



## DESCRIPTION

This specification applies to Hydraulic and Electronic Control Unit (HECU) of the Anti lock Braking System(ABS) and Traction Control System(TCS).

This HECU has the functions as follows:

- Input of signal from the wheel speed sensors attached to each wheel.
- Control of braking force and traction force
- Failsafe function
- Self diagnosis function
- Interface with the external diagnosis tester

## Operation

The HECU shall be put into operation by switching on the operating voltage (IGN).

On completion of the initialization phase, the HECU shall be ready for operation.

In the operating condition, the HECU shall be ready, within the specified limits (voltage and temperature), to process the signals offered by the various sensors and switches in accordance with the control algorithm defined by the software and to control the hydraulic and electrical actuators.

The HECU shall receive wheel speed signal from the four inductive wheel sensors.

The wheel signals are converted to square wave by the signal conditioning circuit and given as input to the  $\mu$  - processor. The sensor connections shall be monitored for short-circuit and inter-ruption and then in the event of 2 sensor failures, the HECU shall shut down the system.

When one side of the valve coil is connected to the positive voltage that is provided through the valve relay and the other side is connected to the ground by the MOSFET, the solenoid valve goes into operation.

The electrical function of the valves are always monitored by the valve test pulse under normal operation conditions.

When overvoltage is detected(above 16V), the HECU switches off the valve relay and shuts down the system. When voltage is returned to operating range, the system goes back to the normal condition after the initialization phase.

In the event of undervoltage(below 10V), ABS control shall be inhibited and the warning lamp shall be turned on.

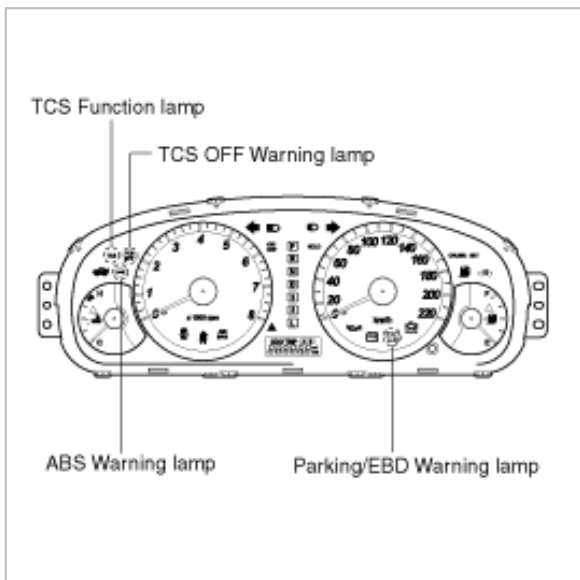
When voltage is returned to operating range, the warning lamp is switched off and the HECU returns to normal operating mode.

The pump motor operates when the ABS is functioning.

The HECU performs a pump motor test at a speed of 20km/h once after turned the Ignition switch on. You may hear the motor operate at this time, but it is normal.

Malfunctions or failures detected by the HECU are encoded on the HECU, stored in a EEPROM and read out by diagnostic equipment (hi-scan pro) when the ignition switch is turned on.

## Warning lamp control



### 1. ABS warning lamp module

The ABS warning lamp module indicates the operating condition of the ABS.

The ABS warning lamp is turned on under the following conditions.

- A. During the initialization phase after ignition switch ON (3 seconds).
- B. In the event of inhibition of ABS functions by failure.
- C. When the system ECU is shut down even though ignition power is applied.
- D. During diagnostic mode.
- E. When the HECU connector is disconnected.

### 2. EBD warning lamp module

The EBD warning lamp module indicates the operating condition of the EBD. However, in case the parking brake switch is turned on, the EBD warning lamp is always turned on regardless of EBD functions.

The EBD warning lamp is turned on under the following conditions.

- A. During the initialization phase after ignition switch ON. (3 seconds).
- B. When the system ECU is shut down even though ignition power is applied.
- C. When the parking brake switch is ON or brake fluid is low level.
- D. In the event of inhibition of EBD functions by failure.

### 3. TCS lamp module

The TCS warning lamp module indicates the operating condition of the TCS.

