

ESP SWITCH

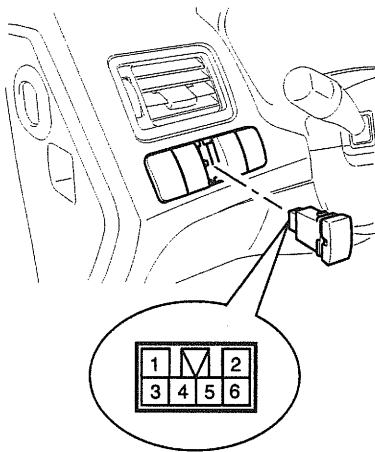
DESCRIPTION EF70E50F

1. The ESP OFF switch is for the user to turn off the ESP system.
2. The ESP OFF lamp is on when ESP OFF switch is engaged.

INSPECTION ECF023A3

1. Remove the ESP OFF switch from the switch panel on the crushpad of the driver's side.

Terminal Function	3	4	5	2
ON	○	○	○	○
OFF			○	○



EJQE900R

KJQE900S

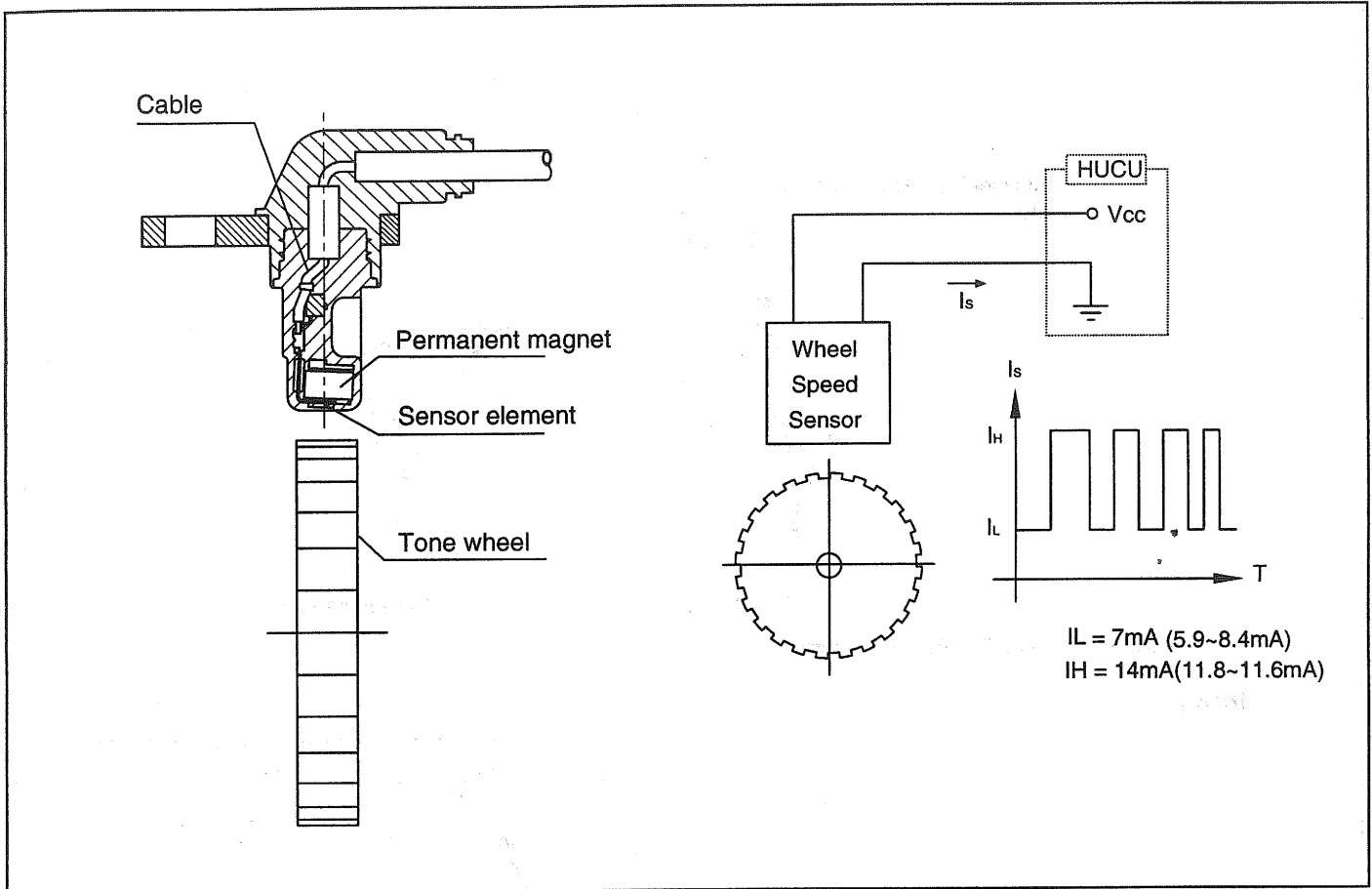
2. Check the continuity between the switch terminals as the ESP OFF switch is engaged.

DESCRIPTION E50EAAAA

A toothed rotor is fixed to the rotating member of the wheel, the sensor to the static member of the suspension. As the wheel rotates the toothed rotor causes magnetic flux changes in the magnetic field of the permanent magnet.

The sensor element senses these changes. Depending on the flux changes the sensor sends a signal out to the ECU. The change in magnet flux thus the sensor signal is directly correlated to the wheel speed.

The controller monitors the sensor signal, compares the four wheel-speed signals and initiates action as required



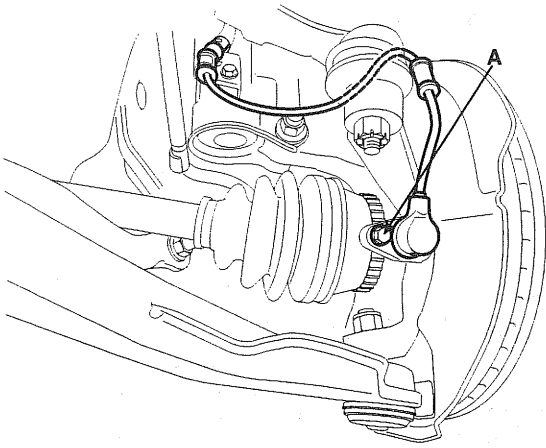
EJQE206D

SPECIFICATIONS EF3ACFBF

Item	Standard Value		Remark
Supply voltage	DC 12V		
Operating temperature	-40~120°C		R=100Ω
Output current range	Low		
	High	14mA(11.8~16.8mA)	
Frequency range	1~200 0Hz		
Airgap	0.5~1.5mm(0.0197~0.0591 in.)		
Tone wheel	Number	48	

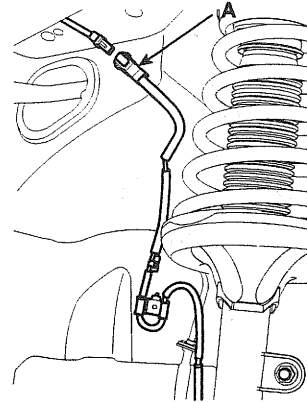
REMOVAL ECCAFD2C**FRONT WHEEL SPEED SENSOR**

1. Remove the front wheel speed sensor mounting bolt (A).



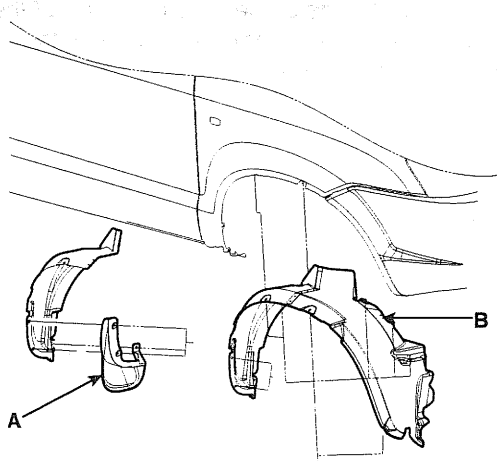
KJKD220A

3. Remove the front wheel speed sensor after disconnecting the wheel speed sensor connector (A).



KJQE710A

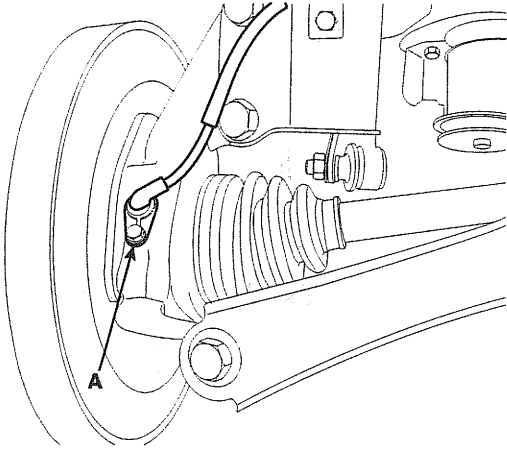
2. Remove the front wheel guard (B), after removing the mud ground (A).



