Brake System

GENERAL

BRAKE SYSTEM
- BRAKE BOOSTER
- BRAKE LINE
- BRAKE PEDAL
- FRONT DISC BRAKE
- MASTER CYLINDER
- PROPORTIONING VALVE
- REAR DISC BRAKE
- REAR DRUM BRAKE

PARKING BRAKE SYSTEM
- PARKING BRAKE
- PARKING BRAKE SWITCH

ABS (ANTI-LOCK BRAKE SYSTEM)
- ANTI-LOCK BRAKING SYSTEM CONTROL MODULE
- FRONT WHEEL SPEED SENSOR
- REAR WHEEL SPEED SENSOR

EBD (ELECTRONIC BRAKE-FORCE DISTRIBUTION)

ESP (ELECTRONIC STABILITY PROGRAM) SYSTEM
- YAW-RATE SENSOR
- ESP SWITCH
- STEERING WHEEL ANGLE SPEED SENSOR
# GENERAL

## SPECIFICATIONS

<table>
<thead>
<tr>
<th>Item</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Master cylinder</strong></td>
<td>Tandem type</td>
</tr>
<tr>
<td>· Type</td>
<td></td>
</tr>
<tr>
<td>· I.D. mm(in)</td>
<td>25.4/(1.0)</td>
</tr>
<tr>
<td>· Piston stroke mm(in)</td>
<td>31(1.22)</td>
</tr>
<tr>
<td>· Output port(ABS/ESP)</td>
<td>2port</td>
</tr>
<tr>
<td>· Fluid level warning sensor</td>
<td>Provided</td>
</tr>
<tr>
<td><strong>Brake booster</strong></td>
<td>Vacuum</td>
</tr>
<tr>
<td>· Type</td>
<td></td>
</tr>
<tr>
<td>· Effective dia. mm(in)</td>
<td>8+9 in</td>
</tr>
<tr>
<td>· Boosting ratio</td>
<td>9:1</td>
</tr>
<tr>
<td><strong>Front brake(Disc)</strong></td>
<td>Floating type with ventilated disc</td>
</tr>
<tr>
<td>· Type</td>
<td></td>
</tr>
<tr>
<td>· Disc O.D.</td>
<td>280 mm (11.02 in)</td>
</tr>
<tr>
<td>· Disc I.D.</td>
<td>172 mm (6.77 in.)</td>
</tr>
<tr>
<td>· Disc thickness</td>
<td>26 mm (1.02 in)</td>
</tr>
<tr>
<td>· Pad thickness</td>
<td>11 mm (0.43 in)</td>
</tr>
<tr>
<td>· Cylinder type</td>
<td>single piston</td>
</tr>
<tr>
<td>· Cylinder I.D.</td>
<td>57.2 mm (2.25 in.)</td>
</tr>
<tr>
<td><strong>Rear brake( Drum)</strong></td>
<td>Leading trailing drum</td>
</tr>
<tr>
<td>· Type</td>
<td></td>
</tr>
<tr>
<td>· Drum I.D.</td>
<td>228.6 mm (9.0 in.)</td>
</tr>
<tr>
<td>· Lining width</td>
<td>42 mm (1.65 in.)</td>
</tr>
<tr>
<td>· Brake offset</td>
<td>29.6 mm (1.17 in)</td>
</tr>
<tr>
<td><strong>Rear brake(Disc)</strong></td>
<td>Floating type with solid disc</td>
</tr>
<tr>
<td>· Type</td>
<td></td>
</tr>
<tr>
<td>· Disc O.D.</td>
<td>262 mm (10.31 in)</td>
</tr>
<tr>
<td>· Parking Brake Drum I.D</td>
<td>168 mm (6.61 in)</td>
</tr>
<tr>
<td>· Disc thickness</td>
<td>10 mm (0.39 in)</td>
</tr>
<tr>
<td>· Pad thickness</td>
<td>10 mm (0.39 in)</td>
</tr>
<tr>
<td>· Cylinder type</td>
<td>single piston</td>
</tr>
<tr>
<td>· Cylinder I.D</td>
<td>34 mm (1.34 in)</td>
</tr>
<tr>
<td><strong>Parking brake</strong></td>
<td>Mechanical brake acting on rear wheels</td>
</tr>
<tr>
<td>· Actuation</td>
<td>Lever</td>
</tr>
<tr>
<td>· Cable arrangement</td>
<td></td>
</tr>
</tbody>
</table>

O.D=Outer Diameter  
I.D=Inner Diameter

**NOTE**  
 ABS : Anti-lock Brake System  
 ESP : Electronic Stability Program
<table>
<thead>
<tr>
<th>Part</th>
<th>Item</th>
<th>Standard value</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HECU (Hydraulic and Electronic Control Unit)</strong></td>
<td>System</td>
<td>4 channel 4 sensor (Solenoid)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Type</td>
<td>Motor, valve relay integrated type</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Operating voltage</td>
<td>10 V~16 V (DC)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Operating temperature</td>
<td>-40<del>120 °C (-40</del>248 °F)</td>
<td></td>
</tr>
<tr>
<td><strong>Warning lamp</strong></td>
<td>Operating voltage</td>
<td>12 V</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Current consumption</td>
<td>80 mA</td>
<td></td>
</tr>
<tr>
<td><strong>Active wheel speed sensor (ABS)</strong></td>
<td>Supply voltage</td>
<td>DC 4.5~2.0 V</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Output current low</td>
<td>5.9~8.4 mA</td>
<td>Typ.7 mA</td>
</tr>
<tr>
<td></td>
<td>Output current High</td>
<td>11.8~16.8 mA</td>
<td>Typ.14 mA</td>
</tr>
<tr>
<td></td>
<td>Frequency range</td>
<td>1~2500 HZ</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Air gap</td>
<td>0.4<del>1.0 mm (0.0157</del>0.04 in.)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tone wheel</td>
<td>47 teeth</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Output duty</td>
<td>30~70 %</td>
<td></td>
</tr>
</tbody>
</table>
### SPECIFICATION(ESP)

<table>
<thead>
<tr>
<th>Part</th>
<th>Item</th>
<th>Standard value</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>HECU(Hydraulic and Electronic Control Unit)</td>
<td>System</td>
<td>4 channel 4 sensor(Solenoid)</td>
<td>-Total control(ABS, EBD, TCS, ESP)</td>
</tr>
<tr>
<td></td>
<td>Type</td>
<td>Motor, valve relay integrated type</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Operating voltage</td>
<td>10 V~16 V(DC)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Operating temperature</td>
<td>-40<del>120 °C(-40</del>248 °F)</td>
<td></td>
</tr>
<tr>
<td>Warning lamp</td>
<td>Operating voltage</td>
<td>12 V</td>
<td>-ESP Operating Lamp</td>
</tr>
<tr>
<td></td>
<td>Current consumption</td>
<td>80 mA</td>
<td>-ESP Warning Lamp</td>
</tr>
<tr>
<td>Active wheel speed sensor</td>
<td>Supply voltage</td>
<td>DC 4.5~20 V</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Output current low</td>
<td>5.9~8. mA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Output current high</td>
<td>11.8~16.8 mA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tone wheel</td>
<td>47 teeth</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Frequency range</td>
<td>1~2500 HZ</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Airgap</td>
<td>0.4<del>1.0 mm (0.02</del>0.04 in)</td>
<td></td>
</tr>
<tr>
<td>Steering Wheel Angle Sensor</td>
<td>Operating Voltage</td>
<td>8 V~16 V</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Current Consumption</td>
<td>Max 150 mA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Operating Angular velocity</td>
<td>Max ±2000 °/sec</td>
<td></td>
</tr>
<tr>
<td>Yaw-rate Lateral G sensor</td>
<td>Operating Voltage</td>
<td>8 V~16 V</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Current Consumption</td>
<td>Max. 120 mA</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Output Voltage</td>
<td>0.35 V~4.65 V</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Yaw Sensor Operating Range</td>
<td>±100 °/s</td>
<td></td>
</tr>
<tr>
<td></td>
<td>G Sensor Operating Range</td>
<td>±1.8 G</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Reference voltage output</td>
<td>2.464~2.536 V</td>
<td>Typ. 2.5 V</td>
</tr>
</tbody>
</table>
### Brake Pedal Height
- Standard value: 184.5 mm (7.264 in.)
- Service limit:

### Brake Pedal Full Stroke
- Standard value: 128 mm (5.04 in.)
- Service limit:

### Adjust Brake Pedal Full Stroke
- Standard value: 76.2 mm (3 in.)
- Service limit:

### Brake Pedal Free Play
- Standard value: 3~8 mm (0.11~0.31 in.)
- Service limit:

### Stop Lamp Switch Outer Case to Pedal Stopper Clearance
- Standard value: 0.5~1.0 mm (0.02~0.04 in.)
- Service limit:

### Booster Push Rod to Master Cylinder Piston Clearance
- Standard value: 0 (at 500 mmHg vacuum)
- Service limit:

### Parking Brake Lever Stroke When Lever Assembly Is Pulled With 196N (20Kgf, 44lb Force)
- Standard value: 7 clicks
- Service limit:

### Front Disc Brake Pad Thickness
- Standard value: 11 mm (0.43 in.)
- Service limit: 2 mm (0.079 in.)

### Front Disc Thickness
- Standard value: 26 mm (1.024 in.)
- Service limit: 24.4 mm (0.961 in.)

### Front Disc Runout
- Standard value: Max.0.03 mm (0.001 in.)
- Service limit:

### Front Disc Thickness Variation
- Standard value: Max.0.005 mm (0.0002 in.)
- Service limit:

### Rear Drum Brake Lining Width
- Standard value: 42 mm (1.65 in.)
- Service limit:

### Rear Drum Brake Drum I.D.
- Standard value: 228.6 mm (9 in.)
- Service limit: Max.230.6mm (9.079 in.)

### Rear Disc Brake Pad Thickness
- Standard value: 10 mm (0.394 in.)
- Service limit: 2 mm (0.079 in.)

### Rear Disc Brake Disc Thickness
- Standard value: 10 mm (0.394 in.)
- Service limit: 8 mm (0.315 in.)

### Rear Disc Runout
- Standard value: Max.0.03 mm (0.001 in.)
- Service limit:

### Rear Disc Thickness Variation
- Standard value: Max.0.01 mm (0.0004 in.)
- Service limit:

### Tightening Torque

<table>
<thead>
<tr>
<th>Component</th>
<th>Nm</th>
<th>Kgf·cm</th>
<th>lb-ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Master cylinder to booster mounting nut</td>
<td>7.84~11.76</td>
<td>80~120</td>
<td>5.9~8.9</td>
</tr>
<tr>
<td>Brake booster mounting nut</td>
<td>12.74~15.68</td>
<td>130~160</td>
<td>9.6~11.8</td>
</tr>
<tr>
<td>Bleeder screw</td>
<td>6.86~12.74</td>
<td>70~130</td>
<td>5.2~9.6</td>
</tr>
<tr>
<td>Brake tube nut, brake hose</td>
<td>13.72~16.66 (M10)</td>
<td>140~170 (M10)</td>
<td>10.326~12.54 (M10)</td>
</tr>
<tr>
<td></td>
<td>18.62~22.54 (M12)</td>
<td>190~230 (M12)</td>
<td>14.01~16.964 (M12)</td>
</tr>
<tr>
<td>Caliper assembly to knuckle</td>
<td>78.4~98</td>
<td>800~1000</td>
<td>59.0~73.8</td>
</tr>
<tr>
<td>Brake hose to front caliper</td>
<td>24.5~29.4</td>
<td>250~300</td>
<td>18.4~22.1</td>
</tr>
<tr>
<td>Brake hub flange nut</td>
<td>196~254.8</td>
<td>2000~2600</td>
<td>147.5~191.8</td>
</tr>
<tr>
<td>Push rod locking nut</td>
<td>15.68~21.56</td>
<td>160~220</td>
<td>11.8~16.2</td>
</tr>
<tr>
<td>Caliper guide rod bolt</td>
<td>21.56~31.36</td>
<td>220~320</td>
<td>16.2~23.6</td>
</tr>
<tr>
<td>Stop lamp switch mounting nut</td>
<td>7.84~9.8</td>
<td>80~100</td>
<td>5.9~7.38</td>
</tr>
</tbody>
</table>
### TIGHTENING TORQUE (ABS)

<table>
<thead>
<tr>
<th>Item</th>
<th>Nm</th>
<th>kgf-cm</th>
<th>lb-ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Active wheel speed sensor mounting bolt on the brake plate</td>
<td>7.84~8.82</td>
<td>80~90</td>
<td>5.9~6.54</td>
</tr>
<tr>
<td>Hydraulic electronic control unit mounting bolt</td>
<td>13.72~17.64</td>
<td>140~180</td>
<td>10.326~13.276</td>
</tr>
<tr>
<td>Hydraulic electronic control unit mounting bracket bolt</td>
<td>16.66~25.48</td>
<td>170~260</td>
<td>12.54~19.177</td>
</tr>
<tr>
<td>Brake tubes nut</td>
<td>13.72~16.66</td>
<td>140~170</td>
<td>10.326~12.54</td>
</tr>
<tr>
<td>Air bleeder screw</td>
<td>6.86~12.74</td>
<td>70~130</td>
<td>5~9.6</td>
</tr>
</tbody>
</table>

### TIGHTENING TORQUE (ESP)

<table>
<thead>
<tr>
<th>Item</th>
<th>Nm</th>
<th>kgf-cm</th>
<th>lb-ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yaw rate lateral acceleration sensor Nut</td>
<td>4.9~7.84</td>
<td>50~80</td>
<td>3.69~5.9</td>
</tr>
<tr>
<td>Brake tube nut</td>
<td>13.72~16.66 (M10)</td>
<td>140~170 (M10)</td>
<td>10.326~12.54 (M10)</td>
</tr>
<tr>
<td></td>
<td>18.62~22.54 (M12)</td>
<td>190~230 (M12)</td>
<td>14.01~16.964 (M12)</td>
</tr>
</tbody>
</table>
GENERAL

SPECIAL TOOL  EF2DDBAE

<table>
<thead>
<tr>
<th>Tool(Number and Name)</th>
<th>Illustration</th>
<th>Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>09581-11000</td>
<td></td>
<td>Spreading the front disc brake piston</td>
</tr>
<tr>
<td>Piston expander</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TROUBLESHOOTING  EBF58C9B

PROBLEM SYMPTOMS TABLE

Use the table below to help you find the cause of the problem. The numbers indicate the priority of the like cause of the problem. Check each part in order. If necessary, replace these parts:

