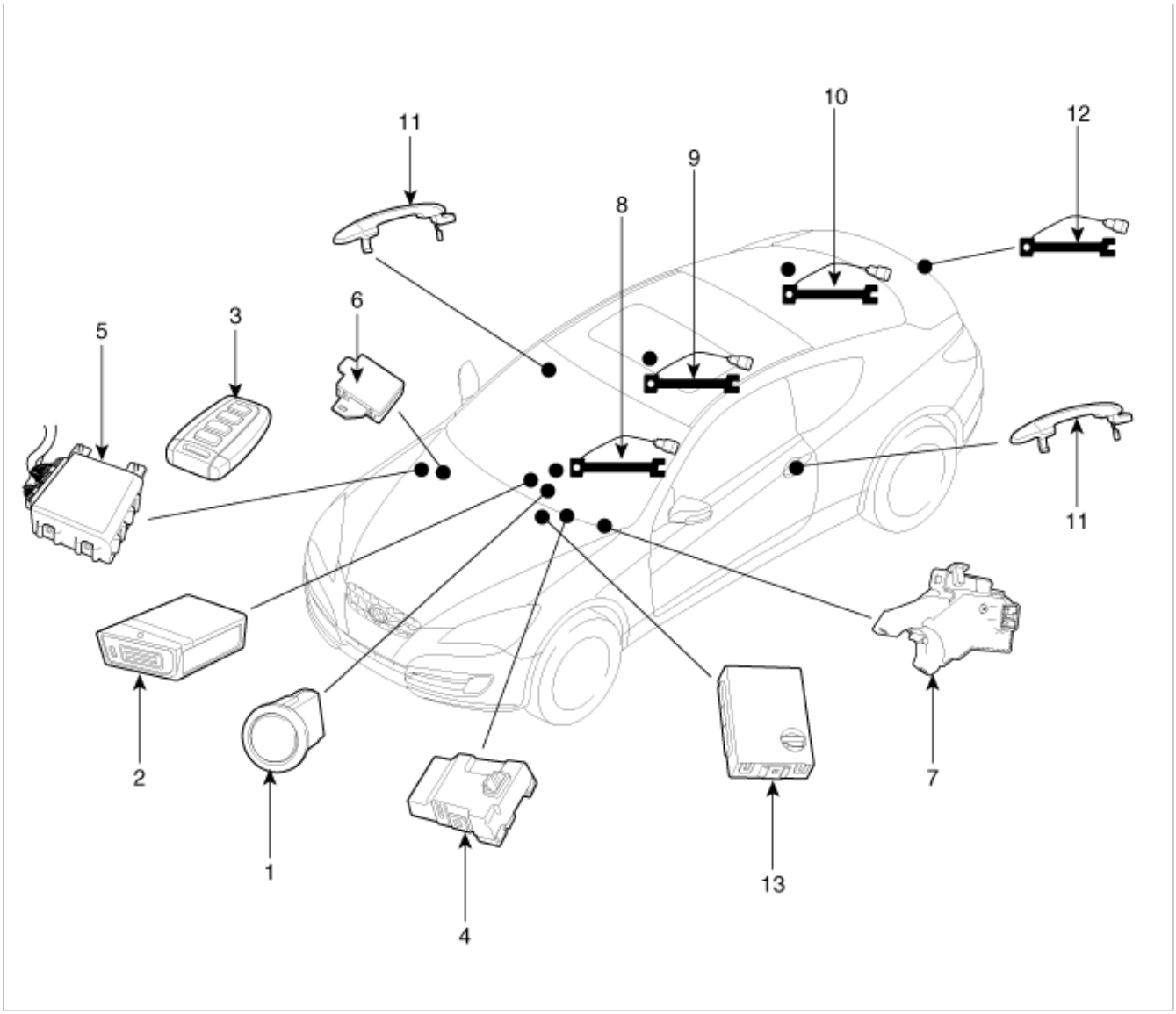
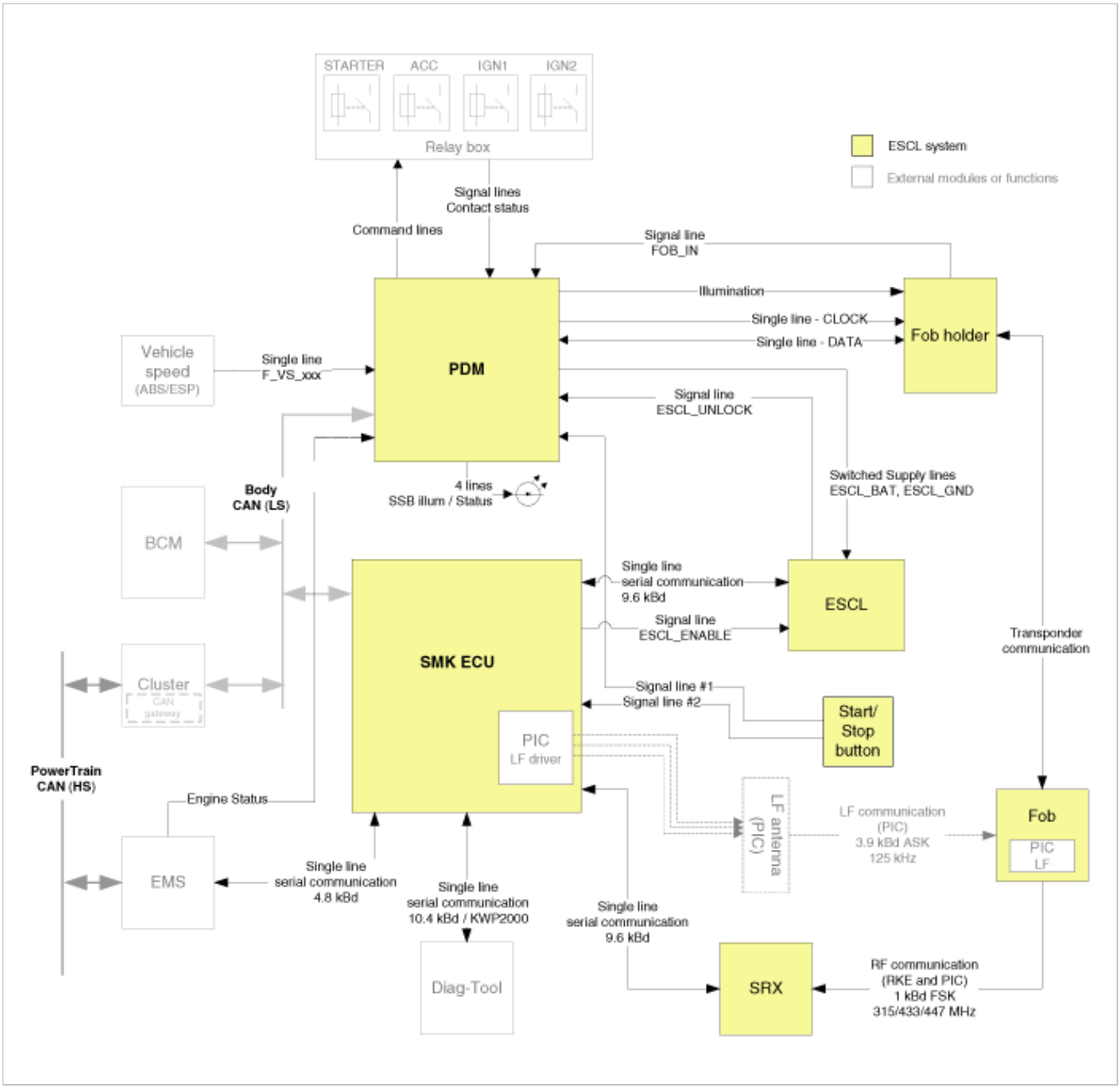
Component Location



1. Start Stop Button(SSB)	8. Interior antenna 1
2. FOB key holder	9. Interior antenna 2
3. FOB key	10. Interior antenna 3
4. PDM(Power Distribution Module)	11. Door handle & door antenna
5. Smart key unit	12. Bumper antenna
6. RF receiver	13. Body control module
7. ESCL(Electrical Steering Column Lock)	

Circuit Diagram



Description

System Overview

The System offers the following features:

- Human machine interface through a 1-stage button, for terminal switching and engine start.
- Control of external relays for ACC / IGN1 / IGN2 terminal switching and STARTER, without use of mechanical ignition switch.
- Steering column locking with an ESCL device; Monitoring of the vehicle status to insure safe activation of the ESCL.
- Indication of vehicle status through LED or explicit messages on display.
- Immobilizer function by LF transponder communication between fob and fob holder.
- Redundant architecture for high system dependability .
- Interface with Low Speed CAN vehicle communication network.
- Interface with LIN vehicle communication network depending on platform .

The RKE and SMART KEY functions are not considered part of this Button Engine Start system and are specified in separated system.

System Main Function

- Steering column locking/unlocking with ESCL.
- Switching of ACC / IGN1 / IGN2 terminals.
- Control of the STARTER relay BAT line (high side) based on communication with EMS ECU.
- Management of the Immobilizer function.
- Management of BES warning function.

Button Engine Start System

The Button Start System allows the driver to operate the vehicle by simply pressing a button (called as SSB) instead of using a standard mechanical key. It also manages the locking and the unlocking of the steering column (called as ESCL) without any specific actions by the driver.

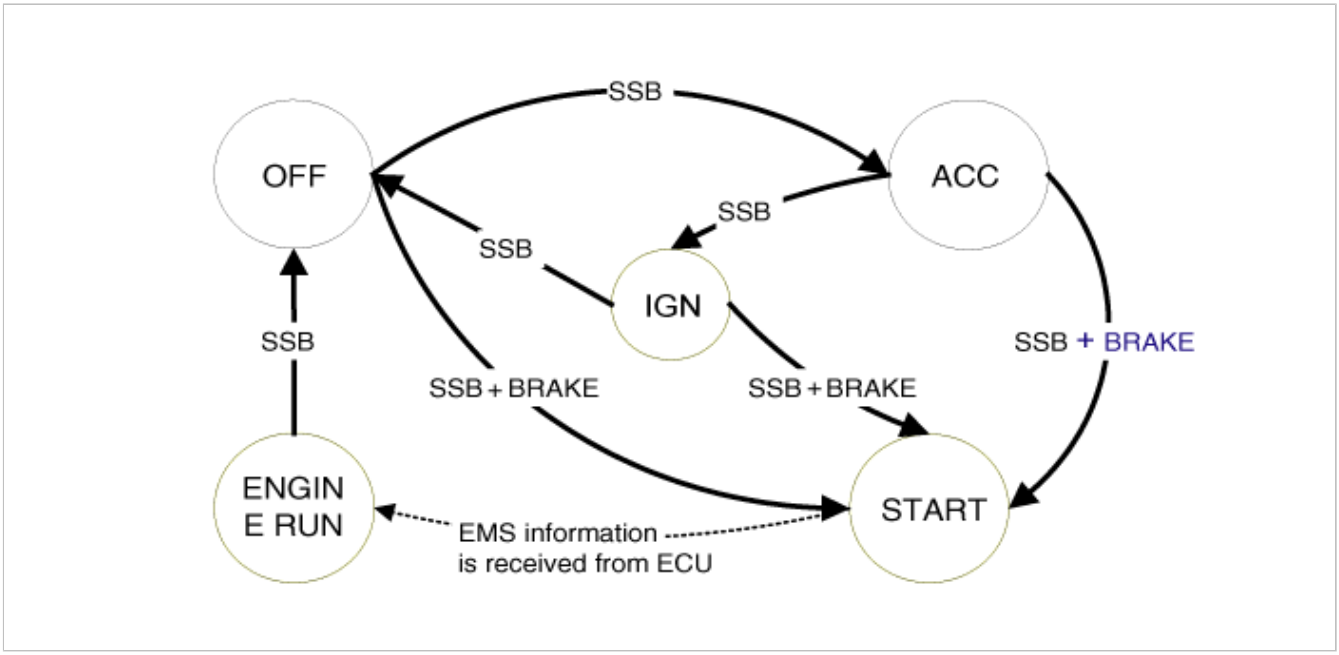
If the driver press the SSB while prerequisites on brakes, fob authentication and transmission status are satisfied, the BES System will proceed with the locking/unlocking of the steering column, the control of the terminal, and the cranking of the engine.

The driver can release the SSB as soon as this sequence initiated. After positive response from immobilizer interrogation, the system will activate the starter motor and communicate with the EMS to check the engine running status for starter release.

The driver will be able to stop the engine by a short push on the SSB if the vehicle is already in standstill. Emergency engine stop will be possible by a long press of the SSB or 3 consecutive presses in case the vehicle is in ENGINE RUNNING.

If the conditions for engine cranking are not satisfied while a push on the SSB is detected and a valid fob authenticated, the system will unlock the steering column and switch the terminals to IGN. Another push on the SSB will be necessary to start the engine.

In case of a vehicle equipped with SMART KEY system, fob authentication will not require any action from the driver. For limp home start or in case of vehicle without SMART KEY, the driver will have to insert the fob into the fob holder.



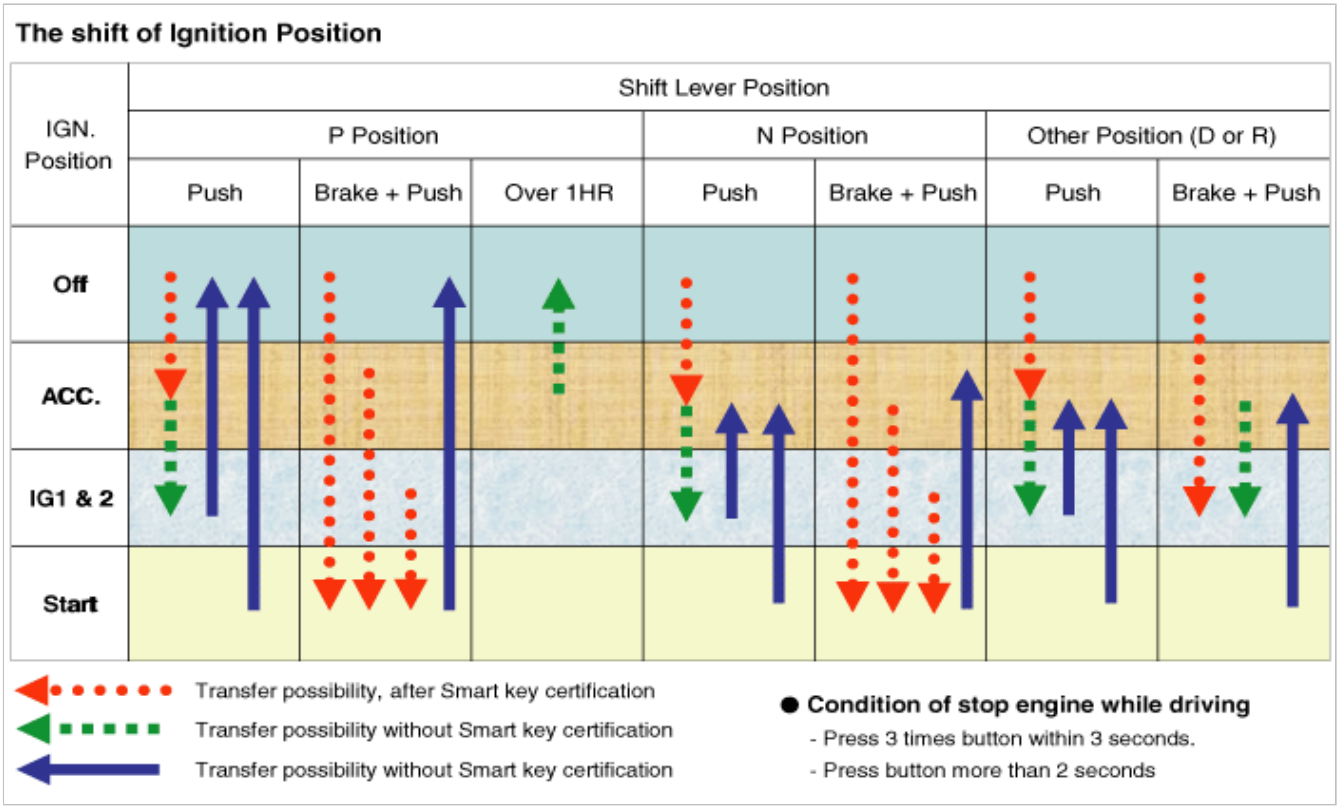
- Control Ignition and engine ON/OFF by Sending signal to IPM and PDM.
- Display status by LED Lamp ON/OFF. (Amber or Blue)

Indicator ON/OFF Condition At Ignition Key Off Condition

No.	Character lamp	Conditions
1	Indicator Lamp ON	Door open, Tail lamp ON, ACC, IG ON
2	Indicator Lamp 30sec ON → Lamp OFF	Door close, Tail lamp OFF, IG OFF
3	Indicator Lamp OFF	Remote LOCK, Passive LOCK
4	Rheostat at tail lamp ON (Illumination lamp)	

Indicator ON/OFF Condition According To Ignition Key's Position

No.	Ignition conditions	Start Button LED status
1	IG OFF	LED OFF
2	IG ACC	Amber color LED ON
3	IG ON (Engine OFF)	Blue color LED ON
4	Cranking	Maintain LED status before cranking
5	Engine running	LED OFF



Wireless Communication

Electromagnetic waves are used to exchange information between the vehicle and the FOB. Two types of RKE Key can supplement the BES system:

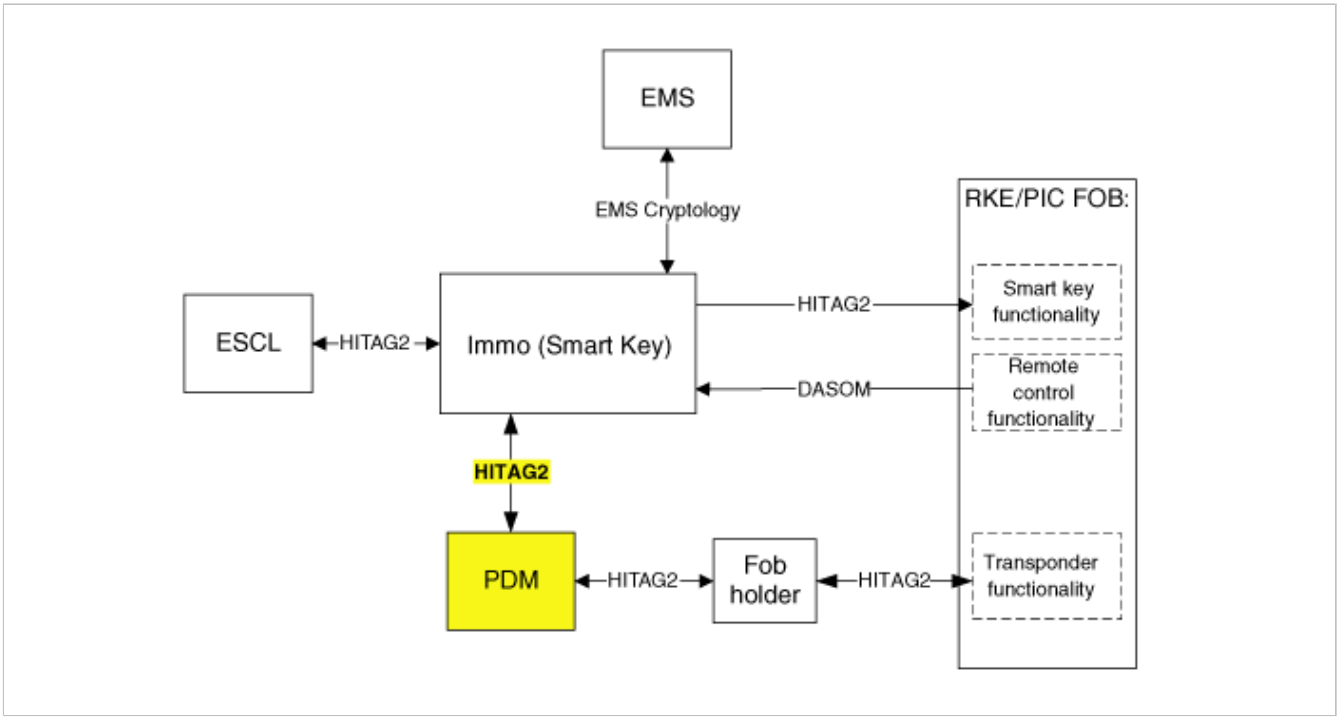
- Non-smart key RKE
- SMART KEY FOB

Currently the BES system comprises with SMART KEY FOB always.
The transmitter, receiver and antennas required for the communication between the fob and the vehicle will differ depending on functionalities and regional areas.
The RKE and SMART KEY functions are in separated documents. Refer to Smart key system for more detailed information about SMART KEY function.

Smart Key

The SMK manages all function related to:

- "Start Stop Button (SSB) monitoring",
- "Immobilizer communication" (with Engine Management System unit for immobilizer release),
- "ESCL control",
- "Authentication server" (Validity of Transponder and in case of Smart Key option Passive Fob authentication),
- "System consistency monitoring",
- "System diagnosis",
- Control of display message / warning buzzer .



The unit behaves as Master role in the whole system.
In case of SMART KEY application, for example “Passive Access”, “Passive Locking” and “Passive Authorization are integrated for ESCL/Terminal switching Operations”.
It collects information about vehicle status from other modules (vehicle speed, alarm status, driver door open...), read the inputs (e.g. SSB, Lock Button and PARK position Switch), controls the outputs (e.g. exterior and interior antennas), and communicates with others devices via the CAN network as well as a single line interfaces.
The diagnosis and learning of the components of the BES System are also handled by the SMK.

PDM

The PDM manages the functions related to the "terminal control" by activating external relays for ACC, IGN1 and IGN2. This unit is also responsible for the control of the STARTER relay.
It controls also the power supply of the ESCL by switching the power and ground ESCL supply lines depending on vehicle status. The purpose of this function is to prevent the ESCL to be energized if ACC or IGN are switched on.
The PDM is also controlling the illumination of the SSB as well as the "system status indicator", which consists of 2 LEDs of different color. The illumination of the fob holder is also managed by the PDM.
The PDM reads the inputs (Engine fob_in, vehicle speed, relays contact status, ESCL lock status), controls the outputs (Engine relay output drivers, ESCL power), and communicates with others devices via the CAN.
The internal architecture of the PDM is defined in a way that the control of the terminal and of the ESCL power is secured even in case of failure of one of the two microcontrollers, system inconsistency or interruption of communication on the CAN network.
In case, failure of one of the two controllers, the remaining controller shall disable the starter relay and the ESCL power supply. The IGN1 and IGN2 terminals relays shall be maintained in the state memorized before the failure and the driver shall be able to switch those IGN terminals off by pressing the SSB with EMERGENCY_STOP pressing sequence. However, engine restart will not be allowed. The state of the ACC relay will depend on the type of failure.
The PDM is diagnosed through the SMK MUT service, using the CAN network.
The main functions of the PDM are:

- Control of Terminal relays
- Monitoring of the Vehicle speed received from sensor or ABS/ESP ECU.
- Control of SSB LEDs (illumination, clamp state) and FOB HOLDER illumination.
- Control of ESCL power lines and monitoring of the ESCL unlock status
- Control of the base station located in fob holder through direct serial interface.
- System consistency monitoring to diagnose SMK failure and to switch to relevant limp home mode.
- Providing vehicle speed information

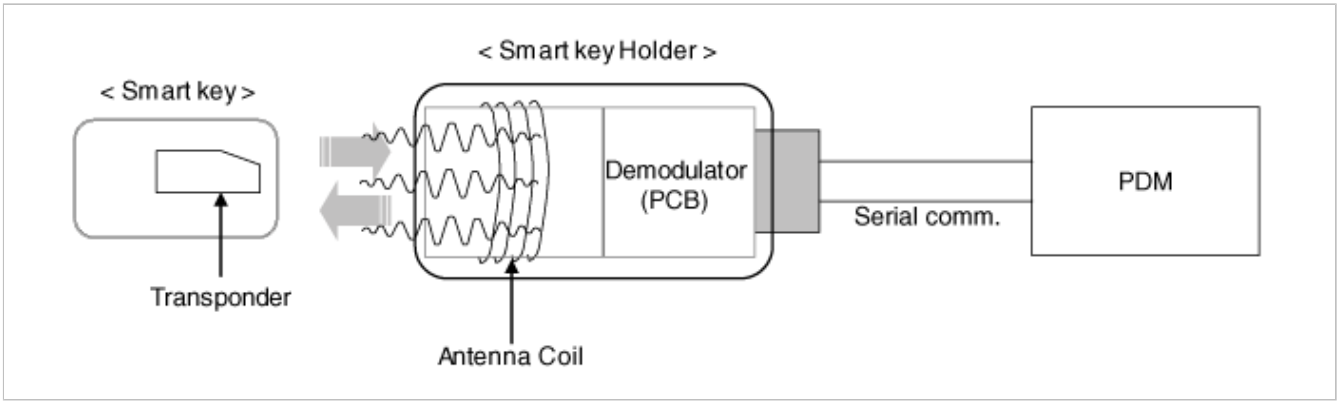
Fob Holder

This unit is used for transponder authentication. In case of a vehicle equipped with Smart key, this transponder

authentication is necessary in case of failure of the passive fob authentication (Engine loss of RF or LF link with the fob).
The Fob holder module integrates a slot where to insert the fob. The fob is maintained in position with a push-push mechanical locking (not electrically driven) and a signal (FOB_IN) is sent back to the PDM as soon as its insertion is detected.
The power supply of the fob holder is active only if a communication is initiated by the PDM.
The insertion of the fob into the holder and the communication with the transponder should be possible regardless of the insertion direction of fob to the holder (buttons facing up or bottom).
A lighting device is also integrated for illumination of the Fob Holder and it is driven directly by the PDM,
The main functions of the Fob holder are:

- Transponder base station
- Fob mechanical lock
- Illumination

Transponder



External Receiver(SRX)

The data transmitted by the RKE or Smart key Fob is received by an external RF receiver called as SRX. This receiver will be same as that one for the SMK applications, with respect to electronics, housing, connector and software.
This receiver is connected to the SMK via a serial communication line.