KJQE160C

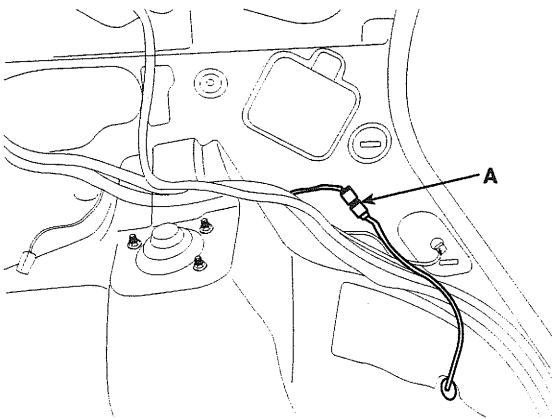
REAR WHEEL SPEED SENSOR

1. Remove the rear wheel speed sensor mounting bolt (A).



KJQE710B

2. Remove the rear seat side pad then disconnect the rear wheel speed sensor connector (A).



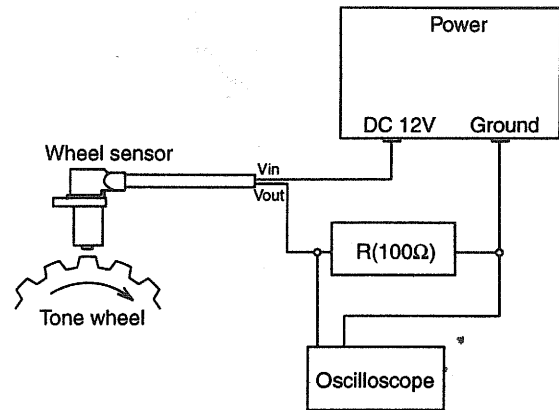
KJQE710C

INSPECTION EAC8D334

1. Measure the output voltage between the terminal of the wheel speed sensor and the body ground.

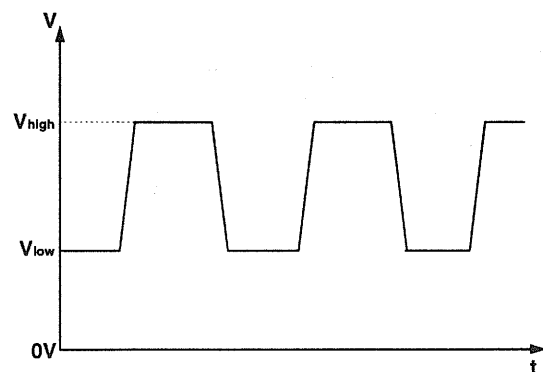
CAUTION

Must use the resistance (100Ω), as shown below, in order to protect the active wheel speed sensor, before measuring the output voltage.



EJQE260A

2. Compare the change of the output voltage of the wheel speed sensor to the normal change of the output voltage as shown below.