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Suspect Area</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower pedal or spongy pedal</td>
<td>1. Brake system (Fluid leaks)</td>
<td>repair</td>
</tr>
<tr>
<td></td>
<td>2. Brake system (Air in)</td>
<td>air·bleed</td>
</tr>
<tr>
<td></td>
<td>3. Piston seals (Worn or damaged)</td>
<td>replace</td>
</tr>
<tr>
<td></td>
<td>4. Rear brake shoe clearance(Out of adjustment)</td>
<td>adjust</td>
</tr>
<tr>
<td></td>
<td>5. Master cylinder (Faulty)</td>
<td>replace</td>
</tr>
<tr>
<td>Brake drag</td>
<td>1. Brake pedal freeplay (Minimum)</td>
<td>adjust</td>
</tr>
<tr>
<td></td>
<td>2. Parking brake lever travel (Out of adjustment)</td>
<td>adjust</td>
</tr>
<tr>
<td></td>
<td>3. Parking brake wire (Sticking)</td>
<td>repair</td>
</tr>
<tr>
<td></td>
<td>4. Rear brake shoe clearance(Out of adjustment)</td>
<td>adjust</td>
</tr>
<tr>
<td></td>
<td>5. Pad or lining (Cracked or distorted)</td>
<td>replace</td>
</tr>
<tr>
<td></td>
<td>6. Piston (Stuck)</td>
<td>replace</td>
</tr>
<tr>
<td></td>
<td>7. Piston (Frozen)</td>
<td>replace</td>
</tr>
<tr>
<td></td>
<td>8. Anchor or Return spring (Faulty)</td>
<td>replace</td>
</tr>
<tr>
<td></td>
<td>9. Booster system (Vacuum leaks)</td>
<td>repair</td>
</tr>
<tr>
<td></td>
<td>10. Master cylinder (Faulty)</td>
<td>replace</td>
</tr>
<tr>
<td>Brake pull</td>
<td>1. Piston (Sticking)</td>
<td>replace</td>
</tr>
<tr>
<td></td>
<td>2. Pad or lining (Oily)</td>
<td>replace</td>
</tr>
<tr>
<td></td>
<td>3. Piston (Frozen)</td>
<td>replace</td>
</tr>
<tr>
<td></td>
<td>4. Disc (Scored)</td>
<td>replace</td>
</tr>
<tr>
<td></td>
<td>5. Pad or lining (Cracked or distorted)</td>
<td>replace</td>
</tr>
<tr>
<td>Hard pedal but brake inefficient</td>
<td>1. Brake system (Fluid leaks)</td>
<td>repair</td>
</tr>
<tr>
<td></td>
<td>2. Brake system (Air in)</td>
<td>air·bleed</td>
</tr>
<tr>
<td></td>
<td>3. Pad or lining (Worn)</td>
<td>replace</td>
</tr>
<tr>
<td></td>
<td>4. Pad or lining (Cracked or distorted)</td>
<td>replace</td>
</tr>
<tr>
<td></td>
<td>5. Rear brake shoe clearance(Out of adjustment)</td>
<td>adjust</td>
</tr>
<tr>
<td></td>
<td>6. Pad or lining (Oily)</td>
<td>adjust</td>
</tr>
<tr>
<td></td>
<td>7. Pad or lining (Glazed)</td>
<td>replace</td>
</tr>
<tr>
<td></td>
<td>8. Disc (Scored)</td>
<td>replace</td>
</tr>
<tr>
<td></td>
<td>9. Booster system (Vacuum leaks)</td>
<td>repair</td>
</tr>
<tr>
<td>Symptom</td>
<td>Suspect Area</td>
<td>Reference</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>------------------------------------------------------------------------------</td>
<td>-----------</td>
</tr>
<tr>
<td>Noise from brake</td>
<td>1. Pad or lining (Cracked or distorted)</td>
<td>replace</td>
</tr>
<tr>
<td></td>
<td>2. Installation bolt (Loosen)</td>
<td>adjust</td>
</tr>
<tr>
<td></td>
<td>3. Disc (Scored)</td>
<td>replace</td>
</tr>
<tr>
<td></td>
<td>4. Sliding pin (Worn)</td>
<td>replace</td>
</tr>
<tr>
<td></td>
<td>5. Pad or lining (Dirty)</td>
<td>clean</td>
</tr>
<tr>
<td></td>
<td>6. Pad or lining (Glazed)</td>
<td>replace</td>
</tr>
<tr>
<td></td>
<td>7. Anchor or Return spring (Faulty)</td>
<td>replace</td>
</tr>
<tr>
<td></td>
<td>8. Brake pad shim (Damage)</td>
<td>replace</td>
</tr>
<tr>
<td></td>
<td>9. Shoe hold-down spring (Damage)</td>
<td>replace</td>
</tr>
<tr>
<td>Brake fades</td>
<td>1. master cylinder</td>
<td>replace</td>
</tr>
<tr>
<td>Brake vibration, pulsation</td>
<td>1. brake booster</td>
<td>replace</td>
</tr>
<tr>
<td></td>
<td>2. pedal free play</td>
<td>adjust</td>
</tr>
<tr>
<td></td>
<td>3. master cylinder</td>
<td>replace</td>
</tr>
<tr>
<td></td>
<td>4. caliper</td>
<td>replace</td>
</tr>
<tr>
<td></td>
<td>5. master cylinder cap seal</td>
<td>replace</td>
</tr>
<tr>
<td></td>
<td>6. damaged brake lines</td>
<td>replace</td>
</tr>
<tr>
<td>Brake Chatter</td>
<td>Brake chatter is usually caused by loose or worn components, or glazed or</td>
<td></td>
</tr>
<tr>
<td></td>
<td>burnt linings. Rotors with hard spots can also contribute to brake chatter.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Additional causes of chatter are out-of-tolerance rotors, brake lining not</td>
<td></td>
</tr>
<tr>
<td></td>
<td>securely attached to the shoes, loose wheel bearings and contaminated brake</td>
<td></td>
</tr>
<tr>
<td></td>
<td>lining.</td>
<td></td>
</tr>
</tbody>
</table>
BRAKE SYSTEM

OPERATION AND LEAKAGE CHECK

CHECK ALL OF THE FOLLOWING ITEMS:

<table>
<thead>
<tr>
<th>Component</th>
<th>Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brake Booster (A)</td>
<td>Check brake operation by applying the brakes during a test drive. If the brakes do not work properly, check the brake booster. Replace the brake booster as an assembly if it does not work properly or if there are signs of leakage.</td>
</tr>
</tbody>
</table>
| Piston cup and pressure cup inspection (B)    | • Check brake operation by applying the brakes. Look for damage or signs of fluid leakage. Replace the master cylinder as an assembly if the pedal does not work properly or if there is damage or signs of fluid leakage.  
  • Check for a difference in brake pedal stroke between quick and slow brake applications. Replace the master cylinder if there is a difference in pedal stroke. |
| Brake hoses (C)                                | Look for damage or signs of fluid leakage. Replace the brake hose with a new one if it is damaged or leaking.                                |
| Caliper piston seal and piston boots (D)      | Check brake operation by applying the brakes. Look for damage or signs of fluid leakage. If the pedal does not work properly, the brakes drag, or there is damage or signs of fluid leakage, disassemble and inspect the brake caliper. Replace the boots and seals with new ones whenever the brake caliper is disassembled. |
BR -10  BRAKE SYSTEM

BRAKE BOOSTER OPERATING TEST

For simple checking of the brake booster operation, carry out the following tests

1. Run the engine for one or two minutes, and then stop it. If the pedal depresses fully the first time but gradually becomes higher when depressed succeeding times, the booster is operating properly, if the pedal height remains unchanged, the booster is defective.

<table>
<thead>
<tr>
<th>Good</th>
<th>No good</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="EJRF500B" alt="Good Image" /></td>
<td><img src="EJRF500B" alt="No good Image" /></td>
</tr>
</tbody>
</table>

2. With the engine stopped, step on the brake pedal several times. Then step on the brake pedal and start the engine. If the pedal moves downward slightly, the booster is in good condition. If there is no change, the booster is defective.

<table>
<thead>
<tr>
<th>When engine is stopped</th>
<th>When engine is started</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="EGGB700B" alt="When engine is stopped Image" /></td>
<td><img src="EGGB700B" alt="When engine is started Image" /></td>
</tr>
</tbody>
</table>

3. With the engine running, step on the brake pedal and then stop the engine. Hold the pedal depressed for 30 seconds. If the pedal height does not change, the booster is in good condition, if the pedal rises, the booster is defective. If the above three tests are okay, the booster performance can be determined as good. Even if one of the above three tests is not okay, check the check valve, vacuum hose and booster for defect.

<table>
<thead>
<tr>
<th>Good</th>
<th>No good</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="EJRF500C" alt="Good Image" /></td>
<td><img src="EJRF500C" alt="No good Image" /></td>
</tr>
</tbody>
</table>
VACUUM HOSE (CHECK VALVE)

INSPECTION

1. Disconnect the brake booster vacuum hose (check valve built in) (A) at the booster (B).
2. Start the engine and let it idle. There should be vacuum available. If no vacuum is available, the check valve is not working properly. Replace the brake booster vacuum hose and check valve and retest.

BRAKE PEDAL BRAKE SWITCH ADJUSTMENT

PEDAL HEIGHT

1. Disconnect the brake switch connector, loosen the brake switch locknut (A), and brake off the brake switch (B) until it is no longer touching the brake pedal.
2. Lift up the carpet. At the insulator cutout, measure the pedal height (C) from the middle of the left-side center of the pedal pad (D).

Standard pedal height (with carpet removed):
184.5 mm (7.26 in.)
3. Loosen the pushrod locknut (A), and screw the pushrod in or out with pliers until the standard pedal height from the floor is reached. After adjustment, tighten the locknut firmly. Do not adjust the pedal height with the pushrod depressed.

PEDAL FREE PLAY

1. With the engine off, inspect the pedal free play (A) on the pedal pad (B) by pushing the pedal by hand.

Free play: 3~8 mm (0.12~0.31 in.)

2. If the pedal free play is out of specification, adjust the brake switch (C). If the pedal free play is insufficient, it may result in brake drag.
INSPECTION OF FRONT DISC BRAKE PAD

1. Check the brake pad thickness through the caliper body inspection hole.

   Pad thickness
   Standard value: 11.0 mm (0.43 in.)
   Service limit: 2.0 mm (0.0787 in.)

   **CAUTION**
   - If the pad lining thickness is out of specification, left and right pads must be replaced as a complete set.
   - When the thickness difference between the left pad and right pad is large, check the sliding condition of the piston and the guide rod.

INSPECTION OF REAR DISC BRAKE PAD

1. Check the rear disk brake pad thickness through the caliper body inspection hole.

   Pad thickness
   Standard value: 10.0 mm (0.39 in.)
   Service limit: 2.0 mm (0.0787 in.)

   **CAUTION**
   - If the pad thickness is out of specification, left and right pads must be replaced as a complete set.
   - When the thickness difference between the left pad and right pad is large, check the sliding condition of the piston and the guide rod.
TORQUE: Nm (kgf·cm, lb-ft)

1. Vacuum hose
2. Check valve
3. Snap pin
4. Seal
5. Clevis pin
6. Brake booster
7. Master cylinder
8. Washer

7.84~11.76 (80~120, 5.82~8.72)

12.74~15.68 (130~160, 9.45~11.63)

15.68~21.56 (160~220, 11.63~15.99)
REMOVAL  EDB5B296

1. Remove the master cylinder.

2. Disconnect the vacuum hose (A) from the brake booster (B).

3. Remove the snap pin (A) and clevis pin (B).

4. Remove the four booster mounting nuts (C).

5. Remove the brake booster (A).
1. Adjust push rod length of the booster, and then install the seal on the booster assembly.

Standard length (A): 108± 0.5 mm (4.25 ± 0.019 in.)

2. Insert the booster and tighten the nuts (C).

3. Connect the booster push rod and brake pedal with a pin (B) and install a snap clevis pin (A) to the clevis pin (B).

**CAUTION**

Grease the pin before installing the snap pin. Always use a new snap pin.

4. Install the master cylinder.

5. Connect the vacuum hose to the brake booster.

6. After filling the brake reservoir with brake fluid, bleed the system.

7. Check for fluid leakage.

8. Check and adjust the brake pedal for proper operation.
### BRAKE LINE

#### COMPONENT

- **Master cylinder to brake line**: 12.74~16.66 (130~170, 9.45~12.36)
- **Air bleeder screw**: 6.86~12.74 (70~130, 5.09~9.45)
- **Brake hose to caliper**: 24.5~29.4 (250~300, 18.18~21.81)
- **Brake line to brake hose**: 12.74~16.66 (130~170, 9.45~12.36)
- **Disc brake**: Brake hose to caliper 24.5~29.4 (250~300, 18.18~21.81) Bleeder screw 6.86~12.74 (70~130, 5.09~9.45)
- **Drum brake**: Brake line to wheel cylinder 12.74~16.66 (130~170, 9.45~12.36) Bleeder screw 6.86~12.74 (70~130, 5.09~9.45)

**TORQUE**: Nm (kgf·cm, lb-ft)
**REMOVAL**

1. Disconnect the brake hose(C) from the brake line(A) using a flare-nut wrench(B).

2. Remove the bracket mounting bolt(A), and then remove the brake hose(B).

3. Remove the connector bolt from the caliper, and disconnect the brake hose from the caliper.

**INSTALLATION**

1. Install a brake hose on the caliper with tightening brake hose bolt.

2. Install the bracket and the brake hose mounting bolt.

3. Connect the brake hose(A) to the brake line.

4. After installing the brake hose, bleed the brake system.
INSPECTION

- Check the brake tubes for cracks, crimps and corrosion.
- Check the brake hoses for cracks, damaged and oil leakage.
- Check the brake tube flare nuts for damage and oil leakage.

BRAKE SYSTEM BLEEDING

**NOTE**

- Do not reuse the drained fluid.
- Always use Genuine DOT3 or DOT 4 Brake Fluid. Using a non-Genuine DOT or 4 brake fluid can cause corrosion and decrease the life of the system.
- Make sure no dirt or other foreign matter is allowed to contaminate the brake fluid.
- Do not spill brake fluid on the vehicle, it may damage the paint; if brake fluid does contact the paint, wash it off immediately with water.
- The reservoir on the master cylinder must be at the MAX (upper) level mark at the start of bleeding procedure and checked after bleeding each brake caliper. Add fluid as required.