Terminal And Starter Relays

Relays will be used to switch the terminals ACC / IGN1 / IGN2. Those normally-open relays will be driven by the PDM and located either in the passenger or engine compartment depending on the vehicle architecture.
Only one relay coil is connected to the terminal outputs of the PDM.
Those relays should integrate a resistor connected in parallel to the coil in order to reduce the transients during commutation.

Start/Stop Button(SSB)

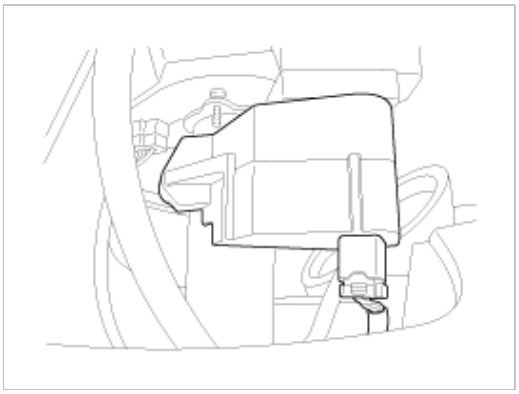
A single stage push button is used for the driver to operate the vehicle. Pressing this button allows:

- To activate the power modes ‘Off’, ’Accessory’, ‘Ignition’ and 'Start' by switching the corresponding terminals
- To start the engine
- To stop the engine

The contact will be insured by a micro-switch and a backlighting is provided to highlight the marking of the button whenever necessary.
Two (2) LED colors are located in the center of the button to display of the status of the system. Another illumination LED is also integrated into the SSB for the lighting of the "Engine Start/Stop" characters.

Electronic Steering Column Lock (ESCL)

The ESCL is needed to lock the steering column in order to prevent unauthorized usage of the vehicle. In order to achieve the required safety integrity level, the ESCL is controlled and monitored by 2 independent units, the SMK and the PDM. Such redundant architecture guarantees that the ESCL motor is supplied only during locking/unlocking operation and that it is disconnected from the battery and ground lines otherwise to avoid unexpected operation while the vehicle is in motion. Data are exchanged between the ESCL and SMK through an encrypted serial communication interface.



BES System State Chart

System STATES in LEARNT MODE

In learnt mode, the BES System can be set in 6 different sates, depending on the status of the terminals, ESCL and Engine status:

System State	Terminal Status	ESCL Status	Engine status
1. OFF - Locked	OFF	Locked	Stopped
2. OFF - Unlocked	OFF	Unlocked	Stopped
3. ACC	ACC	Unlocked	Stopped
4. IGN	IGN1, IGN2, ACC	Unlocked	Stopped
5. Start	IGN1, Start	Unlocked	Cranking
6. IGN - Engine	IGN1, IGN2, ACC	Unlocked	Running (means "self-running")

Referring to the terminals, the system states described in the table above are same as those one found in a system based on a mechanical ignition switch. The one of distinction with Mechanical-Ignition-Switch based system is that the BES system allows specific transition from [OFF] to [START] without going through [ACC] and [IGN] states.

System STATES IN VIRGIN MODE

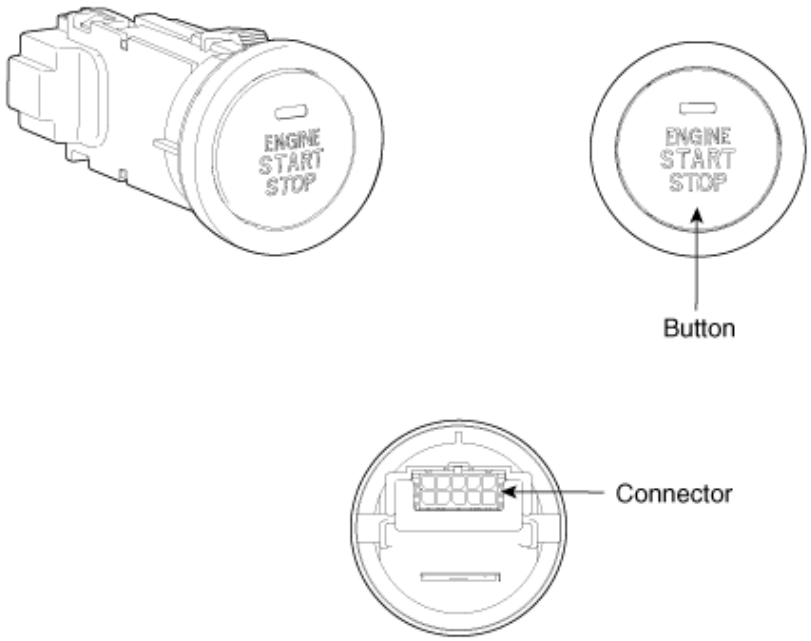
The BES System can be set in 5 different states (OFF LOCKED is not available in virgin mode), depending on the status of the terminals, ESCL and Engine status:

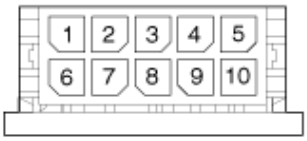
System State	Terminal Status	ESCL Status	Engine status
1. OFF - UNLOCKED	OFF	Unlocked	Stopped

2. ACC	ACC	Unlocked	Stopped
3. IGN	IGN1, IGN2, ACC	Unlocked	Stopped
4. Start	IGN1, START with special pattern of activation see Chap 6.2.1 for details	Unlocked	Cranking
5. IGN - Engine	IGN1, IGN2, ACC	Unlocked	Running (means "self-running")

Referring to the terminals, the system states described in the table above are same as those one found in a system based on a mechanical ignition switch. The one of distinction with Mechanical-Ignition-Switch based system is that the BES system allows specific transition from [OFF] to [START] without going through [ACC] and [IGN] states.

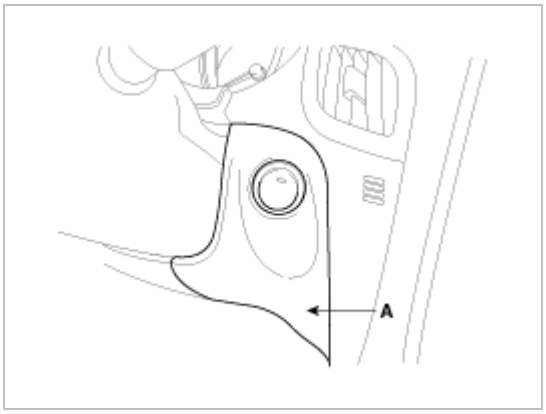
Component



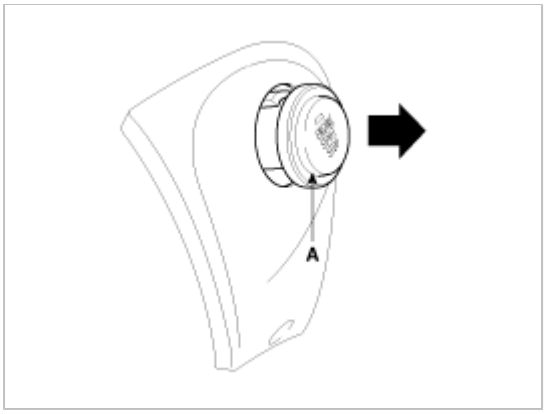
Connector (10 pins)			
Pin No.	Description	Pin No.	Description
1	Start/Stop button switch1(PDM)	6	Battery
2	Battery illumination	7	Start/Stop button switch2(IPM)
3	Start/Stop button LED Amber(PDM)	8	Start/Stop button LED Blue(PDM)
4	Start/Stop button illum. GND(PDM)	9	Rheostat
5	Start/Stop button illum. power	10	-

Removal

1. Disconnect the negative(-) battery terminal.
2. Remove the start/stop button cover(A).



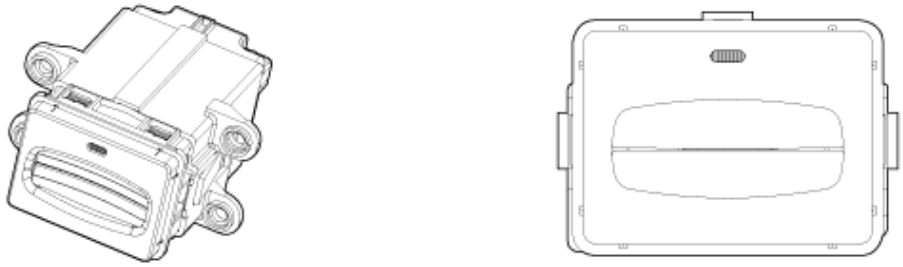
3. Remove the start/stop button (A).

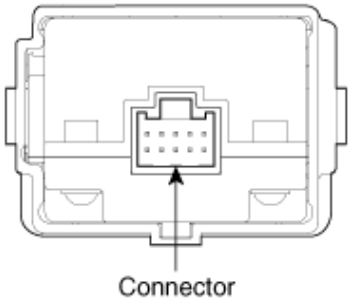


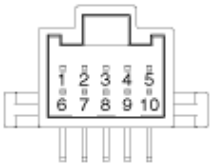
Installation

1. Install the start/stop button.
2. Install the start/stop button cover.

Component

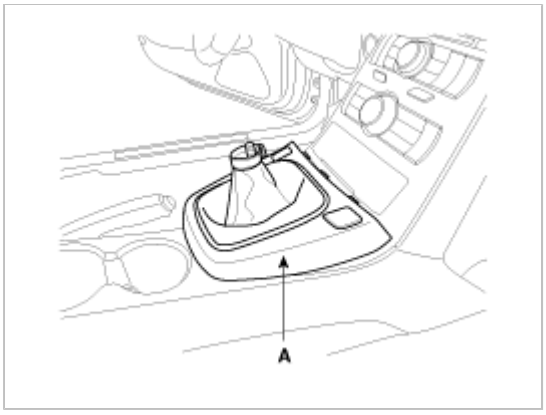




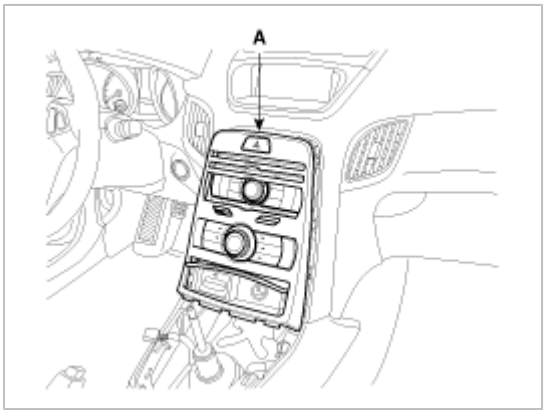
Connector (10 pins)			
Pin No.	Description	Pin No.	Description
1	-	6	Battery
2	Immobilizer clock	7	Immobilizer data
3	Holder illumination(PDM)	8	Illumination battery
4	-	9	Fob in (PDM)
5	GND	10	-

Removal

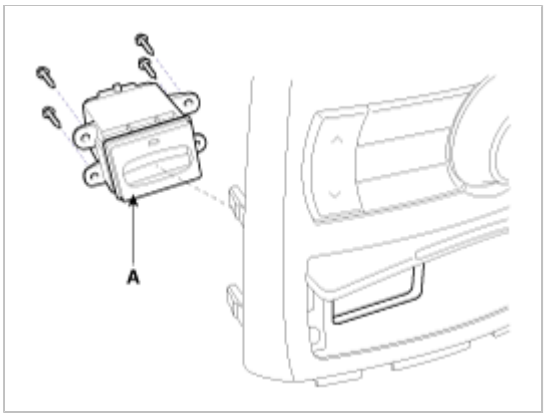
1. Disconnect the negative(-) battery terminal.
2. Remove the console upper cover(A).
   (Refer to BD group - "Console")



3. Remove the center fascia lower panel(A).



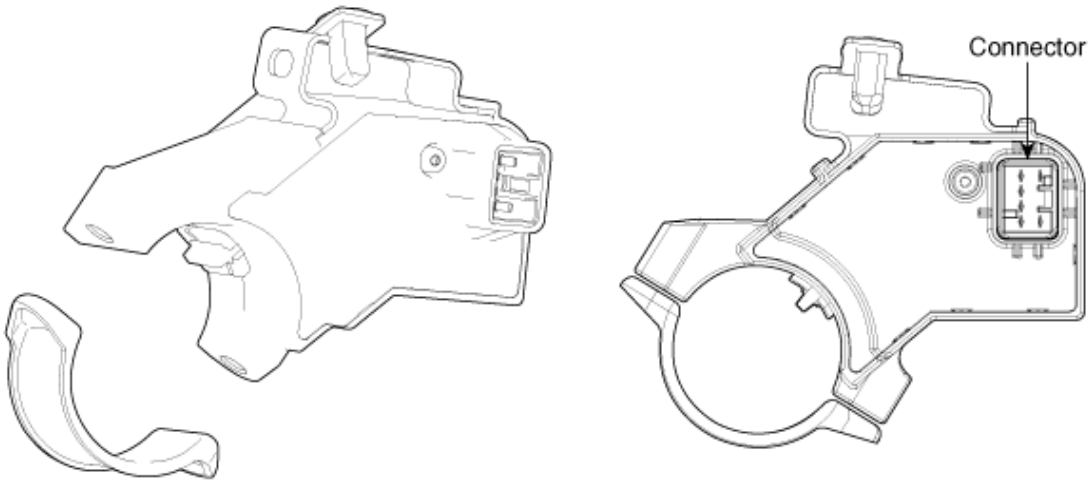
4. Disconnect the connector and remove the fob holder(A) after loosening the mounting screws.



Installation

1. Install the fob holder assembly.
2. Install the center fascia lower panel.
3. Install the console upper cover.

Component

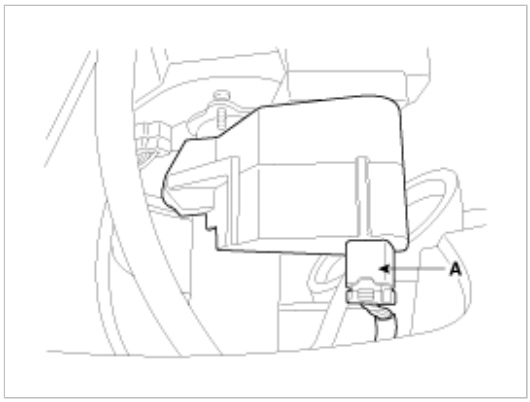


Connector (6 pins)

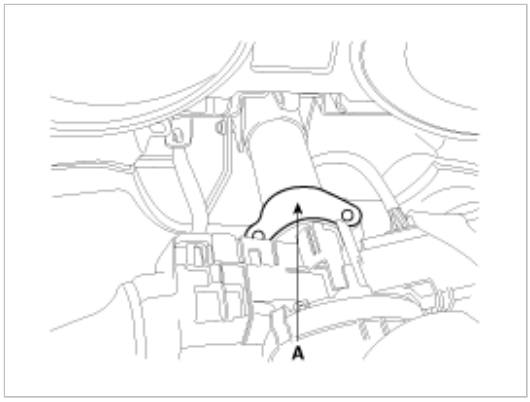
Pin No.	Description
1	-
2	Ground
3	Power(12V)
4	ESCL-Enable (Lock)
5	ESCL- Unlock
6	Data line

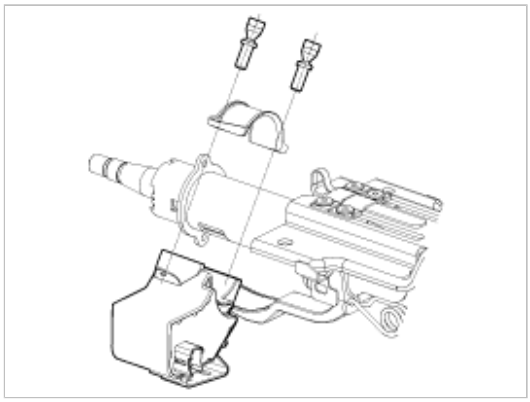
Removal

1. Disconnect the negative(-) battery terminal.
2. Remove the steering column upper and lower shrouds(A).
   (Refer to ST group - "Steering column and shaft")
3. Disconnect the electronic steering column lock connector(A).



4. Remove the electronic steering column lock(A).
   (Refer to Steering system - "Steering column and shaft")





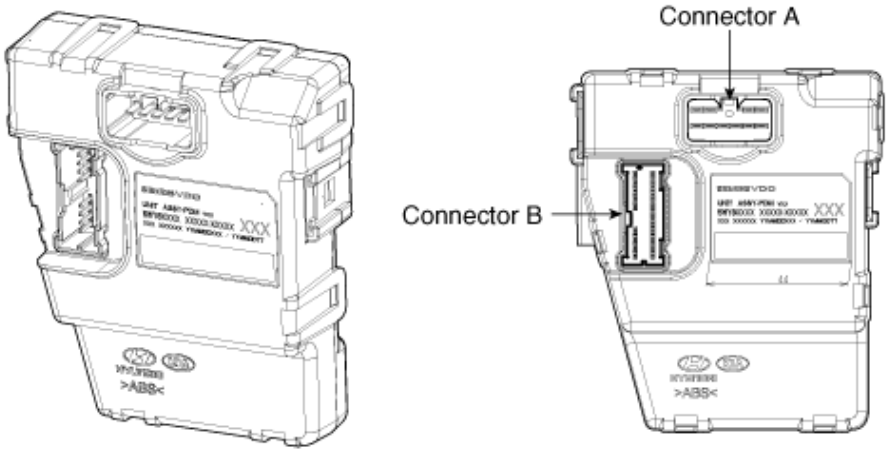
Installation

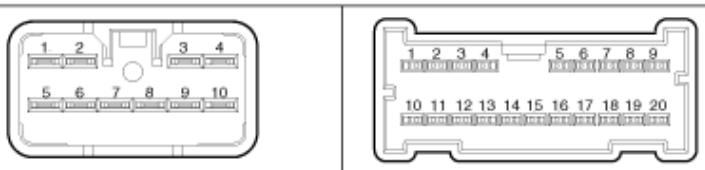
1. Install the electronic steering column lock.

Tightening torque :
7 ~13 N.m (0.7 ~1.3 kgf.m, 5 ~9 lb.ft)

2. Install the steering column.

Component

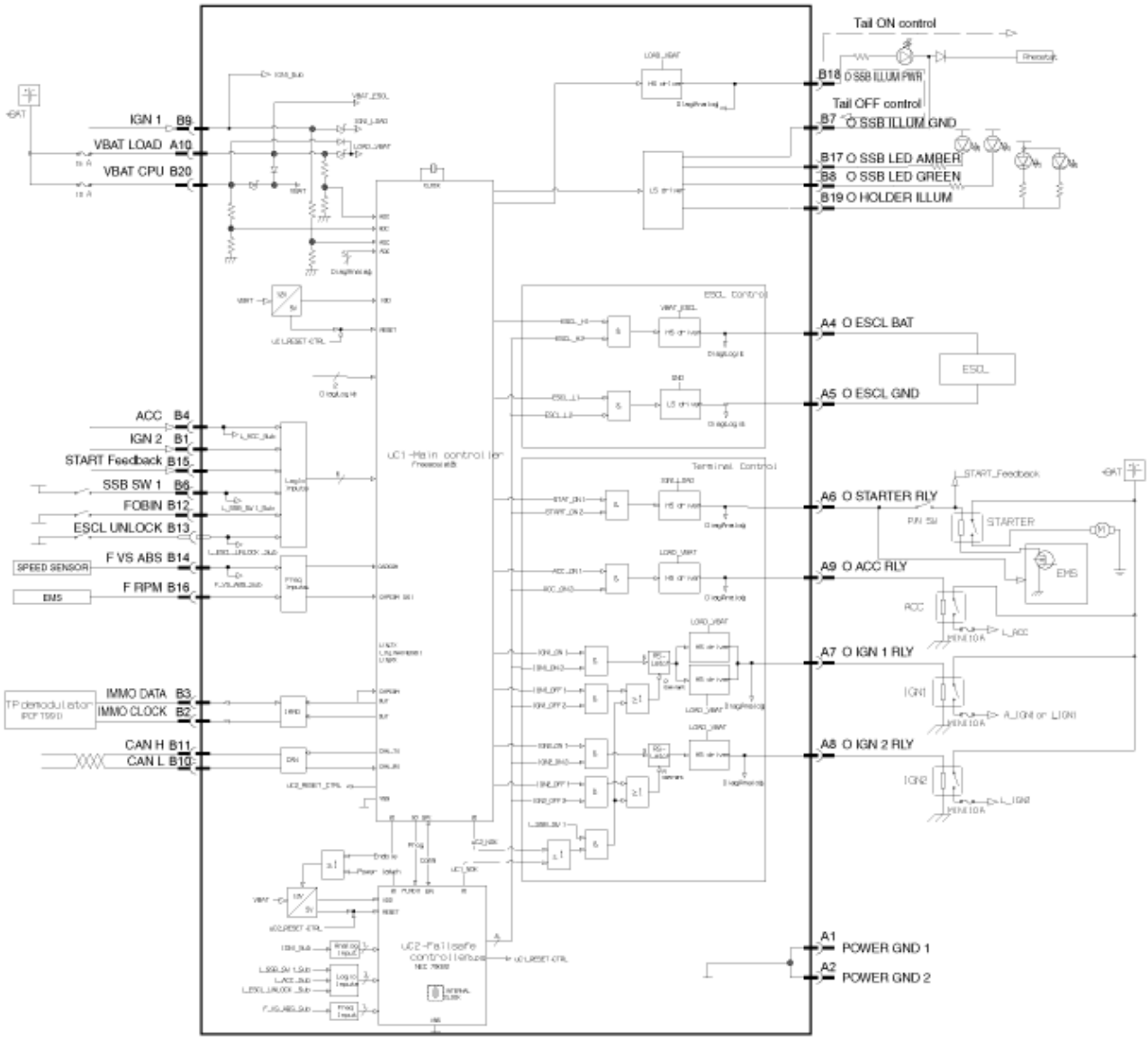




Pin No.	Connector A (10 pin)	Connector B (20 pin)
1	Power ground 1	IGN2
2	Power ground 2	Immobilizer clock
3	-	Immobilizer data
4	ESCL battery	ACC
5	ESCL ground	-
6	Starter relay	SSB switch1
7	IGN1 relay	SSB illumination ground
8	IGN2 relay	SSB LED green
9	ACC relay	IGN1
10	Battery load	CAN L
11		CAN H
12		Fob in
13		ESCL unlock
14		Vehicle speed
15		Start Feed back
16		RPM data (EMS)
17		SSB LED amber
18		SSB illumination power
19		Holder illumination
20		CPU battery

