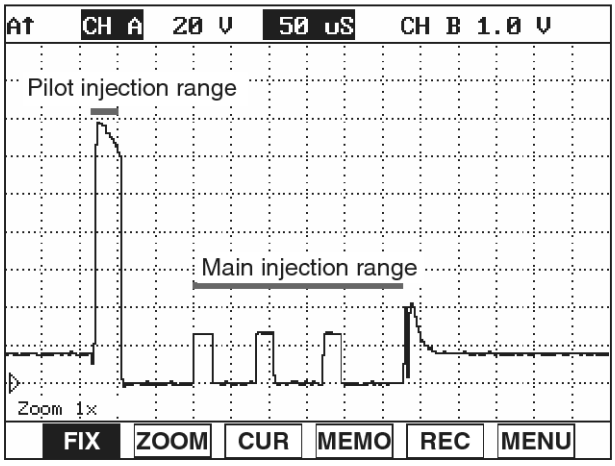


Fig. 1 Waveform of LOW side when injector operates

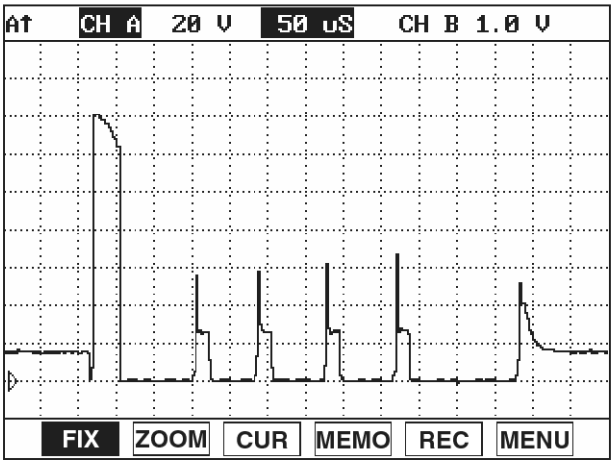


Fig. 2 Injector power waveform of HIGH side

Fig1) Waveform consists of pilot injection and main injection at LOW side.
Fig2) Injector power waveform of HIGH side

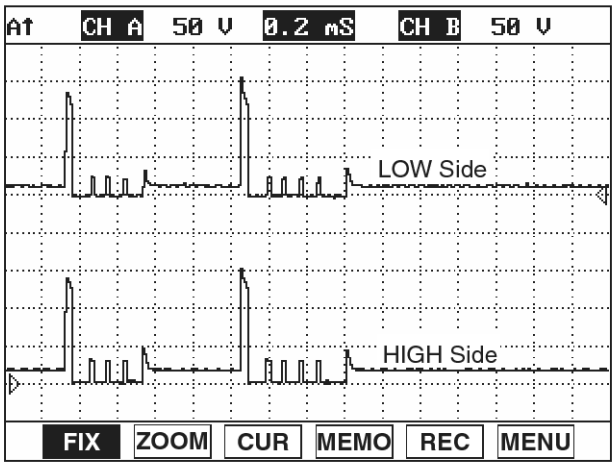


Fig. 3 Both injector waveforms of LOW/HIGH

SUDFLDTC9031L

NOTICE

When checking the injector waveform at LOW side of injector, the waveforms of Fig.1 and Fig.2 are made in turn. The waveform of Fig.2 is made when the power at the HIGH side of the injector # 1 and # 4 or the injector # 2 and # 3 which do not activate is used in common. When the injector does not activate, the waveform at HIGH side of the other injector which uses the power at HIGH side in common is made.

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature.
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Fuel injection amount” parameter on the scan tool.

NOTICE

The value of “Fuel injection amount” varies with the operative condition according to DTC detecting condition. In case of fail safe, be sure to check that the value of “Injection amount” is restricted to below 40㎣/st.

■ Specification: Fuel injection amount approx. 9.0～10.5㎣/st at idle

Parameter	Reference Value
Final Fuel Q. (At IG ON)	-50.0 mm3st
Final Fuel Q. (At idle)	14.5 mm3st
Final Fuel Q. (At 1,500 rpm)	15.7 mm3st
Final Fuel Q. (At 2,000 rpm)	22.3 mm3st

POWER SUPPLY INSPECTION

1. Power Supply Voltage Inspection
   1) Leave the injector #2, #3 connector(EFD 11-2, 3) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 1 of injector #2, #3 harness connector and chassis ground.

      ■ Specification: Injector #2, #3 signal power approx. 12.82 V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Go to “Power Supply Open Inspection” procedure.
2. Power Supply Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the injector #2, #3 connector(EFD 11-2, 3) and the ECM connector(EFD-ECM).
   3) Measure the resistance between the terminal 2 of injector #2, #3 harness connector and the terminals 61, 62 of engine ECM connector(EFD-ECM).

      ■ Specification: Continuity
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Power Supply Short to Ground Inspection” procedure.

      NO

      ▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.
3. Power Supply Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the injector #2, #3 connector(EFD 11-2, 3) and the ECM connector(EFD-ECM).
   3) Measure the resistance between the terminal 1 of injector #2, #3 harness connector and chassis ground

      ■ Specification: Infinite
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Ground Circuit Inspection” procedure.

      NO

      ▶ Repair short to ground and then go to “Verification of Vehicle Repair” procedure.

GROUND CIRCUIT INSPECTION

1. Ground Voltage Drop Inspection
   1) Disconnect the injector #2, #3 connector(EFD 11-2, 3).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage drop between the terminal 2 of injector #2, #3 harness connector and chassis ground.

      ■ Specification: Ground voltage drop within 200mV
   4) Is the voltage drop measured within specification?

      YES

▶ Go to “Ground Open Inspection” procedure.

NO

▶ Repair the cause of excessive resistance (poor connection) and go to “Verification of Vehicle Repair” procedure.

2. Ground Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the injector #2, #3 connector(EFD 11-2, 3) and the ECM connector(EFD-ECM).
   3) Measure the resistance between the terminal 2 of injector #2, #3 harness connector and the terminals 43, 63 of engine ECM connector(EFD-ECM).

      ■ Specification: Continuity
   4) Is the resistance measured within specification?

YES

▶ Go to “Component Inspection” procedure.

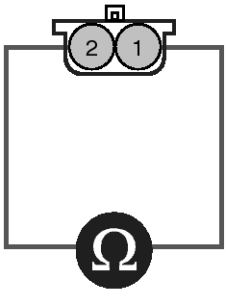
NO

▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.

COMPONENT INSPECTION

1. Injector Component Inspection
   1) Turn the ignition OFF.
   2) Disconnect the injector #2, #3 connector(EFD 11-2, 3).
   3) Measure resistance between the terminals 1 and 2 of injectors #2, #3 connector.

E11-2, 3



■ Specification

Item	Specification
Resistance	0.45Ω (at 20℃)

4) Is the resistance measured within specification?

YES

▶ Go to “Verification of Vehicle Repair” procedure.

NO

▶ Replace the injector and go to “Verification of Vehicle Repair” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

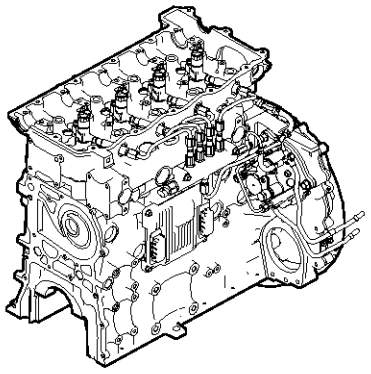
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P2150 COM2 Output Short to GND (TWV 2 or 4 Output Short to GND)

COMPONENT LOCATION



SDFFL7104D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   Injector carries out function to inject fuel amount calculated by ECM by making diesel spread with small particles to combustion chamber compressed with high pressure. Fuel injected generates power through combustion process. Purpose to increase fuel pressure of common rail diesel engine up to Max. 1,800 bar is to make fuel into small particles, small particles of fuel are related to smoke reduction, high power of engine, fuel consumption improvement etc. Also, hydraulic servo type is used to control fuel pressure of 1,800 bar with solenoid, injector solenoid is driven by current after increasing solenoid driving voltage up to 135V. Multi injection is possible by applying fuel injection which is not mechanic injector but electric control injector. ECM injects fuel after dividing into two stages of pilot injection and main injection and it is possible to control injection time and injection amount independently to each cylinder. Power, torque, exhaust gas, fuel consumption improvement etc. can be optimized by controlling engine to optimum fuel injection amount.

2. DTC DESCRIPTION

   If ground short states in injector #2 and injector #3 are detected for more than 2,880 degrees of crank rotating angle, ECM judges this as a fault and DTC is set. The possible causes are short in terminal 43, 61, 62, 63 of ECM connector(EFD-ECM) and wiring problem etc. Lack of engine power will occur since fuel amount is limited to below 40mm³/st in case of fail safe. There may cause damage to engine if the vehicle is driven for a long time with faulty injector.