1. Make sure the brake fluid in the reservoir is at the MAX (upper) level line (A).
2. Have someone slowly pump the brake pedal several times, then apply pressure.
3. Loosen the right-rear brake bleed screw to allow air to escape from the system. Then tighten the bleed screw securely.
4. Repeat the procedure for wheel in the sequence shown below unit air bubbles no longer appear in the fluid.
5. Refill the master cylinder reservoir to MAX(upper) level line.
FRONT DISC BRAKE

6.86~12.74 Nm (70~130 kgf cm, 5.09~9.45 lb-ft)

REAR DRUM BRAKE
1. Member assembly bracket
2. Return spring
3. Stop lamp switch
4. Bushing
5. Brake pedal
1. Member assembly bracket  
2. Bushing  
3. Return spring  
4. Stop lamp switch  
5. Shaft bolt  
6. Brake pedal
REMOVAL

1. Remove the lower crash pad.(Refer to BD-“crash pad”)
2. Pull down steering column shaft after removing 4 bolts.
3. Remove the stop lamp switch connector (A).
4. Remove the shift lock cable (A/T).
5. Remove the pin and snap pin.
6. Loosen the brake pedal member assembly mounting nuts and then remove the brake pedal assembly.

INSTALLATION

1. Installation is the reverse of removal.

CAUTION

Coat the inner surface of the bushings with the specified grease.

| Specified grease : SAE J310 |

2. Before inserting the pin, apply the specified grease to the joint pin.
3. Install the snap pin.
4. Install the nuts with specified torque, when installing the brake pedal.

| TORQUE : Nm(kgf·cm,lb-ft); 12.74~15.68(130~160, 9.45~11.63) |

5. Adjust the brake pedal height and free play.
6. Install the stop lamp switch.
1. Check the bushing for wear.

2. Check the brake pedal for bending or twisting.

3. Check the brake pedal return spring for damage.

4. Check the stop lamp switch.
   
   1) Connect a circuit tester to the connector of stop lamp switch, and check whether or not there is continuity when the plunger of the stop lamp switch is pushed in and when it is released.

   2) The stop lamp switch is in good condition if there is no continuity when plunger(A) is pushed.
TORQUE: Nm (kgf cm, lb-ft)

1. Brake caliper
2. Brake disc
3. Pad retainers
4. Guide rod bolt
5. Indicator
6. Brake pads
7. Brake pad shims
21.56~31.36 (220~320, 15.99~23.26)

63.7~73.5  
(650~750, 47.26~54.53)

TORQUE : Nm (kgf-cm, lb-ft)

1. Guide rod bolt  
2. Bleeder screw  
3. Guide rod  
4. Boot  
5. Caliper mounting bolt  
6. Washer  
7. Caliper bracket  
8. Caliper body  
9. Piston seal  
10. Piston  
11. Piston boot  
12. Inner shim  
13. Brake pad  
14. Pad retainer  
15. Outer shim
**REMOVAL**  
EBFCF815

⚠️ CAUTION  
*Frequent inhalation of brake pad dust, regardless of material composition, could be hazardous to your health.*  
- Avoid breathing dust particles.  
- Never use on air hose or brush to clean brake assemblies.

1. Lossen the front wheel nuts slightly. Raise the front of the vehicle, and make sure it is securely supported. Remove the front wheels.

2. Remove the guide rod bolt(B). After raise the caliper assembly(A), support it with a wire.

3. Remove pad shim(A), pad retainer(B) and pad assembly(C) in the caliper bracket.

---

**INSTALLATION**  
EFD865AB

1. Install the pad retainers (A) on the caliper bracket.

2. Check the foreign material at the pad shims (A) and the back of the pads (B). Contaminated brake discs or pads reduce stopping ability. Keep grease off the discs and pads.
3. Install the brake pads (B) and pad shims (A) correctly. Install the pad with the wear indicator (C) on the inside. If you are reusing the pads, always reinstall the brake pads in their original positions to prevent a momentary loss of braking efficiency.

4. Push in the piston (A) so that the caliper will fit over the pads. Make sure that the piston boot is in position to prevent damaging it when pivoting the caliper down.

5. Pivot the caliper down into position. Being careful not to damage the pin boot, install the guide rod bolt (B) and torque it to proper specification.

6. Depress the brake pedal several times to make sure the brakes work, then test-drive.

**NOTE**

Engagement of the brake may require a greater pedal stroke immediately after the brake pads have been replaced as a set. Several applications of the brake will restore the normal pedal stroke. Be sure to do this before driving the vehicle.

7. After installation, check for leaks at hose and line joints or connections, and retighten if necessary.

**NOTE**

Insert the piston in the cylinder using the special tool (09581-11000).
FRONT BRAKE DISC THICKNESS CHECK

1. Remove all rust and contamination from the surface, and measure the disc thickness at 8 points, at least, of same distance (5 mm) front the brake disc outer circle.

Front brake disc thickness
Standard value : 26.0 mm (1.024 in.)
Limit : 24.4 mm (0.961 in.)

2. Thickness variation should not exceed 0.005 mm (0.0002 in.) (circumference) and 0.01 mm (0.0004 in.) (radius) at any directions.

3. If wear exceeds the limit, replace the discs and pad assembly left and right of the vehicle.

FRONT BRAKE PAD CHECK

1. Check the pad wear. Measure the pad thickness and replace it, if it is less than the specified value.

   Pad thickness
   Standard value : 11 mm (0.43 in.)
   Service limit : 2.0 mm (0.0787 in.)

2. Check that grease is applied, to sliding contact points and the pad and backing metal for damage.
FRONT BRAKE DISC RUN OUT CHECK

1. Place a dial gauge about 5 mm (0.2 in.) from the outer circumference of the brake disc, and measure the run out of the disc.

   Brake disc run out
   Limit: 0.04 mm (0.0016 in.) or less (new one)

2. If the run out of the brake disc exceeds the limit specification, replace the disc, and then measure the run out again.

3. If the run out does not exceed the limit specification, install the brake disc after turning it 180° and then check the run out of the brake disc again.

4. If the run out cannot be corrected by changing the position of the brake disc, replace the brake disc.

SEIZE OF FRONT BRAKE DISC

1. Remove the brake disc from hub using M8 screw(A) if the brake disc has been seized with the hub due to corrosion or overheat.

   NOTE
   Be careful not to use the hammer. The disc can be damaged if you remove the disc from the hub by hammer.
MASTER CYLINDER

COMPONENTS

1. Reservoir cap
2. Brake fluid filter
3. Reservoir
4. Grommet
5. Cylinder pin
6. Retainer
7. Primary piston assembly
8. Secondary piston assembly
9. Master cylinder body
10. Proportioning valve

TORQUE: Nm (Kgf·cm, lb-ft)

- 34.3 ~ 53.9 (350~550, 25.45~39.99)
NOTE
Do not spill brake fluid on the vehicle; it may damage the paint; if brake fluid does contact the paint, wash it off immediately with water.

1. Remove air cleaner mounting bolts (B) from the air cleaner mounting bracket and air cleaner body (A).

2. Disconnect the brake fluid level switch connectors (A), and remove the reservoir cap (B).

3. Remove the brake fluid from the master cylinder reservoir (C) with a syringe.

4. Disconnect the brake lines (A) from the master cylinder. To prevent spills, cover the hose joints with rags or shop towels.

5. Remove the master cylinder mounting nuts (B) and washers.

6. Remove the master cylinder (C) from the brake booster (D). Be careful not to bend or damage the brake lines when removing the master cylinder.
**INSTALLATION**  

1. Install the master cylinder on the brake booster with 2 nuts.

2. Connect 2 brake tubes and the brake fluid level sensor connector.

3. Fill the brake reservoir with the brake fluid and bleed the brake system.

**DISASSEMBLY**

1. Remove the reservoir cap and drain the brake fluid into a suitable container.

2. Remove the fluid level sensor.

3. Remove the reservoir from the master cylinder, after remove mounting screw (A).

4. Remove the proportioning valves (A) - CBS only.
5. Remove the retainer ring by using the snap ring pliers then remove the primary piston assembly.

6. Remove the pin with the secondary piston pushed completely using a screwdriver. Remove the secondary piston assembly.

**NOTE**

Do not disassemble the primary and secondary piston assembly.

**INSPECTION**

1. Check the master cylinder bore for rust or scratch.
2. Check the master cylinder for wear or damage. If necessary, clean or replace the cylinder.

**CAUTION**

- If the cylinder bore is damaged, replace the master cylinder assembly.
- Wash the contaminated parts in alcohol.

**REASSEMBLY**

1. Apply genuine brake fluid to the rubber parts of the cylinder kit and grommets.
2. Carefully insert the springs and pistons in the proper direction.

3. Press the piston with a screwdriver and install the cylinder pin.
4. Press the piston with a screwdriver and install the retainer ring.

5. Mount two grommets.

6. Install the reservoir on the cylinder.
PROPORTIONING VALVE

DESCRIPTION
Do not disassemble the proportioning valve. The proportioning valve makes the ideal distribution of fluid pressure to the front and rear brakes to prevent the brakes from skidding in the event of rear wheel lock up and to obtain a higher brake efficiency within the range of service brake application.

INSPECTION
1. Remove the front brake tube (B) and rear brake tube (C) from the master cylinder (A).
2. Connect two pressure gauges (D); one to the output valve of the front (B) and rear (C) brake.

3. With the brake applied, measure the front pressure and the rear pressure. If the measured pressures are within the specified range as illustrated, the proportioning valve is good.

4. Reconnect the brake lines in their original positions and bleed the system.

**NOTE**
Be sure to bleed the system after connecting the pressure gauges.

<table>
<thead>
<tr>
<th>Input Pressure</th>
<th>Output Pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>A : 35 kg/cm²</td>
<td>A' : 35 kg/cm²</td>
</tr>
<tr>
<td>B : 80 kg/cm²</td>
<td>B' : 49.4 kg/cm²</td>
</tr>
</tbody>
</table>
REAR DISC BRAKE

COMPONENTS

1. Bleeder screw
2. Caliper body
3. Guide rod
4. Boot
5. Piston
6. Piston seal
7. Piston boot
8. Pad retainer
9. Caliper mounting bolt
10. Washer
11. Guide rod bolt
12. Inner shim
13. Brake Pad
14. Outer shim
15. Caliper bracket

TORQUE : Nm (kgf·cm, lb-ft)

- Bleeder screw: 6.86~12.74 (70~130, 5.09~9.45)
- Caliper body: 78.4~98 (800~1,000, 58.16~72.7)
**REMOVAL**

1. Raise the rear of the vehicle and make sure it is securely supported. Remove the rear wheel.

2. Remove the guide rod bolt(B), After raise the caliper assembly(A), support it with a wire.

3. Remove pad shim(A), pad retainer(B) and pad assembly(C) in the caliper bracket.

**INSTALLATION**

1. Install the pad retainers(A) on the caliper bracket.

2. Check the foreign material at the pad shim (A) and the back of the pads (B).

3. Contaminated brake discs or pads reduce stopping ability. Keep grease off the discs and pads.

4. Install the brake pads (B) and pad shims (A) correctly. Install the pad with the wear indicator (C) on the inside. If you are reusing the pads, always reinstall the brake pads in their original position to prevent a momentary loss of braking efficiency.

5. Push in the piston (A) so that the caliper will fit over the pads. Make sure that the piston boot is in position to prevent damaging it when pivoting the caliper down.
6. Pivot caliper down into position. Being careful not to damage the pin boot, install the guide rod bolt (B) and torque it to proper specification

B 21.56~31.36 Nm (220~320 kgf-cm, 15.99~23.26 lb-ft)

**NOTE**

Insert the piston in the cylinder using the special tool(09581-11000).

7. Depress the brake pedal several times to make sure the brakes work, then test-drive.

**NOTE**

Engagement of the brake may require a greater pedal stroke immediately after the brake pads have been replaced as a set. Several applications of the brake will restore the normal pedal stroke.

8. After installation, check for leaks at hose and line joints or connections, and retighten if necessary.

---

**INSPECTION**

**REAR BRAKE DISC THICKNESS CHECK**

1. Remove all rust and contamination from the disc surface, and then measure the disc thickness at 8 points, at least, of the same distance (5mm) from the brake disk outer circle.

Rear brake disc thickness
Standard value: 10.0 mm (0.39 in.)
Limit: 8.0 mm (0.315 in.)

2. Thickness variation should not exceed 0.01 mm (0.0004 in.) (circumference) and 0.01 mm (0.0004 in.) (radius) at any directions.

3. If wear exceeds the limit, replace the discs and pad assembly for left and right of the vehicle.
REAR BRAKE PAD CHECK

1. Check the pad wear. Measure the pad thickness and replace it, if it is less than the specified value.

<table>
<thead>
<tr>
<th>Pad thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard value: 10.0 mm (0.39 in.)</td>
</tr>
<tr>
<td>Service limit: 2.0 mm (0.0787 in.)</td>
</tr>
</tbody>
</table>

2. Check that grease is applied, and the pad and backing metal for damage.

REAR BRAKE DISC RUN OUT CHECK

1. Place a dial gauge about 5 mm (0.2 in.) from the outer circumference of the brake disc, and measure the run out of the disc.

<table>
<thead>
<tr>
<th>Brake disc run out</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limit: 0.05 mm (0.002 in.) or less (new one)</td>
</tr>
</tbody>
</table>

2. If the run out of the brake disc exceeds the limit specification, replace the disc, and then measure the run out again.

3. If the run out does not exceed the limit specification, install the brake disc after turning it 180° and then check the run out of the brake disc again.

4. If the run out cannot be corrected by changing the position of the brake disc, replace the brake disc.
SEIZE OF REAR BRAKE DISC

1. Remove the brake disc from hub using M8 screw(A) if the brake disc has been seized with the hub due to corrosion or overheat.

**NOTE**

Be careful not to use the hammer. The disc can be damaged if you remove the disc from the hub by hammer.
REAR DRUM BRAKE

COMPONENTS

1. Shoe hold down pin
2. Bleeder screw
3. Wheel cylinder
4. Shoe adjuster lever
5. Shoe adjuster
6. Shoe & lining assembly
7. Shoe hold down spring
8. Cup washer
9. Brake drum
10. Rear hub
11. Rear brake backing plate
12. Upper shoe return spring
13. Lower shoe return spring

TORQUE : Nm (Kgf·cm, lb-ft)

4.9~10.78 (50~110, 3.64~8)
6.86~12.74 (70~130, 5.09~9.45)
**CAUTION**

_Frequent inhalation of brake pad dust, regardless of material composition, could be hazardous to your health._

- Avoid breathing dust particles.
- Never use an air hose or brush to clean brake assemblies.