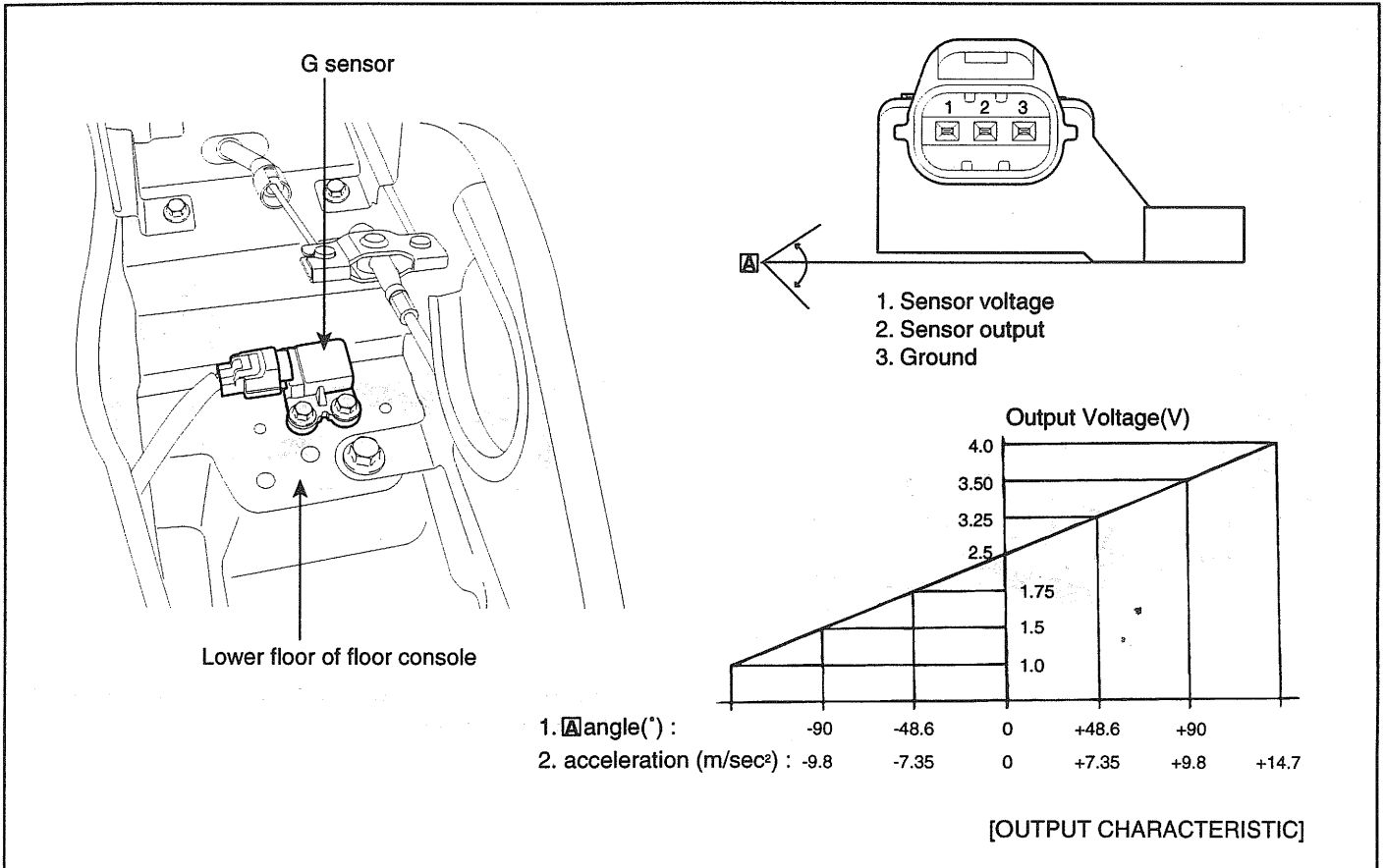
KJQE260B

- V : 590mV ~ 840mV
- V : 1.18V ~ 1.68V
- Frequency range : 1~2,000Hz

G SENSOR

COMPONENTS

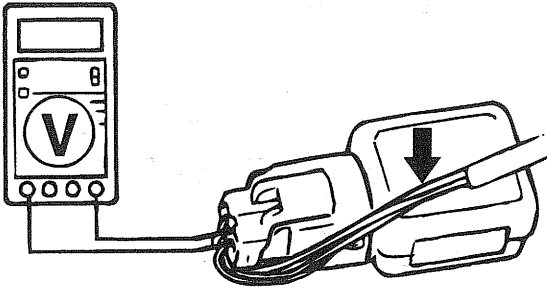
E385EB37



INSPECTION E1C0FF4F

1. Connect a tester to both 2 and 3 terminals of the G sensor.
2. Measure the output voltage when IGN is on.

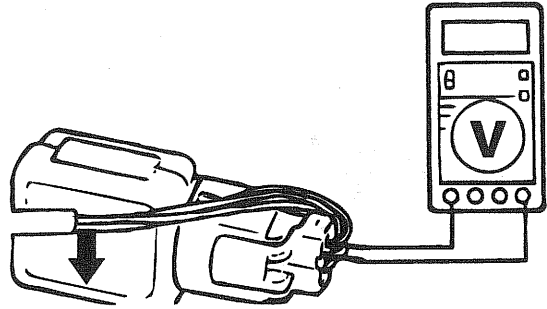
Specification : 2.5V



KJQE820D

3. Measure the output voltage between 2 and 3 terminals, posing the arrow mark on the G sensor downward.

Specification : 3.5V

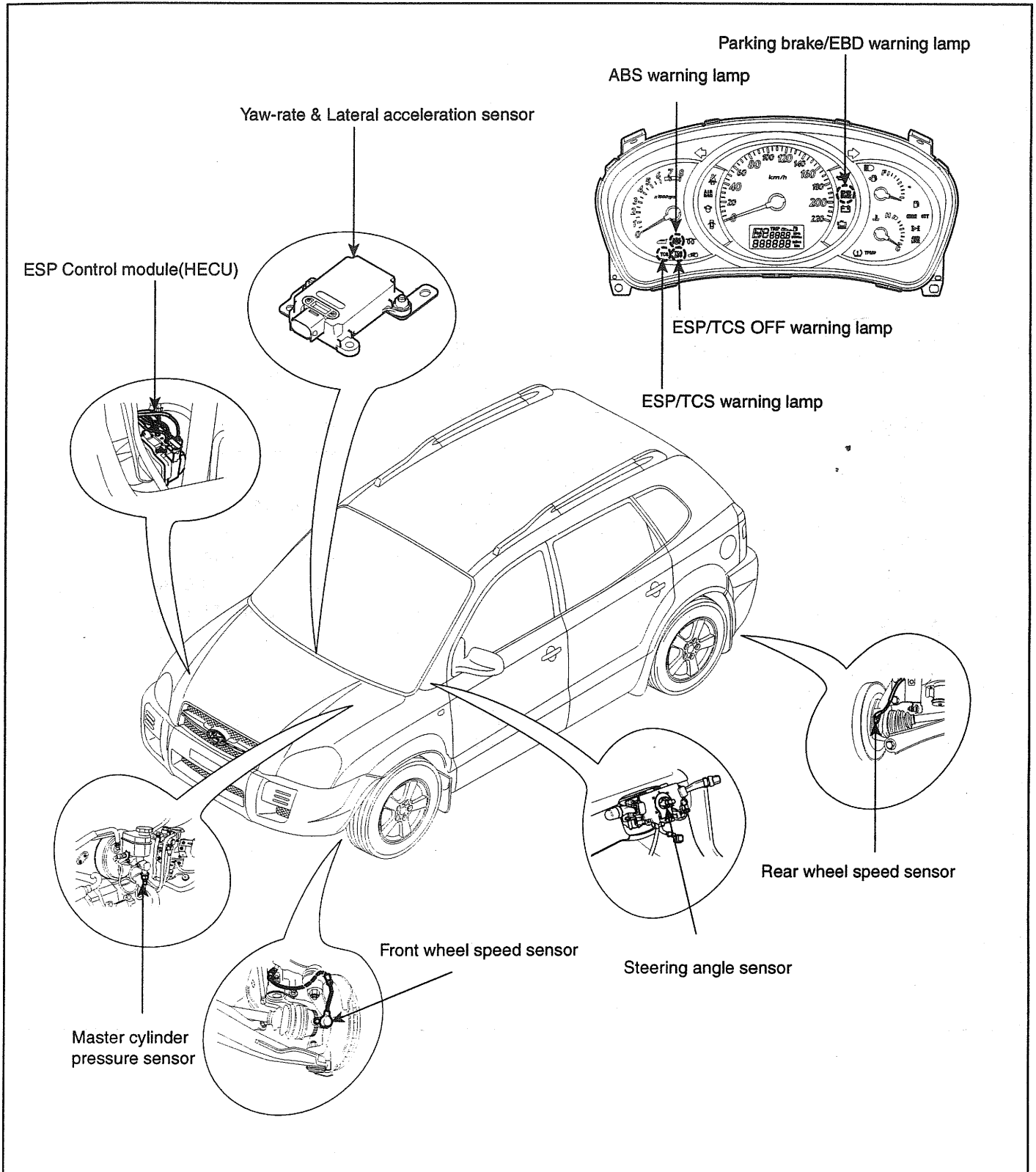


KJQE820C

4. Replace the G sensor if the output voltage is not on the specification.

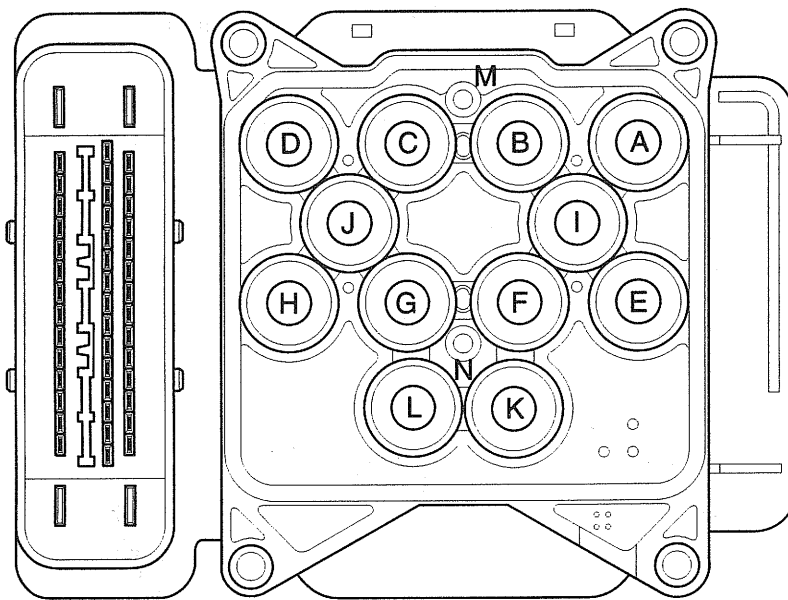
ESP(ELECTRONIC STABILITY PROGRAM) SYSTEM

COMPONENTS EA4A12D8



ESP HECU EXTERNAL DIAGRAM

EE4F7FEF



- A : INLET VALVE(FR)
- B : INLET VALVE(RL)
- C : INLET VALVE(RR)
- D : INLET VALVE(FL)
- E : OUTPUT VALVE(FR)
- F : OUTPUT VALVE(RL)
- G : OUTPUT VALVE(RR)
- H : OUTPUT VALVE(FL)
- I : ELECTRIC SHUTTLE VALVE(ESV-R)
- J : ELECTRIC SHUTTLE VALVE(ESV-L)
- K : TRACTION VALVE (TCR)
- L : TRACTION VALVE (TCL)
- M : MOTOR(+)
- N : MPTOR(GND)

DESCRIPTION OF ESP ECB2ED75

Optimum driving safety now has a name : ESP, the Electronic Stability Program.

ESP is based on the MK 25 ABS Hydraulic System. ESP recognizes critical driving conditions, such as panic reactions in dangerous situations, and stabilizes the vehicle by wheel-individual braking and engine control intervention with no need for actuating the brake or the gas pedal.

ESP adds a further function known as Active Yaw Control (AYC) to the ABS, TCS, EBD and EDC functions. Whereas the ABS/TCS function controls wheel slip during braking and acceleration and, thus, mainly intervenes in the longitudinal dynamics of the vehicle, active yaw control stabilizes the vehicle about its vertical axis.

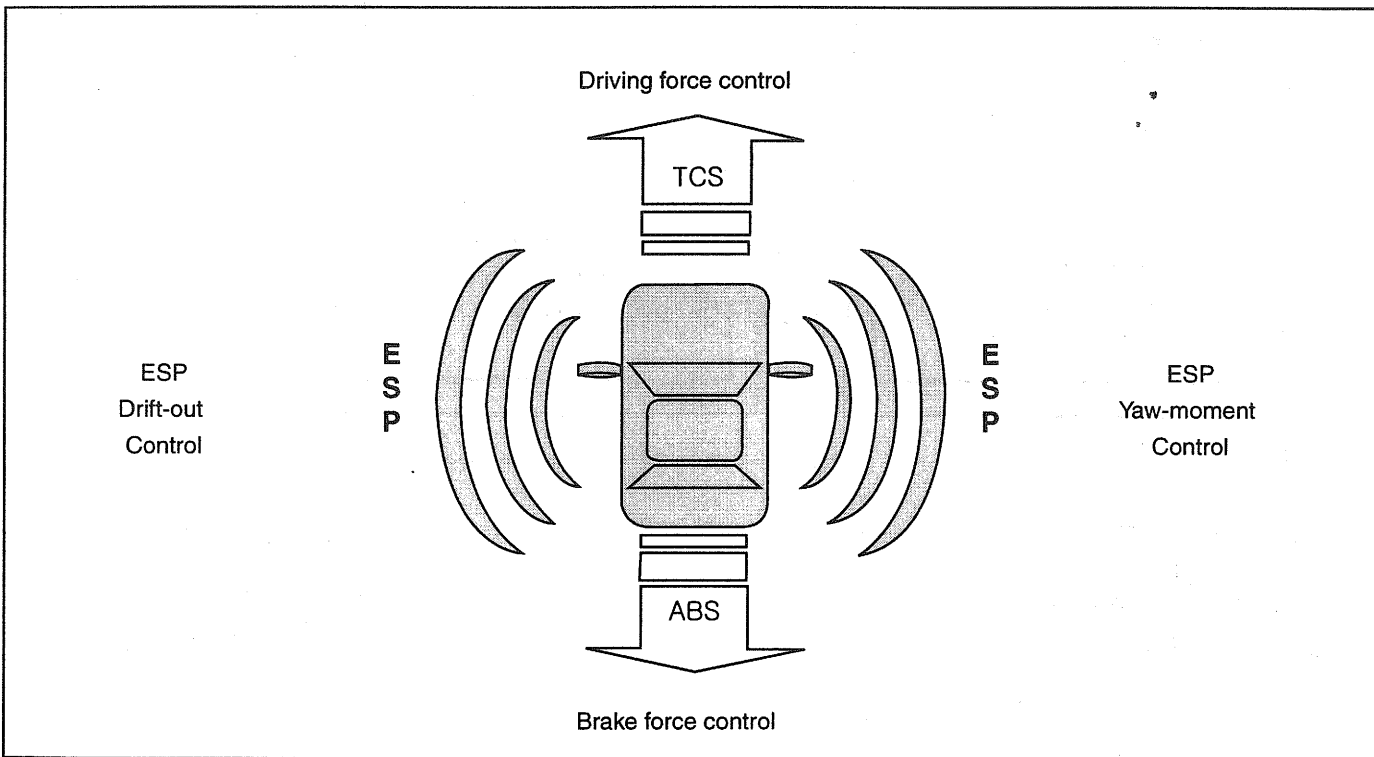
This is achieved by wheel individual brake intervention and adaptation of the momentary engine torque with no need for any action to be taken by the driver.

ESP essentially consists of three assemblies : the sensors, the electronic control unit and the actuators.

The electronic control unit incorporates the technological experience accumulated in connection with the MK 20 system, but has been substantially expanded in terms of capacity and monitoring concept in order to permit the additional sensor signals and arithmetic operations to be processed and converted into corresponding valve, pump and engine control commands. Two 16-bit processors and one 8-bit processor, which monitor each other, cooperate to handle these requirements.

Of course, the stability control feature works under all driving and operating conditions. Under certain driving conditions, the ABS/TCS function can be activated simultaneously with the ESP function in response to a command by the driver.

In the event of a failure of the stability control function, the basic safety function, ABS, is still maintained.



DESCRIPTION OF ESP CONTROL

ESP system includes ABS/EBD, TCS and AYC function.