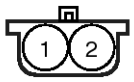
DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Short to GND of terminals 43, 61, 62, 63 of ECM connector (EFD-ECM) • Defective wiring
Enable Conditions	• Engine running			
Threshold Value	• When the circuits of injector #2 and #3 are short to GND at driving circuit			
Diagnosis Time	• 2,880˚ CA or higher			
Fail Safe	Fuel Cut	No	• Fuel amount sets to below 40㎣/st. • Cylinder balancing control stop • Cruise release	
	Fuel limit	Yes		
	Check lamp	ON		

SPECIFICATION

Item	Specification
Resistance	0.45Ω(At 20℃)

Injector driving time	135V
Injector driving current	18.5A
Injector control type	Current control



Sensor connector

SUDFLDTC9030L

WAVEFORM

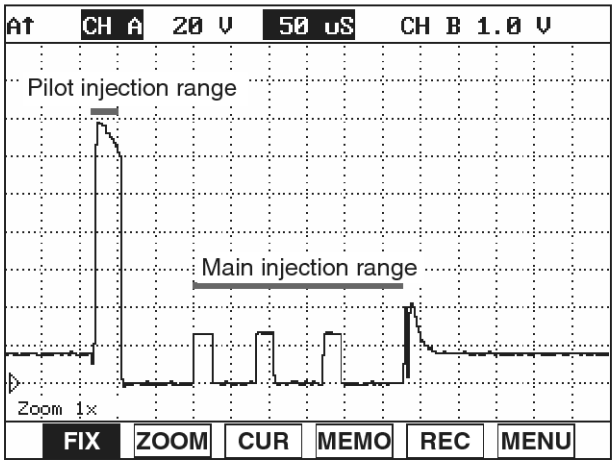


Fig. 1 Waveform of LOW side when injector operates

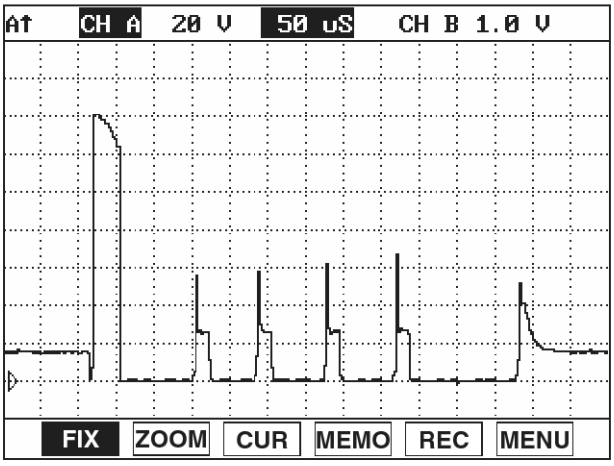


Fig. 2 Injector power waveform of HIGH side

Fig1) Waveform consists of pilot injection and main injection at LOW side.
Fig2) Injector power waveform of HIGH side

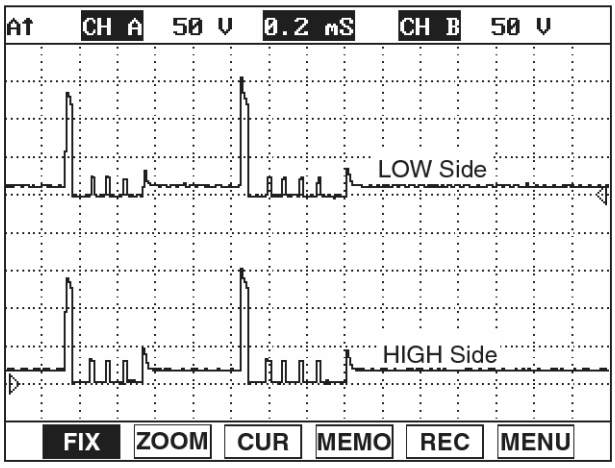


Fig. 3 Both injector waveforms of LOW/HIGH

SUDFLDTC9031L

NOTICE

When checking the injector waveform at LOW side of injector, the waveforms of Fig.1 and Fig.2 are made in turn. The waveform of Fig.2 is made when the power at the HIGH side of the injector # 1 and # 4 or the injector # 2 and # 3 which do not activate is used in common. When the injector does not activate, the waveform at HIGH side of the other injector which uses the power at HIGH side in common is made.

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature.
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Fuel injection amount” parameter on the scan tool.

NOTICE

The value of “Fuel injection amount” varies with the operative condition according to DTC detecting condition. In case of fail safe, be sure to check that the value of “Injection amount” is restricted to below 40㎣/st.

■ Specification: Fuel injection amount approx. 9.0~10.5㎣/st at idle

Parameter	Reference Value
Final Fuel Q. (At IG ON)	-50.0 mm3st
Final Fuel Q. (At idle)	14.5 mm3st
Final Fuel Q. (At 1,500 rpm)	15.7 mm3st
Final Fuel Q. (At 2,000 rpm)	22.3 mm3st

POWER SUPPLY INSPECTION

1. Power Supply Voltage Inspection
   1) Leave the injector #2, #3 connector(EFD 11-2, 3) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 1 of injector #2, #3 harness connector and chassis ground.

      ■ Specification: Injector #2, #3 signal power approx. 12.82 V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Go to “Power Supply Open Inspection” procedure.
2. Power Supply Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the injector #2, #3 connector(EFD 11-2, 3) and the ECM connector(EFD-ECM).
   3) Measure the resistance between the terminal 2 of injector #2, #3 harness connector and the terminals 61, 62 of engine ECM connector(EFD-ECM).

      ■ Specification: Continuity
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Power Supply Short to Ground Inspection” procedure.

      NO

      ▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.
3. Power Supply Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the injector #2, #3 connector(EFD 11-2, 3) and the ECM connector(EFD-ECM).
   3) Measure the resistance between the terminal 1 of injector #2, #3 harness connector and chassis ground

      ■ Specification: Infinite
   4) Is the resistance measured within specification?

      YES

      ▶ Go to “Ground Circuit Inspection” procedure.

      NO

      ▶ Repair short to ground and then go to “Verification of Vehicle Repair” procedure.

GROUND CIRCUIT INSPECTION

1. Ground Voltage Drop Inspection
   1) Disconnect the injector #2, #3 connector(EFD 11-2, 3).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage drop between the terminal 2 of injector #2, #3 harness connector and chassis ground.

      ■ Specification: Ground voltage drop within 200mV

4) Is the voltage drop measured within specification?

YES

▶ Go to “Ground Open Inspection” procedure.

NO

▶ Repair the cause of excessive resistance (poor connection) and go to “Verification of Vehicle Repair” procedure.

2. Ground Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the injector #2, #3 connector(EFD 11-2, 3) and the ECM connector(EFD-ECM).
   3) Measure the resistance between the terminal 2 of injector #2, #3 harness connector and the terminals 43, 63 of engine ECM connector(EFD-ECM).

      ■ Specification: Continuity
   4) Is the resistance measured within specification?

YES

▶ Go to “Component Inspection” procedure.

NO

▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.

COMPONENT INSPECTION

1. Injector Component Inspection
   1) Turn the ignition OFF.
   2) Disconnect the injector #2, #3 connector(EFD 11-2, 3).
   3) Measure resistance between the terminals 1 and 2 of injectors #2, #3 connector.

■ Specification

Item	Specification
Resistance	0.45Ω(at 20℃)

   4) Is the resistance measured within specification?

YES

▶ Go to “Verification of Vehicle Repair” procedure.

NO

▶ Replace the injector and go to “Verification of Vehicle Repair” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

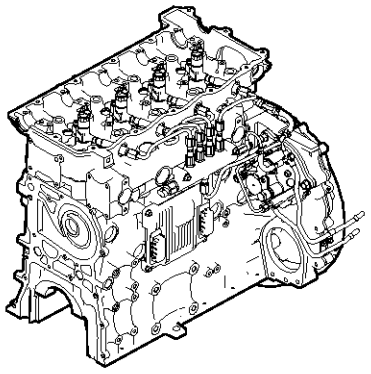
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P2151 COM2 Output Short to BATT (TWV 2 or 4 Output Short to BATT)

COMPONENT LOCATION



SDFFL7104D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   Injector carries out function to inject fuel amount calculated by ECM by making diesel spread with small particles to combustion chamber compressed with high pressure. Fuel injected generates power through combustion process. Purpose to increase fuel pressure of common rail diesel engine up to Max. 1,800 bar is to make fuel into small particles, small particles of fuel are related to smoke reduction, high power of engine, fuel consumption improvement etc. Also, hydraulic servo type is used to control fuel pressure of 1,800 bar with solenoid, injector solenoid is driven by current after increasing solenoid driving voltage up to 135V. Multi injection is possible by applying fuel injection which is not mechanic injector but electric control injector. ECM injects fuel after dividing into two stages of pilot injection and main injection and it is possible to control injection time and injection amount independently to each cylinder. Power, torque, exhaust gas, fuel consumption improvement etc. can be optimized by controlling engine to optimum fuel injection amount.

2. DTC DESCRIPTION

   If power short circuits in injectors #2 and injector #3 are detected for more than 2,880 degrees of crank rotating angle, ECM judges this as a fault and DTC is set. The possible causes are short to terminal 43,61,62,63 (power) of ECM connector(EFD-ECM) and wiring problem etc. Lack of engine power will occur since fuel amount is limited to below 40mm³/st in case of fail safe. There may cause damage to engine if the vehicle is driven for a long time with faulty injector.

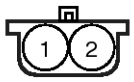
DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Short to B+ of terminals 43, 61, 62, 63 of ECM connector (EFD-ECM) • Defective wiring
Enable Conditions	• Engine running			
Threshold Value	• When the circuits of injector #2 and injector #3 are short to power			
Diagnosis Time	• 2,880˚ CA or higher			
Fail Safe	Fuel Cut	No	• Fuel amount sets to below 40㎣/st. • Cylinder balancing control stop • Cruise release	
	Fuel limit	Yes		
	Check lamp	ON		

SPECIFICATION

Item	Specification
Resistance	0.45Ω(At 20℃)

Injector driving time	135V
Injector driving current	18.5A
Injector control type	Current control