The TCS warning lamp is turned on under the following conditions :

- A. During the initialization phase after ignition switch ON (3 seconds).
- B. In the event of inhibition of TCS functions by failure.
- C. When the TCS OFF switch is turned on.

TCS function lamp is turned on when the TCS functions are operating (Blinking-2Hz).

## Diagnostic trouble code (DTC)

1. If the CPU cannot be activated or the CPU fails, the ABS indicator comes on, but the DTC is not memorized.

2. The memory can hold any number of DTCs. However, when the same DTC is detected more than once, the later one is written over the old one.

Therefore, when the same problem is detected repeatedly, it is memorized as one DTC.

3. The DTCs are indicated in the order they occur.

4. The DTCs are memorized in the EEPROM (non - volatile memory). Therefore, the memorized DTCs cannot be canceled by disconnecting the battery. Perform the specified procedures to erase the DTCs.

## Self-diagnosis

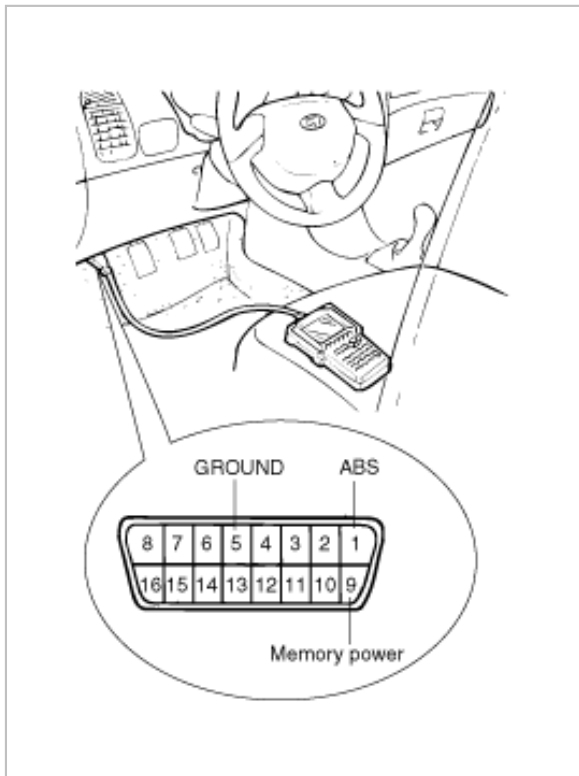
1. Self diagnosis can be classified into two categories:
  - A. Initial diagnosis:  
Performed right after the engine starts and until the ABS indicator goes off.
  - B. Regular diagnosis:  
Performed right after the initial diagnosis until the ignition switch is turned OFF.
2. When a problem is detected by self-diagnosis, the system:
  - A. Turns the solenoid valve OFF
  - B. Turns the pump motor OFF
  - C. Turns the ABS indicator ON

## How to troubleshoot ABS DTC

1. Question the customer about the conditions when the problem occurred, and try to reproduce the same conditions for troubleshooting. Find out when the ABS indicator came on, such as during initial diagnosis, during ABS control, after ABS control, when vehicle speed was at a certain speed, etc.
2. When the ABS indicator does not come on during the test-drive, but troubleshooting is performed based on the DTC. check for loose connectors, poor contact of the terminals, etc. before you start troubleshooting.
3. After troubleshooting, erase the DTC and test-drive the vehicle. Be sure the ABS indicator does not come on.

## HI-SCAN (PRO) CHECK

1. Turn the ignition switch OFF.
2. Connect the Hi-scan (pro) to the 16P data link connector located behind the driver's side kick panel.



3. Turn the ignition switch ON.
4. Check for diagnostic trouble codes using the Hi-scan (pro).
5. After completion of the repair or correction of the problem, erase the stored fault codes using the clear key on the Hi-scan (pro).
6. Disconnect the Hi-scan (pro) from the 16P data link connector.