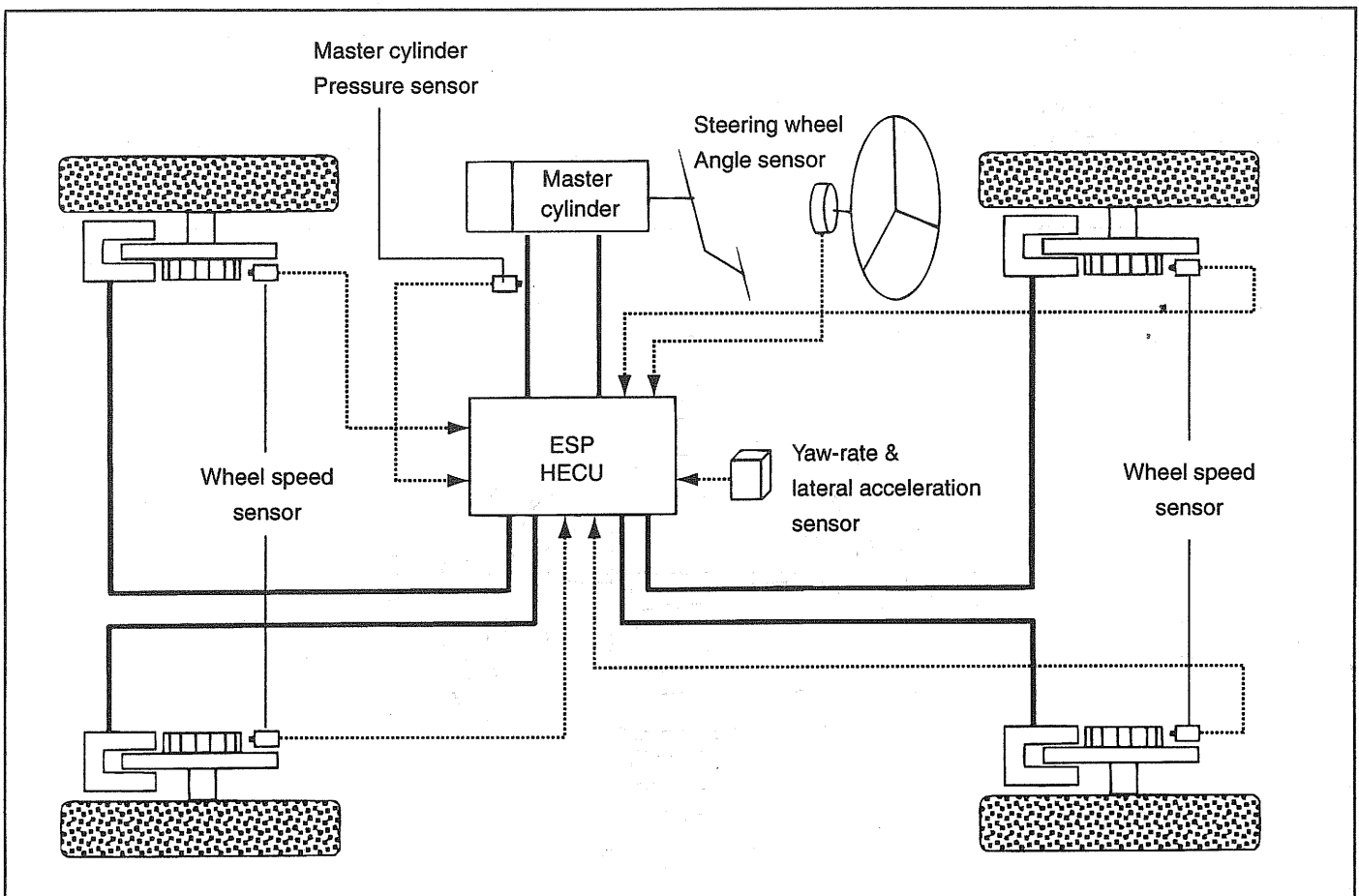
ABS/EBD function The ECU changes the active sensor signal (current shift) coming from the four wheel sensors to the square wave. By using the input of above signals, the ECU calculates the vehicle speed and the acceleration & deceleration of the four wheels. And, the ECU judges whether the ABS/EBD should be actuated or not.

TCS function prevents the wheel slip of drive direction by adding the brake pressure and engine torque reduction via CAN communication. TCS function uses the wheel speed sensor signal to determine the wheel slip as far as

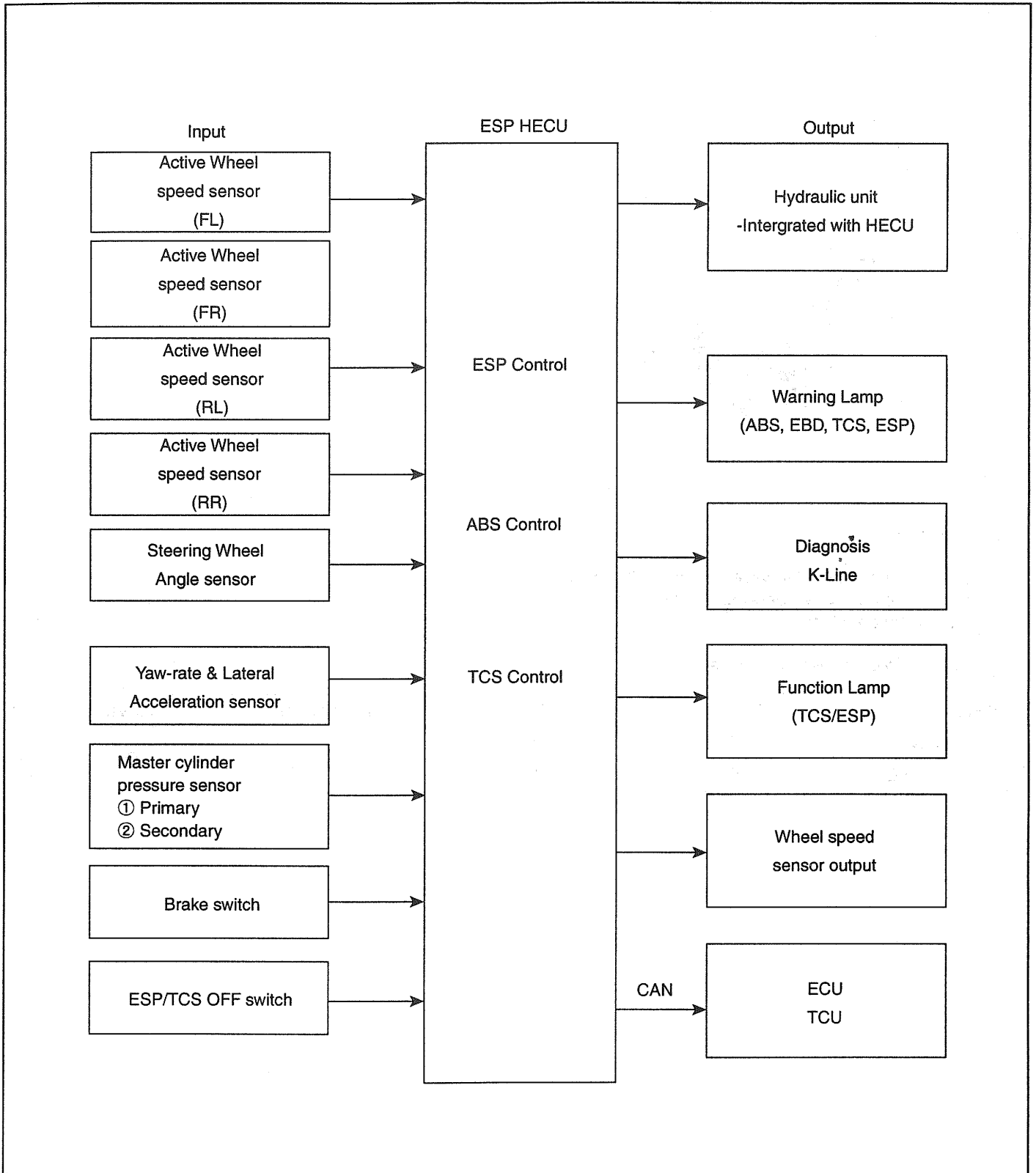
ABS function.

AYC function prevents unstable maneuver of the vehicle. To determine the vehicle maneuver, AYC function uses the maneuver sensor signals (Yaw Rate Sensor, Lateral Acceleration Sensor, Steering Wheel Angle Sensor). If vehicle maneuver is unstable (Over Steer or Under Steer), AYC function applies the brake pressure on certain wheel, and send engine torque reduction signal by CAN.

After the key-on, the ECU continually diagnoses the system failure. (self-diagnosis) If the system failure is detected, the ECU informs driver of the system failure through the BRAKE/ABS/ESP warning lamp. (fail-safe warning)

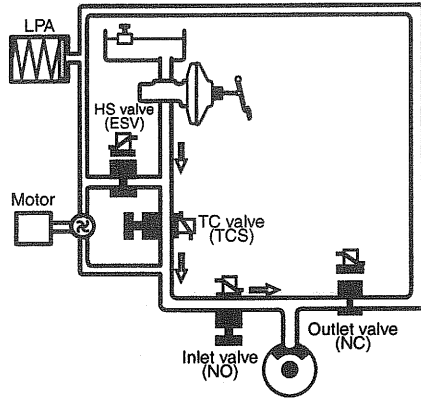


INPUT AND OUTPUT DIAGRAM



ESP OPERATION MODE EEA3FB0A

1. ESP Non-operation-Normal braking.



LJCD207A

Operation

In this position, the inlet valve and the TCS valve are open, the electrically operated shuttle valve and the outlet valve are closed.

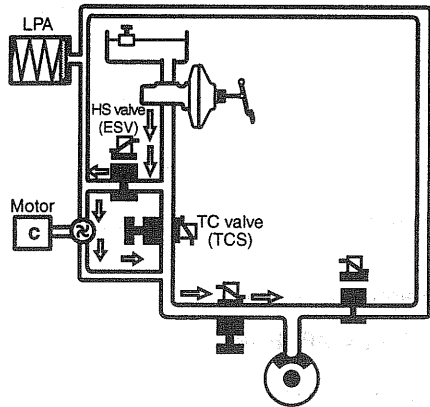
* ESV : Electric reversing valve.