1. Remove the shoe hold down pins (B) by pushing the shoe hold cup washer (C) and turning them.

2. Disengage the upper return spring (A).

3. Remove the lower shoe return spring (B) as removing the brake shoe assembly (A). Make sure not to damage the dust cover on the wheel cylinder.

4. Disconnect the parking brake cable from the parking brake lever.

5. Remove the brake shoe assembly.

6. Remove shoe adjuster (B) and lever (C) from the brake shoes.

7. Disconnect the brake tube (A) from the wheel cylinder.

8. Remove the bolt (C) and the wheel cylinder from the backing plate (D).
**NOTE**

- Do not spill brake fluid on the vehicle; it may damage the paint; if brake fluid does contact the paint, wash it off immediately with water.
- To prevent spills, cover the hose joints with rags or shop towels.
- Use only a genuine wheel cylinder special bolt.

1. Apply sealant (C) between the wheel cylinder (A) and backing plate (B), and install the wheel cylinder.

2. Connect the brake tubes (D) to the wheel cylinder.

3. Connect the parking brake cable to the parking brake lever.

4. Clean the threaded portions of adjuster sleeve (A) and push rod female (B). Grease the threads of the adjuster assembly, turn the adjuster bolt (C), adjusting the length of the shoe adjuster assembly.

5. Hook the shoe adjuster then install to the brake shoe.

6. Install the shoe adjuster assembly and upper return spring (D), noting the installation direction. Be careful not to damage the wheel cylinder dust covers.

7. Install the lower return spring (E).

8. Grease brake cylinder to the sliding surfaces as shown below. Wipe off any excess. Don’t get grease on the brake linings.

9. Grease brake cylinder to the brake shoe ends and opposite edges of the as shoes as shown below. Wipe off any excess. Don’t get grease on the brake linings.
10. Grease brake shoes (A) onto the backing plate. Be careful not to damage the wheel cylinder dust covers.

11. Install the shoe hold down pins (B), shoe hold down spring and the shoe hold down cup (C).

12. Install the brake drum.

13. Bleed the brake system, after refilling the brake fluid.

14. Depress the brake pedal several times to set the self-adjusting brake.

15. Adjust the parking brake.

**INSPECTION**

**CAUTION**

_Frequent inhalation of brake pad dust, regardless of material composition, could be hazardous to your health._

- Avoid breathing dust particles.
- Never use an air hose or brush to clean brake assemblies.

**NOTE**

- Contaminated brake linings or drums reduce stopping ability.
- Block the front wheels before jacking up the rear of the vehicle.

1. Raise the rear of the vehicle, and make sure it is securely supported.

2. Release the parking brake, and remove the rear brake drum.

3. Check the wheel cylinder (A) for leakage.

4. Check the brake linings (B) for cracking, glazing, wear, and contamination.

5. Measure the brake lining thickness (C). Measurement does not include brake shoe thickness.

**Brake lining thickness**

- Standard: 4.5 mm (0.177 in.)
- Service limit: 1.0 mm (0.039 in.)
6. If the brake lining thickness is less than the service limit, replace the brake shoes as a set.

7. Check the bearings in the hub unit for smooth operation. If it requires servicing, replace it.

8. Measure the inside diameter of the brake drum with inside vernier calipers.

<table>
<thead>
<tr>
<th>Drum inside diameter:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard: 228.6 mm (9 in.)</td>
</tr>
<tr>
<td>Service limit: 230.6 mm (9.079 in.)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Drum roundness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service limit: 0.06 mm (0.00236 in.)</td>
</tr>
</tbody>
</table>

9. If the inside diameter of the brake drum is more than the service limit, replace the brake drum.

10. Check the brake drum for scoring, grooves, and cracks.
1. Rear brake caliper
2. Parking brake lever
3. Parking brake switch
4. Parking brake cable
5. Backing plate
6. Operating lever
7. Strut
8. Upper spring
9. Lower spring
10. Adjuster
11. Cup washer
12. Shoe hold down spring
13. Shoe hold down pin
NOTE
The parking brake cables must not be bent or distorted. This will lead to stiff operation and premature failure.

1. Remove the floor console.

2. Loosen the adjusting nut (A) and remove the parking brake cables.

3. Disconnect the connector (A) of the parking brake switch connector.

4. Remove the bolts and parking brake lever assembly (A).

5. Remove the wheel and tire.

6. Remove the brake disc and the brake shoe (Refer to the rear disc brake).

7. Remove the parking brake hook (A).

8. Remove the parking brake cable assembly.
INSTALLATION

1. Install the removed parts in the reverse order of removal.

2. Apply the specified grease to each sliding parts of the ratchet plate or the ratchet pawl.

   Specified grease :
   Multi purpose grease SAE J310, NLGI No.2

3. After installing the parking brake cable adjuster, adjust the parking brake lever stroke (Refer to the parking brake check and adjustment).

INSPECTION

1. Pull the parking brake lever (A) with 196 N (20 kgf, 44 lb) force to fully apply the parking brake. The parking brake lever should be locked within the specified number of clicks.

   Lever locked clicks:7

2. Adjust the parking brake if the lever clicks are out of specification.
NOTE

After rear brake caliper servicing, loosen the parking brake adjusting nut, start the engine and depress the brake pedal several times to set the self-adjusting brake before adjusting the parking brake.

1. Block the front wheels, then raise the rear of the vehicle and make sure it is securely supported.

2. Pull the parking brake lever up one click.

3. Remove the floor console.

4. Tighten the adjusting nut (A) until the parking brakes are dragged slightly when the rear wheels are turned.

5. Release the parking brake lever completely, and check if parking brakes are not dragged when the rear wheels are turned. Readjust if necessary.

6. Make sure that the parking brakes are fully applied when the parking brake lever is pulled up completely.

7. Reinstall the floor console.
PARKING BRAKE SYSTEM

PARKING BRAKE SWITCH

INSPECTION  ED3E4A76

1. Remove the floor console and the connector(B) from the switch(A).

2. Inspect the continuity between (-) terminal and the ground.
   • When the brake lever is pulled, there should be the continuity between them.
   • When the brake lever is released, there should be no continuity between them.
ABS (ANTI-LOCK BRAKE SYSTEM)

COMPONENTS

1. Front left wheel speed sensor
2. ABS control module (HECU)
3. Front right wheel speed sensor
4. Hydraulic line
5. Rear right wheel speed sensor
6. Rear left wheel speed sensor
DESCRIPTION

This specification applies to HCU (Hydraulic Control Unit) and ECU (Electronic Control Unit) of the HECU (Hydraulic and Electronic Control Unit).

This specification is for the wiring design and installation of ABS/TCS/ESP ECU.

This unit has the functions as follows.
- Input of signal from Pressure sensor, Steering angle sensor, Yaw Lateral G sensor, the wheel speed sensors attached to each wheel.
- Control of braking force / traction force/ yaw moment.
- Failsafe function.
- Self diagnosis function.
- Interface with the external diagnosis tester.

Installation position: engine compartment
- Brake tube length from Master cylinder port to HECU inlet port should be max. 1m
- The position should not be close to the engine block and not lower than the wheel.

OPERATION

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

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

In the operating condition, the ECU 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.

WHEEL SENSOR SIGNAL PROCESSING

The ECU shall receive wheel speed signal from the four active wheel sensors.

The wheel signals are converted to voltage signal by the signal conditioning circuit after receiving current signal from active wheel sensors and given as input to the MCU.

SOLENOID VALVE CONTROL

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 semiconductor circuit, the solenoid valve goes into operation.

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

VOLTAGE LIMITS

- Overvoltage
  When overvoltage is detected (above 16V), the ECU 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.
- Undervoltage
  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 ECU returns to normal operating mode.

PUMP MOTOR CHECKING

The ECU performs a pump motor test at a speed of 12km/h once after IGN is switched on.

DIAGNOSTIC INTERFACE

Failures detected by the ECU are encoded on the ECU, stored in a EEPROM and read out by diagnostic equipment when the ignition switch is turned on.

The diagnosis interface can also be used for testing the ECU during production of the ECU and for actuating the HCU in the test line of manufactories (Air-bleeding line or Roll and Brake Test line).
1. ABS WARNING LAMP MODULE
The active ABS warning lamp module indicates the selftest 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.

2. PARKING/EBD WARNING LAMP MODULE
The active EBD warning lamp module indicates the selftest 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.
1. NORMAL BRAKING without ABS

<table>
<thead>
<tr>
<th>Operation</th>
<th>Inlet valve (EV)</th>
<th>Outlet valve (AV)</th>
<th>Pump motor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open</td>
<td>Open</td>
<td>Close</td>
<td>OFF</td>
</tr>
</tbody>
</table>

![Diagram of normal braking without ABS]
2. DECREASE MODE

<table>
<thead>
<tr>
<th></th>
<th>Inlet valve (EV)</th>
<th>Outlet valve (AV)</th>
<th>Pump motor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operation</td>
<td>Close</td>
<td>Open</td>
<td>ON (Motor speed control)</td>
</tr>
</tbody>
</table>

![Diagram of the brake system](image-url)
3. HOLD MODE

<table>
<thead>
<tr>
<th>Operation</th>
<th>Inlet valve (EV)</th>
<th>Outlet valve (AV)</th>
<th>Pump motor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Close</td>
<td>Close</td>
<td>Close</td>
<td>OFF</td>
</tr>
</tbody>
</table>
4. INCREASE MODE

<table>
<thead>
<tr>
<th></th>
<th>Inlet valve(EV)</th>
<th>Outlet valve(AV)</th>
<th>Pump motor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operation</td>
<td>Open</td>
<td>Close</td>
<td>OFF</td>
</tr>
</tbody>
</table>
### ABS (ANTI-LOCK BRAKE SYSTEM)

#### HECU CONNECTOR
**INPUT/OUTPUT(ABS)**

<table>
<thead>
<tr>
<th>Wire No.</th>
<th>Designation</th>
<th>Current max</th>
<th>Current min</th>
<th>max.permissible wire resistance $R_L$ (mΩ)</th>
<th>min.leakage resistance $R_P$ (kΩ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ground for recirculation pump</td>
<td>20~39 A</td>
<td>10 A</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Ground for solenoid valves and ECU</td>
<td>5~15 A</td>
<td>2.5 A</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Voltage supply for pump motor</td>
<td>20~39 A</td>
<td>10 A</td>
<td>10</td>
<td>200</td>
</tr>
<tr>
<td>3</td>
<td>Voltage supply for solenoid valves</td>
<td>5~15 A</td>
<td>2 A</td>
<td>10</td>
<td>200</td>
</tr>
<tr>
<td>18</td>
<td>Voltage for hybrid ECU</td>
<td>1 A</td>
<td>500 mA</td>
<td>60</td>
<td>200</td>
</tr>
<tr>
<td>5,10,17,19</td>
<td>signal wheel speed sensor FL, FR, RL, RR</td>
<td>6 mA</td>
<td>16 mA</td>
<td>250</td>
<td>200 to ground 1.5M to bat</td>
</tr>
<tr>
<td>16,9,6,8</td>
<td>Voltage supply for the active wheel speed sensor FL,FR, RL, RR</td>
<td>6 mA</td>
<td>16 mA</td>
<td>250</td>
<td>200 to ground 1.5M to bat</td>
</tr>
<tr>
<td>14,24</td>
<td>wheel speed sensor output (FR, RL)</td>
<td>20 mA</td>
<td>10 mA</td>
<td>250</td>
<td>200</td>
</tr>
<tr>
<td>11</td>
<td>Diagnostic wire K</td>
<td>6 mA</td>
<td>3 mA</td>
<td>250</td>
<td>200</td>
</tr>
<tr>
<td>22</td>
<td>ABS-warning lamp actuation</td>
<td>30 mA</td>
<td>5 mA</td>
<td>250</td>
<td>200</td>
</tr>
<tr>
<td>12</td>
<td>EBD-warning lamp actuation</td>
<td>30 mA</td>
<td>5 mA</td>
<td>250</td>
<td>200</td>
</tr>
<tr>
<td>20</td>
<td>brake light switch</td>
<td>10 mA</td>
<td>5 mA</td>
<td>250</td>
<td>200</td>
</tr>
</tbody>
</table>
## ABS HECU CONNECTOR

<table>
<thead>
<tr>
<th>Connector terminal</th>
<th>Specification</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number 1: Ground for recirculation pump</td>
<td>Current range: Min.10A Max.20~39A</td>
<td>Always</td>
</tr>
<tr>
<td>Number 4: Ground for solenoid valves and ECU</td>
<td>Current range: Min.2.5A Max.5~15A</td>
<td>Always</td>
</tr>
<tr>
<td>Number 2: Voltage supply for pump motor</td>
<td>Battery voltage</td>
<td>Always</td>
</tr>
<tr>
<td>Number 3: Voltage supply for solenoid valves</td>
<td>Battery voltage</td>
<td>Always</td>
</tr>
<tr>
<td>Number 16: Voltage supply for the active wheel speed sensor FL, FR, RL, RR</td>
<td>Battery voltage</td>
<td>IG ON</td>
</tr>
<tr>
<td>Number 9: Voltage for hybrid ECU</td>
<td>Battery voltage</td>
<td>KEY ON/OFF</td>
</tr>
<tr>
<td>Number 6: signal wheel speed sensor FL, FR, RL, RR</td>
<td>Voltage (High): 0.89~1.26 V</td>
<td>On driving</td>
</tr>
<tr>
<td>Number 8: diagnostic wire K</td>
<td>Voltage (High) ≤ 0.8 * IG ON</td>
<td>On HI-SCAN commu-</td>
</tr>
<tr>
<td>Number 10: diagnostic wire K</td>
<td>Voltage (Low) ≤ 0.2 * IG ON</td>
<td>nication</td>
</tr>
<tr>
<td>Number 17: Brake light switch</td>
<td>Voltage (High) ≥ 0.8 * IG ON</td>
<td>BRAKE ON/OFF</td>
</tr>
<tr>
<td>Number 20: Voltage for hybrid ECU</td>
<td>Voltage (Low) ≥ 0.8 * IG ON</td>
<td></td>
</tr>
</tbody>
</table>

- *(Connectors are labeled from 1 to 20)*
- *(Specifications and conditions are detailed in the table)*
# ABS (ANTI-LOCK BRAKE SYSTEM)

## SENSOR OUTPUT ON HI-SCAN(ABS)

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Abbreviation</th>
<th>Unit</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Vehicle speed sensor</td>
<td>VEH. SPD</td>
<td>Km/h</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Battery voltage</td>
<td>BATT. VOL</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>FL Wheel speed sensor</td>
<td>FL WHEEL</td>
<td>Km/h</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>FR Wheel speed sensor</td>
<td>FR WHEEL</td>
<td>Km/h</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>RL Wheel speed sensor</td>
<td>RL WHEEL</td>
<td>Km/h</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>RR Wheel speed sensor</td>
<td>RR WHEEL</td>
<td>Km/h</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>ABS Warning lamp</td>
<td>ABS LAMP</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>8</td>
<td>EBD Warning lamp</td>
<td>EBD LAMP</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>9</td>
<td>Brake Lamp</td>
<td>B/LAMP</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>10</td>
<td>Pump relay state</td>
<td>PUMP RLY</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>11</td>
<td>Valve relay state</td>
<td>VALVE RLY</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>12</td>
<td>Motor</td>
<td>MOTOR</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>13</td>
<td>Front Left valve (IN)</td>
<td>FL INLET</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>14</td>
<td>Front Right valve (IN)</td>
<td>FR INLET</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>15</td>
<td>Rear Left valve (IN)</td>
<td>RL INLET</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>16</td>
<td>Rear Right valve (IN)</td>
<td>RR INLET</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>17</td>
<td>Front Left valve (OUT)</td>
<td>FL OUTLET</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>18</td>
<td>Front Right valve (OUT)</td>
<td>FR OUTLET</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>19</td>
<td>Rear Left valve (OUT)</td>
<td>RL OUTLET</td>
<td></td>
<td>-</td>
</tr>
<tr>
<td>20</td>
<td>Rear Right valve (OUT)</td>
<td>RR OUTLET</td>
<td></td>
<td>-</td>
</tr>
</tbody>
</table>
HI-SCAN (PRO) CHECK

1. Turn the ignition switch OFF.

2. Connect the Hi-scan(pro) to the 16P data link connector located the driver’s side kick panel.

3. Turn the ignition switch ON.

4. Check for diagnostic trouble using the Hi-scan(pro).

5. After completion trouble of the repair or correction of the problem, erase the stored fault codes the clear key on the Hi-scan(pro).