## SYSTEM FUNCTION

## ABS OPERATION

### 1. NORMAL BRAKING

Solenoid valve	State	Valve	Passage	Pump motor
IN (NO)	OFF	OPEN	Master cylinder ↔ Wheel cylinder	OFF
OUT (NC)	OFF	CLOSE	Wheel cylinder ↔ Reservoir	

Under the normal braking, voltage is not supplied to solenoid valve, inlet valve is opened and outlet valve is closed. When the brake is depressed, brake fluid is supplied to the wheel cylinder via solenoid valve to activate the brake. When the brake is released, brake fluid is back to the master cylinder via inlet valve and check valve.

### 2. DUMP MODE

Solenoid valve	State	Valve	Passage	Pump motor
IN (NO)	ON	CLOSE	Master cylinder ↔ Wheel cylinder	ON
OUT (NC)	ON	OPEN	Wheel cylinder ↔ Reservoir	

Under the emergency braking, if the wheels start to lock up, HECU sends a signal to the solenoid valve to decrease the brakefluid, then voltage is supplied to each solenoid. At this time inlet valve is closed and brake fluid is blocked from the master cylinder. Conversely outlet valve is opened and brake fluid passes through wheel cylinder to reservoir, resulting in pressure decrease.

### 3. HOLD MODE

Solenoid valve	State	Valve	Passage	Pump motor
IN (NO)	ON	CLOSE	Master cylinder ↔ Wheel cylinder	ON
OUT (NC)	OFF	CLOSE	Wheel cylinder ↔ Reservoir	

When the brake fluid pressure is maximally decreased in wheel cylinder, HECU sends a signal to solenoid valve to keep the fluidpressure, voltage is supplied to inlet valve but it is not supplied to outlet valve. At this time inlet and outlet valves are closed and brake fluid is kept in wheel cylinder.

### 4. INCREASE MODE

Solenoid valve	State	Valve	Passage	Pump motor
IN (NO)	OFF	OPEN	Master cylinder ↔ Wheel cylinder	ON
OUT (NC)	OFF	CLOSE	Wheel cylinder ↔ Reservoir	

If HECU determines there's no lock-up in the wheel, HECU cuts voltage to solenoid valve. So voltage is not supplied to each solenoid valve, brake fluid passes through the inlet valve to wheel cylinder, resulting in pressure increase.

## TRACTION CONTROL SYSTEM (TCS) OPERATION

### 1. NORMAL MODE

Solenoid valve	State	Valve	Motor pump	TC valve
IN (NO)	OFF	OPEN	OFF	OFF
OUT (NC)	OFF	CLOSE		

- In the normal driving condition, TC valve (normally open) is the passage between the master cylinder and the each wheel cylinder.
- When brake pedal is applied, brake pressure is delivered to the wheel cylinders via NO-TC valve and all solenoid valves inside the hydraulic unit are deactivated.
- In case of TCS malfunction it does not affect brake operation.

### 2. PRESSURE INCREASE MODE

Solenoid valve	State	Valve	Motor pump	TC valve
IN (NO)	FRONT: OFF REAR: ON	FRONT: OPEN REAR: CLOSE	ON	ON
OUT (NC)	OFF	CLOSE		

- If a front wheel spin is detected, TCS begins a brake control to decrease a wheel spin.
- Hydraulic shuttle valve (HSV) is opened.  
Brake fluid is supplied from the master cylinder by motor operation to the spin wheel via HSV.
- TC valve is closed (ON).  
Brake pressure generated from motor pump is delivered only to the front wheel.
- Inlet valve remains open to deliver the brake pressure generated from motor pump to the spinning wheels.

### 3. PRESSURE DUMP MODE

Solenoid valve	State	Valve	Motor pump	TC valve
IN (NO)	ON	CLOSE	ON	ON
OUT (NC)	FRONT: ON REAR: OFF	FRONT: OPEN REAR: CLOSE		

- When the wheel deceleration is under the threshold and the wheel spin is reduced under a slip threshold, applied brake pressure is reduced to get a optimum traction force.
- Outlet valve is open to release the brake pressure and inlet valve is closed to block the pressure increase from the motor pump.
- Hydraulic shuttle valve (HSV) remains opened, TC valve is ON.
- Motor is ON, to dump the brake fluid being released from the lock-up wheel.