System Circuit Diagram

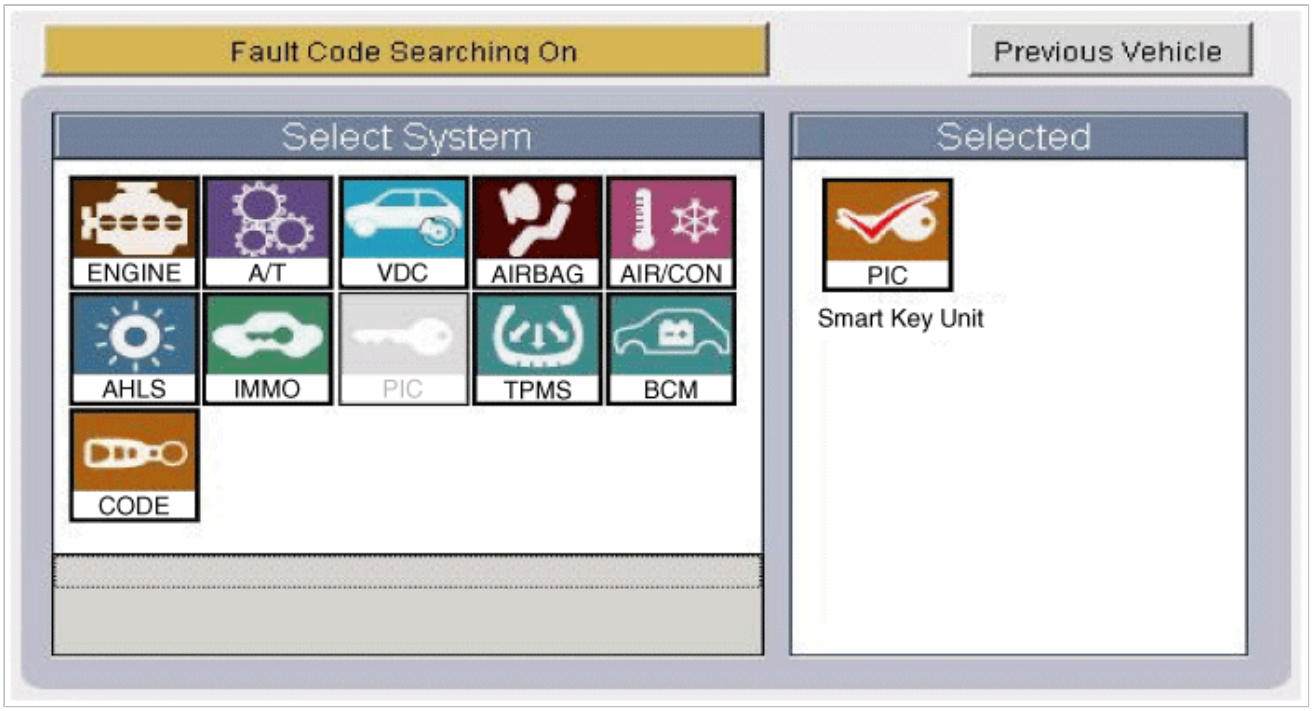
[PDM]



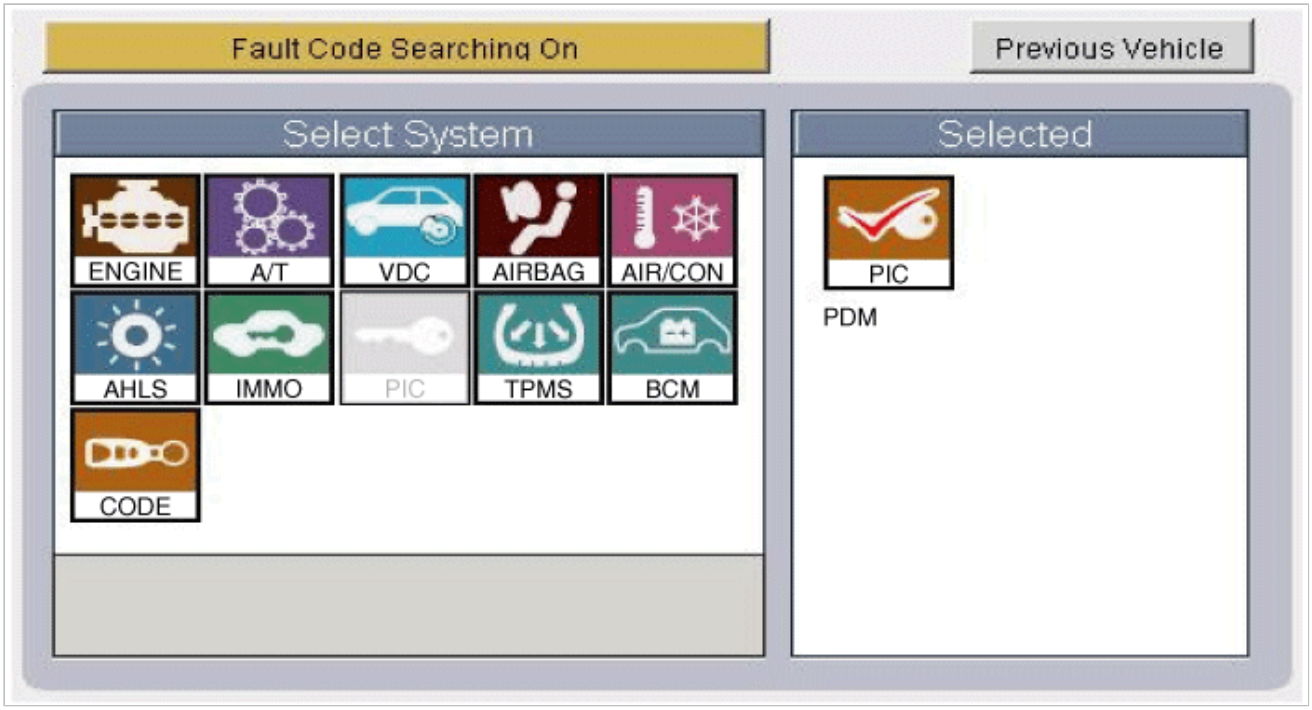
Inspection

PDM Diagnosis With GDS

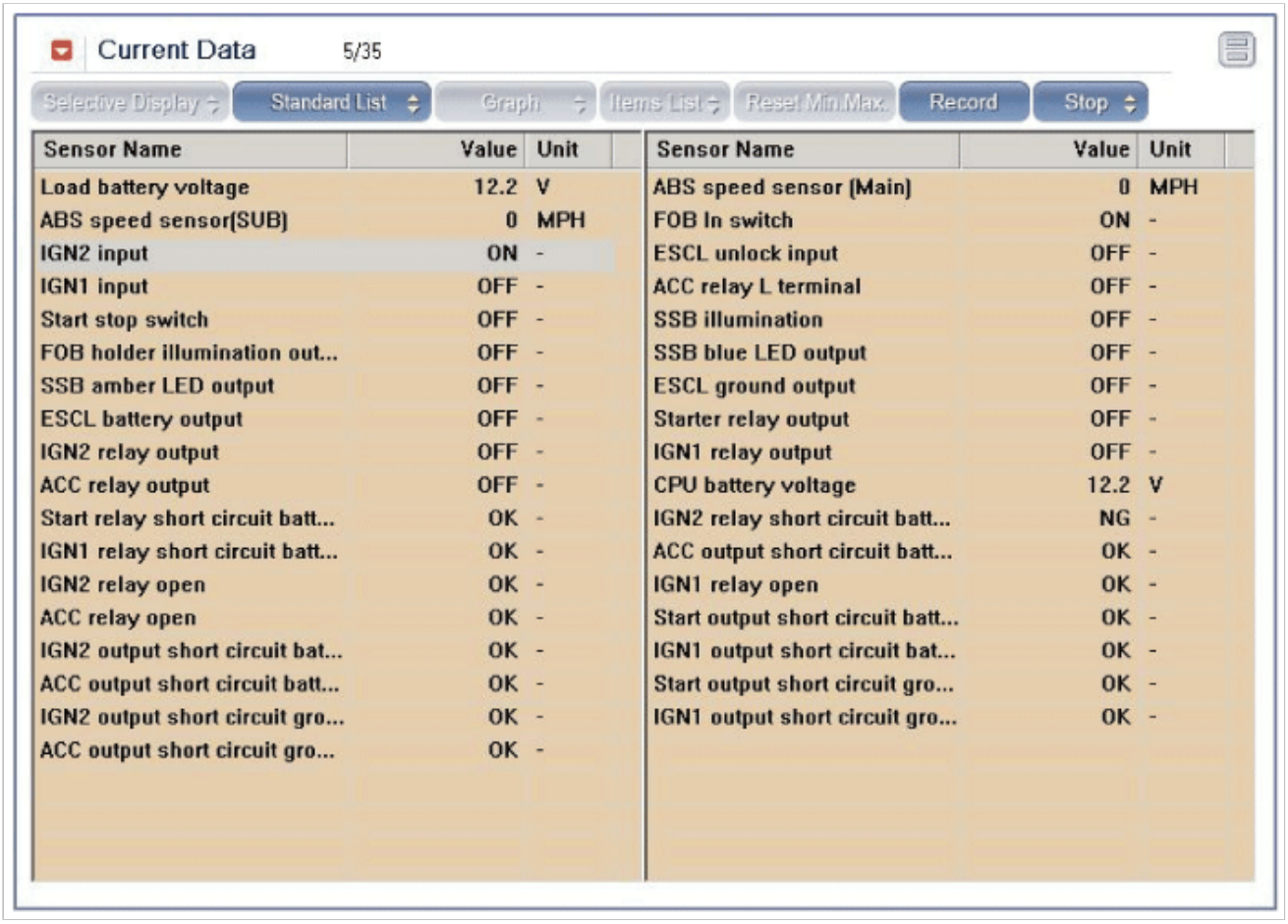
1. It will be able to diagnose defects of Smart key with GDS quickly. GDS can operates actuator forcefully, input/output value monitoring and self diagnosis.
2. Select model and "Smart key system(Button start)" menu if you want to check PDM.



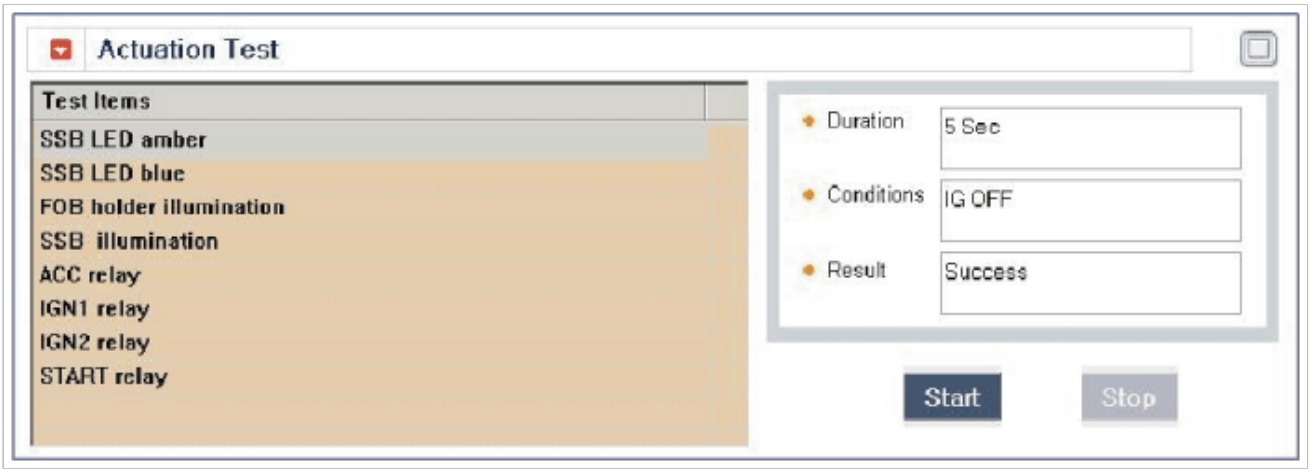
3. Select "PDM" in the manu.



4. Select "Current Data", if you want to check current data of PDM.
   It provides the input/output status of each module.



5. If you want to check PDM data operation forcefully, select "Actuation test".



DTC Code List

No.	DTC CODE	Description
1	B1602	CAN ERR
2	B1603	CAN Communication Bus Off
3	B1987	Sub micom Failed
4	B1988	ESCL BAT Short To BAT
5	B1989	ESCL GND Short To BAT
6	B1990	ESCL BAT Short To GND
7	B1991	IMMO TX Short To GND

Input/output Current Data

NO	Description	Unit
1	Load Battery Voltage	V
2	Abs Speed Sensor(main)	Km/h
3	Start Stop Button SW	OFF/ON
4	ACC input	OFF/ON
5	IGN1 Input	OFF/ON
6	IGN2 Input	OFF/ON
7	Fob In Switch	RELEASE/INSERT
8	Start Relay Monitoring Input	
9	SSB Ember LED Output	OFF/ON
10	SSB Blue LED Output	OFF/ON
11	Fob Holder Illumination Output	OFF/ON
12	SSB Illumination Output	OFF/ON
13	ACC Relay Output	OFF/ON
14	IGN1 Relay Output	OFF/ON
15	IGN2 Relay Output	OFF/ON
16	Start Relay S1 Output	OFF/ON
17	ESCL Battery Output	OFF/ON
18	ESCL GND Output	OFF/ON
19	CPU Battery Voltage	V
20	Engine Speed	DATA*1.0
21	ACC Relay SCB	OFF/ON
22	IGN1 Relay SCB	OFF/ON
23	IGN2 Relay SCB	OFF/ON
24	Start Relay SCB	OFF/ON
25	SCC Relay Open	OFF/ON
26	IGN1 Relay Open	OFF/ON
27	IGN2 Relay Open	OFF/ON
28	ACC Output SCB	OFF/ON
29	IGN1 Output SCB	OFF/ON
30	IGN2 Output SCB	OFF/ON
31	Start Output SCB	OFF/ON
32	ACC Output SCG	OFF/ON
33	IGN1 Output SCG	OFF/ON
34	IGN2 Output SCG	OFF/ON
35	Start Output SCG	OFF/ON

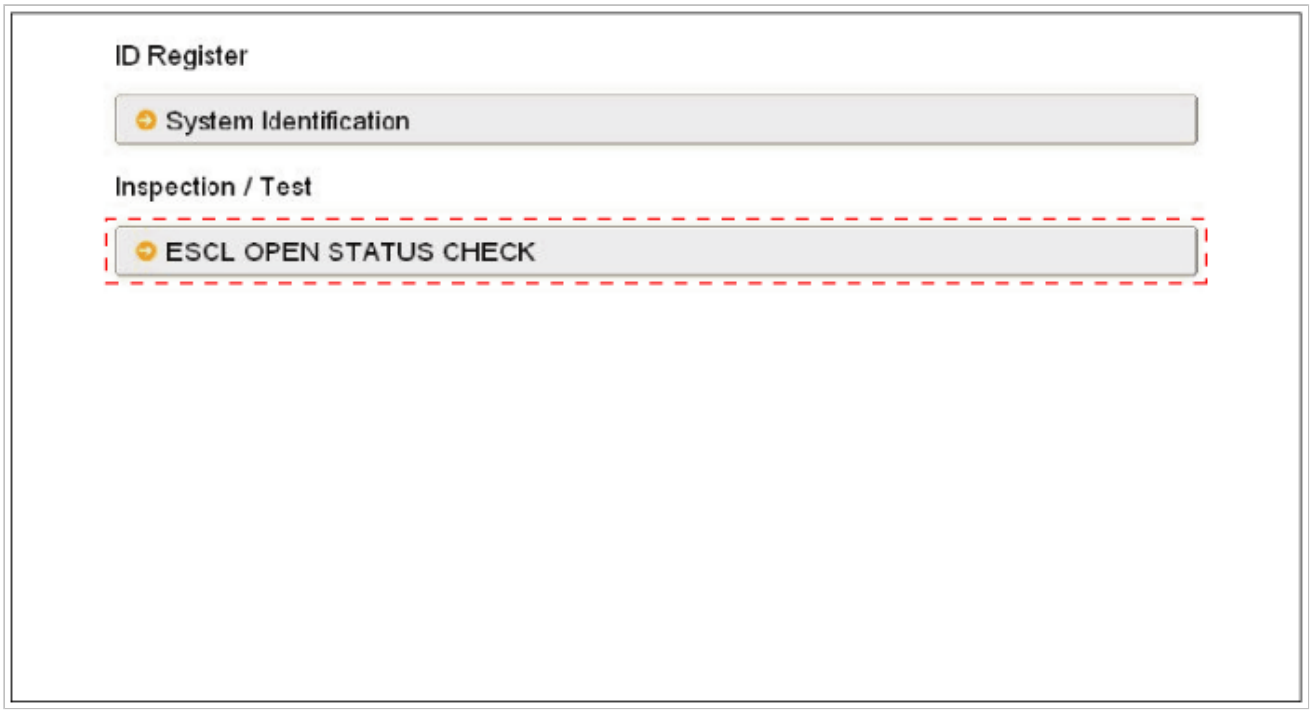
Actuation Test

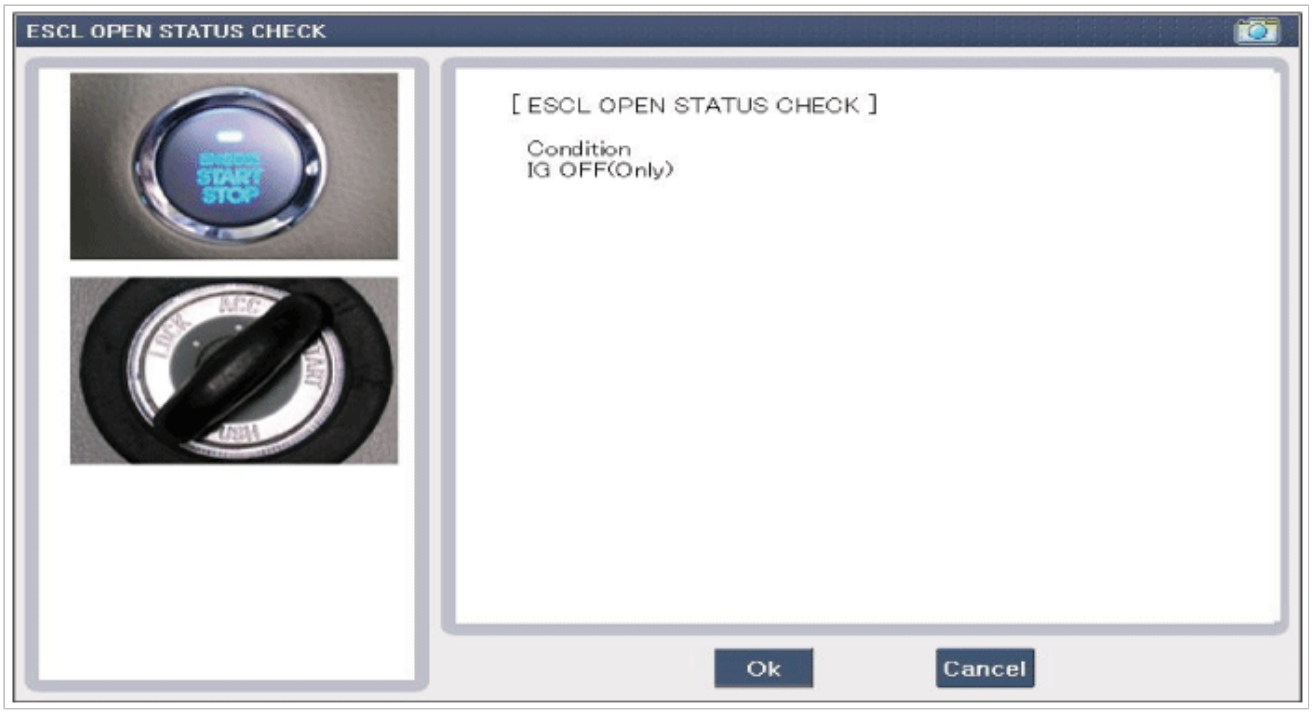
No.	Description
1	SSB Ember LED
2	SSB Blue LED
3	Fob Holder Illumination

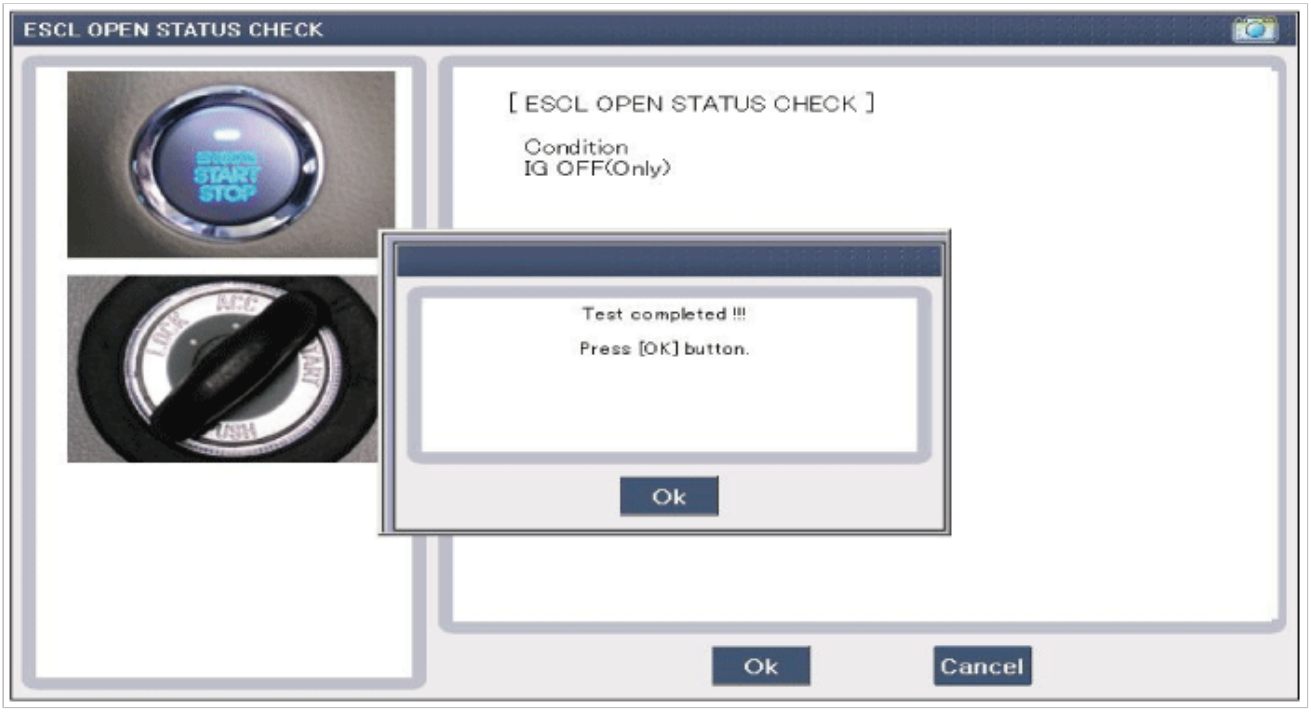
4	SSB Illumination
5	ACC Output
6	ING1 Output
7	ING2 Output
8	Start Output
9	Perform ESCL Open Check

ESCL OPEN STATUS CHECK

1. Select the "ESCL open status check" menu if you want to check ESCL open.

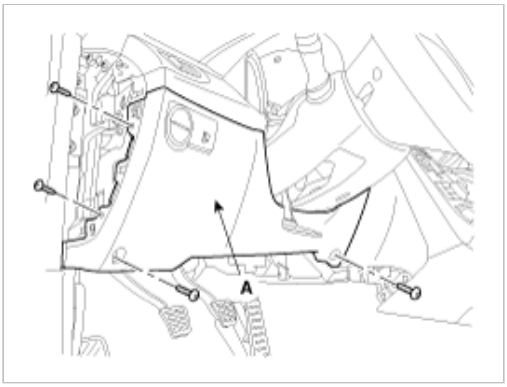




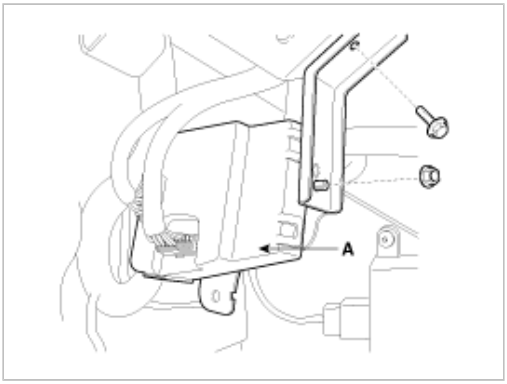


Removal

1. Disconnect the negative(-) battery terminal.
2. Remove the crash pad lower panel(A).
   (Refer to Body group-"Crash pad")



3. Disconnect the power distribution module(PDM) connector.
4. Remove the power distribution module(A) after loosening nut and bolt.