Sensor connector

SUDFLDTC9030L

WAVEFORM

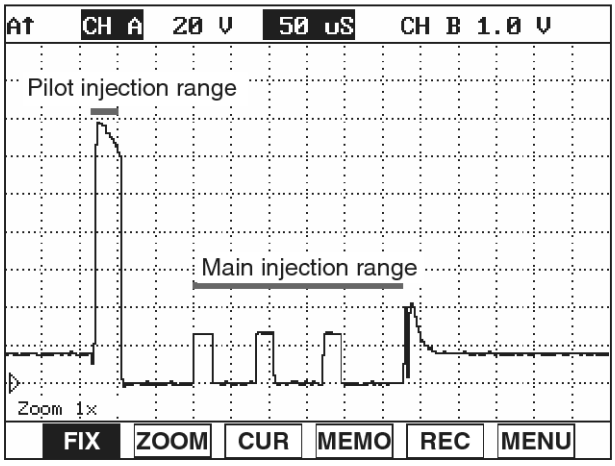


Fig. 1 Waveform of LOW side when injector operates

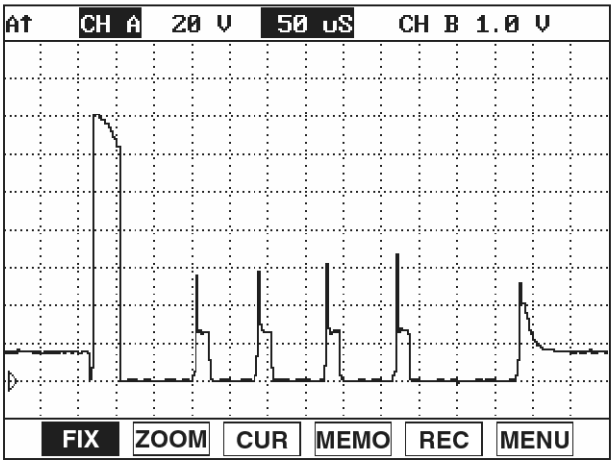


Fig. 2 Injector power waveform of HIGH side

Fig1) Waveform consists of pilot injection and main injection at LOW side.
Fig2) Injector power waveform of HIGH side

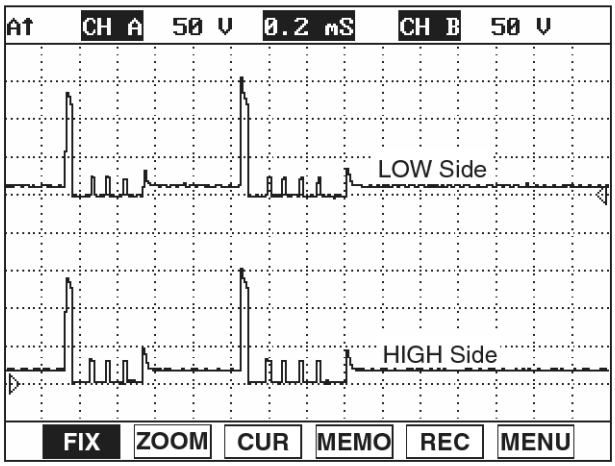


Fig. 3 Both injector waveforms of LOW/HIGH

SUDFLDTC9031L

NOTICE

When checking the injector waveform at LOW side of injector, the waveforms of Fig.1 and Fig.2 are made in turn. The waveform of Fig.2 is made when the power at the HIGH side of the injector # 1 and # 4 or the injector # 2 and # 3 which do not activate is used in common. When the injector does not activate, the waveform at HIGH side of the other injector which uses the power at HIGH side in common is made.

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature.
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Fuel injection amount” parameter on the scan tool.

NOTICE

The value of “Fuel injection amount” varies with the operative condition according to DTC detecting condition. In case of fail safe, be sure to check that the value of “Injection amount” is restricted to below 40㎣/st.

■ Specification: Fuel injection amount approx. 9.0~10.5㎣/st at idle

Parameter	Reference Value
Final Fuel Q. (At IG ON)	-50.0 mm3st
Final Fuel Q. (At idle)	14.5 mm3st
Final Fuel Q. (At 1,500 rpm)	15.7 mm3st
Final Fuel Q. (At 2,000 rpm)	22.3 mm3st

POWER SUPPLY INSPECTION

1. Power Supply Voltage Inspection
   1) Leave the injector #2, #3 connector(EFD 11-2, 3) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminal 1 of injector #2, #3 harness connector and chassis ground.

      ■ Specification: Injector #2, #3 signal power approx. 12.82 V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Go to “Power Supply Short to Power Inspection” procedure.
2. Power Supply Short to Power Inspection
   1) Disconnect the injector #2, #3 connector(EFD 11-2, 3) and the ECM connector(EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure the voltage between the terminal 2 of injector #2, #3 harness connector and chassis ground

      ■ Specification: Below 0~0.1V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Ground Circuit Inspection” procedure.

      NO

      ▶ Repair short to power and then go to “Verification of Vehicle Repair” procedure.

GROUND CIRCUIT INSPECTION

1. Ground Voltage Drop Inspection
   1) Disconnect the injector #2, #3 connector(EFD 11-2, 3).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage drop between the terminal 2 of injector #2, #3 harness connector and chassis ground.

      ■ Specification: Ground voltage drop within 200mV
   4) Is the voltage drop measured within specification?

      YES

      ▶ Go to “Ground Open Inspection” procedure.

      NO

      ▶ Repair the cause of excessive resistance (poor connection) and go to “Verification of Vehicle Repair” procedure.
2. Ground Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the injector #2, #3 connector(EFD 11-2, 3) and the ECM connector(EFD-ECM).
   3) Measure the resistance between the terminal 2 of injector #2, #3 harness connector and the terminals 43, 63 of engine ECM connector(EFD-ECM).

      ■ Specification: Continuity

4) Is the resistance measured within specification?

YES

▶ Go to “Component Inspection” procedure.

NO

▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.

COMPONENT INSPECTION

1. Injector Component Inspection
   1) Turn the ignition OFF.
   2) Disconnect the injector #2, #3 connector(EFD 11-2, 3).
   3) Measure resistance between the terminals 1 and 2 of injectors #2, #3 connector.

■ Specification

Item	Specification
Resistance	0.45Ω(at 20℃)

4) Is the resistance measured within specification?

YES

▶ Go to “Verification of Vehicle Repair” procedure.

NO

▶ Replace the injector and go to “Verification of Vehicle Repair” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

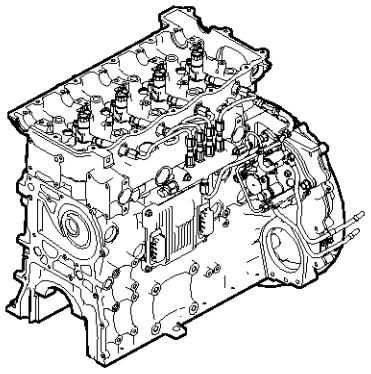
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P2293 Pressure Limiter Activated

COMPONENT LOCATION



SDFFL7104D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   If the pressure limiter detects abnormal high pressure in the common rail system, it works and plays a role to return fuel to the fuel tank to protect system. If the engine is started with SCV connector disconnected, the vehicle is driven with fuel line clogged or the engine is started without fuel in the fuel line, there is a possibility to display this code. Therefore, fuel filter should be replaced according to service interval. When the vehicle performs the initial start, be sure to try to start the engine after replacing it with a new one and feeding fuel to fuel pump by priming the pump with a priming pump.

2. DTC DESCRIPTION

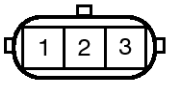
   If common rail pressure sensor has malfunction or fuel pressure in the rail is detected above 191 Mpa for 16.0ms or more, the ECM judges this as a fault and DTC is set.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Check the low pressure fuel line for clogged. • Check fuel filter for clogged. • Check that SCV connector is c-onnected. • Defective common rail assembly
Enable Conditions	• Engine running			
Threshold Value	• Rail pressure>191Mpa			
Diagnosis Time	• 16.0ms or higher			
Fail Safe	Fuel Cut	No	• Fuel pressure limit (60Mpa) • EGR control stop • Cruise release	
	Fuel limit	Yes		
	Check lamp	OFF		

SPECIFICATION

Rail pressure sensor	Specification
Output voltage	Below 2.6 V (Idle state after warm-up)
Rail pressure	40 Mpa (Idle state)



Sensor connector

Component resistance	Specification(20℃)
No. 1, 2	3 kΩ
No. 1, 3	13 kΩ
No. 2, 3	16.4 kΩ

SUDFLDTC9003L

WAVEFORM

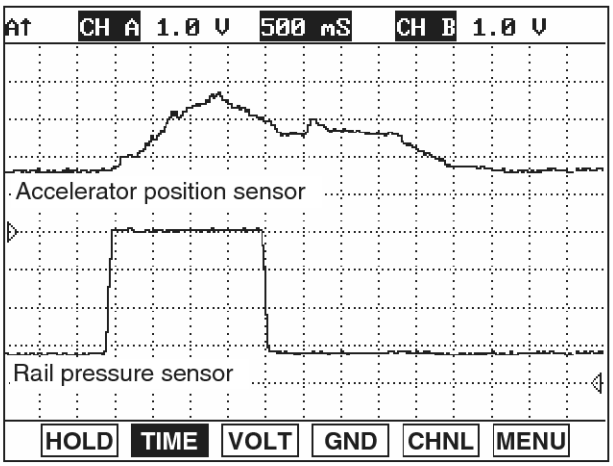


Fig. 1 Measure with oscilloscope waveform

Fig1) indicates waveform which the accelerator position sensor 1 and the rail pressure sensor are measured at the same time, can check the rail pressure sensor output at quick acceleration or deceleration.

SUDFLDTC9004L

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “Rail pressure” parameter on the scan tool.

NOTICE

The value of “Rail pressure” varies with the operative condition according to DTC detecting condition. In case of fail safe, be sure to check that the value of “Rail pressure” sets to 70Mpa and the “Fuel amount” is restricted to below 75% of maximum torque.

Parameter	Reference Value
Real C/R pressure (At IG ON)	0.4 Mpa
Real C/R pressure (At idle)	31.6 Mpa
Real C/R pressure (At 1,500 rpm)	91.2 Mpa
Real C/R pressure (At 2,000 rpm)	122.5 Mpa

Start the engine and monitor the pressure change of the rail pressure sensor. The pressure of about 40Mpa is generated at hot idle (650rpm). At this time,

it is also important to check the duty of the rail pressure governor. Check that the duty of about 46.5% indicates from above service data.

This data increases with acceleration and load condition, not only the rail pressure increases up to max. 180Mpa but also the rail pressure governor duty increases up to 95%.