#### 4. PRESSURE HOLD MODE

Solenoid valve	State	Valve	Motor pump	TC valve
IN (NO)	ON	CLOSE	ON	ON
OUT (NC)	OFF	CLOSE		

### TRACTION CONTROL SYSTEM (TCS) FUNCTION

#### 1. Main performance

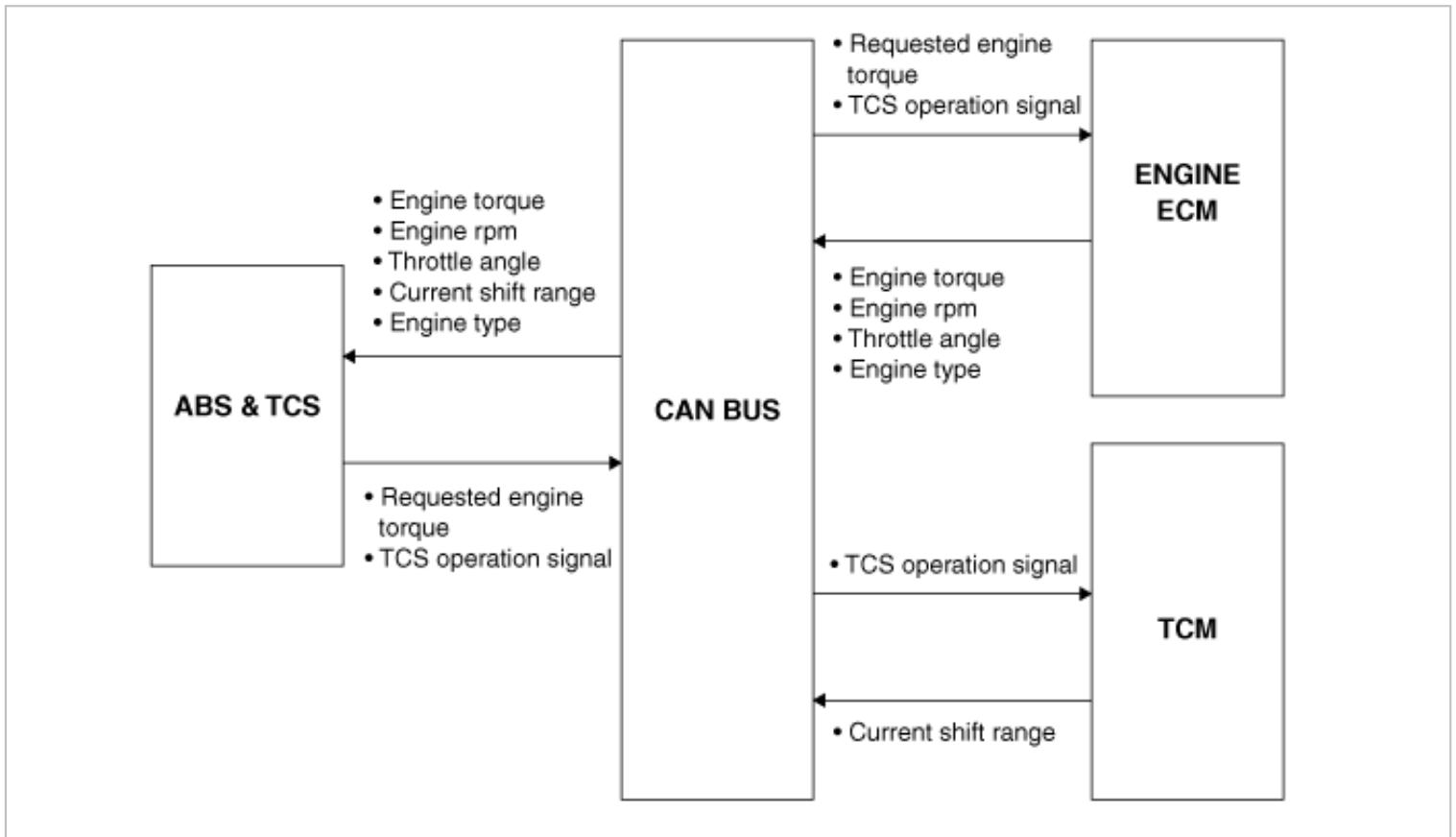
- A. Traction: Lower vibration and higher launchability, acceleration and climbability by slip control.
- B. Cornering and passing: Stable cornering and passing.
- C. Steering stability: Control traction force traverse vector prior to provide easy turning when turning the steering wheel.