Installation

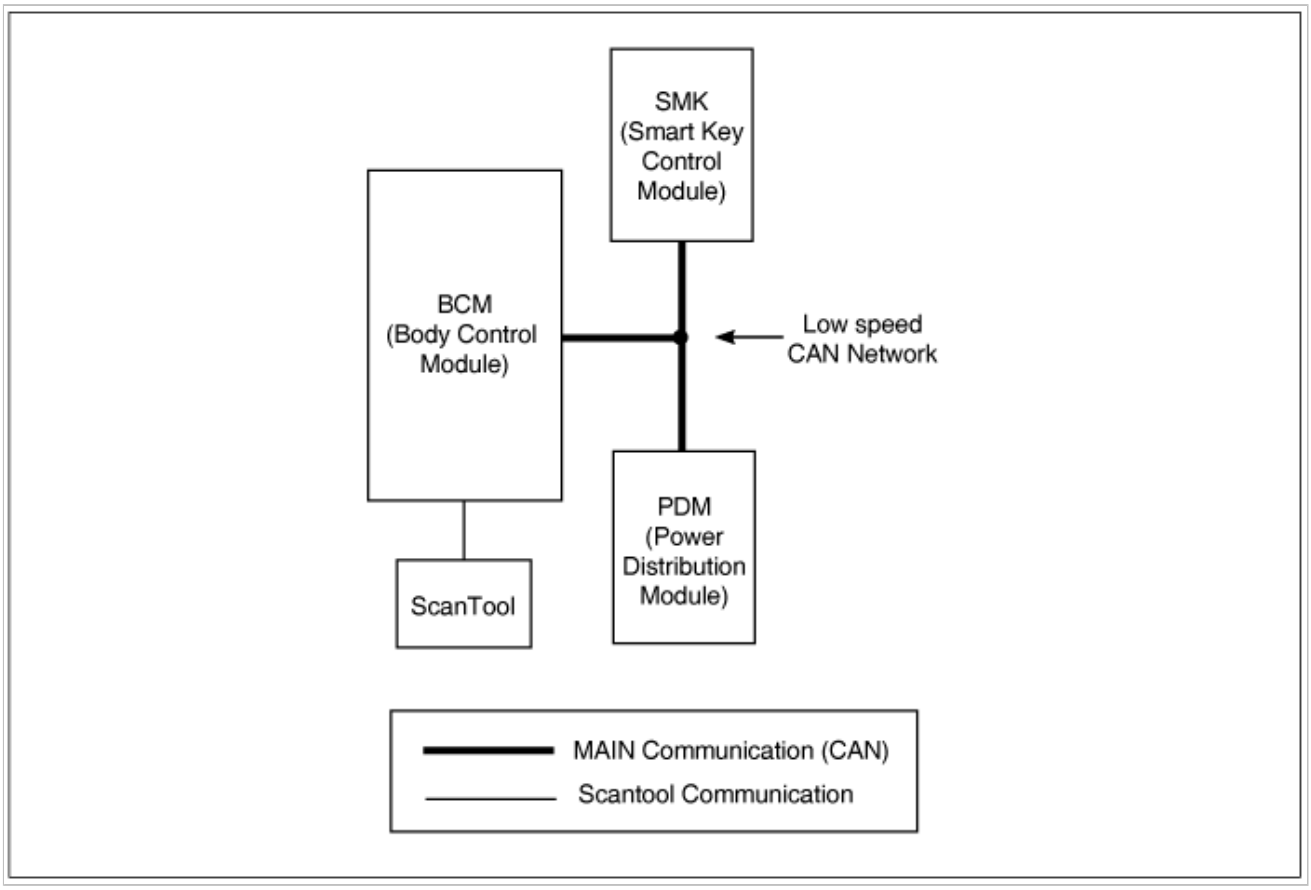
1. Install the power distribution module.
2. Install the crash pad lower panel.

Troubleshooting

NO	DTC code	Description
1	B1602	CAN Error
2	B1603	CAN Bus Off
3	B1987	Sub Micom Failed
4	B1988	ESCL Battery Short Circuit To Battery
5	B1989	ESCL Ground Short Circuit To Battery
6	B1990	ESCL Battery Short Circuit To Ground
7	B1991	Immobilizer TX Short Circuit To Ground

General Description

This is DTC which is related with communication error between PDM and other units.
(※ Control Units : BCM (Body Control Module), PDM(Power Distribution Module), SMK(Smart Key) ECU.
*1 CAN (Controller Area Network) : CAN is serial bus communication type which links not only communication system but also control units each other.
*2 LIN (Local Interconnect Network) : LIN is serial communication type which is used in electrical control system. (This is less expensive.)



DTC Description

Pattern	Status
1	Open in CAN High circuit
2	Open in CAN Low circuit
3	Short to battery in CAN High circuit
4	Short to battery in CAN Low circuit
5	Short to ground in CAN High circuit
6	Short to ground in CAN Low circuit
7	Short between CAN High and Low circuit

Communication is normal but DTC set if PDM detects 7 error status as follows.

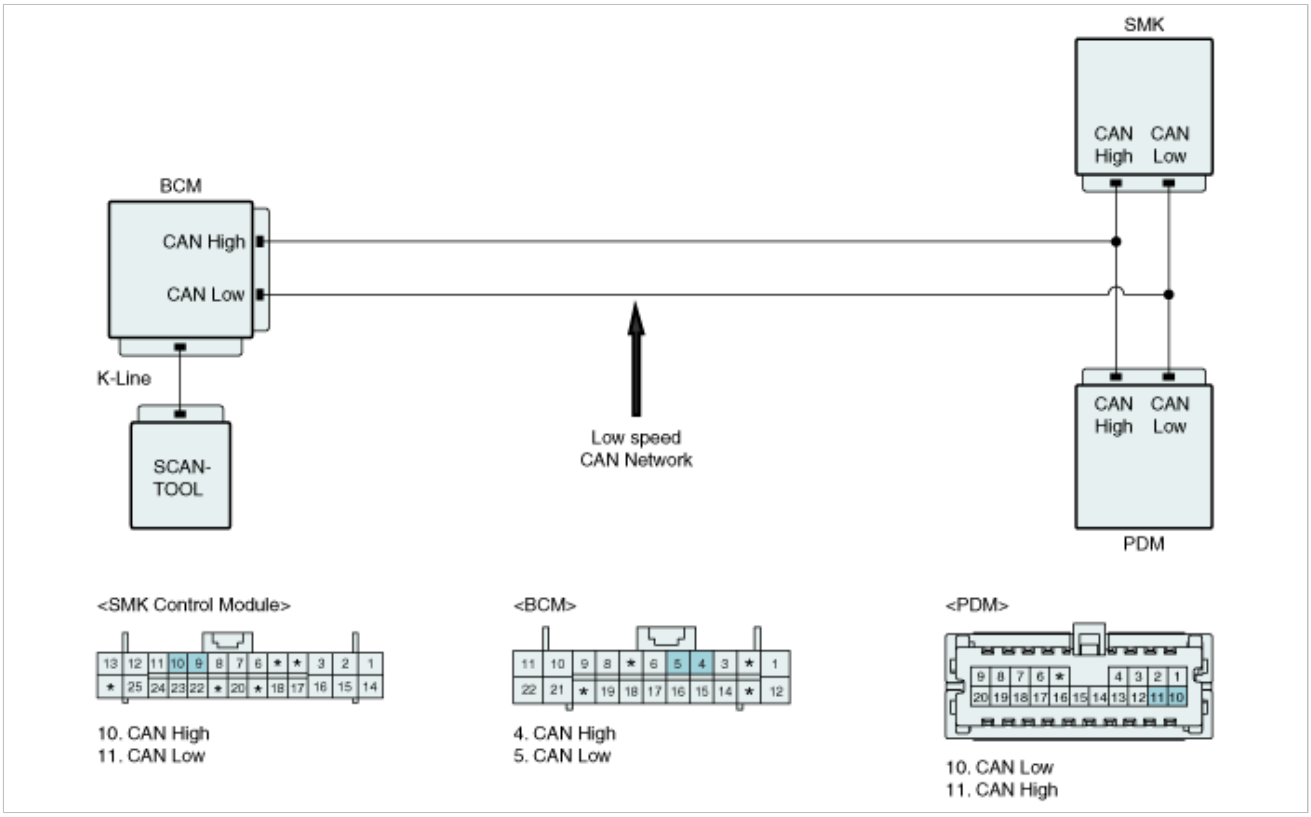
1. Short to battery in CAN High circuit
2. Short to ground in CAN High circuit
3. Short to battery in CAN Low circuit
4. Short to ground in CAN Low circuit
5. Short between CAN High and Low circuit

6. Open or Poor connection in CAN Low circuit
7. Open or Poor connection in CAN High circuit

DTC Detecting Condition

Item	Detecting Condition			Possible Cause
DTC Strategy	• CAN communication status			• Short to battery / ground in CAN high circuit • Short to battery / ground in CAN low circuit • Short between CAN high and CAN low circuit • Open or poor connection in CAN high and low circuit. • Faulty IPM
Enable Conditions	• IG "ON" • Engine "START" • B/T voltage engerzied to PDM			
Threshold Value	CAN high	0 V	Short to ground	
		B+ V	Short to battery	
	CAN low	0 V	Short to ground	
		B+ V	Short to battery	
Diagnostic Time	• Failure has been continued for 2sec.			
DTC Erasing Time	• DTC is erased immediately after trouble fixed(In case of the past error, perform DTC erasing procedure.)			

Diagnostic Circuit Diagram



Signal Waveform & Data

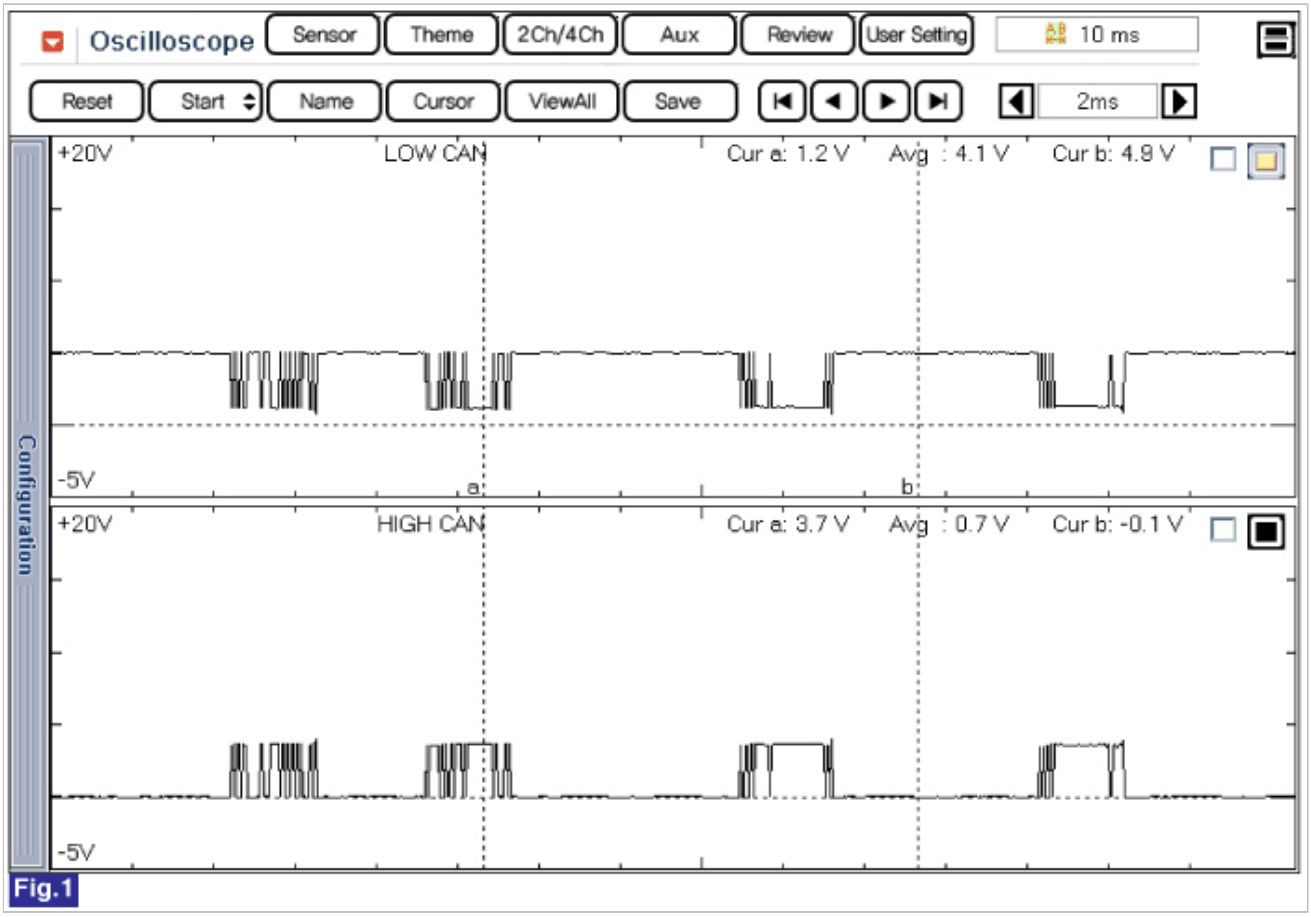


Fig.1

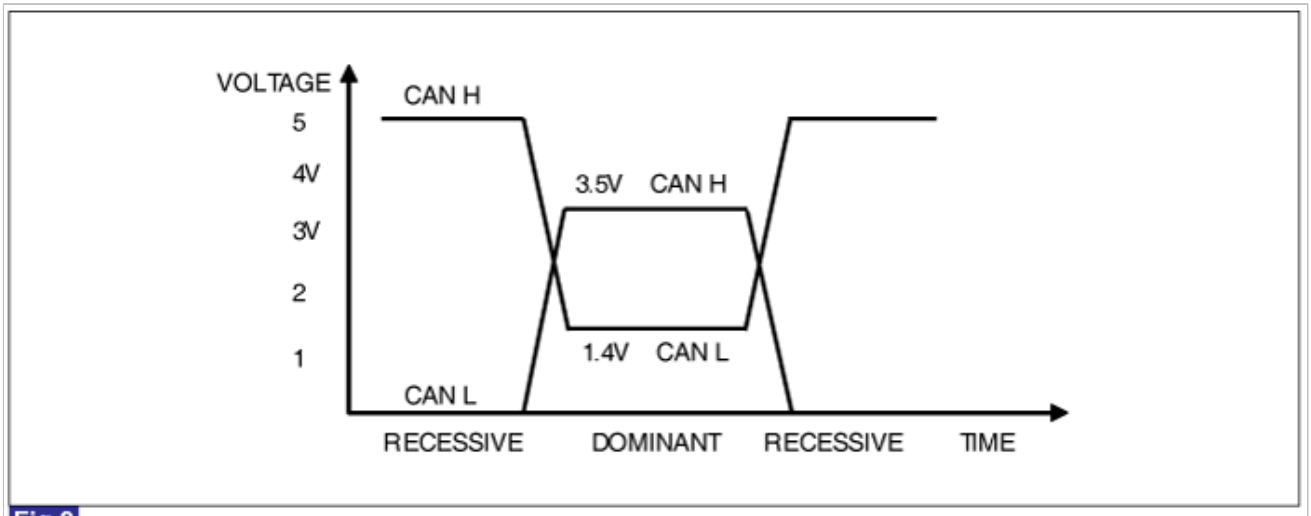


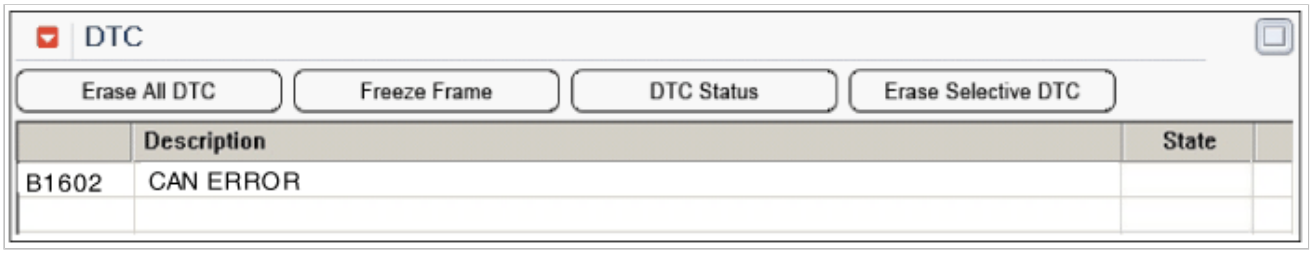
Fig.2

Fig.1) Signal waveform of CAN Low and HIGH
Fig.2) CAN BUS VOLTAGE LEVEL (LOW SPEED CAN)

Monitor Scantool Data

■ Check DTC

1. Connect GDS.
2. IG "ON" and engine "OFF".
3. Select "DTC Analysis" mode.
4. After erase DTC, keep the vehicle condition within "the enable conditions"
   (Refer to "DTC Detecting Condition" table)



5. Is the same DTC occurred again?

YES	▸ Go to next procedure.
NO	▸ Fault is intermittent caused by poor contact in the sensor's and/or PDM's connector or was repaired and PDM memory was not cleared. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and then go to "Verification of Vehicle Repair" procedure.

Terminal & Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness(es) and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▸ Repair as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▸ Go to " Signal Circuit Inpsection " procedure.

Signal Circuit Inpsection

■ Check CAN high circuit

1. IG "ON" & ENG "OFF".
2. Connect GDS and select Scope meter fucntion.
3. Measure signal waveform of PDM CAN High line.

Specification : Refer to signal waveform and data

4. Is the measured signal waveform of CAN high circuit normal ?

YES	▸ Go to next procedure
NO	▸ Check short to battery / ground in CAN high circuit, and repair or replace as necessary. Go to "Verification of Vehicle Repair" procedure.

■ Check CAN Low circuit

1. IG "ON" & ENG "OFF"
2. Connect GDS and select Scope meter fucntion.
3. Measure signal waveform of PDM CAN Low line.

Specification : Refer to signal waveform and data

4. Is the measured signal waveform of CAN low circuit normal ?

YES	▸ Go to next procedure.
NO	▸ Check short to battery / ground in CAN low circuit and, repair or replace as necessary. And then, go to 'Verification of Vehicle Repair" procedure.

Component Inspection

■ Check internal errors of CAN communication units

1. Connect GDS.
2. IG "ON" and engine "OFF".
3. Select "DTC Analysis" mode.
4. Disconnect CAN communication units one by one and monitor DTC to find the cause.
   *CAN communication units : BCM(Body Control Module), PDM(Power Distribution Module), CLU(Cluster), SMK(Smart Key) ECU.
5. Is the code erased?

YES	▸ Substitute with a known - good unit and check for proper operation. If the problem is corrected, replace the unit and go to "Verification of Vehicle Repair" procedure.
NO	▸ Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

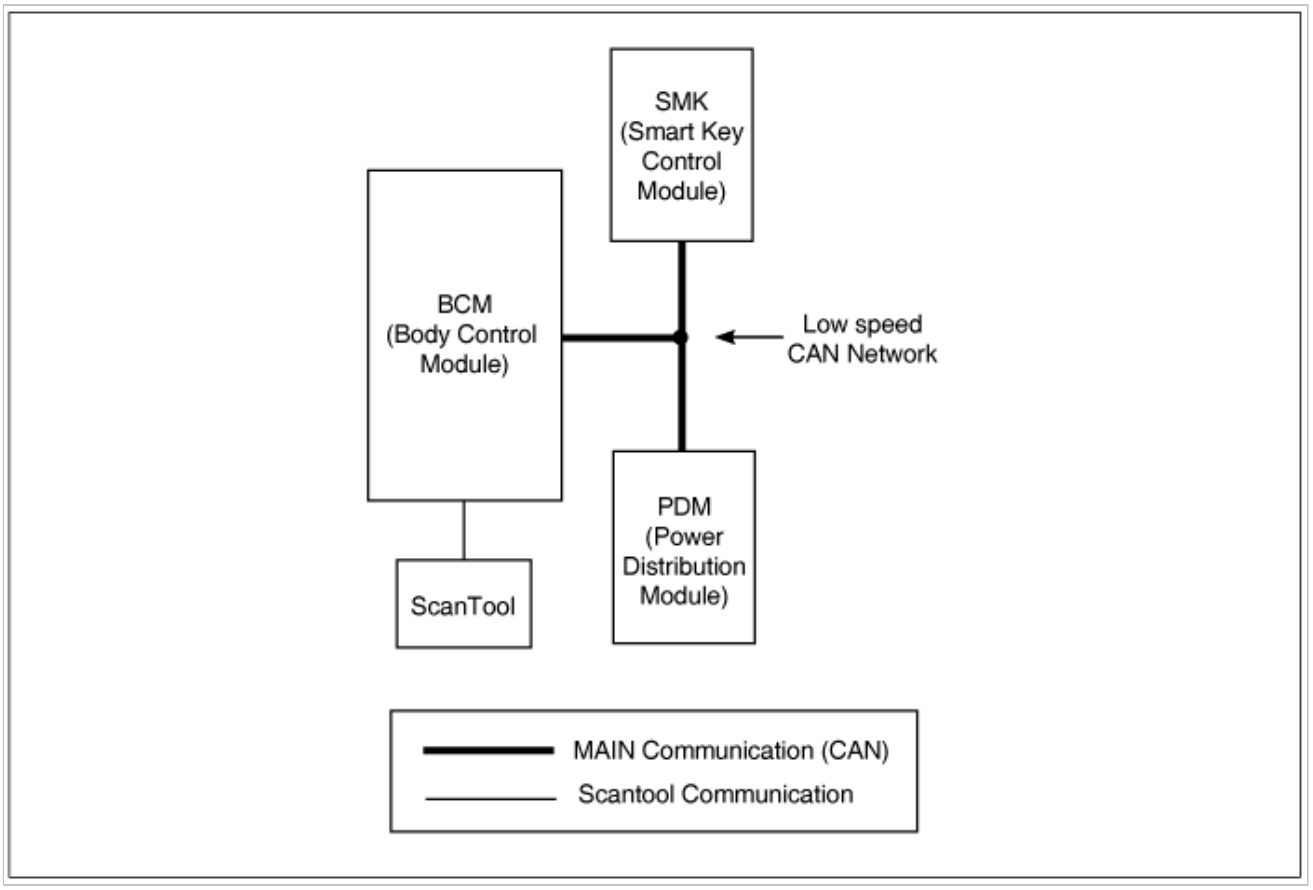
After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select "DTC Analysis" mode.
2. Clear the DTCs and Operate the vehicle within DTC Enable conditions in General information.
3. Is any DTC outputted again?

YES	▸ Go to the applicable troubleshooting procedure.
NO	▸ System performing to specification at this time.

General Description

This is DTC which is related with communication error between PDM and other units.
(※ Control Units : BCM (Body Control Module), PDM(Power Distribution Module), SMK(Smart Key) ECU.
*1 CAN (Controller Area Network) : CAN is serial bus communication type which links not only communication system but also control units each other.
*2 LIN (Local Interconnect Network) : LIN is serial communication type which is used in electrical control system. (This is less expensive.)



DTC Description

This is DTC which is related with communication error between PDM and other units.
※ Control Units : BCM(Body Control Module), PDM(Power Distribution Module), CLU(Cluster), SMK(Smart Key) ECU.
Case1: After short between PDM CAN Low Line and High Line, short to ground together.
Case2: After short between PDM CAN Low Line and High Line, short to power together.
※ This code is occurred when It is not possible to transmit data by CAN Line in those way of Software and Hardware. But, It is possible to receive data by CAN Line.
This code reports BUS OFF status when data transmit error count number is over 255. The purpose is to verify the status of CAN controller and CAN communication line when error is detected.
According to operation condition, some of module which are connected to CAN line may not detect B1603.
Also, B1602 coincides with B1603 at all times.