TROUBLESHOOTING AID

The trouble code related to poor rail pressure is necessary to diagnose high pressure fuel system and low pressure fuel system collectively

High pressure fuel system symptom: Poor high pressure of high pressure fuel pump, the poor air tightness or stuck of the ball valve seat of rail pressure governor, clogged overflow valve, the fuel leak of injector nozzle and return circuit

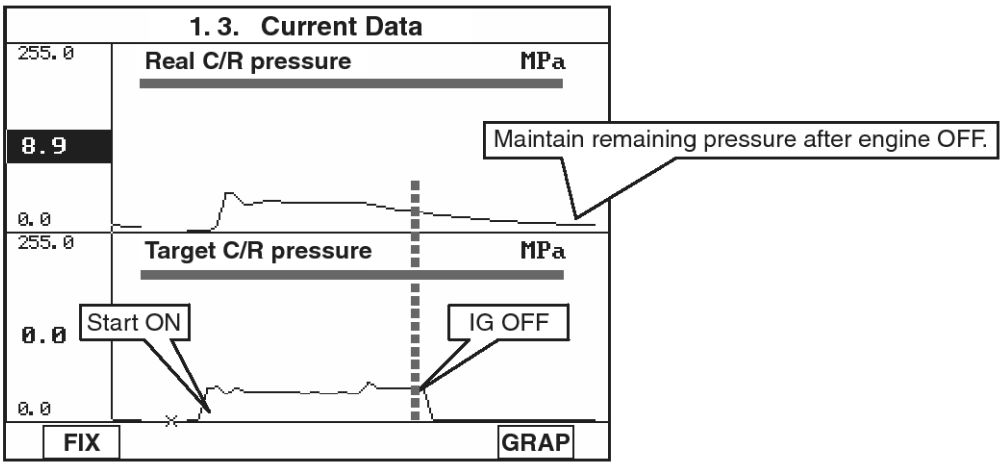
Low pressure fuel system symptom: Poor fuel supply of low pressure fuel pump, clogged fuel filter

NOTICE

Overflow valve plays a role to return fuel to the fuel tank by opening valve to protect fuel system when generating the fuel pressure in common rail with "221Mpa" or more excessively.

NOTICE

It is possible to check by turning the ignition key ON not to lose data due to impossible communication between ECM and scan tool because the main relay switches OFF at stopping the engine.



SUDFLDTC9095L

The above graph waveform indicates the pressure change of the rail pressure sensor at starting ON and OFF. It is possible to diagnose the collective fuel system by checking the condition to maintain the pressure in the common rail at stopping the engine and the time to reach about 40Mpa in the common rail.

1. It is important for the rail pressure to increase quickly at starting.
   - ▶ It is easy to diagnose the supply state of low

pressure fuel pump, the high pressure formation of high pressure fuel pump, the air tightness of rail pressure governor, the air tightness state of injector nozzle and return side.

2. It is important to maintain air tightness at below 101bar of spring tension of common rail pressure governor and to lower fuel pressure gradually at stopping the engine.

   ▶ It is easy to diagnose the air tightness state of rail pressure governor, nozzle and return side.

COMPONENT INSPECTION

1. Fuel Supply System Visual Inspection
   1) Turn the ignition OFF.
   2) Check the fuel hose and pipe for crack, bent, deformation, degradation, and clogged.
   3) Check the fuel filter for clogged, damage, and contamination.
   4) Check that the SCV connector is connected.
   5) Check that the common rail system is normal.
   6) Check fuel.
   7) Is the result of system check normal?

   YES

   ▶ Go to “Verification of Vehicle Repair” procedure.

   NO

   ▶ Repair the problem and go to “Verification of Vehicle Repair” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

   YES

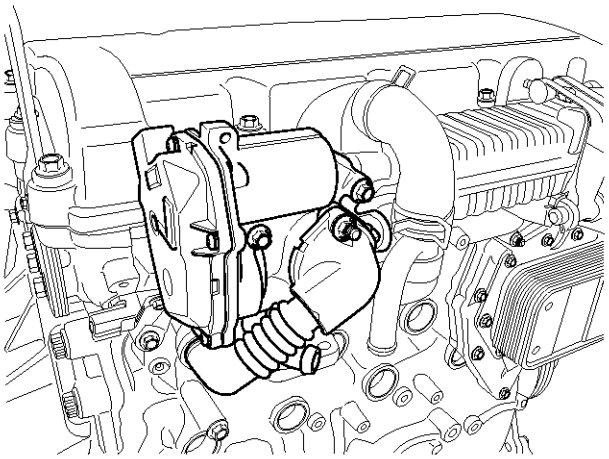
   ▶ Go to the applicable DTC procedure.

   NO

   ▶ System OK

P2413 EGR Valve Open/Close Stuck

COMPONENT LOCATION



SDFFL7101D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   Receiving ECM signal, linear solenoid type electronic EGR actuator operates EEGR valve directly. ECM performs EGR system feed back control with the information of measured mass air flow. (The role of MAFS in diesel engine is different from gasoline engine. Fuel injection quantity is decided by MAFS signal in gasoline engine.) When EGR gas (contains no oxygen) flowing into combustion chamber increases, the air passing through MAFS (contains oxygen) decreases. Thus, with the output signal change of MAFS accompanied by EEGR actuator actuation, ECM determines the amount of recirculated EGR gas quantity.

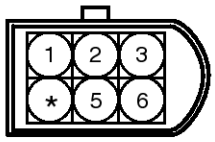
2. DTC DESCRIPTION

   If gap between actual EGR volume and target EGR volume is above 15 %, the ECM judges this as a fault and DTC is set. Check lamp comes on and MIL is blinking when the condition continued 2 driving cycle times. MIL will go off after 3 driving cycle times when the system returns to normal. The probable causes are open/short to ground of EEGR actuator circuit or internal malfunction.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Current monitoring			• Open circuit of terminals 60, 80 of ECM connector (EFD-ECM) • Wiring poor connection • EGR valve
Enable Conditions	• At IG ON			
Threshold Value	• When the difference between actual EGR duty and target EGR is above 15%			
Diagnosis Time	• 10,112ms or higher			
Fail Safe	Fuel Cut	No	• EGR control stop • Fuel amount limit (75% of maximum torque) • Cruise release	
	Fuel limit	Yes		
	Check lamp	ON		

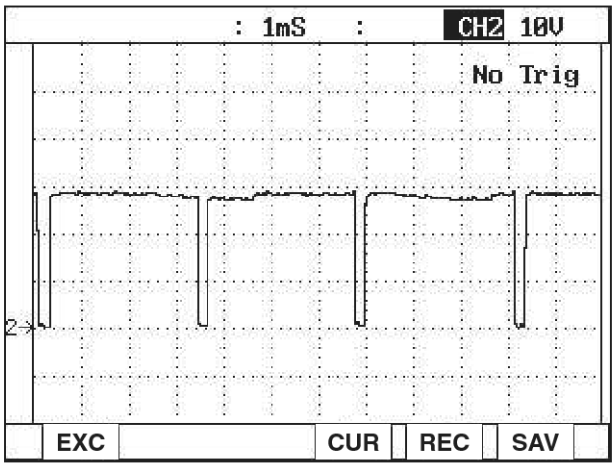
SPECIFICATION



Sensor connector

SUDFLDTC9072L

WAVEFORM



SUDFLDTC9097L

MONITOR SCAN TOOL DATA

1. Connect scan tool to the self-diagnosis connector.
2. Warm up the engine to the normal operating temperature.
3. Turn the electrical equipment and air conditioner OFF.
4. Monitor “EGR valve” parameter on the scan tool.

Parameter	Reference Value
EGR control (At IG ON)	0%
EGR control (At idle)	0%
EGR control (At 1,500 rpm)	35%
EGR control (At 2,000 rpm)	40%

SIGNAL CIRCUIT INSPECTION

1. Signal (LOW/HIGH) Voltage Inspection
   1) Leave the EGR valve connector (EFD19) connected.
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminals 5 and 6 of EGR valve harness connector and chassis ground.

      ■ Specification: EGR valve DC motor terminal power approx. 1.5V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to “Component Inspection” procedure.

      NO

      ▶ Go to “Signal (LOW/HIGH) Open Inspection” procedure.

2. Signal (LOW/HIGH) Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the EGR valve connector (EFD19) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminal 5 of EGR valve harness connector (EFD19) and the terminal 60 of engine ECM connector(EFD-ECM).
   4) Measure resistance between the terminal 6 of EGR valve harness connector (EFD19) and the terminal 80 of engine ECM connector(EFD-ECM).
      ■ Specification: Continuity
   5) Is the resistance measured within specification?

      YES

      ▶ Go to "Component Inspection" procedure.

      NO

      ▶ Repair open circuit and then go to "Verification of Vehicle Repair" procedure.
3. EGR Valve (LOW/HIGH) Short to Power Inspection
   1) Disconnect the EGR valve connector (EFD19) and ECM connector(EFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure voltage between the terminals 5 and 6 of EGR valve harness connector and chassis ground.
      ■ Specification: Below 0~0.1V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to "EGR Valve (LOW/HIGH) Short to Ground Inspection" procedure.

      NO

      ▶ Repair short to power and then go to "Verification of Vehicle Repair" procedure.
4. EGR Valve (LOW/HIGH) Short to Ground Inspection
   1) Turn the ignition OFF.
   2) Disconnect the EGR valve connector (EFD19) and ECM connector(EFD-ECM).
   3) Measure resistance between the terminals 5 and 6 of EGR valve harness connector and chassis ground.
      ■ Specification: Infinite
   4) Is the resistance measured within specification?

      YES

      ▶ Go to "Component Inspection" procedure.

      NO

      ▶ Repair short to ground and then go to "Verification of Vehicle Repair" procedure.

COMPONENT INSPECTION

1. EGR Valve Visual Inspection
   1) Turn the ignition OFF.
   2) Disconnect the EGR valve connector (EFD19).
   3) Check the EGR valve connector terminal for contamination or corrosion.
   4) Check the EGR valve for torque, coolant leak.
   5) Is the result of system check normal?

      YES

      ▶ Go to "EGR Valve Waveform Inspection" procedure.

      NO

      ▶ Replace the EGR valve and go to "Verification of Vehicle Repair" procedure.
2. EGR Valve Waveform Inspection
   1) Turn the ignition OFF.
   2) Connect the EGR valve connector (EFD19).
   3) Connect the oscilloscope probe to the terminal 5 of EGR valve connector (EFD19).
   4) Check the waveform of idle and accelerating condition.
      ■ Specification: Refer to "Standard Waveform" of general information.
   5) Does the waveform of EGR valve display normally?