6. Disconnect the Hi-scan(pro) from the 16P data link connector.
STANDARD FLOW OF DIAGNOSTIC TROUBLESHOOTING

Gathering information from customer

- Reoccurs
- Does not reoccur

Check diagnostic code

- Trouble code displayed
- No trouble code

Recheck trouble code(s) then erase

Basic brake system is normal or not

- Abnormal
- Normal

Refer to BR-Troubleshooting

Problem is intermittent or was repaired and memory was not cleared.

Recheck trouble symptom

Check trouble codes

Inspection chart for diagnostic trouble codes

Intermittent malfunction

* Using the customer problem analysis check sheet for reference, ask the customer as much detail as possible about the problem.

NOTES WITH REGARD TO DIAGNOSIS

The phenomena listed in the following table are not abnormal.

<table>
<thead>
<tr>
<th>Phenomenon</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>System check sound</td>
<td>When starting the engine, a thudding sound can sometimes be heard coming from inside the engine compartment. This is because the system operation check is being performed.</td>
</tr>
<tr>
<td>ABS operation sound</td>
<td>1. Sound of the motor inside the ABS hydraulic unit operation (whine). 2. Sound is generated along with vibration of the brake pedal (scraping). 3. When ABS operates, sound is generated from the vehicle chassis due to repeated brake application and release (Thump: suspension; squeak: tires)</td>
</tr>
<tr>
<td>ABS operation (Long braking distance)</td>
<td>For road surfaces such as snow-covered and gravel roads, the braking distance for vehicles with ABS can sometimes be longer than that for other vehicles. Accordingly, advise the customer to drive safely on such roads by lowering the vehicle speed.</td>
</tr>
</tbody>
</table>

Diagnosis detection conditions can vary depending on the diagnosis code. When checking the trouble symptom after the diagnosis code has been erased, ensure that the requirements listed in "Comment" are met.
# ABS CHECK SHEET

<table>
<thead>
<tr>
<th>Customer's Name</th>
<th>Registration No.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Registration Year / /</td>
</tr>
<tr>
<td></td>
<td>VIN.</td>
</tr>
<tr>
<td>Date Vehicle Brought In</td>
<td>Odometer Km Miles</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Date the Problem First Occurred</th>
<th>/ /</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Frequency of Occurrence of Problem</th>
<th>Continuous</th>
<th>Intermittent (times a day)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Symptoms</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>□ ABS does not operate.</td>
<td></td>
</tr>
<tr>
<td>□ ABS does not operate efficiently.</td>
<td></td>
</tr>
<tr>
<td>□ Intermittent (times a day)</td>
<td></td>
</tr>
<tr>
<td>□ ABS Warning Light Abnormal</td>
<td></td>
</tr>
<tr>
<td>□ Remains ON</td>
<td></td>
</tr>
<tr>
<td>□ Does not light up</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Diagnostic Trouble Code Check</th>
<th>1st Time</th>
<th>2nd Time</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Normal Code</td>
<td>Malfunction Code (Code )</td>
</tr>
<tr>
<td></td>
<td>Normal Code</td>
<td>Malfunction Code (Code )</td>
</tr>
</tbody>
</table>
# PROBLEM SYMPTOMS TABLE

If a normal code is displayed during the DTC check but the problem still occurs, check the circuits for each problem symptom in the order given in the table below and proceed to the relevant troubleshooting page.

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Suspect Area</th>
<th>See page</th>
</tr>
</thead>
</table>
| ABS does not operate.                        | Only when 1. -4. are all normal and the problem is still occurring, replace the HECU.  
  1. Check the DTC reconfirming that the normal code is output.  
  2. Power source circuit.  
  3. Speed sensor circuit.  
  4. Check the hydraulic circuit for leakage. | BR - 68  |
| ABS does not operate intermittently.         | Only when 1. -4. are all normal and the problem is still occurring, replace the ABS actuator assembly.  
  1. Check the DTC reconfirming that the normal code is output.  
  2. Wheel speed sensor circuit.  
  3. Stop lamp switch circuit.  
  4. Check the hydraulic circuit for leakage. | BR - 70  |
| Communication with Hi-scan (pro) is not possible. | 1. Power source circuit  
  2. Diagnosis line            | BR - 71  |
| Communication with Hi-scan (pro) is not possible. (Communication with ABS only is not possible) | 1. Power source circuit  
  2. Diagnosis line  
  3. HECU | BR - 72  |
| When ignition key is turned ON (engine OFF), the ABS warning lamp does not light up. | 1. ABS warning lamp circuit  
  2. HECU | BR - 73  |
| Even after the engine is started, the ABS warning lamp remains ON. | 1. ABS warning lamp circuit  
  2. HECU | BR - 74  |

⚠️ **CAUTION**  
During ABS operation, the brake pedal may vibrate or may not be able to be depressed. Such phenomena are due to intermittent changes in hydraulic pressure inside the brake line to prevent the wheels from locking and is not an abnormality.
DETECTING CONDITION

<table>
<thead>
<tr>
<th>Trouble Symptoms</th>
<th>Possible Cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brake operation varies depending on driving conditions and road surface conditions, so diagnosis can be difficult. However if a normal DTC is displayed, check the following probable cause. When the problem is still occurring, replace the ABS control module.</td>
<td>- Faulty power source circuit</td>
</tr>
<tr>
<td></td>
<td>- Faulty wheel speed sensor circuit</td>
</tr>
<tr>
<td></td>
<td>- Faulty hydraulic circuit for leakage</td>
</tr>
<tr>
<td></td>
<td>- Faulty HECU</td>
</tr>
</tbody>
</table>

INSPECTION PROCEDURES

DTC INSPECTION

1. Connect the Hi-Scan (pro) with the data link connector and turn the ignition switch ON.

2. Verify that the normal code is output.
   Is the normal code output?
   - NO ► Check the power source circuit.
   - YES ► Erase the DTC and recheck using Hi-Scan (pro).

CHECK THE POWER SOURCE CIRCUIT.

1. Disconnect the connector from the ABS control module.

2. Turn the ignition switch ON, measure the voltage between terminal 18 of the ABS control module harness side connector and body ground.

   Specification: approximately B+

   Is the voltage within specification?
   - YES ► Check the ground circuit.
   - NO ► Check the harness or connector between the fuse (10A) in the engine compartment junction block and the ABS control module. Repair if necessary.

CHECK THE GROUND CIRCUIT.

1. Disconnect the connector from the ABS control module.

2. Check for continuity between terminals 1, 4 of the ABS control module harness side connector and ground point.

   Is there continuity?
   - YES ► Check the wheel speed sensor circuit.
   - NO ► Repair an open in the wire and ground point.
CHECK THE WHEEL SPEED SENSOR CIRCUIT.

Refer to the DTC troubleshooting procedures. Is it normal?

- **YES**
  - Check the hydraulic circuit for leakage.

- **NO**
  - Repair or replace the wheel speed sensor.

CHECK THE HYDRAULIC CIRCUIT FOR LEAKAGE.

Refer to the hydraulic lines. Inspect leakage of the hydraulic lines. Is it normal?

- **YES**
  - The problem is still occurring, replace the ABS control module.

- **NO**
  - Repair the hydraulic lines for leakage.
ABS Does Not Operate Intermittently.

DETECTING CONDITION

<table>
<thead>
<tr>
<th>Trouble Symptoms</th>
<th>Possible Cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brake operation varies depending on driving conditions and road surface conditions, so diagnosis can be difficult. However if a normal DTC is displayed, check the following probable cause. When the problem is still occurring, replace the ABS control module.</td>
<td>- Faulty power source circuit</td>
</tr>
<tr>
<td></td>
<td>- Faulty wheel speed sensor circuit</td>
</tr>
<tr>
<td></td>
<td>- Faulty hydraulic circuit for leakage</td>
</tr>
<tr>
<td></td>
<td>- Faulty HECU</td>
</tr>
</tbody>
</table>

INSPECTION PROCEDURES

DTC INSPECTION

1. Connect the Hi-Scan (pro) with the data link connector and turn the ignition switch ON.
2. Verify that the normal code is output. Is the normal code output?
   - NO  
     ▶ Check the wheel speed sensor circuit.
   - YES 
     ▶ Erase the DTC and recheck using Hi-Scan (pro).

CHECK THE WHEEL SPEED SENSOR CIRCUIT.

Refer to the DTC troubleshooting procedures. Is it normal?
   - YES 
     ▶ Check the stop lamp switch circuit.
   - NO 
     ▶ Repair or replace the wheel speed sensor.

CHECK THE STOP LAMP SWITCH CIRCUIT.

1. Check that stop lamp lights up when brake pedal is depressed and turns off when brake pedal is released.
2. Measure the voltage between terminal 20 of the ABS control module harness side connector and body ground when brake pedal is depressed.
   Specification: approximately B+
   Is the voltage within specification?
   - YES 

CHECK THE HYDRAULIC CIRCUIT FOR LEAKAGE.

Refer to the hydraulic lines. Inspect leakage of the hydraulic lines. Is it normal?
   - YES 
     ▶ The problem is still occurring, replace the ABS control module.
   - NO 
     ▶ Repair the hydraulic lines for leakage.
ABS (ANTI-LOCK BRAKE SYSTEM)

Communication With Hi-Scan (pro) Is Not Possible.
(Communication With Any System Is Not Possible)

DETECTING CONDITION

<table>
<thead>
<tr>
<th>Trouble Symptoms</th>
<th>Possible Cause</th>
</tr>
</thead>
</table>
| Possible defect in the power supply system (including ground) for the diagnosis line. | - An open in the wire  
- Poor ground  
- Faulty power source circuit |

INSPECTION PROCEDURES

CHECK THE POWER SUPPLY CIRCUIT FOR THE DIAGNOSIS

Measure the voltage between terminal 9 of the data link connector and body ground.

Specification: approximately B+

Is voltage within specification?

YES

- Check the ground circuit for the diagnosis.

NO

- Repair an open in the wire. Check and replace fuse (15A) from the engine compartment junction block.

CHECK THE GROUND CIRCUIT FOR THE DIAGNOSIS

Check for continuity between terminal 5 of the data link connector and body ground.

Is there continuity?

NO

- Repair an open in the wire between terminal 5 of the data link connector and ground point.
Communication With Hi-Scan (pro) Is Not Possible.
(Communication With ABS Only Is Not Possible)

DETECTING CONDITION

<table>
<thead>
<tr>
<th>Trouble Symptoms</th>
<th>Possible Cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>When communication with Hi-Scan (pro) is not possible, the cause may be probably an open in the HECU power circuit or an open in the diagnosis output circuit.</td>
<td>- An open in the wire</td>
</tr>
<tr>
<td></td>
<td>- Faulty HECU</td>
</tr>
<tr>
<td></td>
<td>- Faulty power source circuit</td>
</tr>
</tbody>
</table>

INSPECTION PROCEDURES

CHECK FOR CONTINUITY IN THE DIAGNOSIS LINE

1. Disconnect the connector from the ABS control module.
2. Check for continuity between terminals 11 of the ABS control module connector and 1 of the data link connector.
   Is there continuity?
   YES
   ► Check the power source of ABS control module.
   NO
   ► Repair an open in the wire.

CHECK THE POWER SOURCE OF ABS CONTROL MODULE

1. Disconnect the connector from the ABS control module.
2. Turn the ignition switch ON, measure the voltage between terminal 18 of the ABS control module harness side connector and body ground.
   Specification: approximately B+
   Is voltage within specification?
   YES
   ► Check for poor ground.
   NO
   ► Check the harness or connector between the fuse (10A) in the engine compartment junction block and the ABS control module. Repair if necessary.
When Ignition Key Is Turned ON (Engine OFF), The ABS Warning Lamp Does Not Light Up.

### DETECTING CONDITION

<table>
<thead>
<tr>
<th>Trouble Symptoms</th>
<th>Possible Cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>When current flows in the HECU the ABS warning lamp turns from ON to OFF as the initial check. Therefore if the lamp does not light up, the cause may be an open in the lamp power supply circuit, a blown bulb, an open in the both circuits between the ABS warning lamp and the HECU, and the faulty HECU.</td>
<td>- Faulty ABS warning lamp bulb</td>
</tr>
<tr>
<td></td>
<td>- Blown No.2 fuse (10A) in the engine compartment junction block</td>
</tr>
<tr>
<td></td>
<td>- Faulty ABS warning lamp module</td>
</tr>
<tr>
<td></td>
<td>- Faulty HECU</td>
</tr>
</tbody>
</table>

### INSPECTION PROCEDURES

#### PROBLEM VERIFICATION
Disconnect the connector from the ABS control module and turn the ignition switch ON.

Does the ABS warning lamp light up?

| NO | It is normal. Recheck the ABS control module. |
| YES | Check the power source for the ABS warning lamp. |

#### CHECK THE POWER SOURCE FOR THE ABS WARNING LAMP

1. Disconnect the instrument cluster connector and turn the ignition switch ON.
2. Measure the voltage between terminal 5 of the cluster harness side connector and body ground.