CAUTION

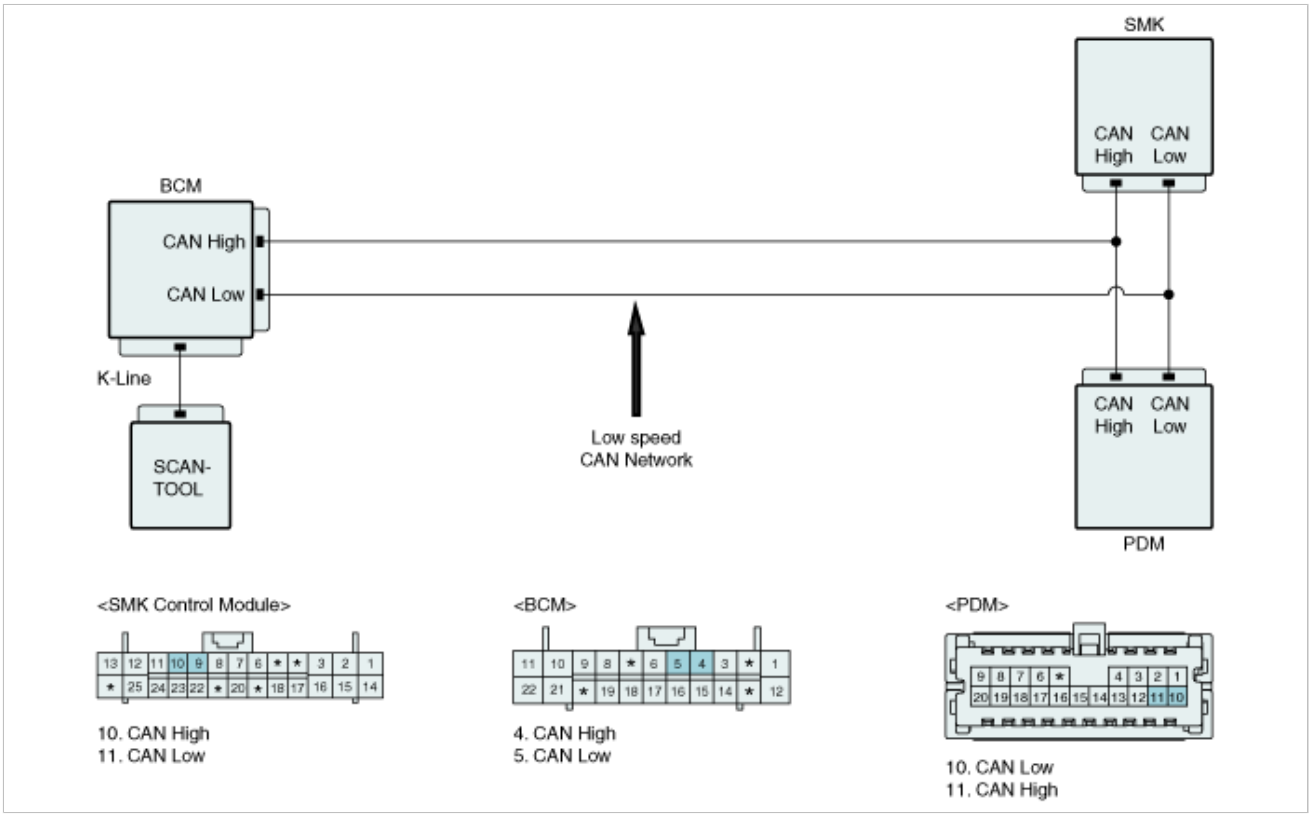
Difference between CAN ERROR and CAN BUS ERROR
CAN Error : MIL On, CAN Bus Error : No MIL

DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• CAN Communication Check	• BCM,PDM are not Sleep

Enable Conditions	• BCM, PDM power on	condition 1. CAN High and Low Line short to ground coincident 2. CAN High and Low Line short to battery coincident
Threshold Value	• CAN High/Low : 0V or B+	
Diagnostic Time	• Immediately	
DTC Erasing Time	• DTC is erased immediately after trouble fixed.	

Diagnostic Circuit Diagram



Signal Waveform & Data

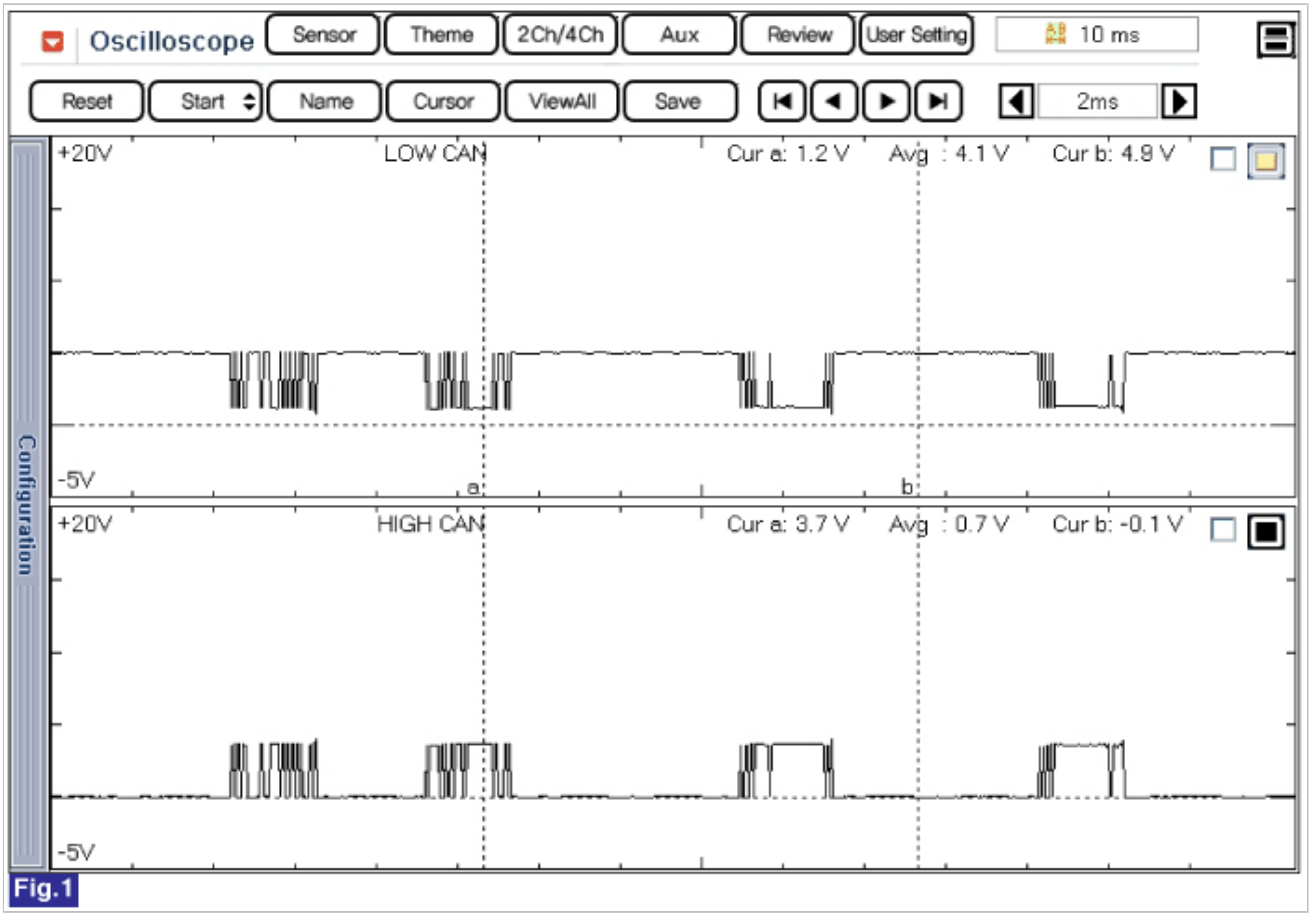


Fig.1

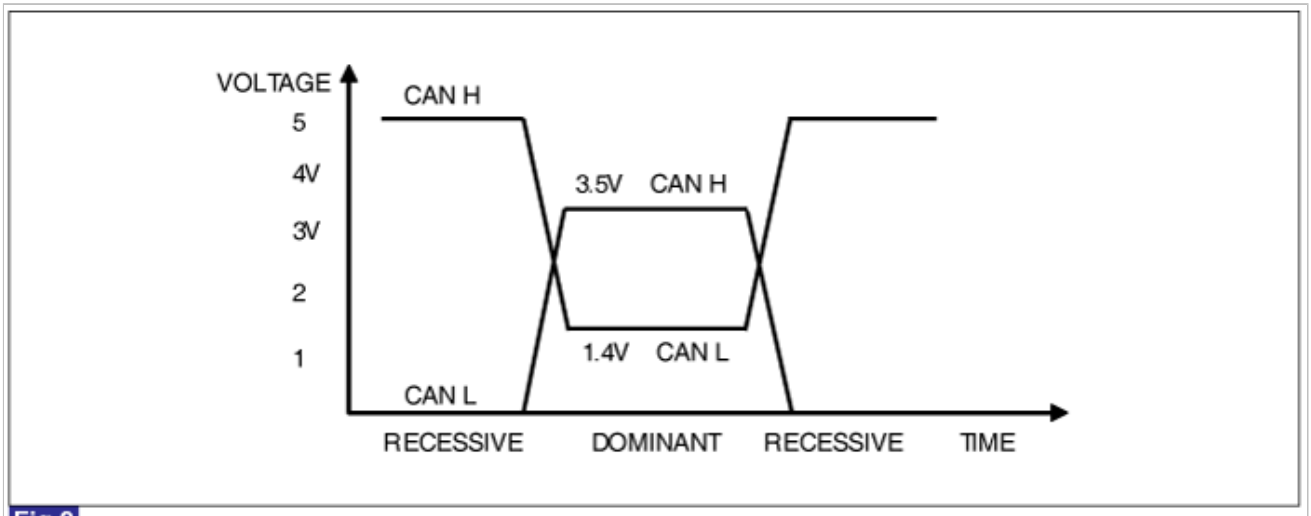


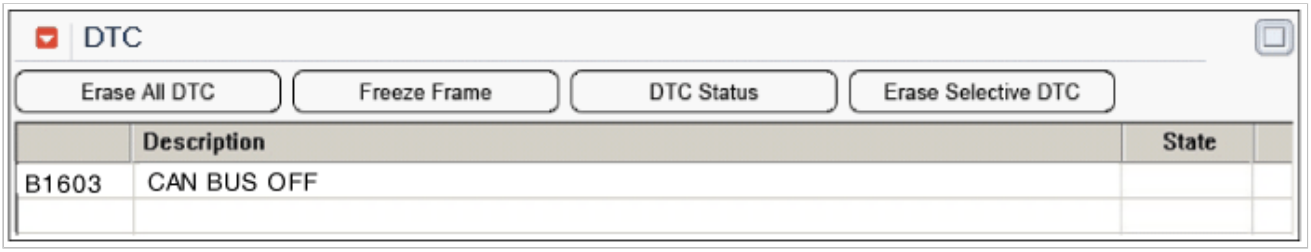
Fig.2

Fig.1) Signal waveform of CAN Low and HIGH
Fig.2) CAN BUS VOLTAGE LEVEL (LOW SPEED CAN)

Monitor Scantool Data

■ Check DTC

1. Connect GDS.
2. IG "ON" and engine "OFF".
3. Select "DTC Analysis" mode.
4. After erase DTC, keep the vehicle condition within "the enable conditions"
   (Refer to "DTC Detecting Condition" table)



5. Is the same DTC occurred again?

YES	▸ Go to next procedure.
NO	▸ Fault is intermittent caused by poor contact in the sensor's and/or PDM's connector or was repaired and PDM memory was not cleared. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and then go to "Verification of Vehicle Repair" procedure.

Terminal & Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness(es) and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▸ Repair as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▸ Go to "Component Inspection" procedure.

Component Inspection

■ Check internal errors of CAN communication in PDM.

1. Replace with a known-good PDM after removing installed PDM
2. Connect GDS.
3. IG "ON" and engine "OFF".
4. Select "DTC Analysis" mode.
5. Is the code erased?

YES	▸ Substitute with a known - good unit and check for proper operation. If the problem is corrected, replace the unit and go to "Verification of Vehicle Repair" procedure.
NO	▸ Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

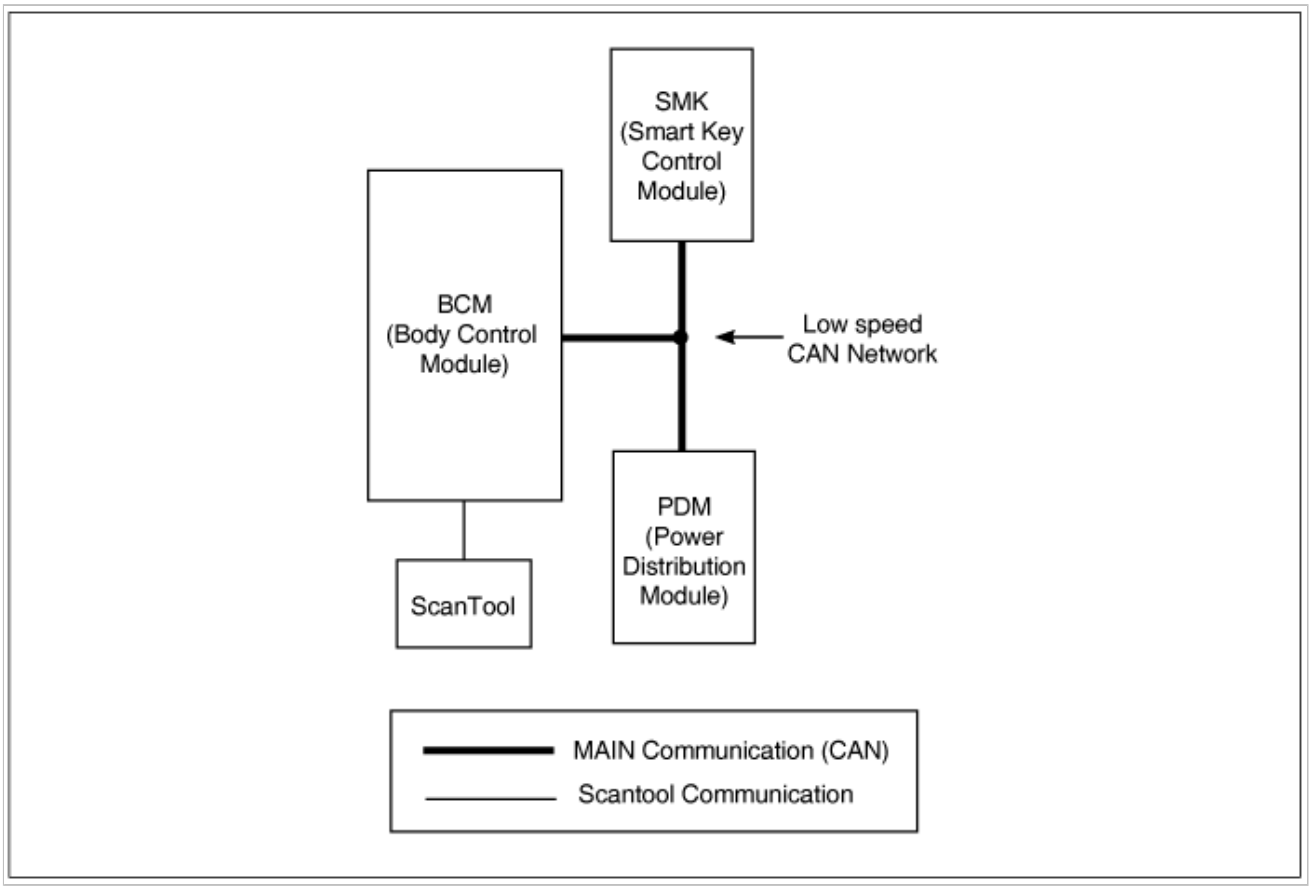
After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select "DTC Analysis" mode.
2. Clear the DTCs and Operate the vehicle within DTC Enable conditions in General information.
3. Is any DTC outputted again?

YES	▸ Go to the applicable troubleshooting procedure.
NO	▸ System performing to specification at this time.

General Description

This is DTC which is related with communication error between PDM and other units.
(※ Control Units : BCM(Body Control Module), PDM(Power Distribution Module), SMK(Smart Key) ECU.
*1 CAN (Controller Area Network) : CAN is serial bus communication type which links not only communication system but also control units each other.
*2 LIN (Local Interconnect Network) : LIN is serial communication type which is used in electrical control system. (This is less expensive.)



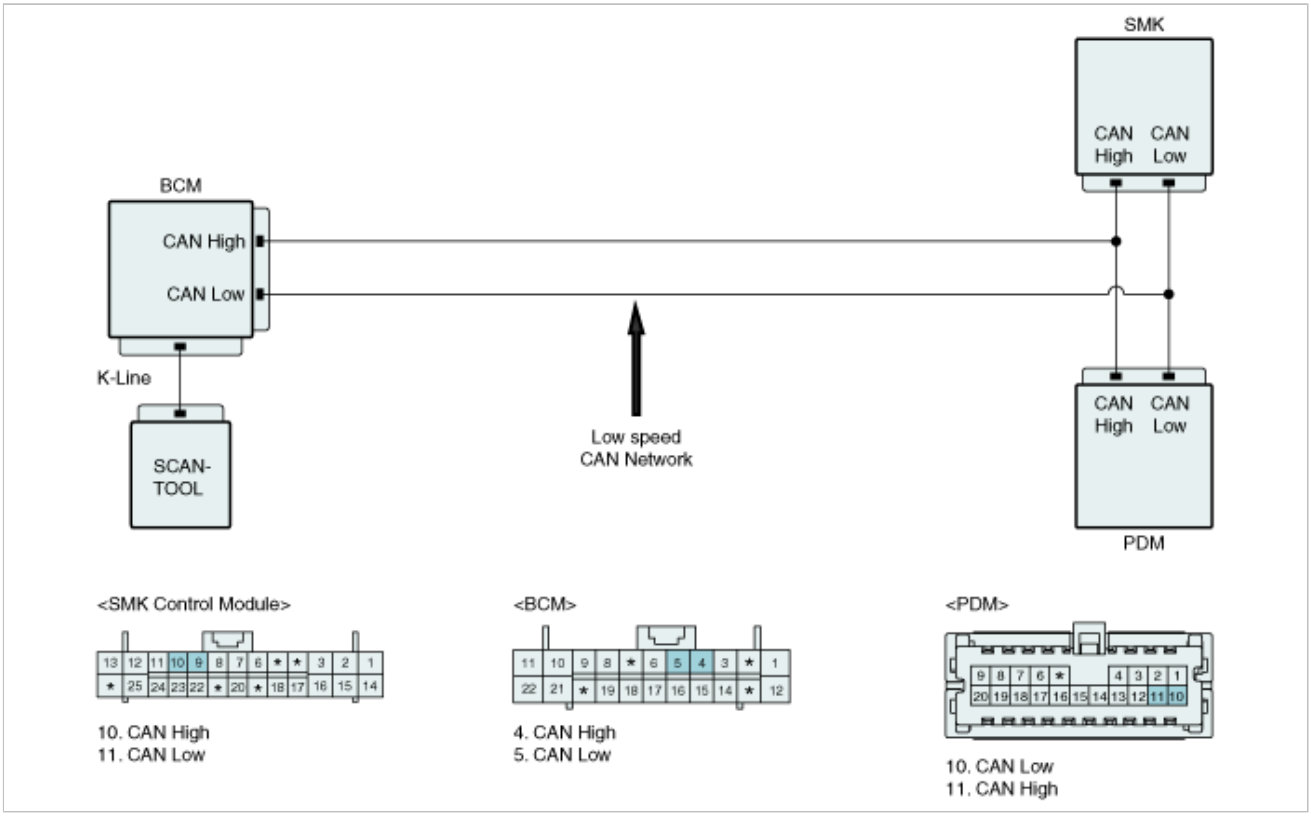
DTC Description

This code reports the malfunction of NEC MCU inside PDM. This is the case which there is the NEC MCU communication error.

DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• NEC MCU Communication Check	• Short to ground/power or open in communication circuit of NEC MCU inside PDM • Replace PDM (In case It is unable to verify the cause.)
Enable Conditions	• PDM power on	
Threshold Value	• Communication error	
Diagnostic Time	• Immediately	
DTC Erasing Time	• DTC is erased immediately after trouble fixed.	

Diagnostic Circuit Diagram



Signal Waveform & Data

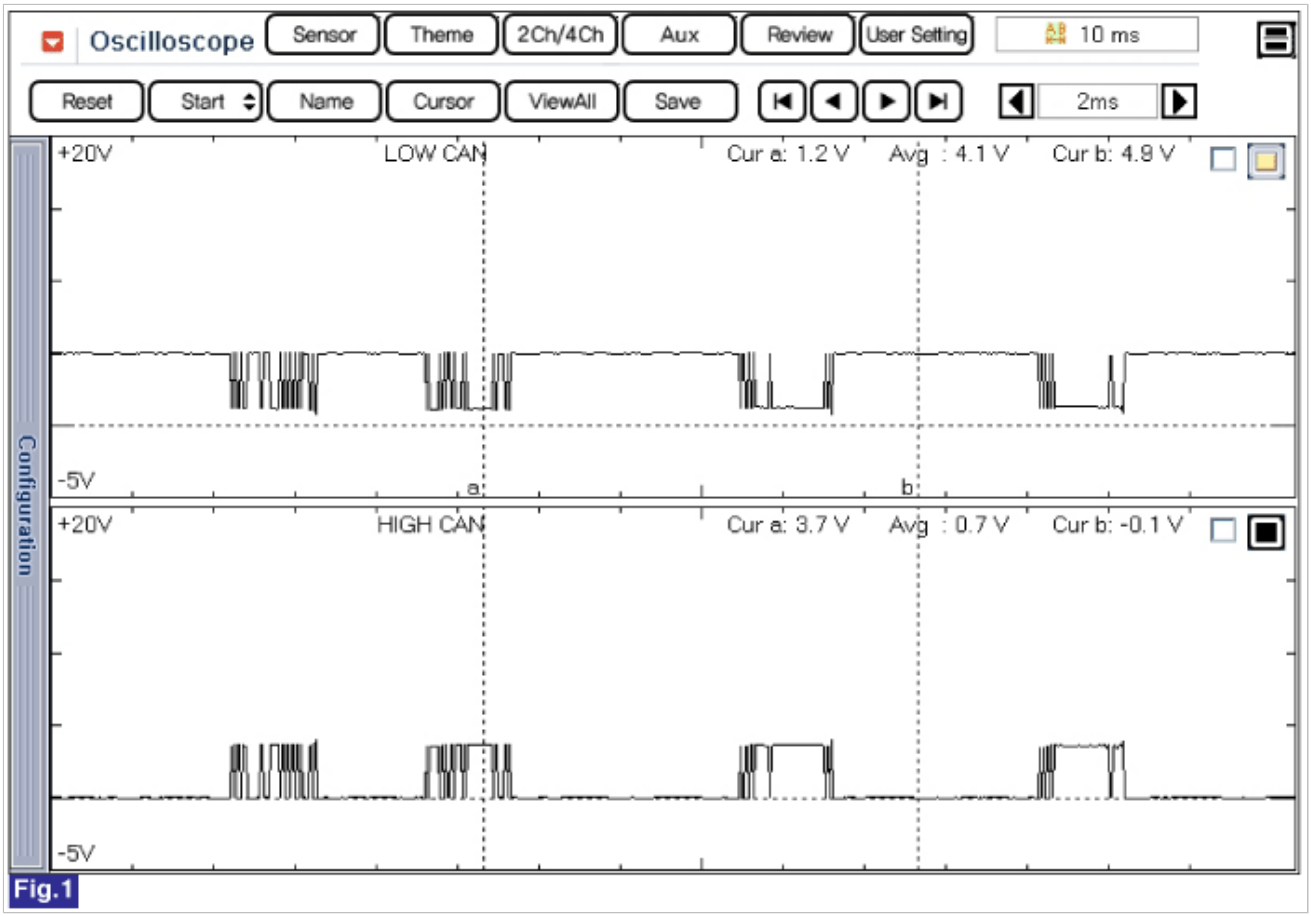


Fig.1

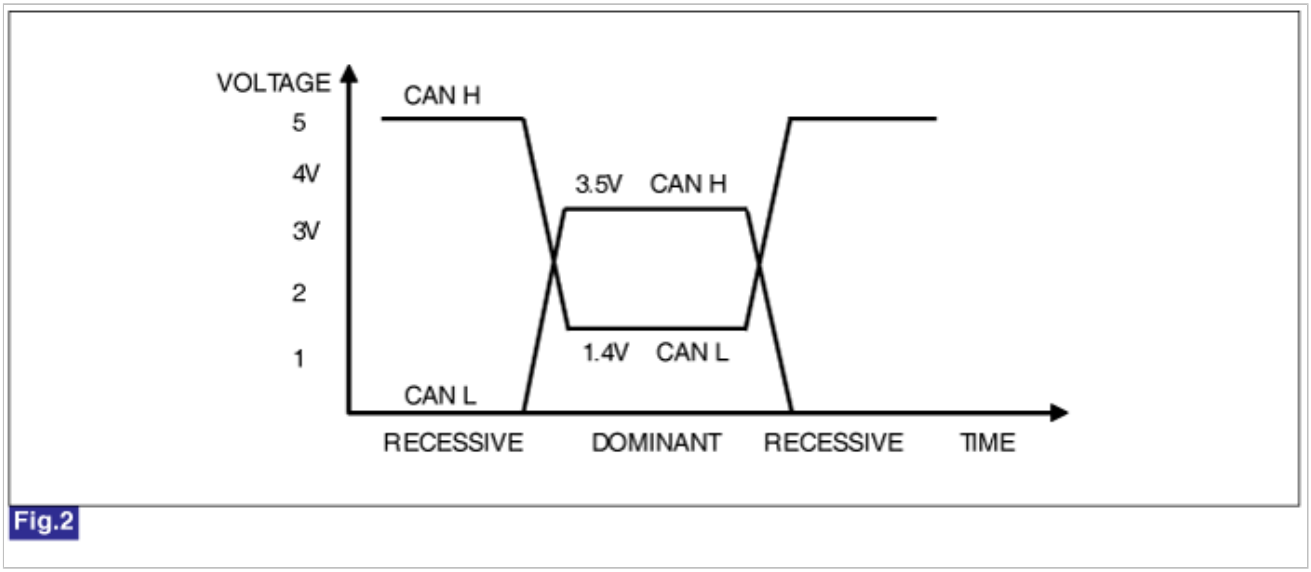


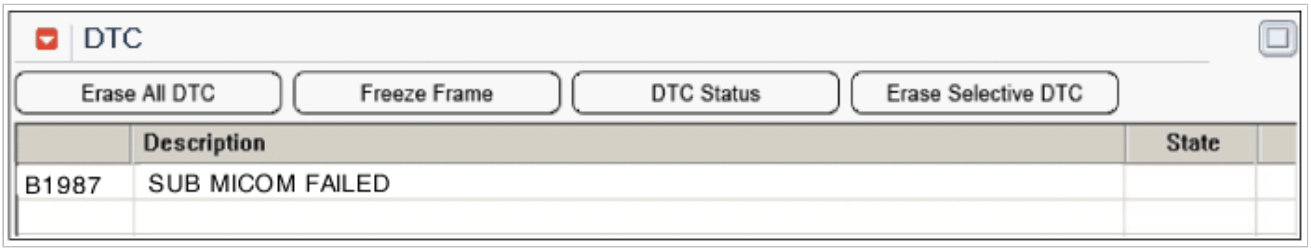
Fig.2

Fig.1) Signal waveform of CAN Low and HIGH
Fig.2) CAN BUS VOLTAGE LEVEL (LOW SPEED CAN)

Monitor Scantool Data

■ Check DTC

1. Connect GDS.
2. IG "ON" and engine "OFF".
3. Select "DTC Analysis" mode.
4. After erase DTC, keep the vehicle condition within "the enable conditions"
   (Refer to "DTC Detecting Condition" table)



5. Is the same DTC occurred again?

YES	▸ Go to next procedure.
NO	▸ Fault is intermittent caused by poor contact in the sensor's and/or PDM's connector or was repaired and PDM memory was not cleared. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and then go to "Verification of Vehicle Repair" procedure.