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

2. ESP operation

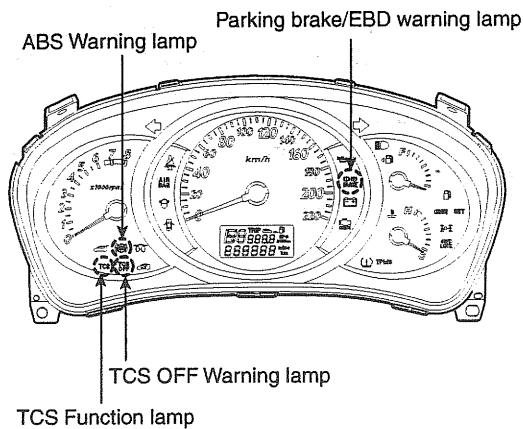
Operation

The on/off booster builds up a pressure of approx. 10 bar in order to enable the ESP pump to suck brake fluid at low temperatures. In this position, the inlet valve is driven in a pulsed cycle. The TCS valve is closed. The outlet valve remains closed. The electrically operated shuttle valve is opened. The hydraulic pressure is led to the wheel brakes which are to be applied for a brief period of time.



LJCD208A

Solenoid valve		Continuity	Valve	Motor pump	TC Valve
Understeering (Only inside of rear wheel)	IN(NO)	OFF	OPEN	ON	ON
	OUT(NC)	OFF	CLOSE		
Oversteering (Only outside of front wheel)	IN(NO)	OFF	OPEN		
	OUT(NC)	OFF	CLOSE		



EJQE300A

ABS WARNING LAMP MODULE

The active ABS warning lamp module indicates the self-test and failure status of the ABS. The ABS warning lamp shall be on:

- During the initialization phase after IGN ON. (continuously 3 seconds).
- In the event of inhibition of ABS functions by failure
- During diagnostic mode.
- When the ECU Connector is separated from ECU.

EBD WARNING LAMP MODULE

The active EBD warning lamp module indicates the self-test and failure status 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 shall be on:

- During the initialization phase after IGN ON. (continuously 3 seconds).
- When the Parking Brake Switch is ON or brake fluid level is low.
- When the EBD function is out of order.
- During diagnostic mode.
- When the ECU Connector is separated from ECU.

ESP WARNING LAMP (ESP SYSTEM)

The ESP warning lamp indicates the self-test and failure status of the ESP.

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

- During the initialization phase after IGN ON. (continuously 3 seconds).
- In the event of inhibition of ESP functions by failure
- When driver turn off the ESP function by on/off switch.
- During diagnostic mode.

ESP FUNCTION LAMP (ESP SYSTEM)

The ESP function lamp indicates the self-test and operating status of the ESP.

The ESP Function lamp operates under the following conditions :

- During the initialization phase after IGN ON. (continuously 3 seconds).
- When the ESP control is operating. (Blinking - 2Hz)

ESP ON/OFF SWITCH (ESP SYSTEM)

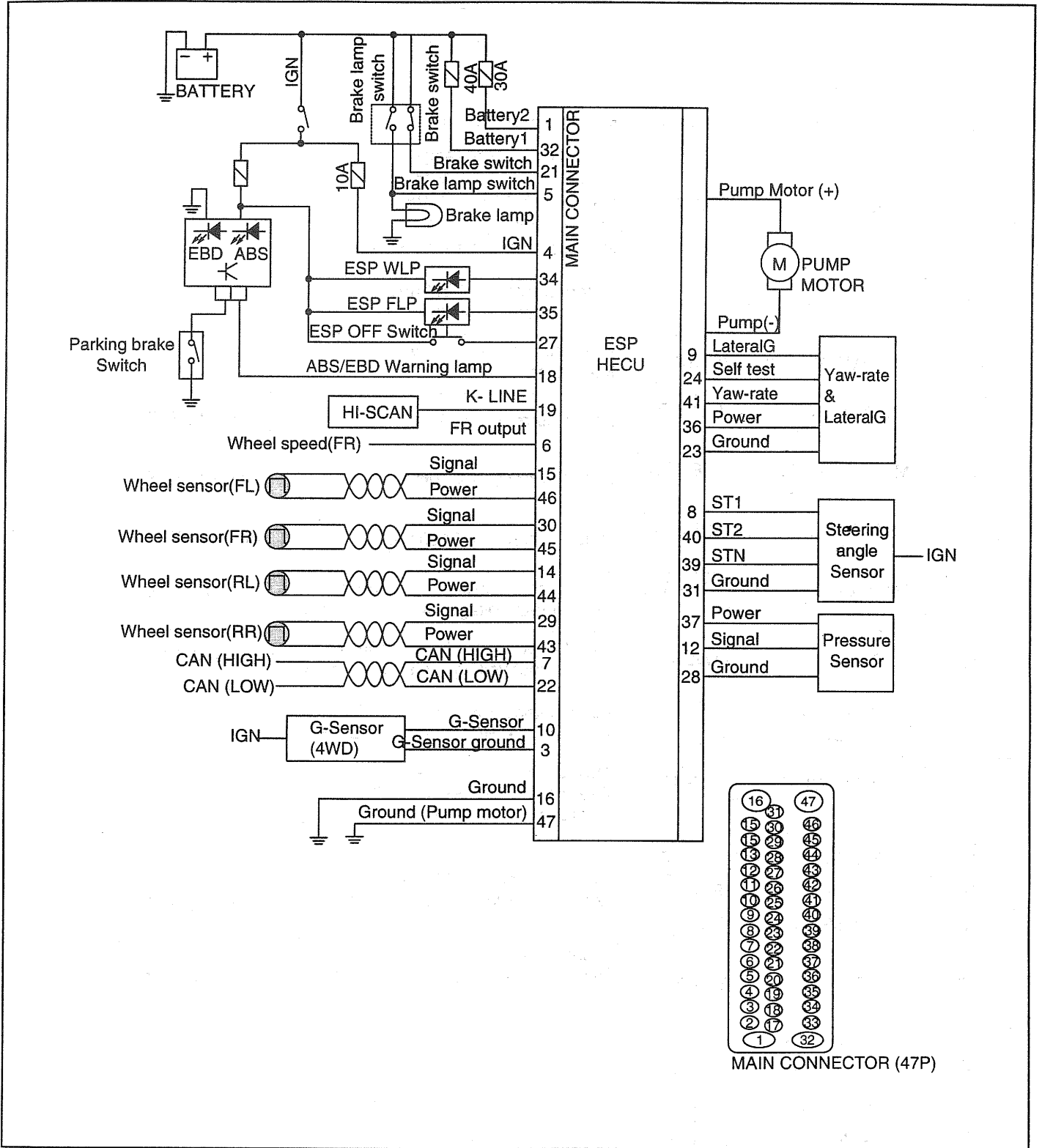
The ESP On/Off Switch shall be used to toggle the ESP function between On/Off states based upon driver input.

The On/Off switch shall be a normally open, momentary contact switch. Closed contacts switch the circuit to ignition.

Initial status of the ESP function is on and switch toggle the state.

ESP CIRCUIT DIAGRAM

E8C60C84



ESP CONNECTOR INPUT/OUTPUT

E526CF9D

Connector Terminal		Specification	Remark
No	Description		
4	IGNITION1(+)		
32	POS.BATTERY.(SOLENOID)	Max leakage current : $I < 0.8\text{mA}$	
1	POS.BATTERY.(MOTOR)	Operating voltage range: $9.5\pm 0.5\text{V} < V < 16.5\pm 0.5\text{V}$ Rush current : $I < 100\text{A}$ Max current : $I < 30\text{A}$ Max leakage current : $I < 0.2\text{mA}$	
16	GROUND	Rated current : $I < 300\text{mA}$ Max. current: $I < 30\text{A}$	
47	PUMP MOTOR GROUND	Rush current : $I < 100\text{A}$ Max current : $I < 30\text{A}$	
23	YAW & LATERAL G SENSOR GROUND	Rated current : $I < 65\text{mA}$	only with ESP
28	MASTER PRESSURE SENSOR GROUND	Rated current : $I < 10\text{mA}$	only with ESP
31	STEERING ANGLE SENSOR GROUND	Rated current : $I < 100\text{mA}$	only with ESP
37	MASTER PRESSURE SENSOR POWER	Max Output current : $I < 10\text{mA}$ Max Output voltage : $4.9\text{V} \leq V \leq 5.1\text{V}$	only with ESP
36	YAW SENSOR POWER	Max Output current : $I < 65\text{mA}$ Max Output voltage : $4.9\text{V} \leq V \leq 5.1\text{V}$	only with ESP
5	BRAKE LIGHT SWITCH	Input voltage low: $0\text{V} \leq V \leq 3.0\text{V}$ Input voltage High: $7.0\text{V} \leq V \leq 16.0\text{V}$	
21	BRAKE SWITCH		
6	SENSOR FRONT RIGHT OUTPUT	Max current : $I < 2\text{mA}$ External pull up resistor : $10\text{KW} < R$ Output duty : $50 \pm 20\%$	
18	ABS/EBD W/LAMP DRIVE	Max. current: $I < 200\text{mA}$ Max. output low voltage: $V < 1.2\text{V}$	
34	ESP W/LAMP DRIVE		
35	ESP F/LAMP DRIVE		
27	ESP ON/OFF SWITCH	Input voltage low: $0\text{V} \leq V \leq 3.0\text{V}$ Input voltage High: $7.0\text{V} \leq V \leq 16.0\text{V}$ Max input current: $I < 10\text{mA}$	only with ESP
22	CAN BUS LINE(LOW)	Max. current : $I < 10\text{mA}$	only with ESP
7	CAN BUS LINE(HIGH)		
46	SENSOR FRONT LEFT POWER	Output voltage : $\text{IGN}(V) \pm 1\text{V}$ Output current : Max 30mA	
45	SENSOR FRONT RIGHT POWER		
44	SENSOR REAR LEFT POWER		
43	SENSOR REAR RIGHT POWER		