Specification: approximately B+

Is voltage within specification?

| NO | Repair bulb or instrument cluster assembly. |
| YES | Check for blown fuse. |

#### CHECK FOR BLOWN FUSE.

Check continuity of fuse (10A) from the engine compartment junction block.

Is there continuity?

| NO | Repair an open in the wire between ABS fuse and 1 of cluster connector. |
| YES | Replace the blown fuse. |
Even After The Engine Is Started, The ABS Warning Lamp Remains ON.

DETECTING CONDITION

<table>
<thead>
<tr>
<th>Trouble Symptoms</th>
<th>Possible Cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>If the HECU detects trouble, it lights the ABS warning lamp while at the same</td>
<td>An open in the wire</td>
</tr>
<tr>
<td>time prohibiting ABS control. At this time, the HECU records a DTC in memory.</td>
<td>Faulty instrument cluster assembly</td>
</tr>
<tr>
<td>Even though the normal code is output, the ABS warning lamp remains ON, then</td>
<td>Faulty ABS warning lamp module</td>
</tr>
<tr>
<td>the cause may be probably an open or short in the ABS warning lamp circuit.</td>
<td>Faulty HECU</td>
</tr>
</tbody>
</table>

INSPECTION PROCEDURES

CHECK DTC OUTPUT

1. Connect the Hi-Scan (pro) to the 16P data link connector located behind the     |
   driver’s side kick panel.                                                     |

2. Check the DTC output using Hi-Scan (pro).
   Is DTC output?
     NO
       ► Repair circuit indicated by code output.
     YES
       ► Check instrument cluster.

CHECK INSTRUMENT CLUSTER

Disconnect the cluster connector and turn the ignition switch ON.
Does the ABS warning lamp remains ON?

YES
   ► Replace the instrument cluster.

NO
   ► Check for open the wire.

CHECK FOR OPEN IN THE WIRE

Check for continuity in the wire between cluster and ABS control module.
Is there continuity?

YES
   ► Replace the ABS control module and recheck.

NO
   ► Repair an open in the wire between cluster and ABS control module.
BLEEDING OF BRAKE SYSTEM

This procedure should be followed to ensure adequate bleeding of air and filling of the ABS unit, brake lines and master cylinder with brake fluid.

1. Remove the reservoir cap and fill the brake reservoir with brake fluid.

   **CAUTION**
   If there is any brake fluid on any painted surface, wash it off immediately.

   **NOTE**
   When pressure bleeding, do not depress the brake pedal.
   Recommended fluid........ DOT3 or DOT4

2. Connect a clear plastic tube to the wheel cylinder bleeder plug and insert the other end of the tube into a half filled clear plastic bottle.

   6.86~12.74 Nm (70~130 kgf·cm, 5.09~9.45 lb·ft)

3. Connect the hi-scan (pro) to the data link connector located underneath the dash panel.

4. Select and operate according to the instructions on the hi-scan (Pro) screen.

   **CAUTION**
   You must obey the maximum operating time of the ABS motor with the hi-scan (Pro) to prevent the motor pump from burning.

   1) Select hyundai vehicle diagnosis.
   2) Select vehicle name.
   3) Select Anti-Lock Brake system.
   4) Select air bleeding mode.
   5) Press "YES" to operate motor pump and solenoid valve.

   1.6 AIR BLEEDING MODE

<table>
<thead>
<tr>
<th>ABS AIR BLEEDING STATUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>01. SOLENOID VALVE STATUS</td>
</tr>
<tr>
<td>02. MOTOR PUMP STATUS</td>
</tr>
<tr>
<td>DO YOU WANT TO START ?</td>
</tr>
<tr>
<td>(PRESS [YES] KEY)</td>
</tr>
</tbody>
</table>

   6) Wait 60 sec. before operating the air bleeding. (If not, you may damage the motor.)

   1.6 AIR BLEEDING MODE

<table>
<thead>
<tr>
<th>ABS AIR BLEEDING STATUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>01. SOLENOID VALVE STATUS</td>
</tr>
<tr>
<td>02. MOTOR PUMP STATUS</td>
</tr>
<tr>
<td>TIME : AUTOMATIC COUNT (1-60 SEC.)</td>
</tr>
</tbody>
</table>
5. Pump the brake pedal several times, and then loosen the bleeder screw until fluid starts to run out without bubbles. Then close the bleeder screw.

6. Repeat step 5 until there are no more bubbles in the fluid for each wheel.

7. Tighten the bleeder screw.

Bleed screw tightening torque:
6.86~12.74 Nm (70 ~ 130 kgf-cm, 5.09 ~ 9.45 lb-ft)
### ABS (ANTI-LOCK BRAKE SYSTEM)

#### DIAGNOSTIC TROUBLE CODE CHART (DTC)

<table>
<thead>
<tr>
<th>DTC</th>
<th>DESCRIPTION</th>
<th>WARNING LAMP</th>
<th>REMARK</th>
<th>SEE PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>ABS  EBD  ESP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C1101</td>
<td>BATTERY VOLTAGE HIGH</td>
<td>O   O    O</td>
<td></td>
<td>BR - 79</td>
</tr>
<tr>
<td>C1102</td>
<td>BATTERY VOLTAGE LOW</td>
<td>O   O    O</td>
<td></td>
<td>BR - 79</td>
</tr>
<tr>
<td>C1200</td>
<td>FL WHEEL SPEED SENSOR- OPEN/SHORT</td>
<td>O   O    O</td>
<td></td>
<td>BR - 84</td>
</tr>
<tr>
<td>C1201</td>
<td>FL WHEEL SPEED SENSOR- RANGE/PERFORMANCE</td>
<td>O   O    O</td>
<td></td>
<td>BR - 88</td>
</tr>
<tr>
<td>C1202</td>
<td>FL WHEEL SPEED SENSOR-NO SIGNAL</td>
<td>O   O    O</td>
<td></td>
<td>BR - 91</td>
</tr>
<tr>
<td>C1203</td>
<td>FR WHEEL SPEED SENSOR- OPEN/SHORT</td>
<td>O   O    O</td>
<td></td>
<td>BR - 84</td>
</tr>
<tr>
<td>C1204</td>
<td>FR WHEEL SPEED SENSOR- RANGE/PERFORMANCE</td>
<td>O   O    O</td>
<td></td>
<td>BR - 88</td>
</tr>
<tr>
<td>C1205</td>
<td>FR WHEEL SPEED WHEEL SPEED SENSOR-NO SIGNAL</td>
<td>O   O    O</td>
<td></td>
<td>BR - 91</td>
</tr>
<tr>
<td>C1206</td>
<td>RL WHEEL SPEED SENSOR- OPEN/SHORT</td>
<td>O   O    O</td>
<td></td>
<td>BR - 84</td>
</tr>
<tr>
<td>C1207</td>
<td>RL WHEEL SPEED SENSOR- RANGE/PERFORMANCE</td>
<td>O   O    O</td>
<td></td>
<td>BR - 88</td>
</tr>
<tr>
<td>C1208</td>
<td>RL WHEEL SPEED WHEEL SPEED SENSOR-NO SIGNAL</td>
<td>O   O    O</td>
<td></td>
<td>BR - 91</td>
</tr>
<tr>
<td>C1209</td>
<td>RR WHEEL SPEED SENSOR- OPEN/SHORT</td>
<td>O   O    O</td>
<td></td>
<td>BR - 84</td>
</tr>
<tr>
<td>C1210</td>
<td>RR WHEEL SPEED SENSOR- RANGE/PERFORMANCE</td>
<td>O   O    O</td>
<td></td>
<td>BR - 88</td>
</tr>
<tr>
<td>C1211</td>
<td>RR WHEEL SPEED SENSOR-NO SIGNAL</td>
<td>O   O    O</td>
<td></td>
<td>BR - 91</td>
</tr>
<tr>
<td>C1213</td>
<td>WHEEL SPEED FREQUENCY ERROR</td>
<td>O   O    O</td>
<td></td>
<td>BR - 95</td>
</tr>
<tr>
<td>C1235</td>
<td>PRESSURE SENSOR-ELECTRICAL</td>
<td>O   ESP  ESP</td>
<td></td>
<td>BR - 97</td>
</tr>
<tr>
<td>C1237</td>
<td>PRESSURE SENSOR-SIGNAL FAULT</td>
<td>O   ESP  ESP</td>
<td></td>
<td>BR - 97</td>
</tr>
<tr>
<td>C1260</td>
<td>STEERING ANGLE SENSOR-SIGNAL</td>
<td>O   ESP  ESP</td>
<td></td>
<td>BR - 100</td>
</tr>
<tr>
<td>C1261</td>
<td>STEERING ANGLE SENSOR IS NOT CALIBRATED</td>
<td>O   ESP  ESP</td>
<td></td>
<td>BR - 100</td>
</tr>
<tr>
<td>C1282</td>
<td>YAW RATE LATERAL G SENSOR-ELECTRICAL</td>
<td>O   ESP  ESP</td>
<td></td>
<td>BR - 103</td>
</tr>
<tr>
<td>C1283</td>
<td>YAW RATE LATERAL G SENSOR-SIGNAL</td>
<td>O   ESP  ESP</td>
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<td>BR - 107</td>
</tr>
<tr>
<td>C1503</td>
<td>ESP SWITCH ERROR</td>
<td>O   ESP  ESP</td>
<td></td>
<td>BR - 110</td>
</tr>
<tr>
<td>C1513</td>
<td>BRAKE LIGHT SWITCH MAL.</td>
<td>O   ESP  ESP</td>
<td></td>
<td>BR - 113</td>
</tr>
<tr>
<td>C1604</td>
<td>ECU HARDWARE ERROR</td>
<td>O   O    O</td>
<td></td>
<td>BR - 115</td>
</tr>
<tr>
<td>C1605</td>
<td>CAN CONTROL HARDWARE ERROR</td>
<td>O   ESP  ESP</td>
<td></td>
<td>BR - 117</td>
</tr>
<tr>
<td>C1611</td>
<td>CAN TIME OUT-ECM</td>
<td>O   ESP  ESP</td>
<td></td>
<td>BR - 119</td>
</tr>
<tr>
<td>C1612</td>
<td>CAN TIME OUT-TCU</td>
<td>O   ESP  ESP</td>
<td></td>
<td>BR - 119</td>
</tr>
<tr>
<td>C1616</td>
<td>CAN BUS OFF</td>
<td>O   ESP  ESP</td>
<td></td>
<td>BR - 121</td>
</tr>
<tr>
<td>DTC</td>
<td>DESCRIPTION</td>
<td>WARNING LAMP</td>
<td>REMARK</td>
<td>SEE PAGE</td>
</tr>
<tr>
<td>-------</td>
<td>-------------------------------------------</td>
<td>--------------</td>
<td>--------</td>
<td>----------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ABS</td>
<td>EBD</td>
<td>ESP</td>
</tr>
<tr>
<td>C1623</td>
<td>CAN TIMEOUT STEERING ANGLE SENSOR</td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td>C1625</td>
<td>CAN TIME OUT-ESP</td>
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<tr>
<td>C1626</td>
<td>IMPLAUSIBLE CONTROL</td>
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</tr>
<tr>
<td>C1702</td>
<td>VARIANT CODING</td>
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<td>0</td>
</tr>
<tr>
<td>C2112</td>
<td>VALVE RELAY MAL.</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>C2308</td>
<td>FL INLET VALVE MAL.</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>C2312</td>
<td>FL OUTLET VALVE MAL.</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>C2316</td>
<td>FR INLET VALVE MAL.</td>
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<td>0</td>
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</tr>
<tr>
<td>C2320</td>
<td>FR OUTLET VALVE MAL.</td>
<td>0</td>
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</tr>
<tr>
<td>C2324</td>
<td>RL INLET VALVE MAL.</td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td>C2328</td>
<td>RL OUTLET VALVE MAL.</td>
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</tr>
<tr>
<td>C2332</td>
<td>RR INLET VALVE MAL.</td>
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<tr>
<td>C2336</td>
<td>RR OUTLET VALVE MAL.</td>
<td>0</td>
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<td>0</td>
</tr>
<tr>
<td>C2366</td>
<td>TC VALVE PRIMARY (USV1) ERROR</td>
<td>0</td>
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</tr>
<tr>
<td>C2370</td>
<td>TC VALVE SECONDARY (USV2) ERROR</td>
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</tr>
<tr>
<td>C2372</td>
<td>ESP VALVE 1 (HSV1) ERROR</td>
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</tr>
<tr>
<td>C2374</td>
<td>ESP VALVE 2 (HSV2) ERROR</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>C2402</td>
<td>MOTOR-ELECTRICAL</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
DTC C1101 BATTERY VOLTAGE HIGH
DTC C1102 BATTERY VOLTAGE LOW

COMPONENT LOCATION

EBC713EC

GENERAL DESCRIPTION

The ABS ECU (Electronic Control Unit) checks the battery voltage to determine, as a safety issue, whether the ABS system can operate normally or not. The normal battery voltage range is essential for controlling the ABS system as intended.

DTC DESCRIPTION

The ABS ECU monitors battery voltage by reading the value of voltage.

1. When the voltage is higher than the expected normal value, this code is set, and the ABS/EBD/TCS/ESP functions are prohibited. If the voltage recovers, to within normal operating ranges, then the controller returns to normal operation as well.

2. When the voltage is lower than the expected normal value, this code is set. The ABS/TCS/ESP functions are prohibited and the EBD function is allowed on LOW VOLTAGE CONDITION 1, the ABS/EBD/TCS/ESP functions are prohibited on UNDER VOLTAGE CONDITION.