      YES

      ▶ Go to "Verification of Vehicle Repair" procedure.

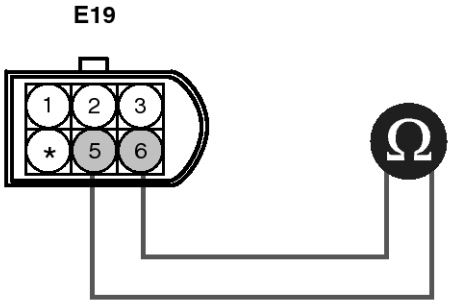
      NO

      ▶ Go to "EGR Valve DC Motor Resistance Inspection" procedure.

3. EGR Valve DC Motor Resistance Inspection
   1) Turn the ignition OFF.
   2) Disconnect the EGR valve connector (EFD19).
   3) Measure the resistance between terminals 5 and 6 of EGR valve connector.

■ Specification :

Itme	Specification
Resistance	Infinite



SUDFLDTC9048L

   4) Is the resistance measured within specification?

YES

▶ Go to “Verification of Vehicle Repair” procedure.

NO

▶ Replace the EGR valve and go to “Verification of Vehicle Repair” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

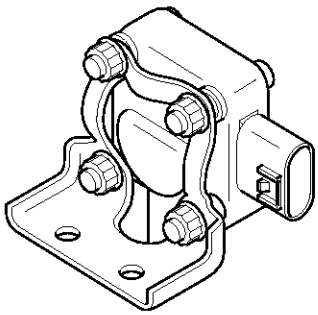
▶ Go to the applicable DTC procedure.

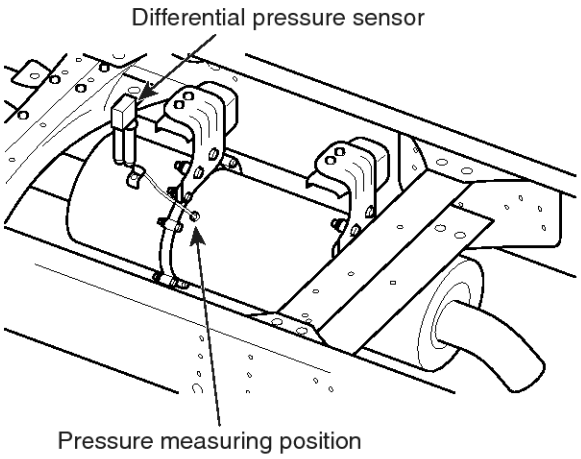
NO

▶ System OK

P2454 Differential Pressure Sensor Signal Too Low

COMPONENT LOCATION





SUDFLDTC9101L

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   The differential pressure sensor is installed upper side of PMC and measures the pressure difference between before and after PMC. If the pressure difference is above or below the specified value, the ECM considers that the stored soot inside the PMC is excessive. It also has a purpose to monitor that PMC is arbitrarily removed by a user.

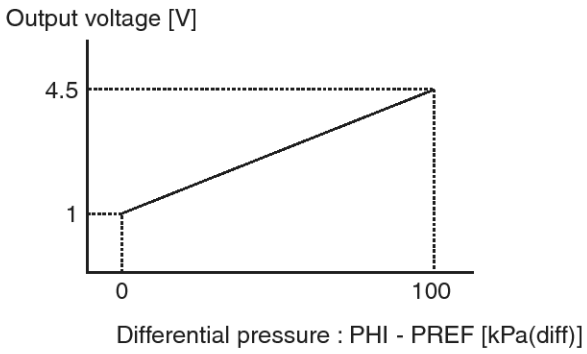
2. DTC DESCRIPTION

   If the output value of differential pressure sensor is detected below 0.3V for 3,008ms or more, the ECM judges this as a fault and DTC is set. The probable causes are open or short to ground of terminal 70 of ECM connector (CFD-ECM).

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Poor wiring harness • Open or short to ground of terminal 70 of ECM
Enable Conditions	• Engine running			
Threshold Value	• Sensor output<0.3V			
Diagnosis Time	• 3,008ms			
Fail Safe	Fuel Cut	-		
	Fuel limit	-		
	Check lamp	ON		

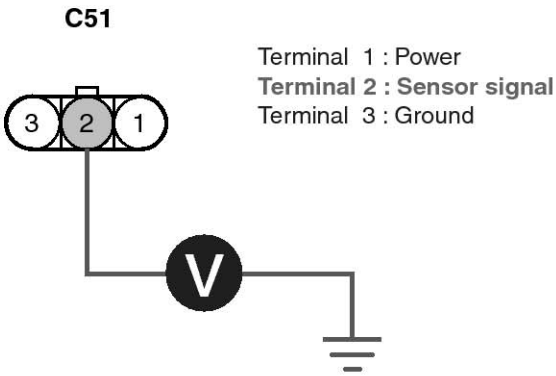
SPECIFICATION



SUDFLDTC9102L

SIGNAL CIRCUIT INSPECTION

1. Disconnect the differential pressure sensor connector.
2. Turn the ignition ON. Leave the engine OFF.
3. Measure voltage between terminal 2 of the differential pressure sensor and chassis ground.
   ■ Specification: Approx. 5V



SUDFLDTC9104L

4. Is the voltage measured within specification?

YES

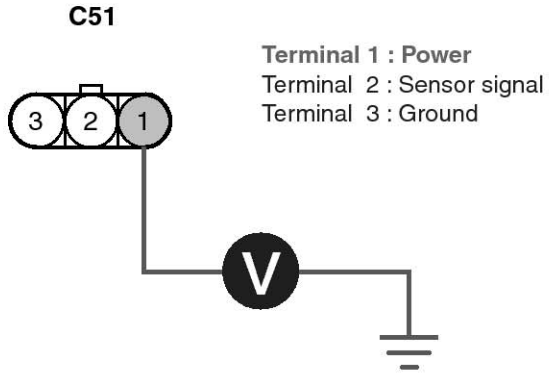
▶ Go to “Component Inspection” procedure.

NO

▶ Repair open or short to ground and then go to “Verification of Vehicle Repair” procedure.

POWER SUPPLY INSPECTION

1. Disconnect the differential pressure sensor connector.
2. Turn the ignition ON. Leave the engine OFF.
3. Measure voltage between terminal 1 of the differential pressure sensor and chassis ground.
   ■ Specification: Approx. 5V



SUDFLDTC9105L

4. Is the voltage measured within specification?

YES

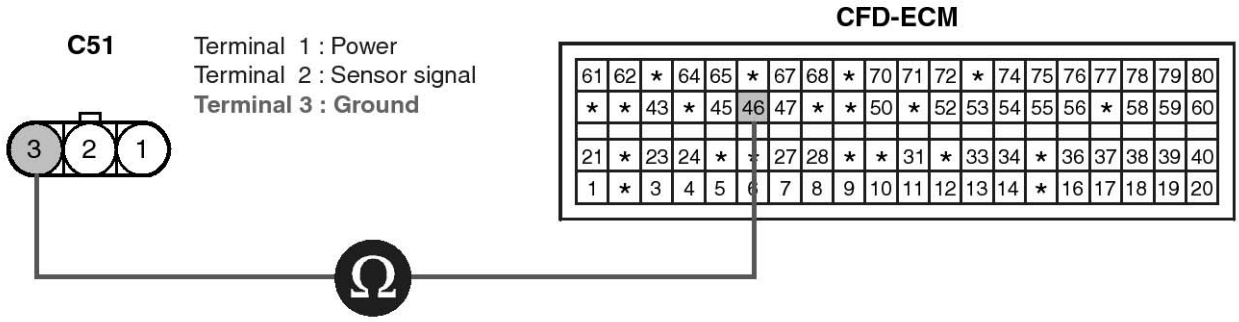
▶ Go to “Ground Circuit Inspection” procedure.

NO

▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.

GROUND CIRCUIT INSPECTION

1. Disconnect the differential pressure sensor connector and ECM connector (CFD-ECM).
2. Turn the ignition ON. Leave the engine OFF.
3. Measure resistance between terminal 3 of the differential pressure sensor and terminal 46 of ECM connector (CFD-ECM).
   ■ Specification: Continuity (Below 1Ω)



SUDFLDTC9106L

4. Is the resistance measured within specification?

YES

▶ Go to “Signal Circuit Inspection” procedure.

NO

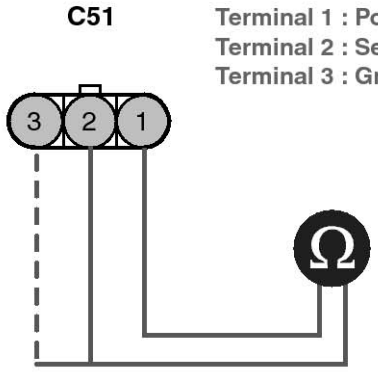
▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.

COMPONENT INSPECTION

1. Disconnect the differential pressure sensor connector.
2. Turn the ignition OFF.
3. Measure resistance between each terminal of the differential pressure sensor (C51).

■ Specification:

Terminal	1-2	1-3	2-3
Specification	5 KΩ	6.3 KΩ	10.5 KΩ



SUDFLDTC9107L

4. Is the resistance measured within specification?

YES

▶ Go to “Verification of Vehicle Repair” procedure.

NO

▶ Replace the differential pressure sensor and then go to “Verification of Vehicle Repair” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

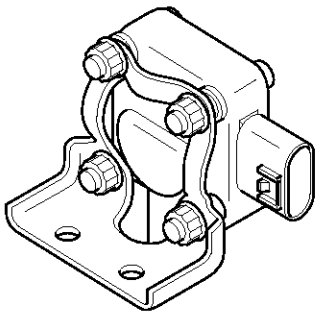
▶ Go to the applicable DTC procedure.