15	SENSOR FRONT LEFT SIGNAL	Input current LOW : 5.9 ~8.4 mA Input current HIGH :11.8 ~ 16.8 mA Frequency range :1 ~ 2000 Hz Input duty : 50 ±20%	
30	SENSOR FRONT RIGHT SIGNAL		
14	SENSOR REAR LEFT SIGNAL		
29	SENSOR REAR RIGHT SIGNAL		
8	STEERING ANGLE SENSOR PHASE 1	Input duty (ST1, ST2): 50 ±10 Phase difference (ST1, ST2): 2 ± 0.6deg High voltage: 3.0V < V < 4.1V Low voltage: 1.3V < V < 2.0V	only with ESP
40	STEERING ANGLE SENSOR PHASE 2		
39	STEERING ANGLE SENSOR PHASE N		
12	"MASTER PRESSURESENSOR SIGNAL	Sensor Input Voltage : 0V ≤ V ≤ 5.0V Zero offset Voltage : 0.5V ± 0.15V Input current :Max 2 Ma	only with ESP
9	LATERAL G SENSOR SIGNAL	Sensor Input Voltage :0V ≤ V ≤ 5.0V Zero offset Voltage : 2.5 ± 0.1V	
41	YAW SENSOR SIGNAL	Sensor Input Voltage :0V ≤ V ≤ 5.0V Zero offset Voltage : 2.5 ±0.1V	only with ESP
10	G SENSOR SIGNAL Input Voltage	Input Volge: 0≤V≤5.0V	with 4WD
3	G SENSOR GROUND	Rated current: I < 10mA	
19	DIAGNOSIS INPUT/OUTPUT	Input voltage IL(V) < 0.3 IGN (V) IH(V) > 0.7 IGN (V) Output voltage OL(V) < 0.2 IGN (V) OH(V) > 0.8 IGN (V)	

FAILURE DIAGNOSIS

EB9A3EAB

1. In principle, ESP and TCS controls are prohibited in case of ABS failure.
2. When ESP or TCS is fail, only the failed system control is prohibited.
3. However, when the solenoid valve relay should be turned off in case of ESP fail, refer to the ABS fail-safe.
4. Information on ABS fail-safe is identical with the fail-safe in which ESP is not installed.

MEMORY OF FAIL CODE

1. It keeps the code as far as the backup lamp power is connected. (O)
2. It keeps the code as far as the HCU power is on. (X)

FAILURE CHECKUP

1. Initial checkup is performed immediately after the HECU power on.
2. Valve relay checkup is performed immediately after the IG2 ON.
3. It executes the checkup all the time while the IG2 power is on.
4. Initial checkup is made in the following cases.
 - 1) When the failure is not detected now
 - 2) When ABS and ESP are not in control.
 - 3) Initial checkup is not made after ECU power on.
 - 4) If the vehicle speed is over 409 mph(8 km/h) when the brake lamp switch is off.
 - 5) When the vehicle speed is over 24.8 mph(40 km/h).
5. Though, it keeps on checkup even if the brake lamp switch is on.
6. When performing ABS or ESP control before the initial checkup, stop the initial checkup and wait for the HECU power input again.
7. Judge fail in the following cases.
 - 1) When the power is normal.
 - 2) From the point in which the vehicle speed reaches 4.9 mph(8 km/h) after HECU power on.

COUNTERMEASURES IN FAIL

1. Turn the system down and perform the following actions and wait for HECU power OFF.
2. Turn the valve relay off.
3. Stop the control during the operation and do not execute any until the normal condition recovers.

WARNING LAMP ON

1. ABS warning lamp turns on when ABS is fail.
2. TCS warning lamp turns on when TCS is fail.
3. ESP operation lamp turns on and TCS OFF warning lamp blinks when ESP is fail.

When power voltage and valve relay voltage are abnormal, input/output related failure judgment is not made.

DIAGNOSTIC TROUBLE CODE CHART

Follow an inspection procedure of a detected DTC in the chart below.

 **NOTE**

EBD Δ - warning lamp "ON", in case of errors on more than 2 wheels.

DTC	DESCRIPTION	WARNING LAMP "ON"				DTC MEMORY	REMARK	SEE PAGE
		ABS	EBD	TCS	ESP			
C1101	Battery voltage high	○	○	○	○	○		BR-84
C1102	Battery voltage low	○	○	○	○	○		BR-87
C1200	Wheel speed sensor FR-LH open/short	○	○	○	○	○		BR-89
C1201	Wheel speed sensor FR-LH range/performance/intermittent	○	Δ	○	○	○		BR-91
C1202	Wheel speed sensor FR-LH invalid/no signal	○	Δ	○	○	○		BR-95
C1203	Wheel speed sensor FR-LH open/short	○	Δ	○	○	○		BR-89
C1204	Wheel speed sensor FR-LH range/performance/intermittent	○	Δ	○	○	○		BR-91
C1205	Wheel speed sensor FR-LH invalid/no signal	○	Δ	○	○	○		BR-95
C1206	Wheel speed sensor FR-LH open/short	○	Δ	○	○	○		BR-89
C1207	Wheel speed sensor FR-LH range/performance/intermittent	○	Δ	○	○	○		BR-91
C1208	Wheel speed sensor FR-LH invalid/no signal	○	Δ	○	○	○		BR-95
C1209	Wheel speed sensor FR-LH open/short	○	Δ	○	○	○		BR-89
C1210	Wheel speed sensor FR-LH range/performance/intermittent	○	Δ	○	○	○		BR-91
C1211	Wheel speed sensor RR-RH invalid/no signal	○	Δ	○	○	○		BR-95
C1604	ECU hardware error	○	○	○	○	○		BR-98
C2112	Valve relay error	○	○	○	○	○		BR-99
C2380	ABS/TCS/ESP valve error	○	○	○	○	○		BR-101
C2402	Motor - electrical	○	×	○	○	○		BR-103
C1274	G sensor - electrical	○	×	○	○	○	4WD	BR-106
C1275	G sensor - signal	○	×	○	○	○	4WD	BR-108
C1503	TCS switch error	×	×	○	○	○		BR-110
C1605	CAN hardware error	×	×	○	○	○		BR-113
C1611	CAN time-out EMS	×	×	○	○	○		BR-114

DTC	DESCRIPTION	WARNING LAMP "ON"				DTC MEMORY	REMARK	SEE PAGE
		ABS	EBD	TCS	ESP			
C1612	CAN time-out TCU	×	×	○	○	○		BR-115
C1613	CAN wrong message	×	×	○	○	○		BR-116
C1616	CAN bus off	×	×	○	○	○		BR-117
C2227	Excessive temperature of brake disc	×	×	○	○	○		BR-118
C1112	Sensor source voltage	×	×	○	○	○		BR-119
C1235	Pressure sensor(primary) - electrical	×	×	×	○	○		BR-120
C1237	Pressure sensor(secondary) - electrical	×	×	×	○	○		BR-122
C1259	Steering angle sensor - electrical	×	×	×	○	○		BR-124
C1260	Steering angle sensor - signal	×	×	×	○	○		BR-126
C1282	Yaw rate & lateral G sensor - electrical	×	×	×	○	○		BR-128
C1283	Yaw rate & lateral G sensor - signal	×	×	×	○	○		BR-130
C1513	Brake switch error	×	×	×	○	○		BR-132

STEERING WHEEL ANGLE SPEED SENSOR

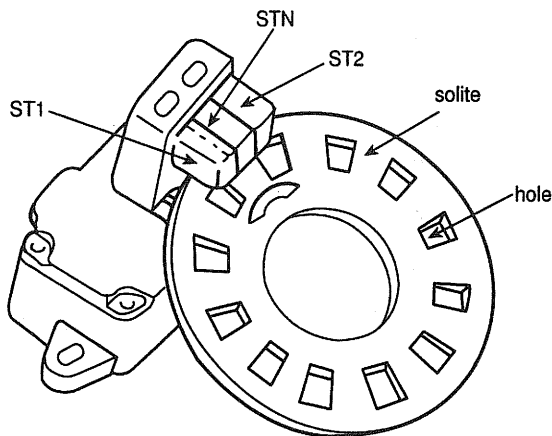
DESCRIPTION E62CE4A1

The steering angle speed sensor detects the angle of the steering wheel in order to which direction a user chooses. The sensor is detached on the MPS(Mutil-Function Switch) under the steering wheel.

OPERATION

The split of the steering angle sensor detects a steering angle of the steering wheel by a ON/OFF pulse caused by whether or not the LED lights go through the hole of the split, rotating as the steering wheel revolves. There are three LEDs, two(ST1, ST2) for detecting a steering direction, and the other for the neutral position.

The HECU calculates the steering angle by the pulse from the steering angle sensor.