Terminal & Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness(es) and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▸ Repair as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▸ Go to "Component Inspection" procedure.

Component Inspection

■ Check internal errors of CAN communication in PDM

1. Replace with a known-good PDM after removing installed PDM.
2. Connect GDS.
3. IG "ON" and engine "OFF".
4. Select "DTC Analysis" mode.
5. Is the code erased?

YES	▸ Substitute with a known - good unit and check for proper operation. If the problem is corrected, replace the unit and go to "Verification of Vehicle Repair" procedure.
NO	▸ Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and go to "Verification of Vehicle Repair" procedure.

Verification of Vehicle Repair

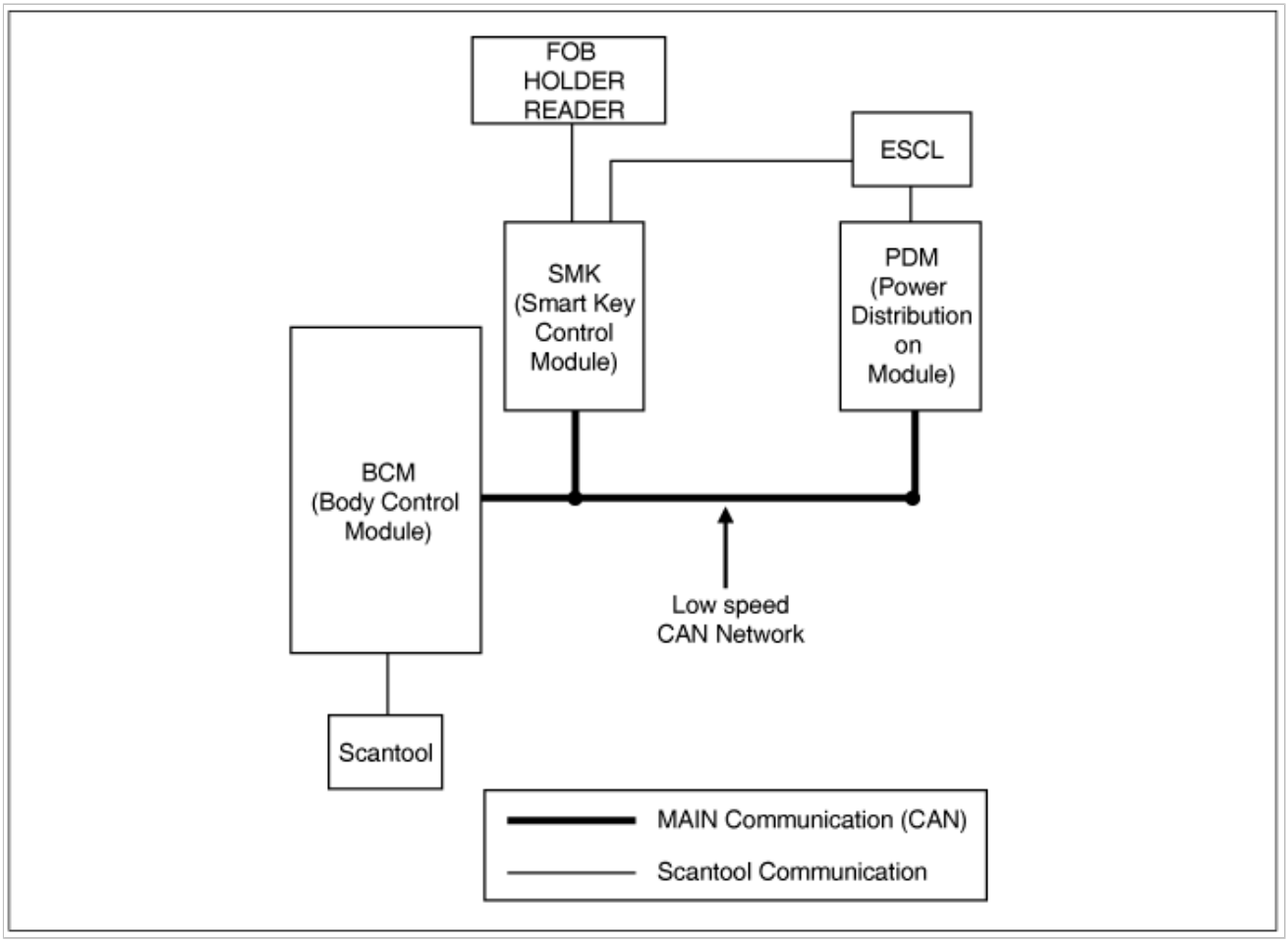
After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select "DTC Analysis" mode.
2. Clear the DTCs and Operate the vehicle within DTC Enable conditions in General information.
3. Is any DTC outputted again?

YES	▸ Go to the applicable troubleshooting procedure.
NO	▸ System performing to specification at this time.

General Description

The body electrical system is comprised of four ECU applied CAN*¹ communication nodes.
※ Control Units : BCM(Body Control Module), PDM(Power Distribution Module), SMK(Smart Key) ECU.
The steering wheel lock/unlock state of ESCL and the required data when EMS(Engine Management System)controls starting are sent to PDM by the serial communication line.
*¹ CAN (Controller Area Network) : CAN is serial bus communication type which links not only communication system but also control units each other.
*² LIN (Local Interconnect Network) : LIN is serial communication type which is used in electrical control system. (This is less expensive.)



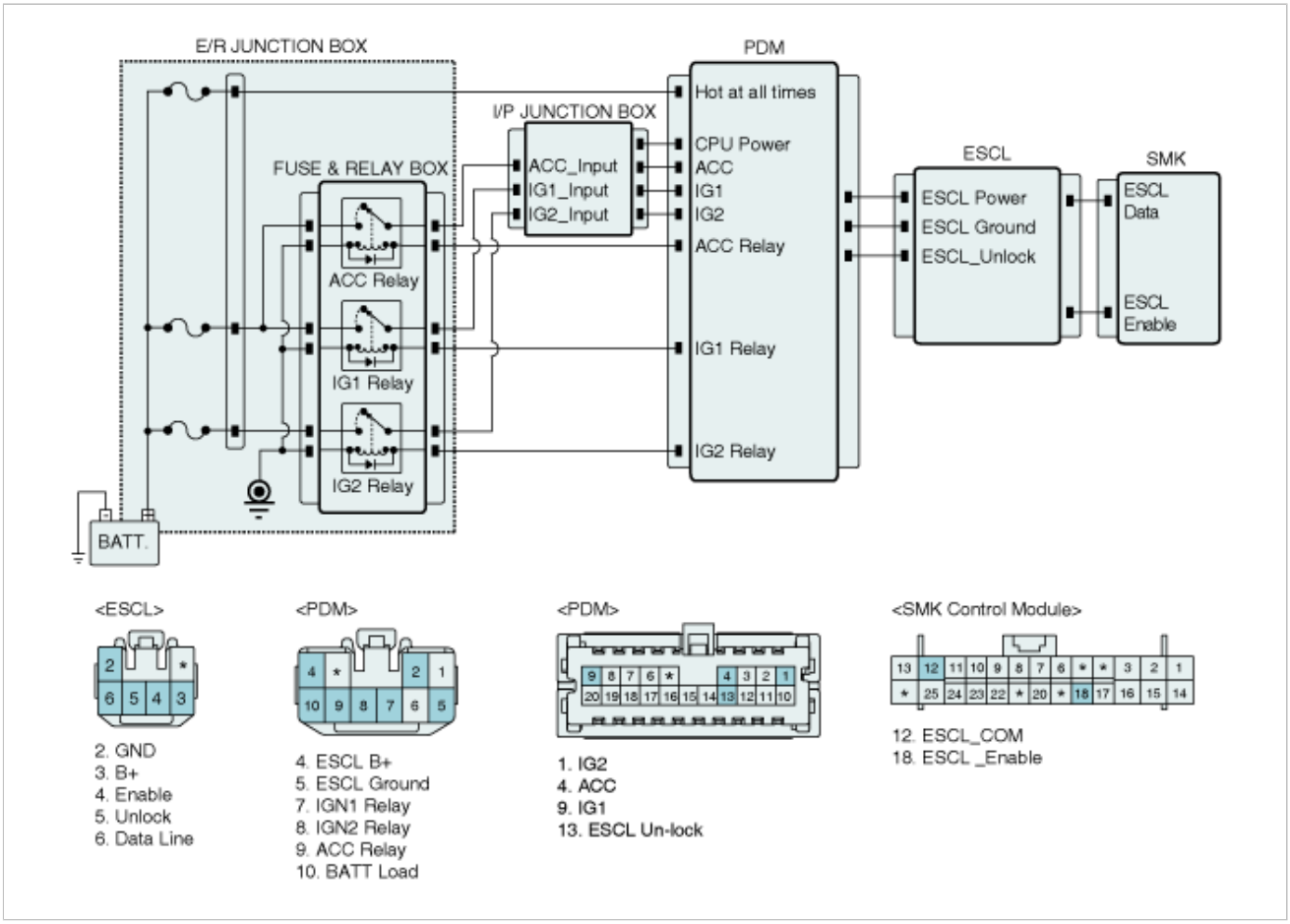
DTC Description

This code is outputted when power circuit is shorted to battery.
(During no power supply from PDM to ESCL)

DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• ESCL power output line check (by voltage monitoring)	• Short to power in ESCL power circuit
Enable Conditions	• No power supply from PDM to ESCL	
Threshold Value	• ESCL power circuit is shorted to power (7V and above)	
Diagnostic Time	• Immediately	
DTC Erasing Time	• DTC is erased immediately after trouble fixed. (Under no power supply from PDM to ESCL state)	

Diagnostic Circuit Diagram



Signal Waveform & Data

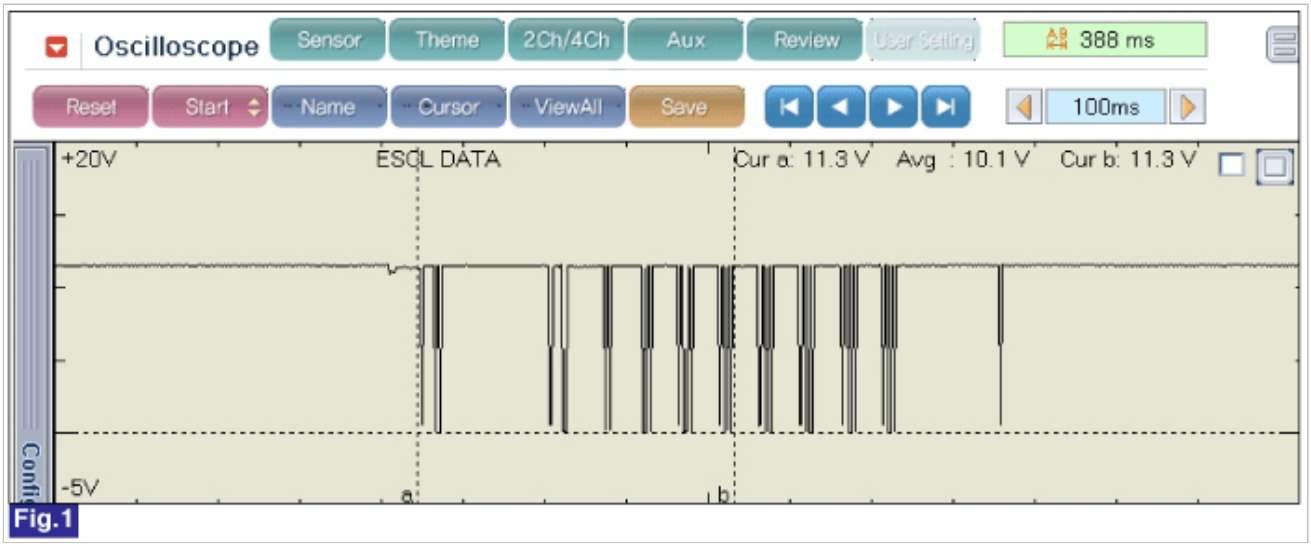
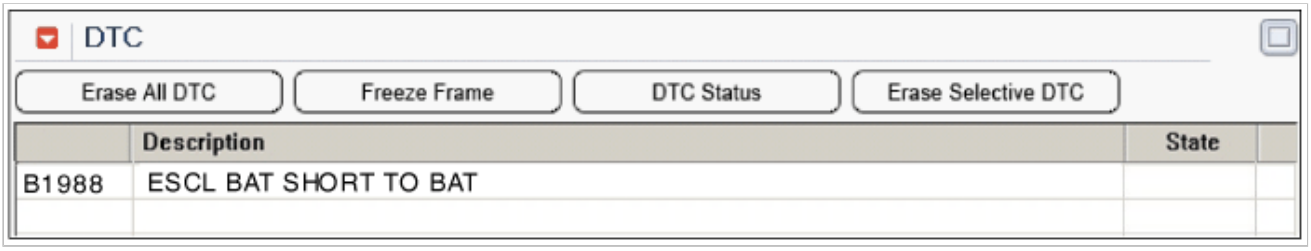


Fig.1) ESCL Data Signal Waveform

Scantool Data Analysis

1. Connect GDS.
2. IG "ON" and engine "OFF".
3. Select "DTC Analysis" mode.
4. After erase DTC, keep the vehicle condition within "the enable conditions" (Refer to "DTC Detecting Condition" table).



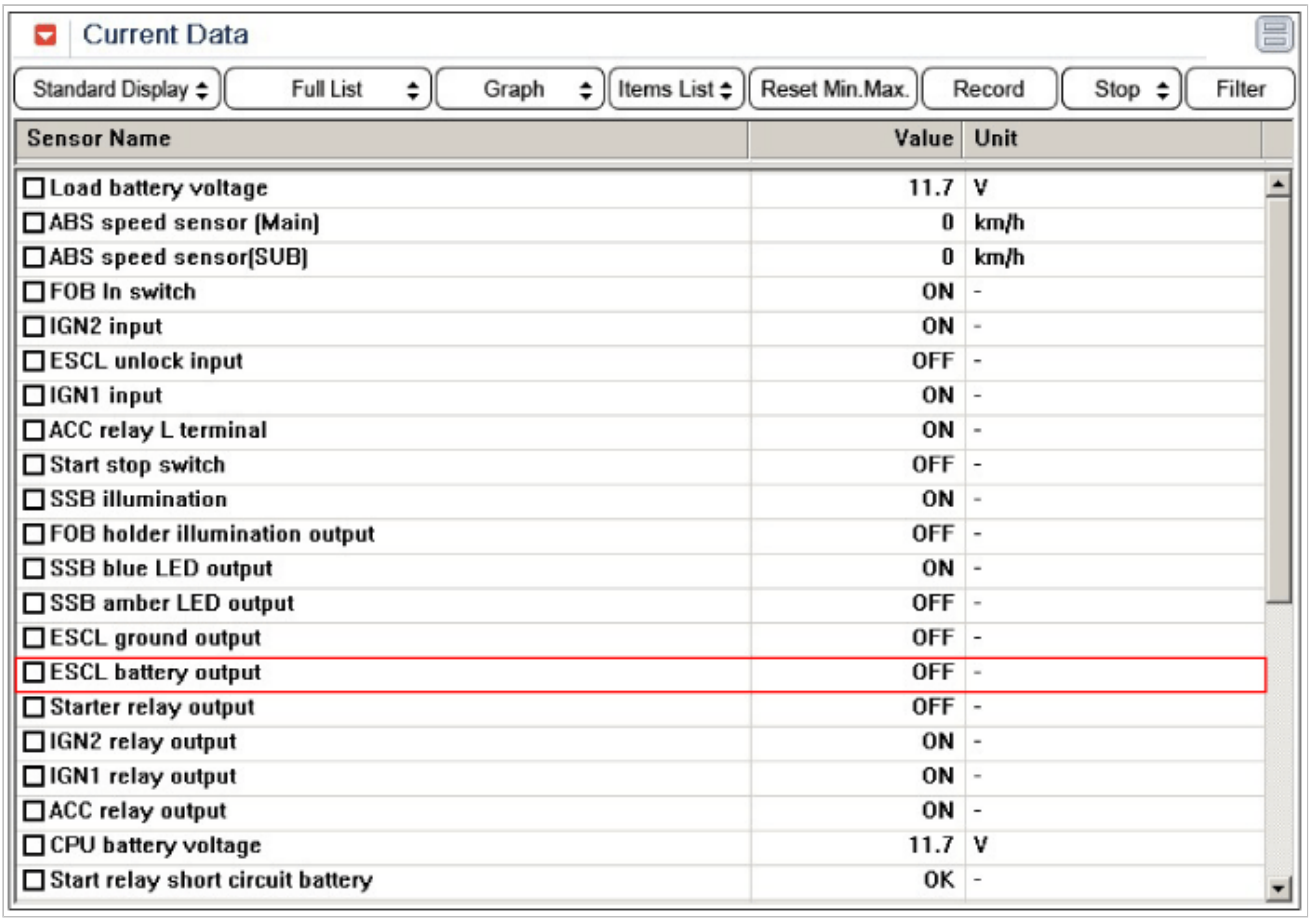
5. Is the same DTC occurred again?

YES	▸ Go to next procedure.
NO	▸ Fault is intermittent caused by poor contact in ESCL's and/or PDM's connector or was repaired and PDM memory was not cleared. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and then go to "Verification of Vehicle Repair" procedure.

■ Service Data Analysis

1. IG "OFF" and connect GDS.
2. IG "ON" and select "Cu rrent Data" menu.
3. Check the service data of ESCL BATT.

Specification : OFF



4. Is the service data within specifications?

YES	▸ Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and then go to "Verification of Vehicle Repair" procedure.

NO	▸ Go to next procedure.

Terminal & Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness(es) and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▸ Repair as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▸ Go to "Component Inspection" procedure.

PDM Ground Circuit Inspection

■ Check short at power terminal of PDM

1. IG "ON" & ENG "OFF".
2. Measure voltage between ESCL power terminal of PDM and chassis ground.
   (Measure the voltage while ESCL doesn't work.)

Specification : Approx. 0 V

3. Is the measured voltage within specifications?

YES	▸ Go to next procedure.
NO	▸ Check open or short on the power circuit between PDM and ESCL. Repair as necessary and go to "Verification of Vehicle Repair"

■ Check short to power on ESCL power circuit

1. IG "ON" & ENG "OFF"
2. Disconnect the connectors of IPM, PDM, ESCL.
3. Measure voltage between ESCL power terminal and chassis ground.

Specification : Approx. 0V

4. Is the measured voltage within specifications?

YES	▸ Substitute with a known - good ESCL and check for proper operation. If the problem is corrected, replace the unit and go to "Verification of Vehicle Repair" procedure. ▸ Substitute with a known - good PDM and check for proper operation. If the problem is corrected, replace the unit and go to "Verification of Vehicle Repair" procedure.
NO	▸ Repair as necessary and go to "Verification of Vehicle Repair".

Verification of Vehicle Repair

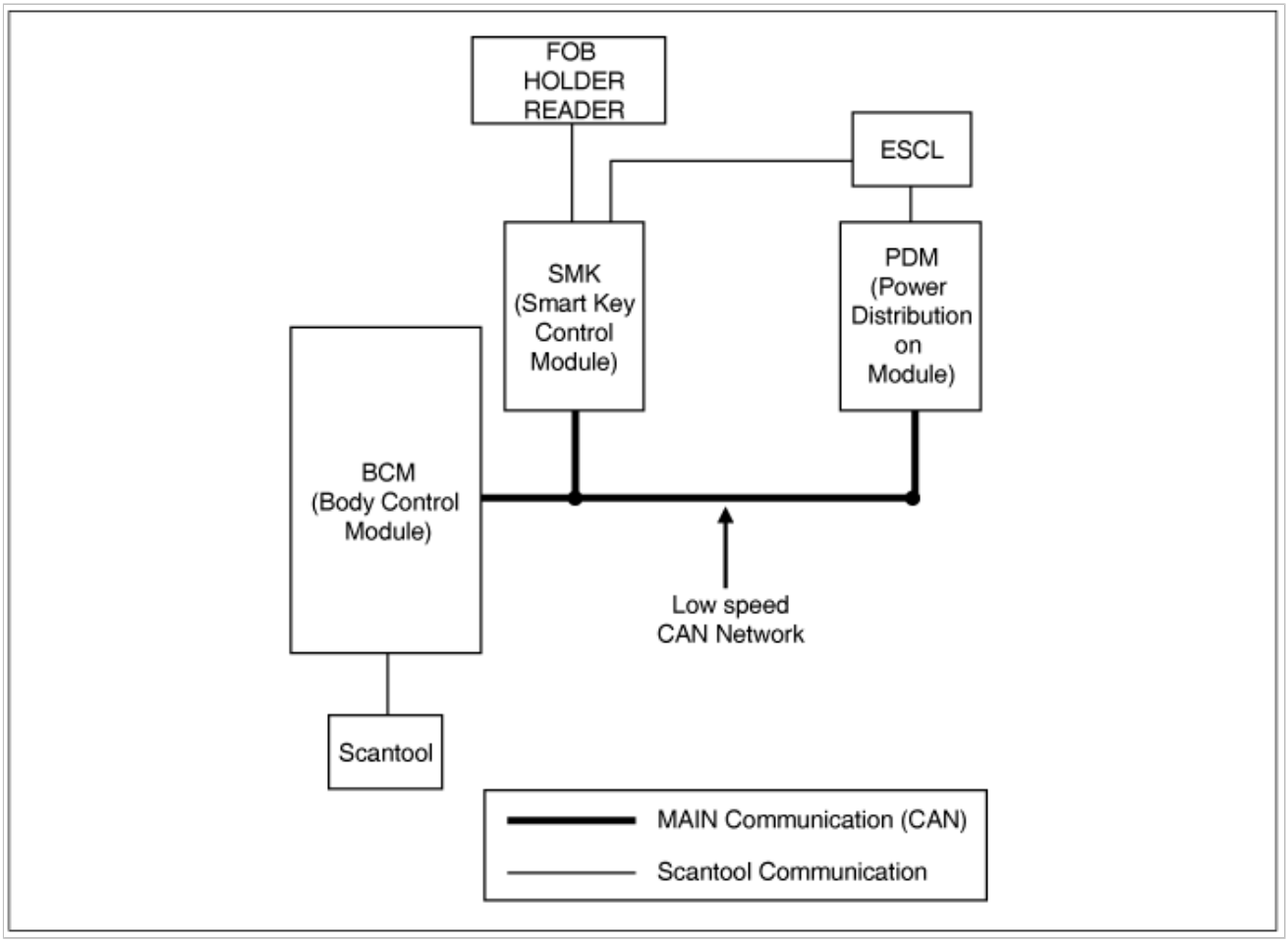
After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select "DTC Analysis" mode.
2. Clear the DTCs and Operate the vehicle within DTC Enable conditions in General information.
3. Is any DTC outputted again?