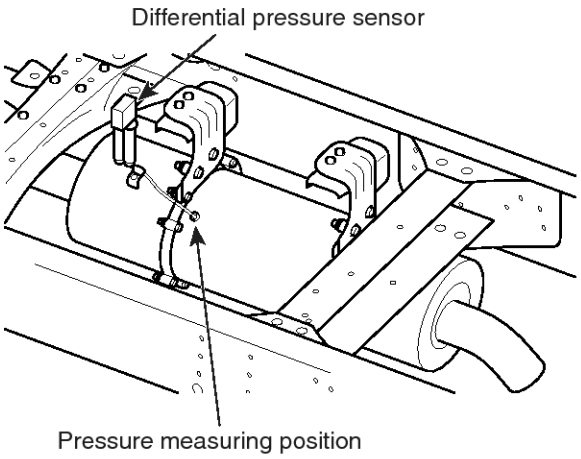
NO

▶ System OK

P2455 Differential Pressure Sensor Signal Too High

COMPONENT LOCATION





SUDFLDTC9101L

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   The differential pressure sensor is installed upper side of PMC and measures the pressure difference between before and after PMC. If the pressure difference is above or below the specified value, the ECM considers that the stored soot inside the PMC is excessive. It also has a purpose to monitor that PMC is arbitrarily removed by a user.

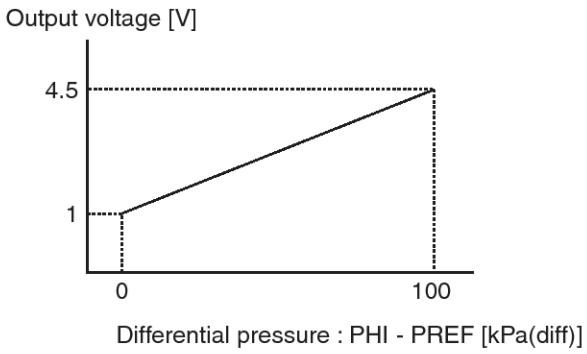
2. DTC DESCRIPTION

   If the output value of differential pressure sensor is detected above 4.8V for 3,008ms or more, the ECM judges this as a fault and DTC is set. The probable causes are short to power of terminal 70 of ECM connector (CFD-ECM).

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Poor wiring harness • Short to power of terminal 70 of ECM
Enable Conditions	• Engine running			
Threshold Value	• Sensor output>4.8V			
Diagnosis Time	• 3,008ms			
Fail Safe	Fuel Cut	-		
	Fuel limit	-		
	Check lamp	ON		

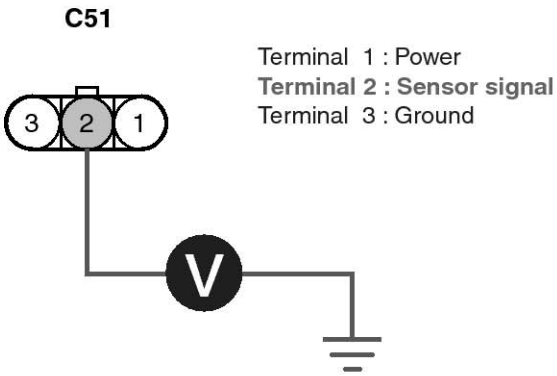
SPECIFICATION



SUDFLDTC9102L

SIGNAL CIRCUIT INSPECTION

1. Disconnect the differential pressure sensor connector.
2. Turn the ignition ON. Leave the engine OFF.
3. Measure voltage between terminal 2 of the differential pressure sensor and chassis ground.
   ■ Specification: Approx. 5V



SUDFLDTC9104L

4. Is the voltage measured within specification?

YES

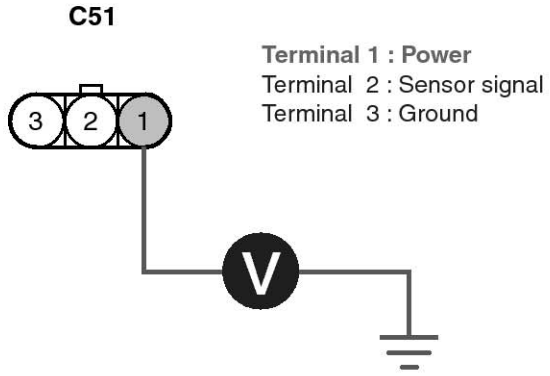
▶ Go to “Component Inspection” procedure.

NO

▶ Repair open or short to ground and then go to “Verification of Vehicle Repair” procedure.

POWER SUPPLY INSPECTION

1. Disconnect the differential pressure sensor connector.
2. Turn the ignition ON. Leave the engine OFF.
3. Measure voltage between terminal 1 of the differential pressure sensor and chassis ground.
   ■ Specification: Approx. 5V



SUDFLDTC9105L

4. Is the voltage measured within specification?

YES

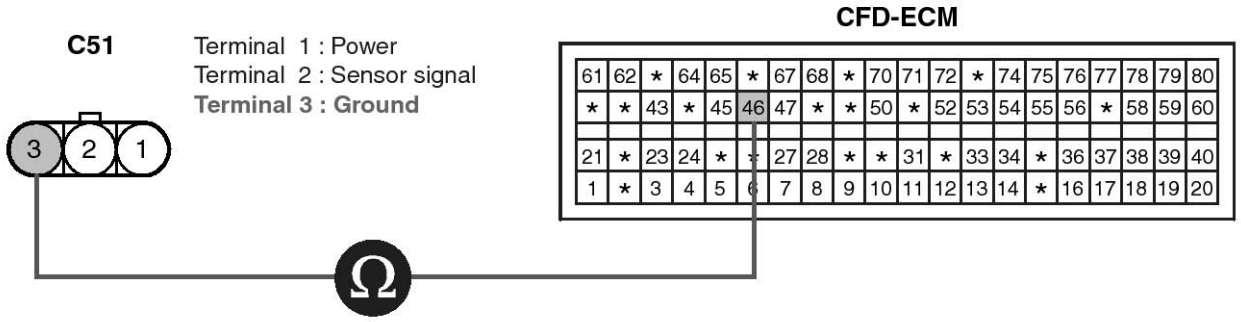
▶ Go to “Ground Circuit Inspection” procedure.

NO

▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.

GROUND CIRCUIT INSPECTION

1. Disconnect the differential pressure sensor connector and ECM connector (CFD-ECM).
2. Turn the ignition ON. Leave the engine OFF.
3. Measure resistance between terminal 3 of the differential pressure sensor and terminal 46 of ECM connector (CFD-ECM).
   ■ Specification: Continuity (Below 1Ω)



SUDFLDTC9106L

4. Is the resistance measured within specification?

YES

▶ Go to “Signal Circuit Inspection” procedure.

NO

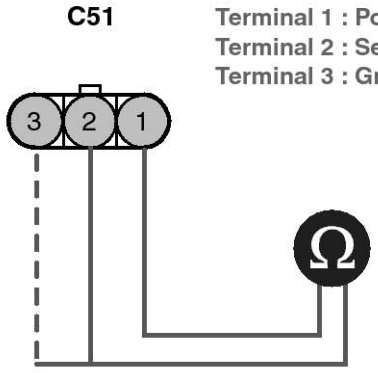
▶ Repair open circuit and then go to “Verification of Vehicle Repair” procedure.

COMPONENT INSPECTION

1. Disconnect the differential pressure sensor connector.
2. Turn the ignition OFF.
3. Measure resistance between each terminal of the differential pressure sensor (C51).

■ Specification:

Terminal	1-2	1-3	2-3
Specification	5 KΩ	6.3 KΩ	10.5 KΩ



SUDFLDTC9107L

4. Is the resistance measured within specification?

YES

▶ Go to “Verification of Vehicle Repair” procedure.

NO

▶ Replace the differential pressure sensor and then go to “Verification of Vehicle Repair” procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

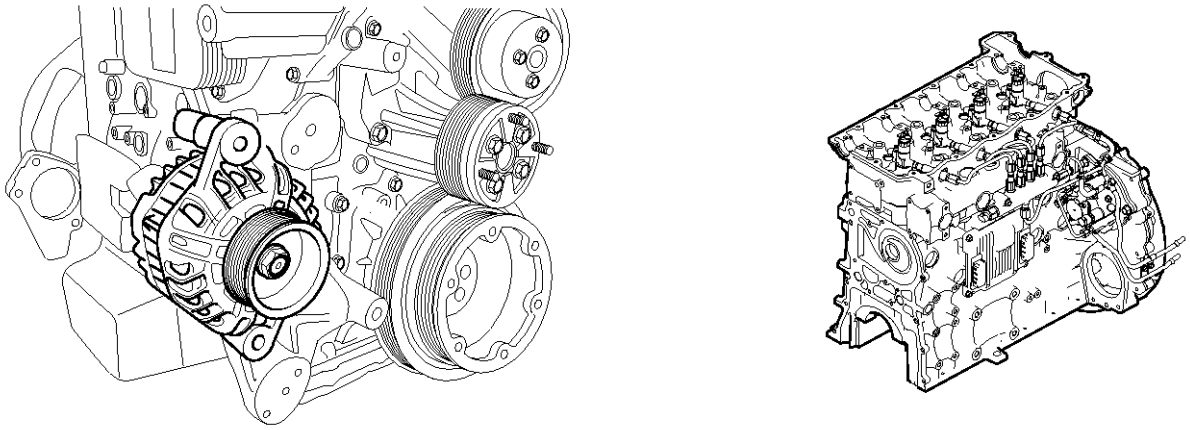
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P2503 Capacitor Charge-up Circuit Malfunction (Insufficient Charge)

COMPONENT LOCATION



SUDFL8426D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   The ECM should be able to effectively control the injector that hydraulic pressure of max. 1,800 bar is applied. The injector, electronic diesel engine, is current control type and the change of driving voltage converts into change of current and compensates for injector driving current value by detecting injector driving voltage. When the voltage change of range that exceeds current compensation limit according to the change of injector driving voltage of ECM occurs, fuel injection control that the ECM targets is impossible and ECM controls fuel and fuel pressure supplied to engine with a certain amount and limits vehicle output.