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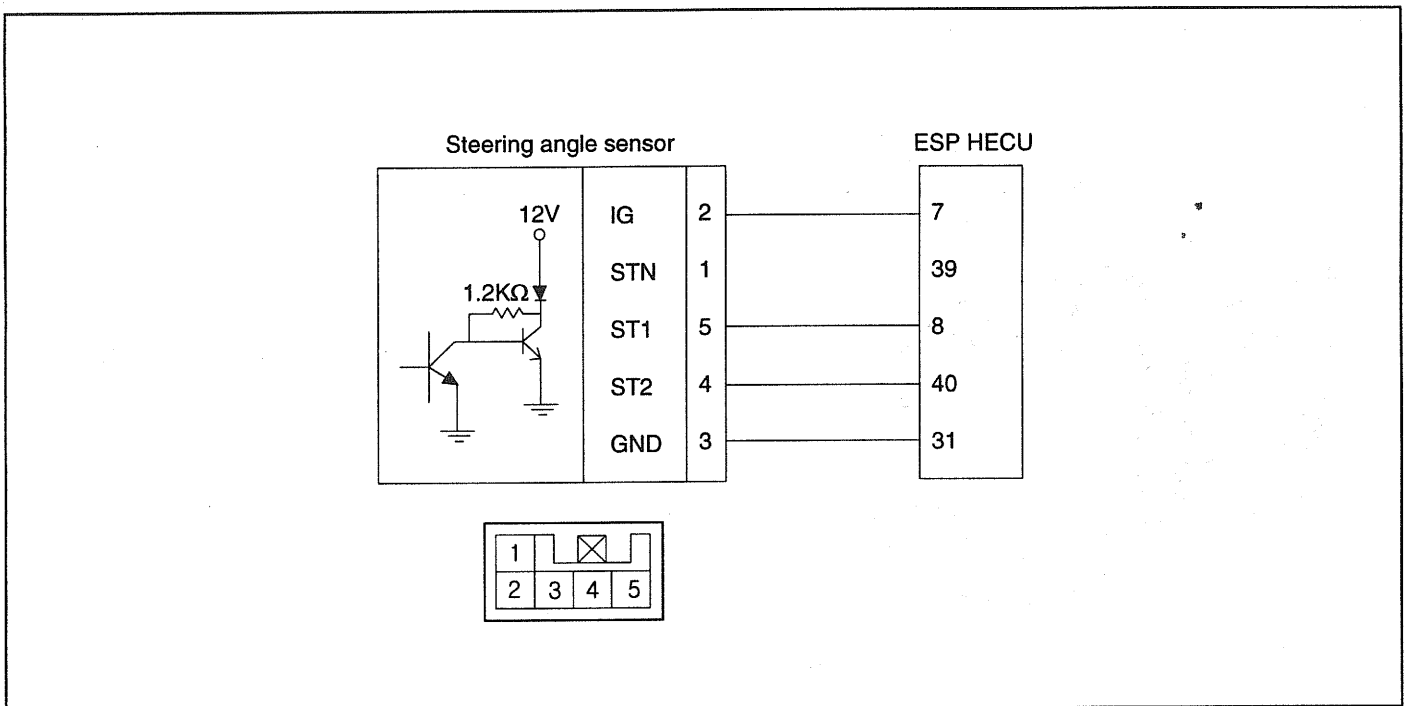
SPECIFICATIONS

E1C41B1D

Item	Specification
Operating Voltage	9V~16V
Operating temperature	-30°C~75°C
Current consumption	Max. 100mA
Pulse duty	50±10%
Pulse width	8°/1pulse
Voltage(HIGH)	3.0V~4.1V
Voltage(LOW)	1.3V~2.0V
Steering angle velocity	Max 1500°/sec

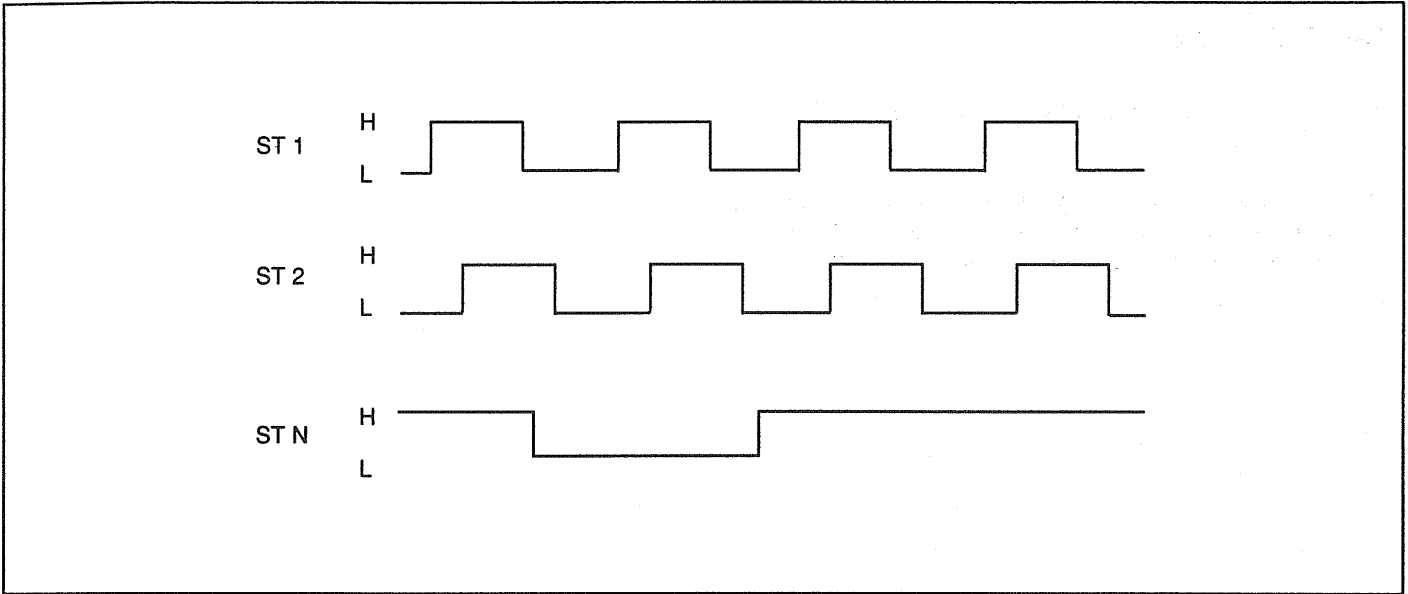
CIRCUIT DIAGRAM

EA86D422



OUTPUT CHARACTERISTIC

EA78AE2A



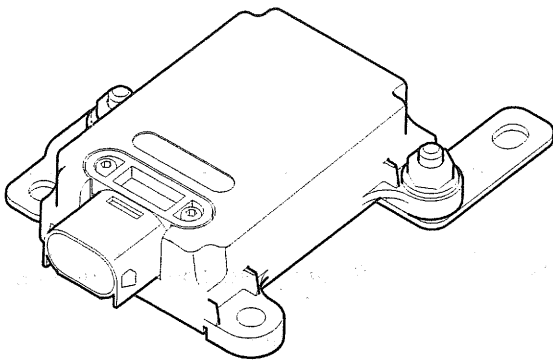
ARCD204A

No.	INPUT		OUTPUT	Steering direction	Remark
1	ST1	L	L	Right	
	ST2	L	H		
	ST1	L	H	Left	
	ST2	L	L		
2	ST1	L	L	Left	
	ST1	H	L		
	ST1	L	H	Right	
	ST2	H	H		
3	ST1	H	H	Left	
	ST2	L	H		
	ST1	H	L	Right	
	ST2	L	L		
4	ST1	H	H	Right	
	ST2	H	L		
	ST1	H	L	Left	
	ST2	H	H		

YAW-RATE SENSOR

DESCRIPTION E213C5D3

1. The yaw-rate & lateral G sensor is applied for the ESP system.
2. The yaw-rate is the angular velocity, when a vehicle turns a corner, and the lateral G is the acceleration to move a vehicle out of the way when cornering.