YES	▸ Go to the applicable troubleshooting procedure.
NO	▸ System performing to specification at this time.

General Description

The body electrical system is comprised of four ECU applied CAN*¹ communication nodes.
※ Control Units : BCM(Body Control Module), PDM(Power Distribution Module), CLU(Cluster), SMK(Smart Key) ECU.
The steering wheel lock/unlock state of ESCL and the required data when EMS(Engine Management System) controls starting are sent to PDM by the serial communication line.
*¹ CAN (Controller Area Network) : CAN is serial bus communication type which links not only communication system but also control units each other.
*² LIN (Local Interconnect Network) : LIN is serial communication type which is used in electrical control system. (This is less expensive.)



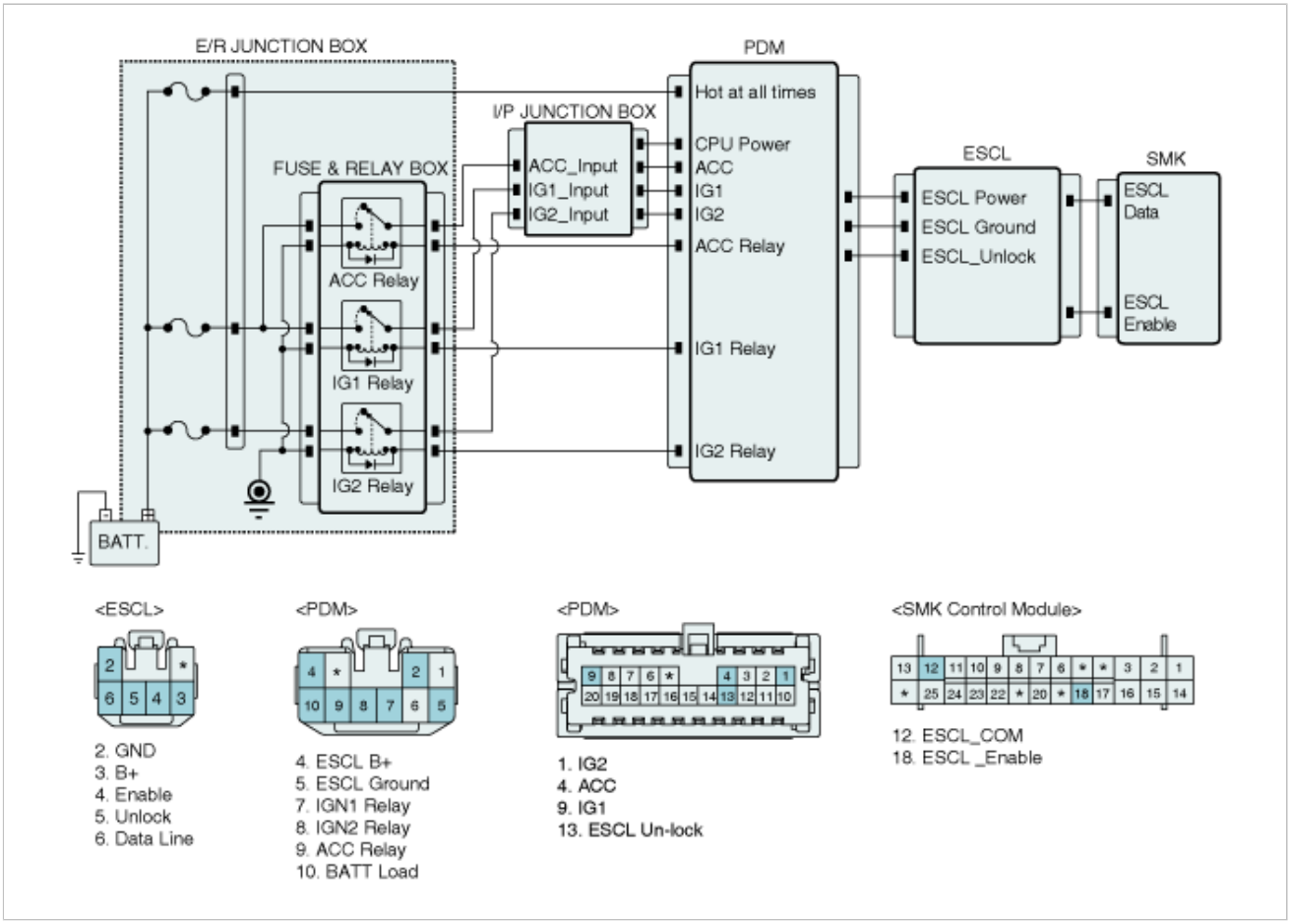
DTC Description

This code is outputted when ground circuit is shorted to battery.
(During no power supply from PDM to ESCL)

DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• ESCL ground output line check (by voltage monitoring)	• Short to power in ESCL ground circuit
Enable Conditions	• No power supply from PDM to ESCL	
Threshold Value	• ESCL ground circuit is shorted to power (7V and above)	
Diagnostic Time	• Immediately	
DTC Erasing Time	• DTC is erased immediately after trouble fixed. (Under no power supply from PDM to ESCL state)	

Diagnostic Circuit Diagram



Signal Waveform & Data

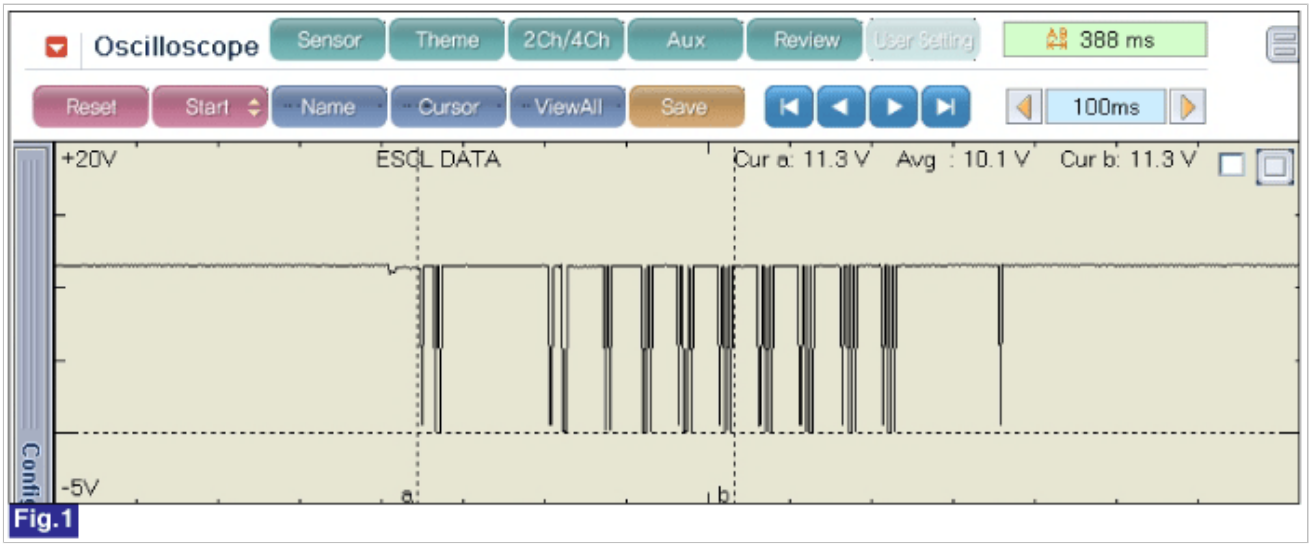
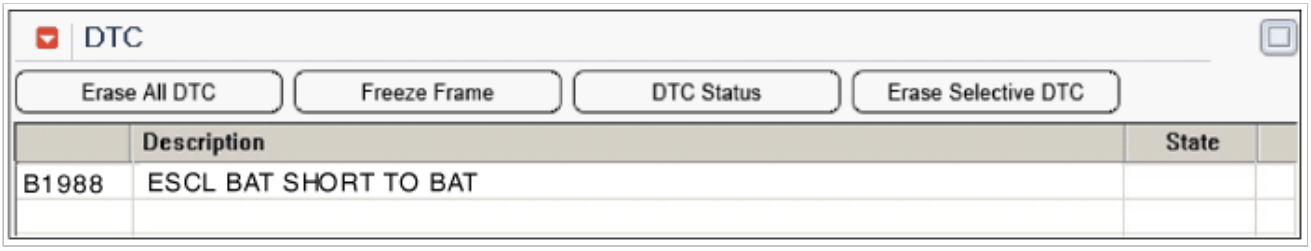


Fig.1) ESCL Data Signal Waveform

Scantool Data Analysis

1. Connect GDS.
2. IG "ON" and engine "OFF".
3. Select "DTC Analysis" mode.
4. After erase DTC, keep the vehicle condition within "the enable conditions" (Refer to "DTC Detecting Condition" table).



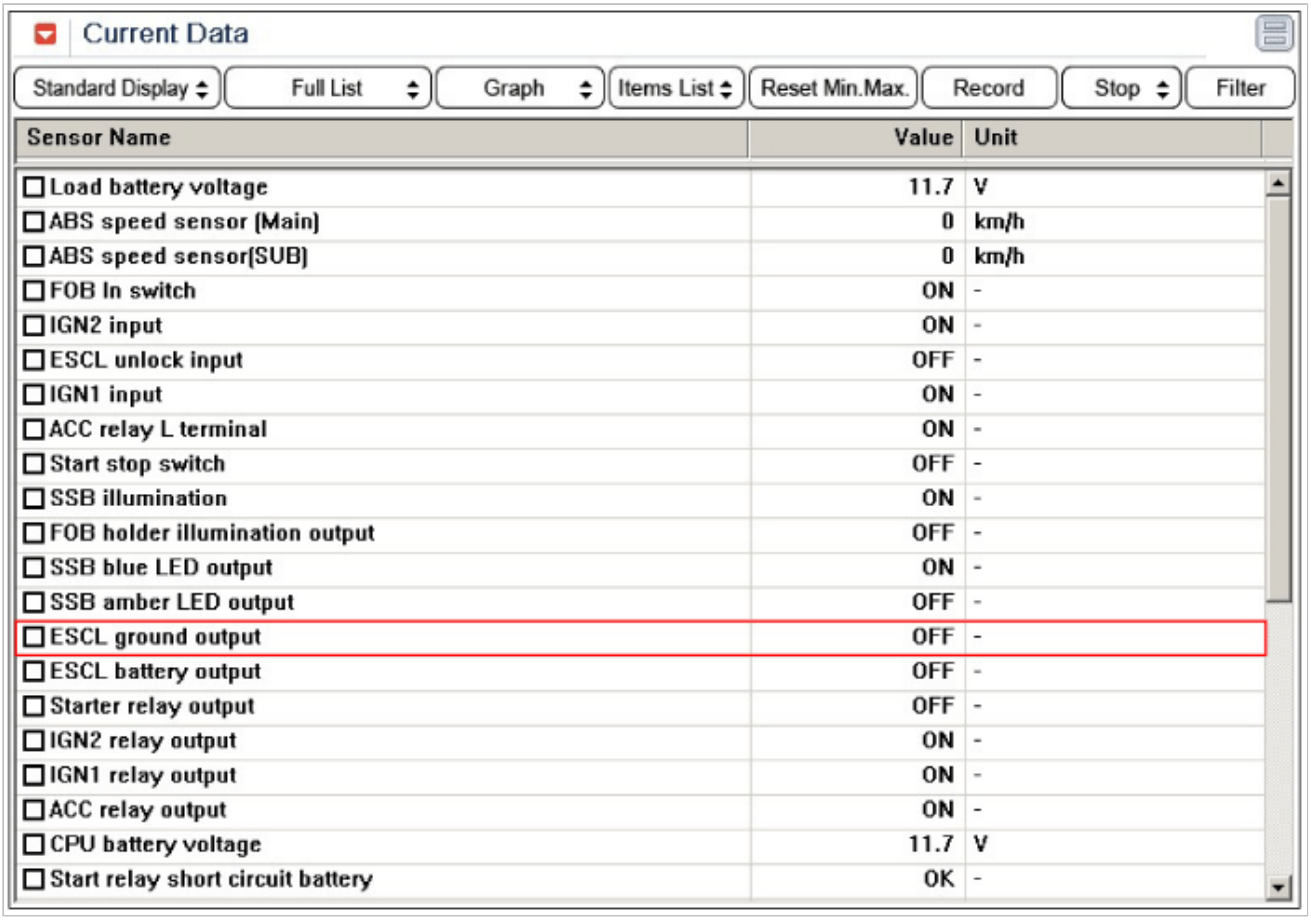
5. Is the same DTC occurred again?

YES	▸ Go to next procedure.
NO	▸ Fault is intermittent caused by poor contact in ESCL's and/or PDM's connector or was repaired and PDM memory was not cleared. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and then go to "Verification of Vehicle Repair" procedure.

■ Service Data Analysis

1. IG "OFF" and connect GDS.
2. IG "ON" and select "Current Data" menu.
3. Check the service data of ESCL GND.

Specification : OFF



4. Is the service data within specifications?

YES	▸ Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and then go to "Verification of Vehicle Repair" procedure.

NO	▸ Go to next procedure.

Terminal & Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness(es) and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▸ Repair as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▸ Go to "Component Inspection" procedure.

PDM Ground Circuit Inspection

■ Check short at ground terminal of PDM

1. IG "ON" & ENG "OFF".
2. Measure voltage between ESCL ground terminal of PDM and chassis ground.
   (Measure the voltage while ESCL doesn't work.)

Specification : Approx. 0 V

3. Is the measured voltage within specifications?

YES	▸ Go to next procedure.
NO	▸ Check open or short on the ground circuit between PDM and ESCL. Repair as necessary and go to "Verification of Vehicle Repair"

■ Check short to power on ESCL GND circuit

1. IG "ON" & ENG "OFF"
2. Disconnect the connectors of IPM, PDM, ESCL.
3. Measure voltage between ESCL ground terminal and chassis ground.

Specification : Approx. 0 V

4. Is the measured voltage within specifications?

YES	▸ Substitute with a known - good ESCL and check for proper operation. If the problem is corrected, replace the unit and go to "Verification of Vehicle Repair" procedure. ▸ Substitute with a known - good PDM and check for proper operation. If the problem is corrected, replace the unit and go to "Verification of Vehicle Repair" procedure.
NO	▸ Repair as necessary and go to "Verification of Vehicle Repair".

Verification of Vehicle Repair

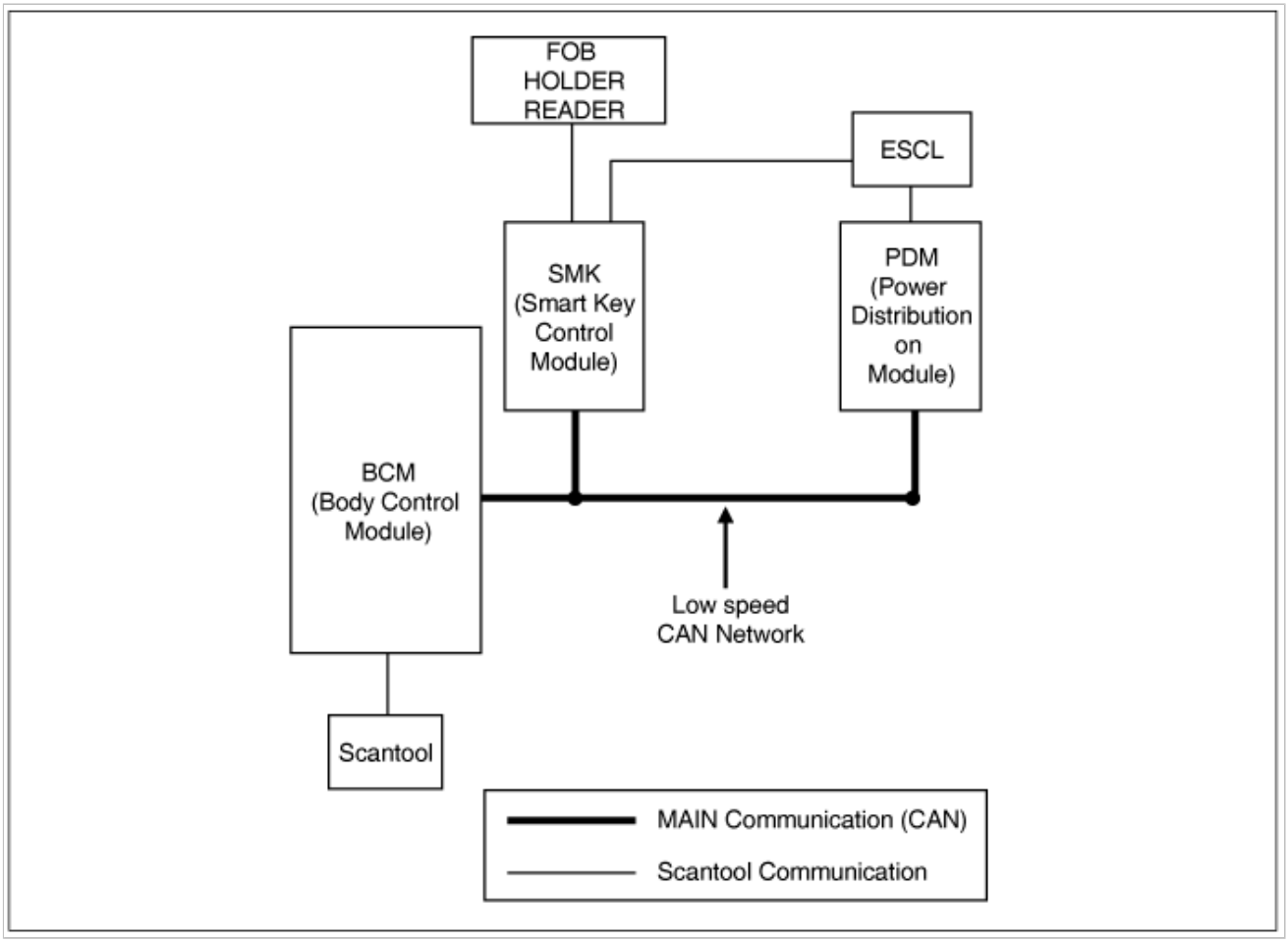
After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select "DTC Analysis" mode.
2. Clear the DTCs and Operate the vehicle within DTC Enable conditions in General information.
3. Is any DTC outputted again?

YES	▸ Go to the applicable troubleshooting procedure.
NO	▸ System performing to specification at this time.

General Description

The body electrical system is comprised of four ECU applied CAN*¹ communication nodes.
※ Control Units : BCM(Body Control Module), PDM(Power Distribution Module), CLU(Cluster), SMK(Smart Key) ECU.
The steering wheel lock/unlock state of ESCL and the required data when EMS(Engine Management System) controls starting are sent to PDM by the serial communication line.
*¹ CAN (Controller Area Network) : CAN is serial bus communication type which links not only communication system but also control units each other.
*² LIN (Local Interconnect N etwork) : LIN is serial communication type which is used in electrical control system. (This is less expensive.)



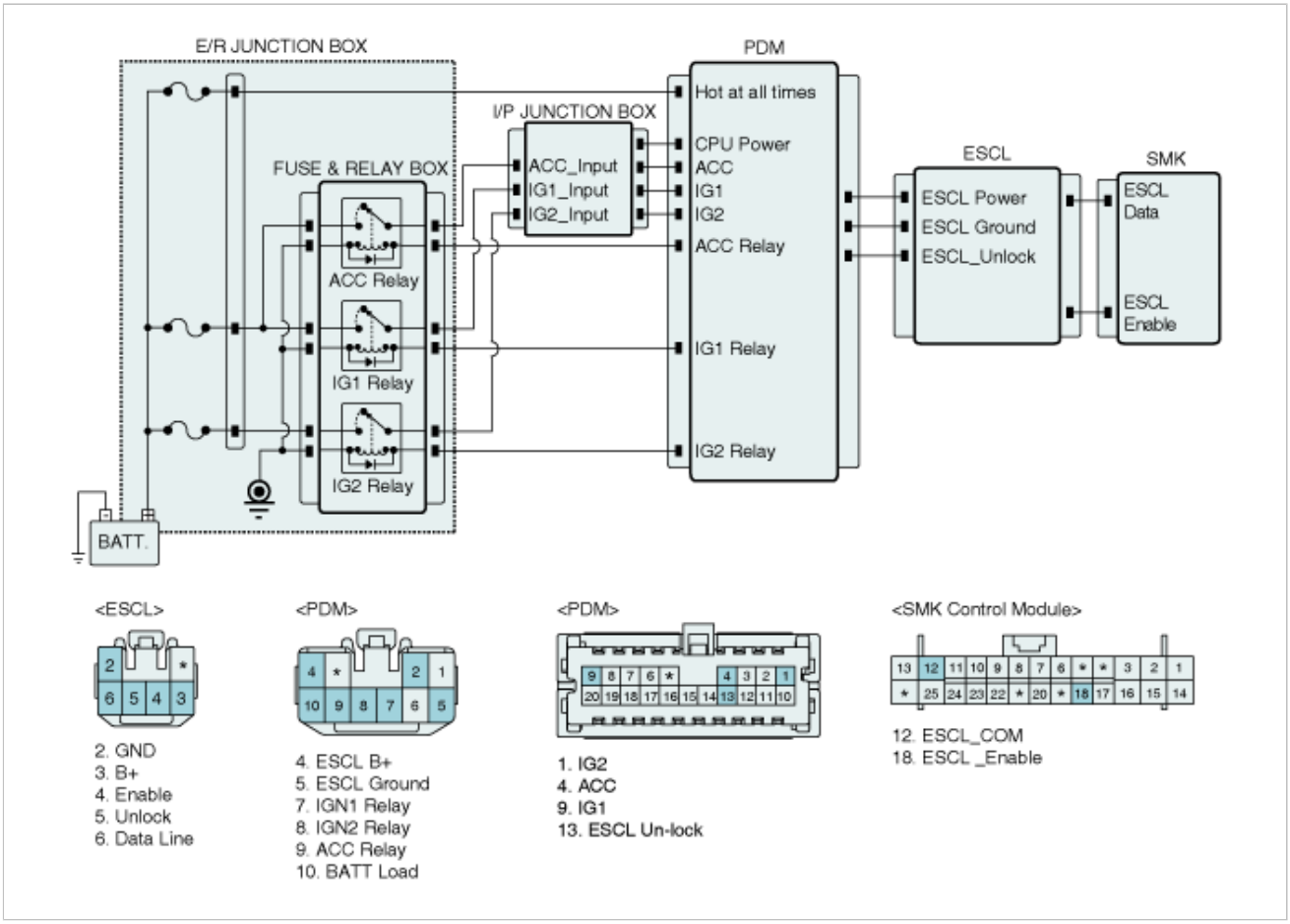
DTC Description

This code is outputted when power circuit is shorted to ground.
(During power supply from PDM to ESCL)

DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• ESCL power output line check (by voltage monitoring)	• Short to ground in ESCL power circuit
Enable Conditions	• Under power supply from PDM to ESCL	
Threshold Value	• ESCL power circuit is shorted to ground(2V and below)	
Diagnostic Time	• Immediately	
DTC Erasing Time	• DTC is erased immediately after trouble fixed. (Under power supply from PDM to ESCL state)	

Diagnostic Circuit Diagram



Signal Waveform & Data

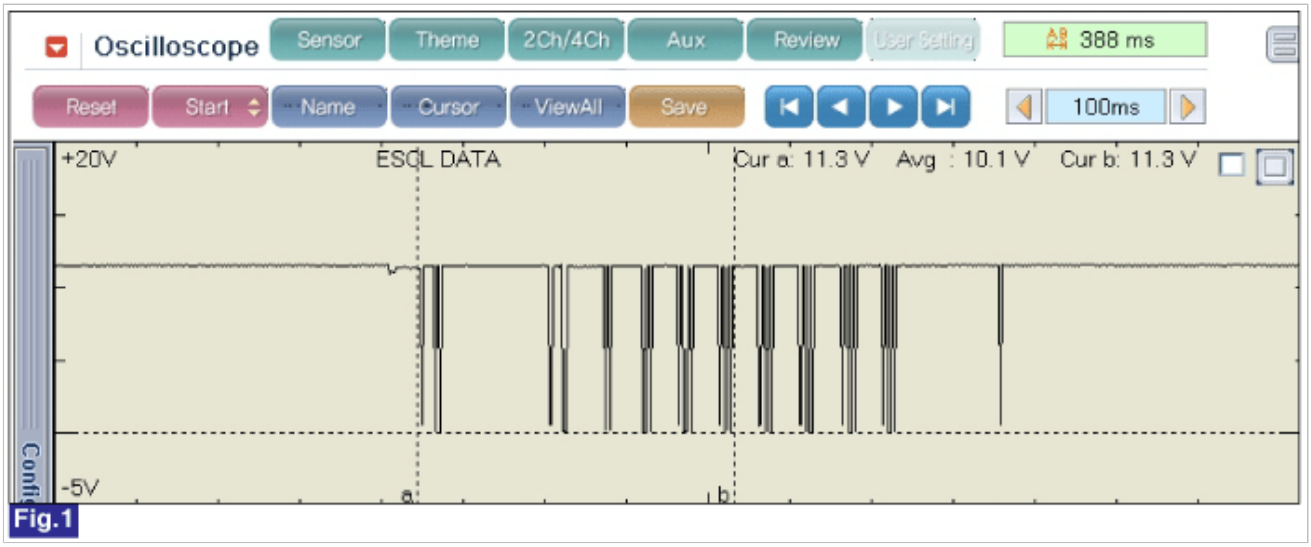
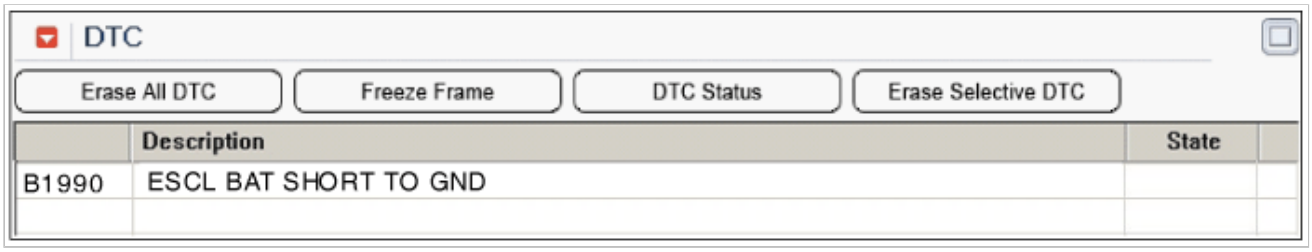


Fig.) ESCL Data Signal Waveform

Scantool Data Analysis

1. Connect GDS.
2. IG "ON" and engine "OFF".
3. Select "DTC Analysis" mode.
4. After erase DTC, keep the vehicle condition within "the enable conditions" (Refer to "DTC Detecting Condition" table).