2. DTC DESCRIPTION

   If "No charge" in the circuit inside ECM is detected for 96 ms or more, the ECM judges this as a fault and DTC is set. The probable cause may be bad booster system in voltage, poor charging of alternator, faulty ECM. In case of fail safe, lack of engine power will occur since fuel amount is limited to below 40mm³/st, fuel pressure is limited to 60 Mpa. PTO(if equipped) operation stops and engine power is restricted, starting is impossible.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Alternator • Charge circuit • Defective ECM internal
Enable Conditions	• At IG ON/ running			
Threshold Value	• When no charge is detected from the ECM internal circuit			
Diagnosis Time	• 96ms or higher			
Fail Safe	Fuel Cut	No	• Fuel amount sets to below 40㎣/st. • Fuel pressure sets to 60Mpa. • PTO control stop • Cruise release	
	Fuel limit	Yes		
	Check lamp	ON		

TROUBLESHOOTING AID

There is no special diagnostic procedure on this diagnostic trouble code due to the internal error of ECM. Replace the ECM with new one if there is not the diagnostic trouble code any more after checking the vehicle with a known-good ECM.

COMPONENT INSPECTION

1. Turn the ignition OFF. Leave the engine OFF.
2. Remove the ECM from the vehicle.
3. Install a known-good ECM, check the system operates well.
4. Replace the ECM with new one if there is not the DTC anymore.

NOTICE

By using the scan tool when replacing the ECM, be sure to correct ECM data with the injector QR correction value (30-digit) installed to the current engine. Engine performance and exhaust gas problem can occur when the correction value marked to the injector is not input.

1. *Upgrade when replacing the ECM.*
2. *Correct the ECM data.*
   - *QR code data input*
   - *Gear ratio correction value*
   - *Final reduction ratio/ tire radius input*
   - *VIN input*

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

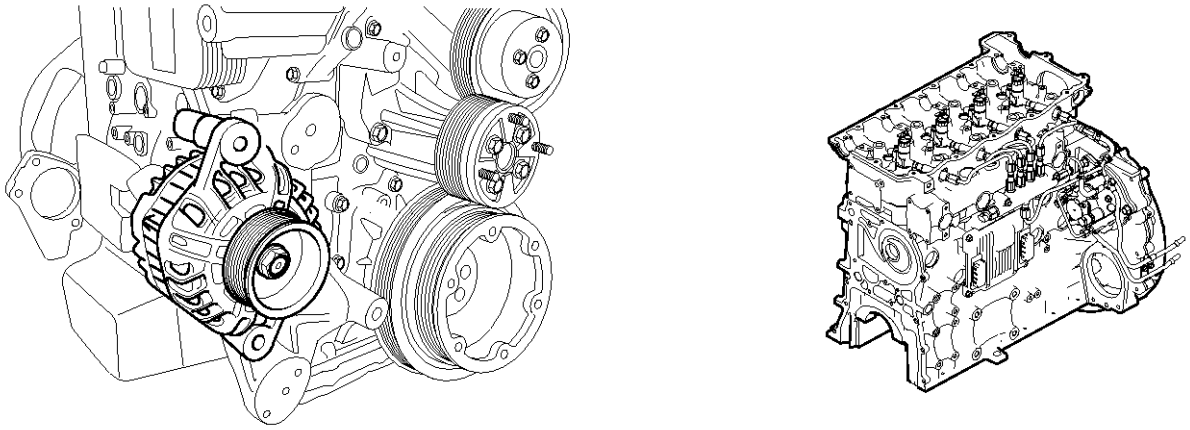
▶ Go to the applicable DTC procedure.

NO

▶ System OK

P2504 Capacitor Charge-up Circuit Malfunction (Excessive Charge)

COMPONENT LOCATION



SUDFL8426D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   The ECM should be able to effectively control the injector that hydraulic pressure of max. 1,800 bar is applied. The injector, electronic diesel engine, is current control type and the change of driving voltage converts into change of current and compensates for injector driving current value by detecting injector driving voltage. When the voltage change of range that exceeds current compensation limit according to the change of injector driving voltage of ECM occurs, fuel injection control that the ECM targets is impossible and ECM controls fuel and fuel pressure supplied to engine with a certain amount and limits vehicle output.

2. DTC DESCRIPTION

   If "Over charge" in the circuit inside ECM is detected for 96 ms or more, the ECM judges this as a fault and DTC is set. The probable cause may be bad booster system in voltage, poor charging of alternator, faulty ECM. In case of fail safe, starting is impossible.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Alternator • Charge circuit • Defective ECM internal
Enable Conditions	• At IG ON/ running			
Threshold Value	• When over charge is detected from the ECM internal circuit			
Diagnosis Time	• 96ms or higher			
Fail Safe	Fuel Cut	No	• Engine stop	
	Fuel limit	Yes		
	Check lamp	ON		

TROUBLESHOOTING AID

There is no special diagnostic procedure on this diagnostic trouble code due to the internal error of ECM. Replace the ECM with new one if there is not the diagnostic trouble code any more after checking the vehicle with a known-good ECM.

COMPONENT INSPECTION

1. Turn the ignition OFF. Leave the engine OFF.
2. Remove the ECM from the vehicle.
3. Install a known-good ECM, check the system operates well.
4. Replace the ECM with new one if there is not the DTC anymore.

NOTICE

By using the scan tool when replacing the ECM, be sure to correct ECM data with the injector QR correction value (30-digit) installed to the current engine. Engine performance and exhaust gas problem can occur when the correction value marked to the injector is not input.

1. *Upgrade when replacing the ECM.*
2. *Correct the ECM data.*
   - *QR code data input*
   - *Gear ratio correction value*
   - *Final reduction ratio/ tire radius input*
   - *VIN input*

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

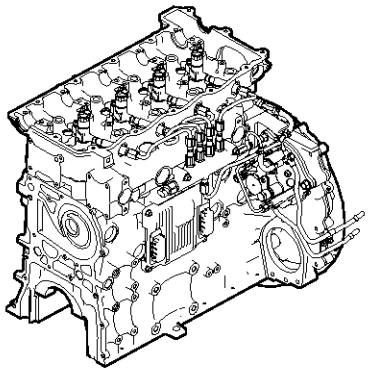
▶ Go to the applicable DTC procedure.

NO

▶ System OK

U0001 CAN1 BUS / Node Error (500K)

COMPONENT LOCATION



SDFFL7104D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   There are various control modules to control vehicle for computerization in the vehicle. These modules receive much information through many sensors or switches and controls system for optimization of vehicle. It became necessary to use together and share information of sensors between each control unit. The CAN communication method has been adopted to the vehicle power train control(engine, ABS, EGR etc.) to make high speed communication possible as well as to be strong to outside noise. ECM performs active control after shared with such signals as engine revolution, accelerator position sensor, shift range, torque reduction etc. through CAN communication. And ECM and ABS control module perform active control after shared with such signals as brake and engine revolution through CAN communication.

2. DTC DESCRIPTION

   It is set when signal transmission through CAN 1 communication line is impossible for more than 1,312 ms because of open or short to ground in CAN 1 communication line. Checking CAN 1 communication BUS and signals from ECM is required.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Signal open circuit of terminal 16, 36 of ECM (CFD-ECM) • Short to CAN1 High ground • Short to CAN1 Low power • Check the connector for poor connection.
Enable Conditions	• At IG ON			
Threshold Value	• CAN1 communication impossible			
Diagnosis Time	• 1,312ms or higher			
Fail Safe	Fuel Cut	No		
	Fuel limit	No		
	Check lamp	ON		

WAVEFORM

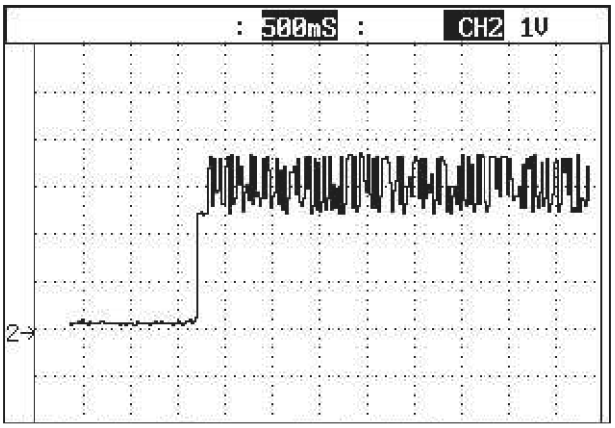


Fig. 1 CAN communication HI

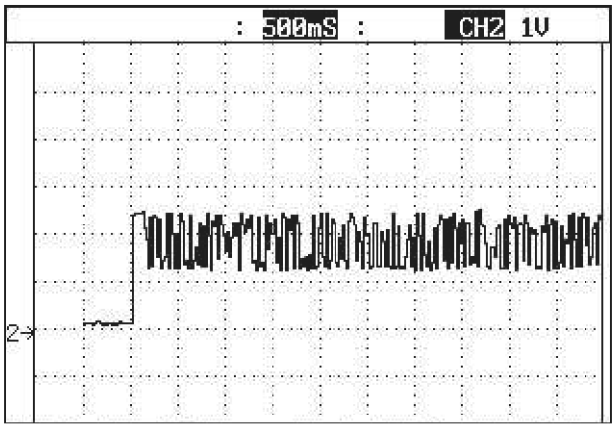


Fig. 2 CAN communication LOW

SUDFLDTC9098L

MONITOR SCAN TOOL DATA

1. Turn the ignition OFF. Leave the engine OFF.
2. Connect scan tool to the self-diagnosis connector (M72).
3. Turn the ignition ON.
4. Select the model year and system of vehicle to diagnose and press ENTER.
5. Does the system communicate with each other?

YES

▶ A fault is intermittently caused by poor contact of wiring harness or was repaired and ECM memory was not cleared. Thoroughly check wiring harness and then go to "Verification of Vehicle Repair" procedure.

NO

▶ Go to "Signal Circuit Inspection" procedure.