3. If the voltage recovers, to within normal operating ranges, then the controller returns to normal operations as well.
### DTC DETECTING CONDITION  
**E3F0E11E**

<table>
<thead>
<tr>
<th>Item</th>
<th>Detecting Condition</th>
<th>Possible cause</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DTC Strategy</strong></td>
<td>Battery Voltage Monitoring</td>
<td></td>
</tr>
<tr>
<td><strong>Enable Conditions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C1101</td>
<td>High voltage problem will be monitored if filtered Ignition Voltage is ( \geq 16.8 \text{ V} ). It will be reset if filtered Ignition Voltage ( \leq 16.7 \text{ V} ).</td>
<td></td>
</tr>
</tbody>
</table>
| C1102 | 1. Ignition Voltage is monitored for a level of filtered Ignition Voltage \( \geq 9.3 \text{ V} \) outside control, or a level of filtered Ignition Voltage \( \geq 9.2 \text{ V} \) during control.  
2. Hard under voltage due to low voltage glitches is detected if unfiltered Ignition Voltage \( = 8.2 \text{ V} \) for \( t \geq 20 \text{ ms} \).  
3. A hard under voltage problem will be detected if the filtered UZ \( \leq 7.7 \text{ V} \). The system remains in this condition until filtered UZ \( \geq 7.8 \text{ V} \). | • Poor connection in power supply circuit (IGN+)  
• Faulty Alternator  
• Faulty HECU |

**NOTE**

All under voltage failures will only be saved in EEPROM if vehicle speed is \( \geq 6 \text{ km/h}(3 \text{ MPH}) \). This prevents false failure entries due to a bad battery at ignition on.

| Monitoring period | Continuous. Under voltage faults are only entered in the EEPROM if the vehicle speed is \( \geq 6 \text{ km/h}(3 \text{ MPH}) \). Over voltage faults will be always stored. | |
| Effect | The proper function of valves and return pump is not guaranteed. | |
| Fail Safe | • System down. The ABS/EBD/TCS/ESP functions are inhibited.  
- The valve relay and all solenoids are prevented from being switched on.  
- The ABS/EBD/TCS/ESP warning lamps are activated. | |

### SPECIFICATION  
**EED030FA**

Voltage: \( 9.3 \leq V \leq 16.8 \text{ V} \)

### TERMINAL & CONNECTOR INSPECTION  
**ECDFEACF**

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 then go to "Verification of Vehicle Repair" procedure.

**NO**

- Go to the next step.
1. ALTERNATOR OUTPUT VOLTAGE INSPECTION

1) Engine "ON".

2) Measure voltage between the battery terminal(+) and the battery terminal(-).

Specification: Approx. 14.4 ± 0.3 V (20 °C)

<table>
<thead>
<tr>
<th>Voltage regulator ambient temperature(°C)</th>
<th>Regulating voltage</th>
</tr>
</thead>
<tbody>
<tr>
<td>-30</td>
<td>14.1 ~ 15.2</td>
</tr>
<tr>
<td>20</td>
<td>14.1 ~ 14.7</td>
</tr>
<tr>
<td>120</td>
<td>13.3 ~ 14.7</td>
</tr>
</tbody>
</table>

Is the measured voltage within specifications?

YES

► Go to "Power Circuit Inspection" procedure.

NO

► Check for damaged harness and poor connection between alternator and battery. If OK, repair or replace alternator and then go to "Verification of vehicle Repair" procedure.

2. POWER CIRCUIT INSPECTION

1) Engine "ON".

2) Measure voltage between the battery terminal(+) and terminal "18(28:ESP)" of the HECU harness connector.

Specification: Approx. below 0.2 V
Is the measured voltage within specifications?

**YES**

- Go to "Ground Circuit Inspection" procedure.

**NO**

- Check for damaged harness and poor connection between the battery terminal(+) and terminal "18(28:ESP)" of the HECU harness connector. Repair as necessary and then go to "Verification of vehicle Repair" procedure.

**GROUND CIRCUIT INSPECTION**

1. Ignition "OFF".
2. Disconnect HECU connector.
3. Measure resistance between terminal "1,4" of the HECU harness connector and chassis ground.

**Specification : Approx. below 1Ω**

Is the measured resistance within specifications?

**NO**

- Check for damaged harness and poor connection between terminal "1,4" of the HECU harness connector and chassis ground. Repair as necessary and then go to "Verification of vehicle Repair" procedure.

**YES**

- Go to "Component Inspection" procedure.
COMPONENT INSPECTION

1. Ignition "OFF".
2. Engine "ON".
   Does warning lamp remain On?
   YES
   ► Substitute with a known-good HECU and check for proper operation. If problem is corrected, replace HECU and then go to "Verification of Vehicle Repair" procedure.
   NO
   ► Fault is intermittent caused by poor connection in power harness (IGN+), faulty Alternator and/or faulty HECU or was repaired and HECU memory was not cleared. Go to the applicable troubleshooting procedure.

VERIFICATION OF VEHICLE REPAIR

After a repair, it is essential to verify that the fault has been corrected.
1. Connect scantool and select "Diagnostic Trouble Codes(DTCs)" mode.
2. Using a scantool, Clear DTC.
3. Operate the vehicle within DTC Detecting Condition in General Information. Are any DTCs present?
   YES
   ► Go to the applicable troubleshooting procedure.
   NO
   ► A system performs normally at this time.
**DTC C1200 FL SENSOR-OPEN/SHORT**
**DTC C1203 FR SENSOR-OPEN/SHORT**
**DTC C1206 RL SENSOR-OPEN/SHORT**
**DTC C1209 RR SENSOR-OPEN/SHORT**

**GENERAL DESCRIPTION**

The wheel speed sensor is the essential component the ABS ECU uses to calculate vehicle speed and to determine whether wheel lock occurs. For example, rear wheel speed signal is used as a reference value, for vehicle speed, in front wheel drive vehicles, and if a difference between front and rear wheel speed occurs, then ABS control is performed. Wheel speed sensor is an active hall-sensor type and good at temperature and noise characteristic. Digital wave is produced as tone wheel rotate according as hall sensor principle. Frequency of duty wave is changed in proportion to rotation of tone wheel and HECU calculate vehicle speed by this frequency.

**DTC DESCRIPTION**

The ABS ECU monitors the wheel speed sensor circuit continuously. If the sensor signal current is continuously out of the specified range for 200msec, then the HECU determines that the circuit is open/short, and sets this code. Warning lamp is turned OFF if the detected fault is not more than when the IG KEY is turned to ON again, and wheel speeds are more than 10 Km/h(6 MPH).
## DTC DETECTING CONDITION E3AD2BA0

<table>
<thead>
<tr>
<th>Item</th>
<th>Detecting Condition</th>
<th>Possible cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>DTC Strategy</td>
<td>Current Monitoring</td>
<td></td>
</tr>
<tr>
<td>Monitoring period</td>
<td>Once after power up.</td>
<td></td>
</tr>
<tr>
<td>CASE 1</td>
<td>Enable Conditions</td>
<td></td>
</tr>
<tr>
<td>Monitoring period</td>
<td>Continuous</td>
<td>Open or short of Wheel speed sensor circuit</td>
</tr>
<tr>
<td>Enable Conditions</td>
<td>Wheel speed sensor test starts immediate after power. Especially shorts between WSS(Wheel speed sensor) lines and shorts to UZ(ECU voltage supply) can be detected by switching single WSS channels in sequence. After end of test only the channels with no fault are switched on.</td>
<td>Faulty Wheel speed sensor</td>
</tr>
<tr>
<td>CASE 2</td>
<td>Enable Conditions</td>
<td>Faulty HECU</td>
</tr>
<tr>
<td>Monitoring period</td>
<td>Continuous</td>
<td></td>
</tr>
<tr>
<td>Enable Conditions</td>
<td>The sensor circuitry has two current levels I = 7mA and I= 14mA. If the sensor line is broken, shorted to ground or shorted to supply voltage a faulty current level will be detected.WSS line faults are detected, if the fault condition exists uninterrupted for t = 200ms.</td>
<td></td>
</tr>
<tr>
<td>Effect</td>
<td>No correct WSS Signal can be generated. Control of the corresponding wheel is no longer possible. If a sensor fault occurs on a front wheel, pressure is increased; on a rear wheel, pressure is decreased (until switch off).</td>
<td></td>
</tr>
</tbody>
</table>

## TERMINAL & CONNECTOR INSPECTION EBEA9B88

Refer to DTC C1101.

## POWER SUPPLY CIRCUIT INSPECTION EGBF51BA

1. Ignition "ON" & Engine "OFF".
2. Measure voltage between terminal "2" of the wheel speed sensor harness connector and chassis ground.

Specification : approx. B+
Is the measured voltage within specifications?

**YES**

- Go to "Signal Circuit Inspection" procedure.

**NO**

- Check for open or short to GND in wheel speed sensor harness between terminal "16(ESP:26),9,6,8" of the HECU harness connector and terminal "2" of the Wheel speed sensor harness connector. Repair as necessary and then go to "Verification of vehicle Repair" procedure.

**SIGNAL CIRCUIT INSPECTION**

1. Ignition "ON" & Engine "OFF".
2. By turning the wheel with hand.
3. Measure voltage between terminal "5,10,17(ESP:27),19(ESP:29)" of the HECU harness connector and chassis ground.

**Specification**: High : 0.89~1.26V , Low : 0.44~0.63V

Is the measured voltage within specifications?

**YES**

- Go to "Component Inspection" procedure.

**NO**

- Check for open or short to GND in wheel speed sensor harness between terminal "1" of the wheel speed sensor harness connector and terminal "5,10,17(ESP:27),19(ESP:29)" of the HECU harness connector. Repair as necessary and then go to "Verification of vehicle Repair" procedure.
COMPONENT INSPECTION

1. Ignition "OFF".
2. Engine "ON".
3. Start and drive vehicle in gear and maintain vehicle speed is approx. 10km/h or more (6mph or more). Does warning lamp remain On?

   YES

   ▶ Substitute with a known-good HECU and check for proper operation. If problem is corrected, replace HECU and then go to "Verification of Vehicle Repair" procedure.

   NO

   ▶ Fault is intermittent caused by open or short of wheel speed sensor harness, faulty wheel speed sensor and/or faulty HECU or was repaired and HECU memory was not cleared. Go to the applicable troubleshooting procedure.

VERIFICATION OF VEHICLE REPAIR

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

1. Connect scantool and select "Diagnostic Trouble Codes (DTCs)" mode.
2. Using a scantool, Clear DTC.
3. Operate the vehicle within DTC Detecting Condition in General Information. (Start and drive vehicle in gear and maintain vehicle speed is approx. 10km/h or more (6mph or more))

Are any DTCs present?

   YES

   ▶ Go to the applicable troubleshooting procedure.

   NO

   ▶ A system performs normally at this time.
The wheel speed sensor is the essential component the ABS ECU uses to calculate vehicle speed and to determine whether wheel lock occurs. For example, rear wheel speed signal is used as a reference value, for vehicle speed, in front wheel drive vehicles, and if a difference between front and rear wheel speed occurs, then ABS control is performed. Wheel speed sensor is an active hall-sensor type and good at temperature and noise characteristic. Digital wave is produced as tone wheel rotate according as hall sensor principle. Frequency of duty wave is changed in proportion to rotation of tone wheel and HECU calculate vehicle speed by this frequency.

The ABS ECU monitors the wheel speed sensor signal continuously. This code is set if an abnormal speed change ratio is detected while the vehicle speed is 10~80 Km/h(6~50 MPH). Warning lamp is turned OFF if the detected fault is not more than when the IG KEY is turned to ON again, and wheel speeds are more than 12 Km/h(7 MPH).
### DTC DETECTING CONDITION

<table>
<thead>
<tr>
<th>Item</th>
<th>Detecting Condition</th>
<th>Possible cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>DTC Strategy</td>
<td>Current Monitoring</td>
<td></td>
</tr>
<tr>
<td>Monitoring period</td>
<td>The monitoring is active from 10 km/h to 80km/h(6~50 MPH) and if no ABS-control is active at a front wheel and a rear wheel.</td>
<td></td>
</tr>
</tbody>
</table>
| EnableConditions    | Every time, if a gap in the wheel speed sensor signal occurs cyclically with one wheel rotation, a fault counter is increased by one. If the fault counter exceeds its limit of 10, a wheel specific fault is stored in the EEPROM. | • Improper installation of wheel speed sensor  
• Abnormal Rotor and wheel bearing  
• Faulty Wheel speed sensor  
• Faulty HECU |
| CASE 1 EnableConditions | Continuous if V_Vehicle ≤ 12 m/s                                                                                                                                                                           |                                                                              |
| CASE 2 EnableConditions | No wheel speed signals within 10 ms to 20 ms at a vehicle speed> 12 m/s (43.2 km/h, 27 MPH). If the dynamic sensor monitor responses, the failures will be stored into failure memory immediately after a waiting period of 60ms. |                                                                              |
| Effect              | Due to faulty wheel speed information the control of the corresponding wheel is no longer possible. reaction of the controller: If a sensor fault occurs on a front wheel, pressure is increased; on a rear wheel, pressure is decreased. |                                                                              |

### MONITOR SCANTOOL DATA

1. Connect scantool to Data Link Connector(DLC).
2. Engine “ON”.
3. Start and drive vehicle in gear and maintain vehicle speed is approx. 40km/h or more(24 mph or more) Monitor the "Wheel speed sensor" parameter on the Scantool.

**Specification :** Approx. 12 km/h or more(7 mph or more)

**Is it normal?**

**YES**

- Fault is intermittent caused by faulty wheel speed sensor and/or faulty HECU or was repaired and HECU memory was not cleared. Repair or replace as necessary and then go to "Component Inspection" procedure.

**NO**

1) Check for improper installation of wheel speed sensor. If NG, repair as necessary and then go to “Verification of vehicle Repair” procedure.
2) Check for damage of rotor teeth or wheel bearing. If NG, repair as necessary and then go to “Verification of vehicle Repair” procedure.
3) Substitute with a known-good Wheel speed sensor and check for proper operation. If problem is corrected, replace Wheel speed sensor and then go to “Verification of Vehicle Repair” procedure.
COMPONENT INSPECTION  EDF75AF5

1. Ignition "OFF".
2. Engine "ON".
3. Start and drive vehicle in gear and maintain vehicle speed is approx. 12 km/h or more(7 mph or more). Does warning lamp remain On?
   YES

   ► Substitute with a known-good HECU and check for proper operation. If problem is corrected, replace HECU and then go to "Verification of Vehicle Repair" procedure.

   NO

   ► Fault is intermittent caused by open or short of wheel speed sensor harness, faulty wheel speed sensor and/or faulty HECU or was repaired and HECU memory was not cleared. Go to the applicable troubleshooting procedure.