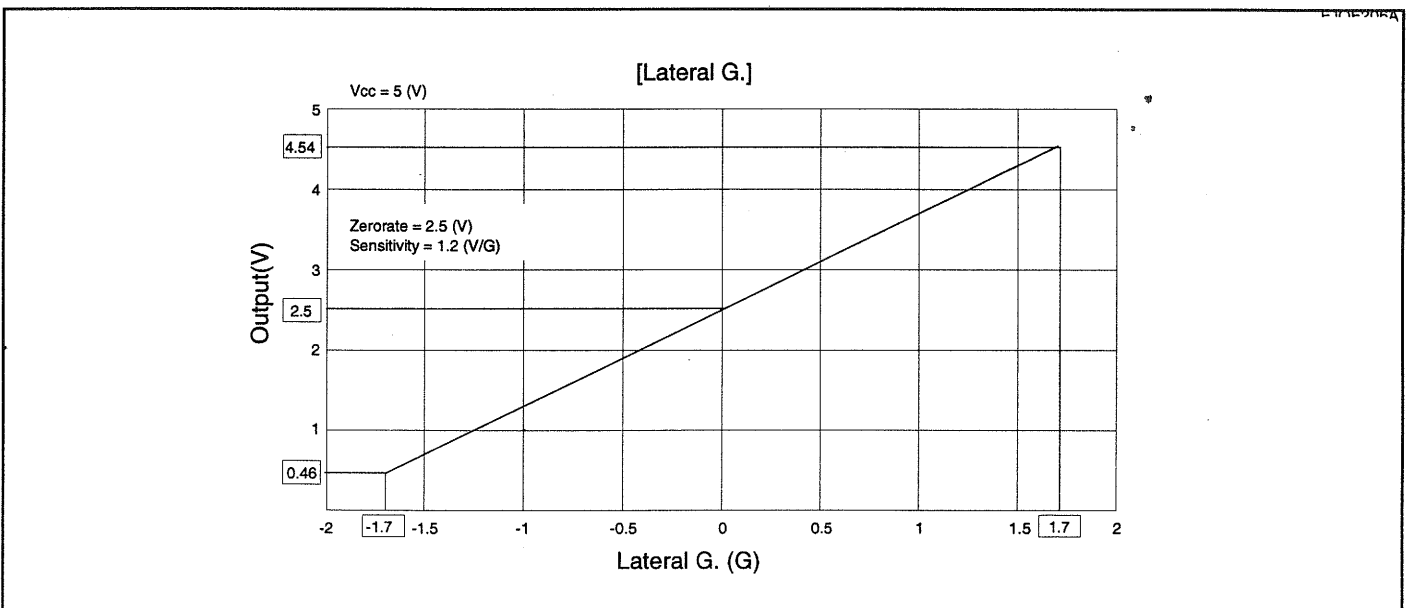
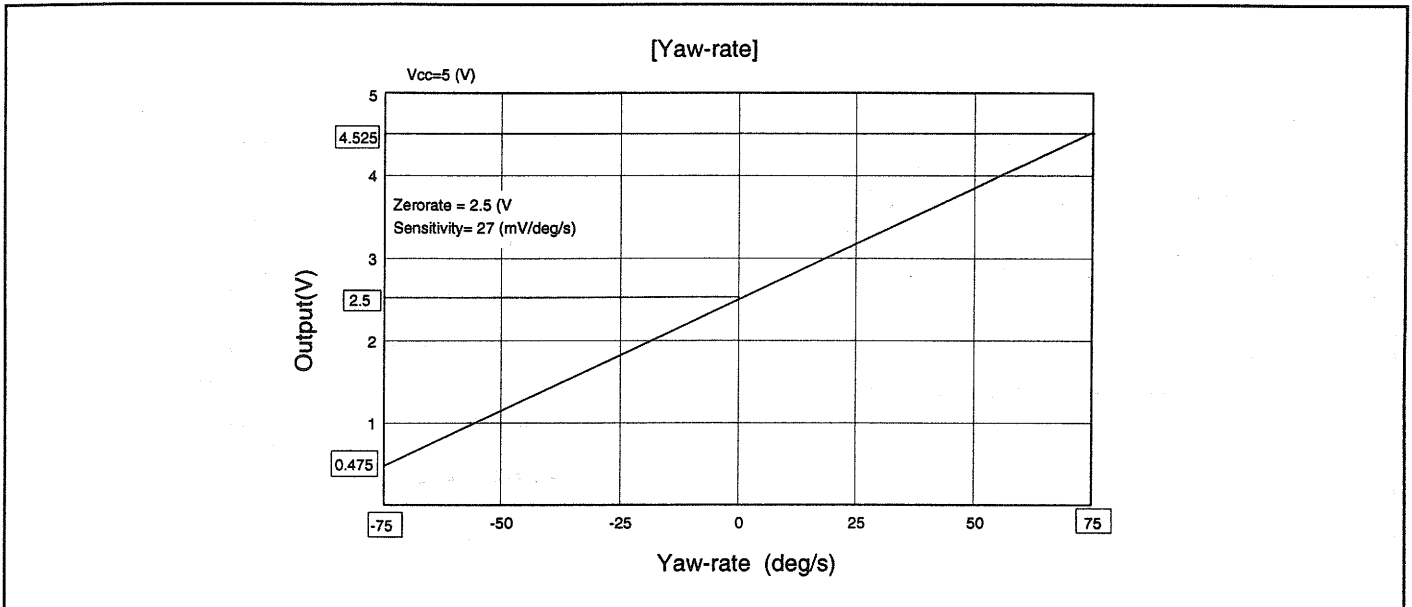
KJQE380A

SPECIFICATIONS EEE8E7EB

ITEM		SPECIFICATION	REMARK
Operating voltage		4.75 ~ 5.25V	
Current consumption		less than 65mA	
Output voltage range		0.5 ~ 4.5V	
Operating temperature		-40 ~ 85°C	
Yaw-rate sensor	Measurement range	-75 ~ +75°/sec	
	Output voltage range	0.5 ~ 4.5V	
	Sensitivity	26.67mV(°/sec.)	
	Zero rate output	2.5V	
	Frequency response	10Hz	
Lateral G. sensor	Measurement range	-1.5 ~ +1.5g	
	Output voltage range	0.5 ~ 4.5 V	
	Sensitivity	1.33V/g	
	Zero rate output	2.5V	
	Frequency response	50Hz	

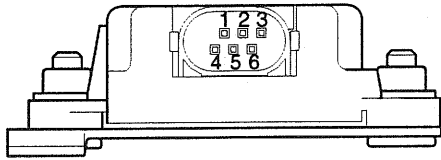
OUTPUT CHARACTERISTIC

E724FB78

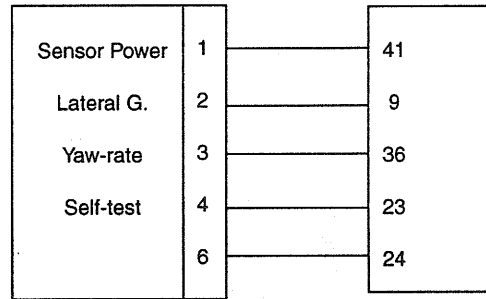


EXTERNAL DIAGRAM

E9948A75



[Yaw-rate & Lateral G sensor's connector]



Yaw-rate &
Lateral G. sensor

ESP HECU

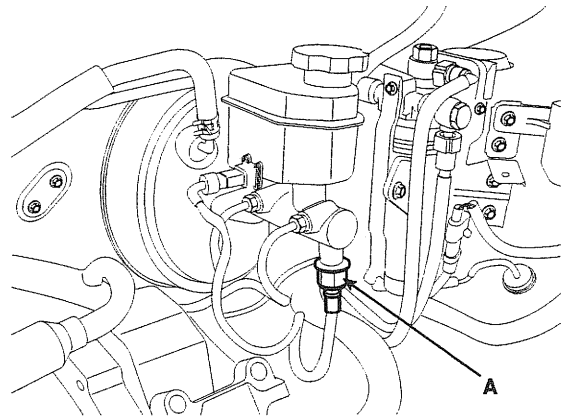
MASTER CYLINDER PRESSURE SENSOR

DESCRIPTION EAFB05FA

The pressure sensor(A) is connected to the master cylinder, when ESP is on operation, detecting the brake pressure in order to sense the user's will to brake a vehicle.

The pressure sensor(A) is consisted of two ceramic disks, one is fixed and the other movable, so that changes the distance of the two disks.

(Max. measurable pressure is 200bar.)

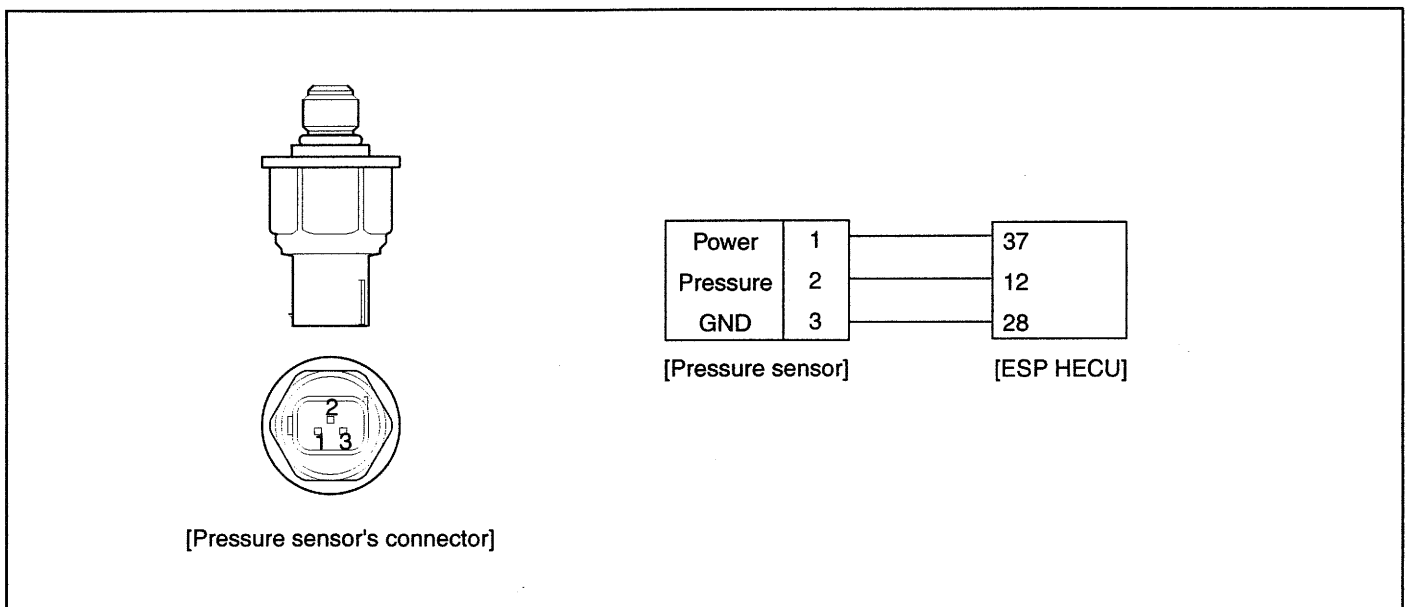


KJQE710E

SPECIFICATIONS E54D4809

Item	Specification	Remark
Supply voltage	4.75V ~ 5.25V	
Supply current	less than 15mA	
Operating temperature	-40°C ~ 125°C	
Measurement pressure range	0 ~ 200bar	
Max. pressure limit	350bar	
Zero rate output	0.5V	
Output range	0.5 ~ 4.4V	

CIRCUIT DIAGRAM E60BD2FD



OUTPUT CHARACTERISTIC

EB092AA6