#### 2. General TCS features

- A. Improved drivability. Minor operation of acceleration is not necessary in launching and acceleration on slippery road.
- B. More stable cornering by stable acceleration on normal road condition.
- C. TCS system will compare vehicle speed received from rear wheel speed sensor and driving wheel speed from front wheel speed sensor on slippery road condition, and provide optimum slipping rate of driving wheels.

### FULL TRACTION CONTROL SYSTEM (FTCS)

- 1. The ABS control module (HECU) controls TCS control too.
- 2. HECU will compare signals from front (driving) and rear wheel speed sensors to detect driving wheels slip.
- 3. Upon detecting driving wheels slip, HECU will perform TCS control. The TCS control will include brake TCS (BTCS) control.
- 4. HECU will transmit engine torque reduction request, fuel cut cylinder number, and TCS control request signals in accordance with slip level to engine ECM and TCM through BUS line which will provide CAN communication for TCS control.
- 5. Engine ECM will perform fuel cut as requested by HECU and retard ignition timing as per engine torque reduction request signal.
- 6. TCM will hold shift position by TCS control time according to TCS operation signal. Then enhanced acceleration by kick-down will not occur.



## **BRAKE TRACTION CONTROL SYSTEM (BTCS)**

1. On TCS control, only brake control will be performed. (engine and TCM control will not happen)
2. Controlled by motor pump output pressure.

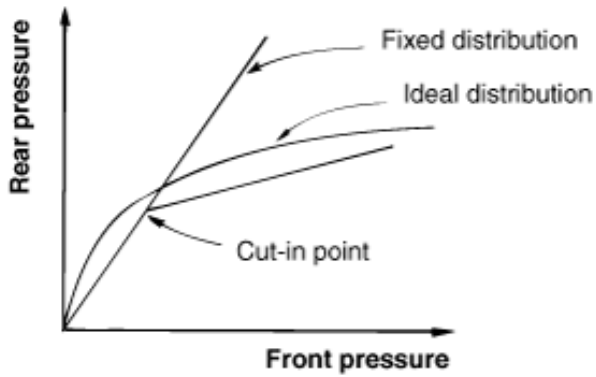
## **EBD (ELECTRONIC BRAKE-FORCE DISTRIBUTION) OPERATION**

### **ADVANTAGES**

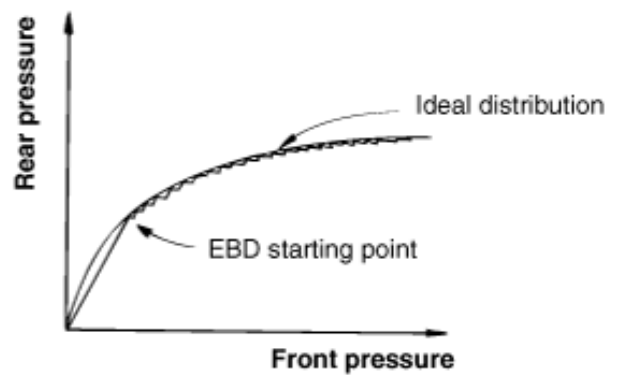
- Function improvement of the base-brake system.
- Compensation for the different friction coefficients.
- Elimination of the proportioning valve.
- Failure recognition by the warning lamp.

## **Comparison between Proportioning valve and EBD**

**[With P-Valve]**



**[With EBD]**



**FAIL SAFE**

FAIL CAUSE	SYSTEM		WARNING LAMP	
	ABS	EBD	ABS	EBD
None	ON	ON	OFF	OFF
1-Wheel speed sensor failure	OFF	ON	ON	OFF
Pump malfunction	OFF	ON	ON	OFF
Low voltage	OFF	ON	ON	OFF
2 or more wheel speed sensor failure Solenoid valve failure HECU malfunction Valve relay failure Over voltage Other failure	OFF	OFF	ON	ON