SIGNAL CIRCUIT INSPECTION

1. Signal Voltage Inspection
   1) Turn the ignition ON. Leave the engine OFF.
   2) Measure voltage of the terminal 16 (CAN1 LOW) of self diagnosis connector (M72).
   3) Measure voltage of the terminal 8 (CAN1 HIGH) of self diagnosis connector (M72)

      ■ Specification: CAN (HIGH) communication supply power approx. 2.4V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to "Component Inspection" procedure.

      NO

      ▶ Go to "Signal Open Inspection" procedure.
2. Signal Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the ECM connector(CFD-ECM).
   3) Measure resistance between the terminal 8 of self diagnosis connector (M72) and the terminal 36 of engine ECM connector(CFD-ECM).
   4) Measure resistance between the terminal 16 of self diagnosis connector (M72) and the terminal 16 of engine ECM connector(CFD-ECM).

      ■ Specification: Continuity
   5) Is the resistance measured within specification?

      YES

      ▶ Go to "Signal CAN1 HIGH Short to Ground Inspection" procedure.

      NO

      ▶ Repair open circuit and then go to "Verification of Vehicle Repair" procedure.
3. Signal CAN1 HIGH Short to Ground Inspection
   1) Disconnect the ECM connector(CFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure resistance between the terminal 8 of self diagnosis connector (M72) and chassis ground.

      ■ Specification: Infinite

4) Is the resistance measured within specification?

YES

▶ Go to “Component Inspection” procedure.

NO

▶ Repair short to ground and then go to “Verification of Vehicle Repair” procedure.

4. Signal CAN1 LOW Short to Power Inspection
   1) Disconnect the ECM connector(CFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure resistance between the terminal 16 of self diagnosis connector (M72) and chassis ground.
      ■ Specification: Below 0~0.1V
   4) Is the voltage measured within specification?

YES

▶ Go to “Component Inspection” procedure.

NO

▶ Repair short to power and then go to “Verification of Vehicle Repair” procedure.

COMPONENT INSPECTION

1. ECM Component Inspection
   1) Turn the ignition OFF.
   2) Disconnect the ECM connector(CFD-ECM).
   3) Check the ECM for water inflow and internal burnt smell.
   4) Reconnect the ECM and perform the diagnostic troubleshooting.
2. Is the diagnostic troubleshooting normal?

YES

▶ Go to “Verification of Vehicle Repair” procedure.

NO

▶ Replace the engine ECM and go to “Verification of Vehicle Repair” procedure.

⚠CAUTION

Before replacing the ECM, check the ECM for connection state of communication cable, the normal input/output power of ECM.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

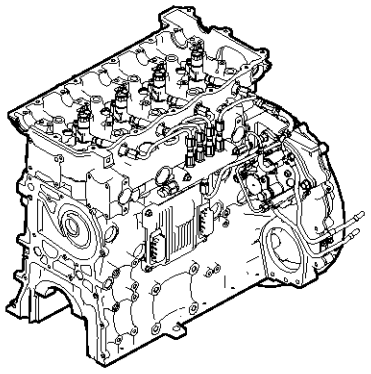
▶ Go to the applicable DTC procedure.

NO

▶ System OK

U0010 CAN2 BUS / Node Error (250K)

COMPONENT LOCATION



SDFFL7104D

DIAGNOSTIC TROUBLE CODE DESCRIPTION

1. GENERAL DESCRIPTION

   There are various control modules to control vehicle for computerization in the vehicle. These modules receive much information through many sensors or switches and controls system for optimization of vehicle. It became necessary to use together and share information of sensors between each control unit. The CAN communication method has been adopted to the vehicle power train control(engine, ABS, EGR etc.) to make high speed communication possible as well as to be strong to outside noise. ECM performs active control after shared with such signals as engine revolution, accelerator position sensor, shift range, torque reduction etc. through CAN communication. And ECM and ABS control module perform active control after shared with such signals as brake and engine revolution through CAN communication.

2. DTC DESCRIPTION

   It is set when signal transmission through CAN 2 communication line is impossible for more than 1,312 ms because of open or short to ground in CAN 2 communication line. Checking CAN 1 communication BUS and signals from ECM is required.

DTC DETECTING CONDITION

Item	Detecting Condition			Possible Cause
DTC Strategy	• Voltage monitoring			• Signal open circuit of terminal 17, 37 of ECM (CFD-ECM) • Short to CAN2 High ground • Short to CAN2 Low power • Check the connector for poor connection.
Enable Conditions	• At IG ON			
Threshold Value	• CAN2 communication impossible			
Diagnosis Time	• 1,312ms or higher			
Fail Safe	Fuel Cut	No		
	Fuel limit	No		
	Check lamp	ON		

WAVEFORM

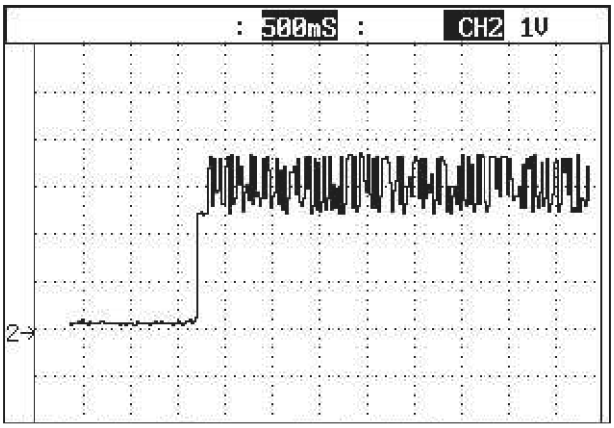


Fig. 1 CAN communication HI

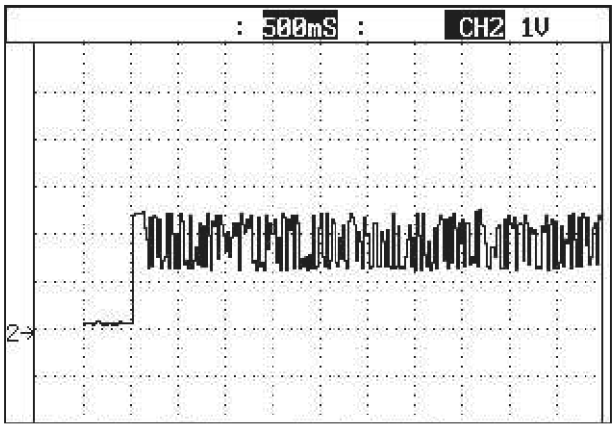


Fig. 2 CAN communication LOW

SUDFLDTC9098L

MONITOR SCAN TOOL DATA

1. Turn the ignition OFF. Leave the engine OFF.
2. Connect scan tool to the self-diagnosis connector (M72).
3. Turn the ignition ON.
4. Select the model year and system of vehicle to diagnose and press ENTER.
5. Does the system communicate with each other?

YES

▶ A fault is intermittently caused by poor contact of wiring harness or was repaired and ECM memory was not cleared. Thoroughly check wiring harness and then go to "Verification of Vehicle Repair" procedure.

NO

▶ Go to "Signal Circuit Inspection" procedure.

SIGNAL CIRCUIT INSPECTION

1. Signal Voltage Inspection
   1) Turn the ignition ON. Leave the engine OFF.
   2) Measure voltage of the terminal 11 (CAN2 LOW) of self diagnosis connector (M72).
   3) Measure voltage of the terminal 3 (CAN2 HIGH) of self diagnosis connector (M72).

      ■ Specification: CAN (HIGH) communication supply power approx. 2.4V
   4) Is the voltage measured within specification?

      YES

      ▶ Go to "Component Inspection" procedure.

      NO

      ▶ Go to "Signal Open Inspection" procedure.
2. Signal Open Inspection
   1) Turn the ignition OFF.
   2) Disconnect the ECM connector(CFD-ECM).
   3) Measure resistance between the terminal 3 of self diagnosis connector (M72) and the terminal 37 of engine ECM connector(CFD-ECM).
   4) Measure resistance between the terminal 11 of self diagnosis connector (M72) and the terminal 17 of engine ECM connector(CFD-ECM).

      ■ Specification: Continuity
   5) Is the resistance measured within specification?

      YES

      ▶ Go to "Signal CAN2 HIGH Short to Ground Inspection" procedure.

      NO

      ▶ Repair open circuit and then go to "Verification of Vehicle Repair" procedure.
3. Signal CAN2 HIGH Short to Ground Inspection
   1) Disconnect the ECM connector(CFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure resistance between the terminal 3 of self diagnosis connector (M72) and chassis ground.

      ■ Specification: Infinite

4) Is the resistance measured within specification?

YES

▶ Go to “Component Inspection” procedure.

NO

▶ Repair short to ground and then go to “Verification of Vehicle Repair” procedure.

4. Signal CAN2 LOW Short to Power Inspection
   1) Disconnect the ECM connector(CFD-ECM).
   2) Turn the ignition ON. Leave the engine OFF.
   3) Measure resistance between the terminal 11 of self diagnosis connector (M72) and chassis ground.
      ■ Specification: Below 0~0.1V
   4) Is the voltage measured within specification?

YES

▶ Go to “Component Inspection” procedure.

NO

▶ Repair short to power and then go to “Verification of Vehicle Repair” procedure.

COMPONENT INSPECTION

1. ECM Component Inspection
   1) Turn the ignition OFF.
   2) Disconnect the ECM connector(CFD-ECM).
   3) Check the ECM for water inflow and internal burnt smell.
   4) Reconnect the ECM and perform the diagnostic troubleshooting.
2. Is the diagnostic troubleshooting normal?

YES

▶ Go to “Verification of Vehicle Repair” procedure.

NO

▶ Replace the engine ECM and go to “Verification of Vehicle Repair” procedure.

⚠CAUTION

Before replacing the ECM, check the ECM for connection state of communication cable, the normal input/output power of ECM.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select “Diagnostic Trouble Codes (DTCs)” mode and then clear DTC.
2. Drive the vehicle under conditions noted in failure records.
3. Did the DTC return?

YES

▶ Go to the applicable DTC procedure.

NO

▶ System OK