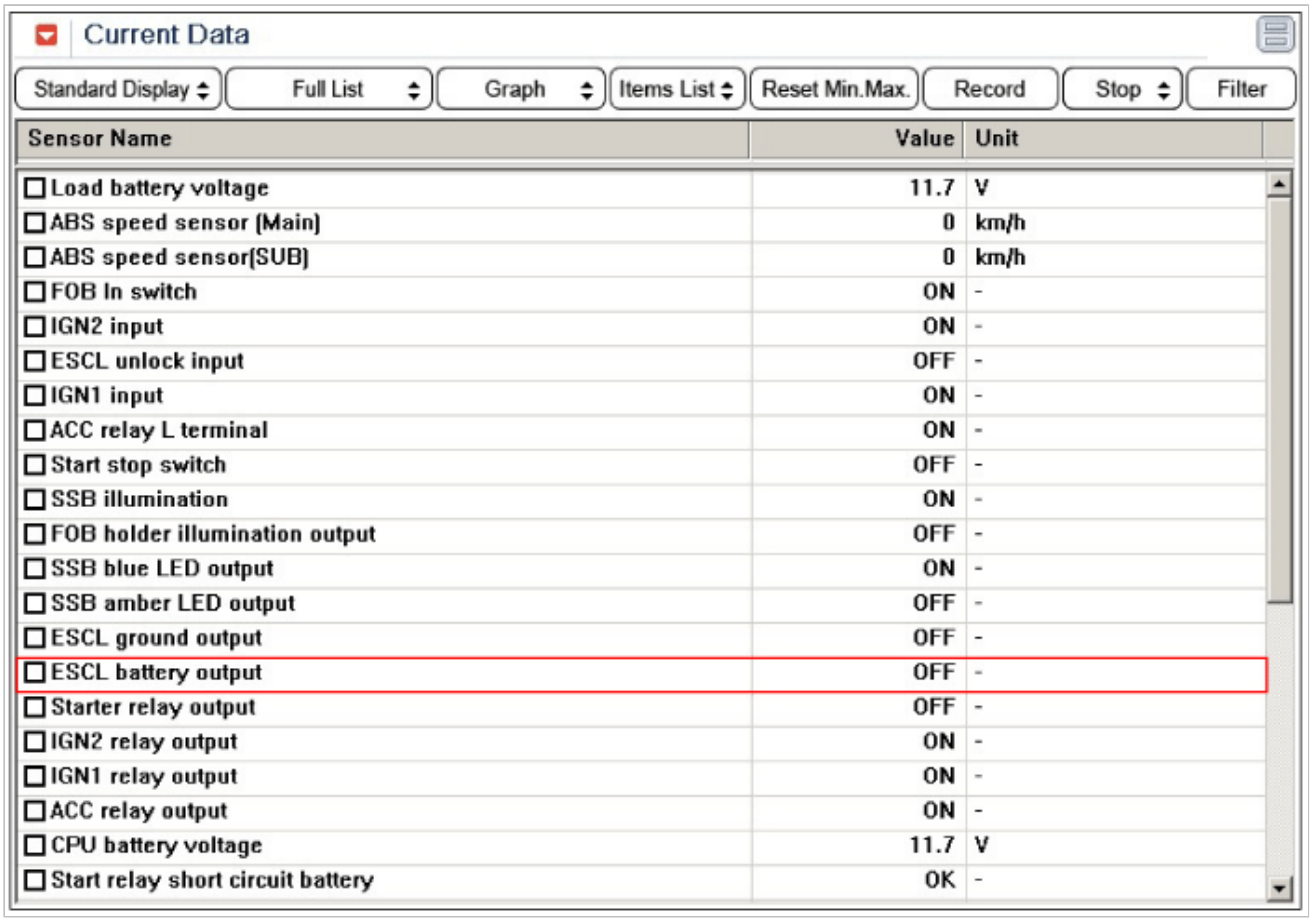
5. Is the same DTC occurred again?

YES	▸ Go to next procedure.
NO	▸ Fault is intermittent caused by poor contact in ESCL's and/or PDM's connector or was repaired and PDM memory was not cleared. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and then go to "Verification of Vehicle Repair" procedure.

■ Service Data Analysis

1. IG "OFF" and connect GDS.
2. IG "ON" and select "Current Data" menu.
3. Check the service data of ESCL BATT.

Specification : ON



4. Is the service data within specifications?

YES	▸ Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and then go to "Verification of Vehicle Repair" procedure.

NO	▸ Go to next procedure.

Terminal & Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness(es) and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▸ Repair as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▸ Go to "Component Inspection" procedure.

PDM Ground Circuit Inspection

■ Check short at power terminal of PDM

1. IG "ON" & ENG "OFF".
2. (2) Measure voltage between ESCL power terminal of PDM and chassis ground.
   (Measure the voltage while ESCL works.)

Specification : Approx. 12 V

3. Is the measured voltage within specifications?

YES	▸ Go to next procedure.
NO	▸ Check open or short on the power circuit between PDM and ESCL. Repair as necessary and go to "Verification of Vehicle Repair"

■ Check short to ground on ESCL power circuit

1. IG "ON" & ENG "OFF"
2. Disconnect the connectors of IPM, PDM, ESCL.
3. Measure resistance between ESCL power terminal and chassis ground.

Specification : ∞ Ω

4. Is the measured voltage within specifications?

YES	▸ Substitute with a known - good ESCL and check for proper operation. If the problem is corrected, replace the unit and go to "Verification of Vehicle Repair" procedure. ▸ Substitute with a known - good PDM and check for proper operation. If the problem is corrected, replace the unit and go to "Verification of Vehicle Repair" procedure.
NO	▸ Repair as necessary and go to "Verification of Vehicle Repair".

Verification of Vehicle Repair

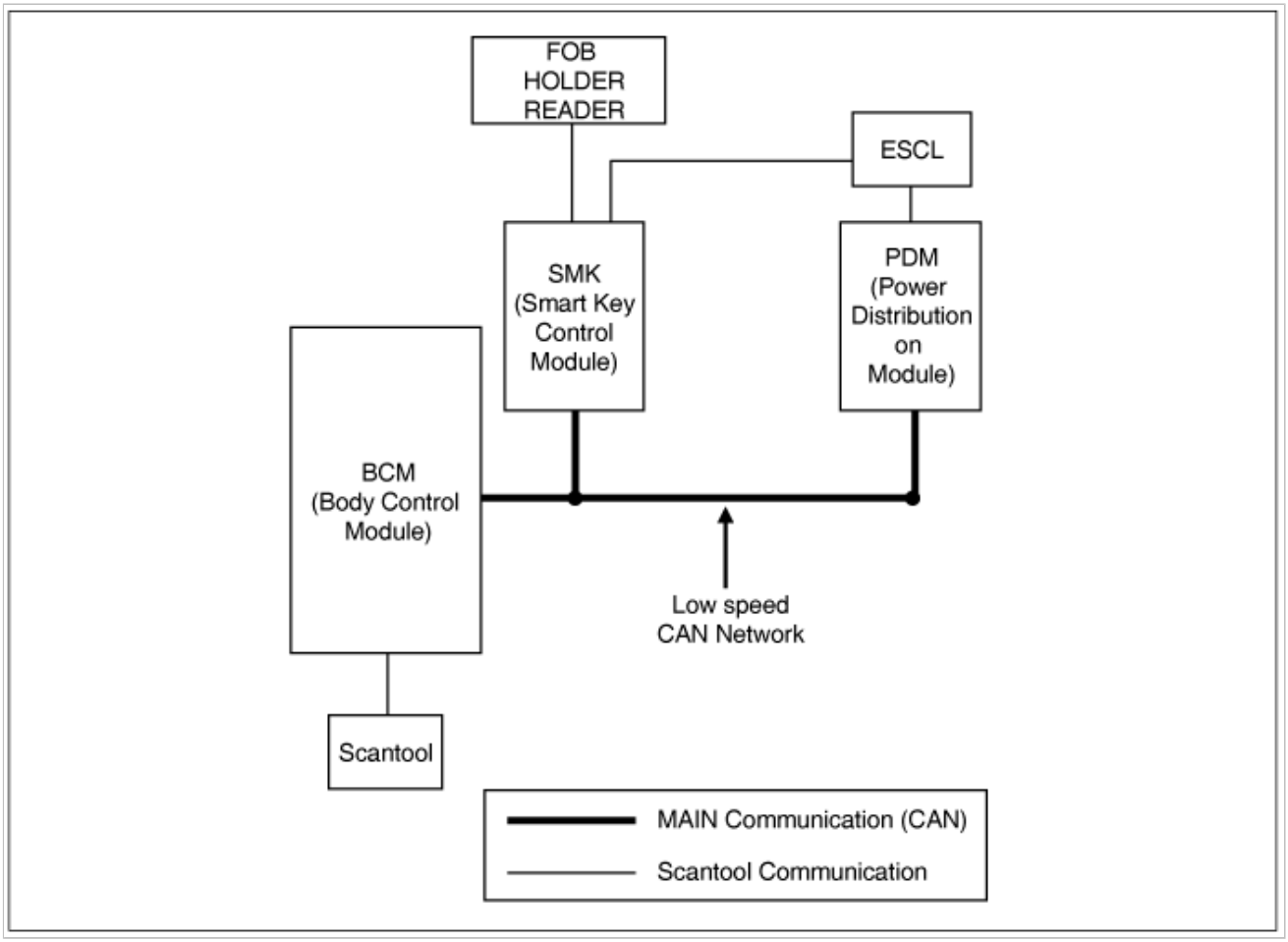
After a repair, it is essential to verify that the fault has been corrected.

1. Connect scan tool and select "DTC Analysis" mode.
2. Clear the DTCs and Operate the vehicle within DTC Enable conditions in General information.
3. Is any DTC outputted again?

YES	▸ Go to the applicable troubleshooting procedure.
NO	▸ System performing to specification at this time.

General Description

The body electrical system is comprised of four ECU applied CAN*¹ communication nodes.
※ Control Units : BCM(Body Control Module), PDM(Power Distribution Module), CLU(Cluster), SMK(Smart Key) ECU.
After insert the fob into the fob holder, press SSB button. Then, the communication state between the fob and the immobilizer is inputted to PDM.
*¹ CAN (Controller Area Network) : CAN is serial bus communication type which links not only communication system but also control units each other.
*² LIN (Local Interconnect Network) : LIN is serial communication type which is used in electrical control system. (This is less expensive.)



DTC Description

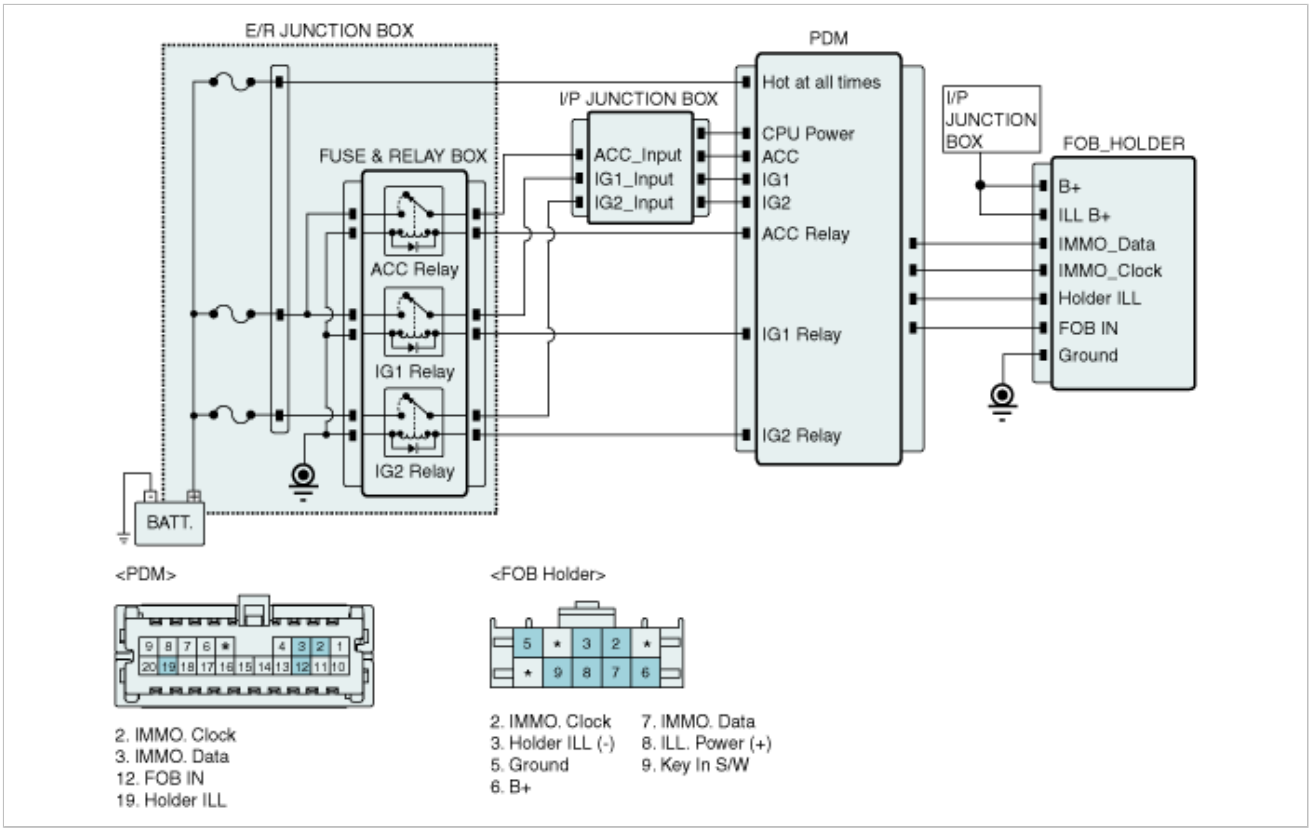
This code is outputted when the immobilizer data circuit is shorted to ground.
(In this case, it is not possible to get authorization although the fob is in the holder.)

DTC Detecting Condition

Item	Detecting Condition	Possible Cause
DTC Strategy	• Immobilizer data line check (by voltage monitoring)	• Short to ground in immobilizer data circuit
Enable Conditions	• The communication state between the fob and the fob holder when SSB button is pushed. (The fob is in the holder.)	
Threshold Value	• Short to ground in immobilizer data circuit (2V and below)	
Diagnostic Time	• Immediately	
	• DTC is erased immediately after trouble fixed. (After	

DTC Erasing Time	communication recovery)	

Diagnostic Circuit Diagram

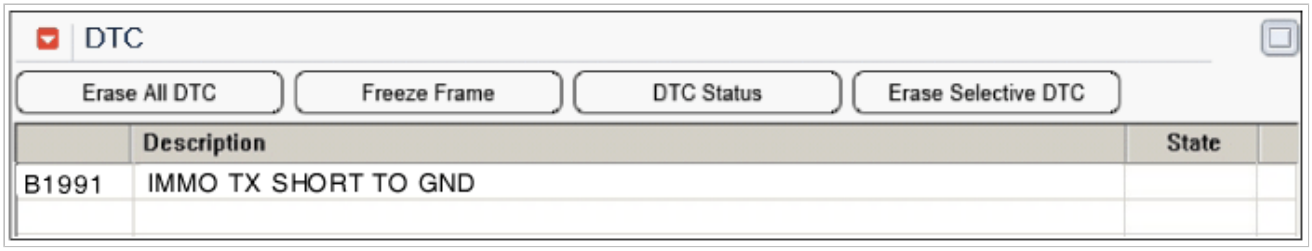


Signal Waveform & Data

Fig.1) IMMO_CLOCK & IMMO_DATA signal waveform

Scantool Data Analysis

1. Connect GDS.
2. IG "ON" and engine "OFF".
3. Select "DTC Analysis" mode.
4. After erase DTC, keep the vehicle condition within "the enable conditions" (Refer to "DTC Detecting Condition" table).



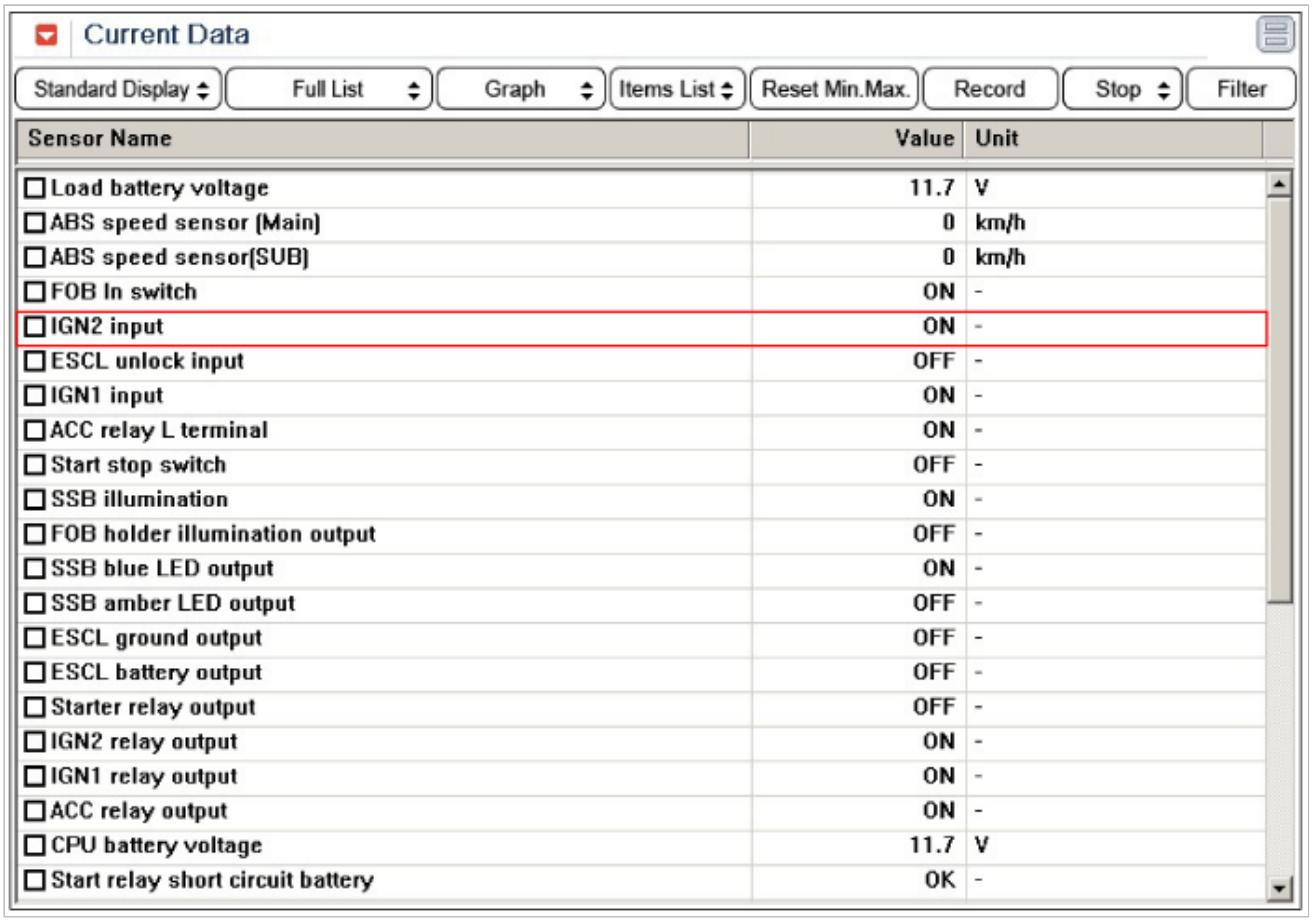
5. Is the same DTC occurred again?

YES	▸ Go to next procedure.
NO	▸ Fault is intermittent caused by poor contact in PDM's connector or was repaired and PDM memory was not cleared. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and then go to "Verification of Vehicle Repair" procedure.

■ Service Data Analysis

1. IG "OFF" and connect GDS.
2. IG "ON" and select "Current Data" menu.
3. Check the service data of SMART KEY HOLDER INSERT SIGNAL.

Specification : ON (When the fob is inserted in the holder)



Sensor Name	Value	Unit
Load battery voltage	11.7	V
ABS speed sensor (Main)	0	km/h
ABS speed sensor(SUB)	0	km/h
FOB In switch	ON	-
IGN2 input	ON	-
ESCL unlock input	OFF	-
IGN1 input	ON	-
ACC relay L terminal	ON	-
Start stop switch	OFF	-
SSB illumination	ON	-
FOB holder illumination output	OFF	-
SSB blue LED output	ON	-
SSB amber LED output	OFF	-
ESCL ground output	OFF	-
ESCL battery output	OFF	-
Starter relay output	OFF	-
IGN2 relay output	ON	-
IGN1 relay output	ON	-
ACC relay output	ON	-
CPU battery voltage	11.7	V
Start relay short circuit battery	OK	-

4. Is the service data within specifications?

YES	▸ Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage. Repair or replace as necessary and then go to "Verification of Vehicle Repair" procedure.
NO	▸ Go to next procedure.

Terminal & Connector Inspection

1. Many malfunctions in the electrical system are caused by poor harness(es) and terminals. Faults can also be caused by interference from other electrical systems, and mechanical or chemical damage.
2. Thoroughly check connectors for looseness, poor connection, bending, corrosion, contamination, deterioration, or damage.
3. Has a problem been found?

YES	▸ Repair as necessary and go to "Verification of Vehicle Repair" procedure.
NO	▸ Go to next procedure.

Immobilizer TX Terminal Inspection

■ Check short to ground on IMMO TX terminal

1. IG "ON" & ENG "OFF".
2. Disconnect the connectors of IPM, PDM, ESCL.
3. Measure resistance between IMMO TX terminal and chassis ground.

Specification : ∞ Ω

4.
5. Is the measured resistance within specifications?

YES	▸ Substitute with a known - good PDM and check for proper operation. If the problem is corrected, replace the unit and go to "Verification of Vehicle Repair" procedure. ▸ Substitute with a known - good fob holder and check for proper operation. If the problem is corrected, replace the unit and go to "Verification of Vehicle Repair" procedure.
NO	▸ Repair as necessary and go to "Verification of Vehicle Repair".

Verification of Vehicle Repair

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

1. Connect scan tool and select "DTC Analysis" mode.
2. Clear the DTCs and Operate the vehicle within DTC Enable conditions in General information.
3. Is any DTC outputted again?

YES	▸ Go to the applicable troubleshooting procedure.
NO	▸ System performing to specification at this time.