VERIFICATION OF VEHICLE REPAIR  EE24FA21

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

1. Connect scantool and select "Diagnostic Trouble Codes(DTCs)" mode.
2. Using a scantool, Clear DTC.
3. Operate the vehicle within DTC Detecting Condition in General Information.(Start and drive vehicle in gear and maintain vehicle speed is approx. 12 km/h or more(7 mph or more)) Are any DTCs present ?
   YES

   ► Go to the applicable troubleshooting procedure.

   NO

   ► A system performs normally at this time.
DTC C1202 FL WHEEL SPEED SENSOR-NO SIGNAL
DTC C1205 FR WHEEL SPEED SENSOR-NO SIGNAL
DTC C1208 RL WHEEL SPEED SENSOR-NO SIGNAL
DTC C1211 RR WHEEL SPEED SENSOR-NO SIGNAL

COMPONENT LOCATION

GENERAL DESCRIPTION

The wheel speed sensor is the essential component the ABS ECU uses to calculate vehicle speed and to determine whether wheel lock occurs. For example, rear wheel speed signal is used as a reference value, for vehicle speed, in front wheel drive vehicles, and if a difference between front and rear wheel speed occurs, then ABS control is performed. Wheel speed sensor is an active hall-sensor type and good at temperature and noise characteristic. Digital wave is produced as tone wheel rotate according as hall sensor principle. Frequency of duty wave is changed in proportion to rotation of tone wheel and HECU calculate vehicle speed by this frequency.

DTC DESCRIPTION

The ABS ECU monitors the wheel speed sensor signal continuously. This code is set when the sensor air gap is out of specified range or when No wheel speed signals within 10 ms to 20 ms at a vehicle speed ≤ 43.2 km/h(26 MPH) . Warning lamp is turned OFF if the detected fault is not more than when the IG KEY is turned to ON again, and wheel speeds are more than 12 Km/h(7MPH).
### DTC DETECTING CONDITION

<table>
<thead>
<tr>
<th>Item</th>
<th>Detecting Condition</th>
<th>Possible cause</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DTC Strategy</strong></td>
<td>Signal monitoring</td>
<td></td>
</tr>
<tr>
<td>Monitoring period</td>
<td>Continuous except no under voltage is detected.</td>
<td></td>
</tr>
<tr>
<td>CASE 1</td>
<td>Enable Conditions</td>
<td>The test detects a failure if one (or two) wheel are at Vmin(2.75 km/h; 1.7 MPH) and the other wheels are above 12 km/h for longer than 1s. A fault could also be set during driving, if the vehicle accelerates 18 km/h after a particular wheel speed gets to vmin(2.75 km/h; 1.7 MPH) and stays there. This monitoring could only detect singular faults.</td>
</tr>
<tr>
<td>Monitoring period</td>
<td>Continuous except no under voltage is detected.</td>
<td></td>
</tr>
<tr>
<td>CASE 2</td>
<td>Enable Conditions</td>
<td>No wheel speed signals within 10 ms to 20 ms at a vehicle speed ≥ 12 m/s (43.2 km/h). If the dynamic sensor monitor responses, the failures will be stored into failure memory immediately after a waiting period of 60ms.</td>
</tr>
<tr>
<td>Monitoring period</td>
<td>Continuous except no under voltage is detected.</td>
<td></td>
</tr>
</tbody>
</table>
| CASE 3 | Enable Conditions | • The main monitor (λ 5) needs additional information of the ESP-sensors and is active for a velocity ≥ 20 km/h (12 MPH) and no under voltage (9.2 V) is detected.  
• The backup monitor (λ 6) manages with the wheel speeds alone.  
• The main monitor (λ 5): If the maximum difference of wheel speeds related to maximum wheel speed exceeds 5% a wheel specific wheel speed sensor fault is set.  
- the above conditions apply for 20s for 1 defective WSS.  
- the above conditions apply for 40s for 2 defective WSS.  
• The backup monitor (λ 6): If the velocity is higher than 50 km/h (31 MPH), the deviation between the fastest and the slowest wheel must exceed 6% related to the fastest wheel. If the velocity is below 50 km/h (31 MPH), the deviation must exceed an absolute value of 3 km/h (1.8 MPH).  
- detection filter time: normally 20s | • Improper installation of wheel speed sensor  
• Abnormal Rotor and wheel bearing  
• Faulty Wheel speed sensor  
• Faulty HECU |
| Effect | Due to faulty wheel speed information the control of the corresponding wheel is no longer possible.  
reaction of the controller: If a sensor fault occurs on a front wheel, pressure is increased; on a rear wheel, pressure is decreased |  |
MONITOR SCANTOOL DATA

1. Connect scantool to Data Link Connector (DLC).
2. Engine "ON".
3. Start and drive vehicle in gear and maintain vehicle speed is approx. 50 km/h or more (31 mph or more). Monitor the "Wheel speed sensor" parameter on the Scantool.

Specification : Approx. 50 km/h or more (31 mph or more)

Is it normal?

YES

- Fault is intermittent caused by faulty wheel speed sensor and/or faulty HECU or was repaired and HECU memory was not cleared. Repair or replace as necessary and then go to "Component Inspection" procedure.

NO

1) Check for improper installation of wheel speed sensor. If NG, repair as necessary and then go to "Verification of vehicle Repair" procedure.

2) Check for damage of rotor teeth or wheel bearing. If NG, repair as necessary and then go to "Verification of vehicle Repair" procedure.

3) Substitute with a known-good Wheel speed sensor and check for proper operation. If problem is corrected, replace Wheel speed sensor and then go to "Verification of Vehicle Repair" procedure.

COMPONENT INSPECTION

1. Ignition "OFF".
2. Engine "ON".
3. Start and drive vehicle in gear and maintain vehicle speed is approx. 50 km/h or more (31 mph or more). Does warning lamp remain On?

YES

- Substitute with a known-good HECU and check for proper operation. If problem is corrected, replace HECU and then go to "Verification of Vehicle Repair" procedure.

NO

- Fault is intermittent caused by open or short of wheel speed sensor harness, faulty wheel speed sensor and/or faulty HECU or was repaired and HECU memory was not cleared. Go to the applicable troubleshooting procedure.
After a repair, it is essential to verify that the fault has been corrected.

1. Connect scantool and select "Diagnostic Trouble Codes(DTCs)" mode.

2. Using a scantool, Clear DTC.

3. Operate the vehicle within DTC Detecting Condition in General Information.(Start and drive vehicle in gear and maintain vehicle speed is approx. 50km/h or more(31mph or more)).

   Are any DTCs present?
   
   YES
   
   ► Go to the applicable troubleshooting procedure.

   NO
   
   ► A system performs normally at this time.
DTC C1213 WHEEL SPEED FREQUENCY ERROR

COMPONENT LOCATION

GENERAL DESCRIPTION

The wheel speed sensor is the essential component the ABS ECU uses to calculate vehicle speed and to determine whether wheel lock occurs. For example, rear wheel speed signal is used as a reference value, for vehicle speed, in front wheel drive vehicles, and if a difference between front and rear wheel speed occurs, then ABS control is performed. Wheel speed sensor is an active hall-sensor type and good at temperature and noise characteristic. Digital wave is produced as tone wheel rotate according as hall sensor principle. Frequency of duty wave is changed in proportion to rotation of tone wheel and HECU calculate vehicle speed by this frequency.

DTC DESCRIPTION

The ABS ECU monitors the wheel speed sensor signal continuously. The monitoring reports a failure if the ABS target slip breaks out.

DTC DETECTING CONDITION

<table>
<thead>
<tr>
<th>Item</th>
<th>Detecting Condition</th>
<th>Possible cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>DTC Strategy</td>
<td>Signal monitoring</td>
<td></td>
</tr>
</tbody>
</table>
| Enable Conditions     | The monitoring reports a failure if the ABS target slip is exceeded for a time period \( t = 10 \)s at one or more wheels.  
If the driver brakes or the velocity is lower than 50 km/h(31 MPH) the detection time is enlarged to 60s. | • Improper installation of wheel speed sensor  
• Abnormal Rotor and wheel bearing  
• Faulty Wheel speed sensor  
• Faulty HECU |
| Monitoring period     | Continuous                                                                          |                                                                                  |
| Effect                | Reduced function of the ESP system.                                                  |                                                                                  |
MONITOR SCANTOOL DATA

1. Connect scantool to Data Link Connector (DLC).
2. Engine "ON".
3. Start and drive vehicle in gear and maintain vehicle speed is approx. 10 km/h or more (6 mph or more). Monitor the "Wheel speed sensor" parameter on the Scantool.

Specification: Approx. 10 km/h or more (6 mph or more)

Is it normal?

YES

- Fault is intermittent caused by faulty wheel speed sensor and/or faulty HECU or was repaired and HECU memory was not cleared. Repair or replace as necessary and then go to "Component Inspection" procedure.

NO

1) Check for improper installation of wheel speed sensor. If NG, repair as necessary and then go to "Verification of vehicle Repair" procedure.
2) Check for damage of rotor teeth or wheel bearing. If NG, repair as necessary and then go to "Verification of vehicle Repair" procedure.
3) Substitute with a known-good Wheel speed sensor and check for proper operation. If problem is corrected, replace Wheel speed sensor and then go to "Verification of Vehicle Repair" procedure.

COMPONENT INSPECTION

1. Ignition "OFF".
2. Engine "ON".
3. Start and drive vehicle in gear and maintain vehicle speed is approx. 10 km/h or more (6 mph or more). Does warning lamp remain On?

YES

- Substitute with a known-good HECU and check for proper operation. If problem is corrected, replace HECU and then go to "Verification of Vehicle Repair" procedure.

NO

- Fault is intermittent caused by open or short of wheel speed sensor harness, faulty wheel speed sensor and/or faulty HECU or was repaired and HECU memory was not cleared. Go to the applicable troubleshooting procedure.

VERIFICATION OF VEHICLE REPAIR

Refer to DTC C1200.
DTC C1235 PRESSURE SENSOR-ELECTRICAL
DTC C1237 PRESSURE SENSOR-SIGNAL FAULT

COMPONENT LOCATION

GENERAL DESCRIPTION

The pressure sensor senses the brake oil pressure to judge driver’s brake intention when ESP is operating.
<table>
<thead>
<tr>
<th>Item</th>
<th>Detecting Condition</th>
<th>Possible cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>DTC Strategy</td>
<td>Signal monitoring</td>
<td></td>
</tr>
<tr>
<td>DTC Strategy</td>
<td>1. Sensor supply voltage is continuous monitored (except power on). A sensor supply voltage [5.3 \text{ V} \text{ OR } \text{ Sensor Supply Voltage} \leq 4.7 \text{ V} \text{ for } \geq 60 \text{ ms}.</td>
<td></td>
</tr>
<tr>
<td>DTC Strategy</td>
<td>2. Pressure signal 1 (DSO: original pressure value) is continuous monitored (except power on). Line faults like open, short to GND or short to UZ are detected. A Fault is set if the DSO signal is \text{ U DSO} \leq 4.7 \text{ V} \text{ OR } DSO \leq 0.3 \text{ V} \text{ for a time } t \leq 100 \text{ ms}.</td>
<td></td>
</tr>
<tr>
<td>DTC Strategy</td>
<td>3. Pressure signal 2 (DSI: inverted pressure value) is continuous monitored (except power on). Line faults like open, short to GND or short to UZ are detected. A Fault is set if the DSI signal is \text{ U DSI} \leq 4.7 \text{ V} \text{ OR } DSI \leq 0.3 \text{ V} \text{ for a time } t \leq 100 \text{ ms}.</td>
<td></td>
</tr>
<tr>
<td>DTC Strategy</td>
<td>4. Plausibility of DSO and DSI pressure lines are continuous monitored. Internal DS5 faults (amplification-, bridge-, analog-digital converter malfunction, etc.) are detected if \text{ DSO}+\text{DSI} &lt; 4.5 \text{ V} \text{ OR } \text{ DSO}+\text{DSI} \geq 5.5 \text{ V} \text{ is present longer than } \geq 100 \text{ ms} .</td>
<td></td>
</tr>
<tr>
<td>DTC Strategy</td>
<td>5. POS (Power On Selftest) detects internal sensor malfunctions. The test phase is divided in two 60 ms parts. DSO signal must be \text{ U DSO} \geq 0.5 \text{ V} \text{ for } 30 \text{ ms}. In phase 2 DSO signal must be between 1.9 \text{ V} \text{ and } 3.1 \text{ V} \text{ for } 30 \text{ ms} \text{ then the POS Test is passed.}</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C1235</td>
<td>Enable Conditions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. The DS (Pressure sensor)-offset value must be in the range of 15 bar. A failure is detected if this range is exceeded.</td>
<td>Faulty HECU</td>
</tr>
<tr>
<td></td>
<td>2. There are three monitoring which have different thresholds concerning the allowed pressure and the detection time.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>a) Plausibility 1: For redundancy reasons an additional hardware-BLS signal is created by the pressure sensor signal.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>If the pressure sensor is compensated, the threshold for generating the hardware-BLS signal is 10 bar.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>If the pressure sensor is not compensated, the threshold is increased by 15 bar.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>If this signal is set without any hardware-BLS-signals being set, and if no pump is operated during that time, a fault is set after the braking.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>b) Plausibility 2: If the pressure signal is higher than 30 bar and not both of the hardware-BLS are set, a fault is stored after 2s.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>c) Plausibility 3: If the pressure signal is higher than 80 bar and not both of the hardware-BLS are set, a fault is stored after 1s.</td>
<td></td>
</tr>
<tr>
<td>Monitoring period</td>
<td>1~4 : Continuous \text{ or } 5 : Once during Power Up</td>
<td></td>
</tr>
<tr>
<td>C1237</td>
<td>Enable Conditions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. After DS-initialization, no under voltage, no pumps are running and no BLS-signal is set.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Continuous in the normal operating voltage range.</td>
<td></td>
</tr>
<tr>
<td>Effect</td>
<td>No Pressure Signal available.</td>
<td></td>
</tr>
</tbody>
</table>
ABS (ANTI-LOCK BRAKE SYSTEM)  

COMPONENT INSPECTION  

1. Ignition "OFF".
2. Engine "ON". 
   Does warning lamp remain On?
   YES
   - Substitute with a known-good HECU and check for proper operation. If problem is corrected, replace HECU and then go to "Verification of Vehicle Repair" procedure.
   NO
   - Fault is intermittent caused by faulty HECU or was repaired and HECU memory was not cleared. Go to the applicable troubleshooting procedure.

VERIFICATION OF VEHICLE REPAIR  

Refer to DTC C1101.
DTC C1260 STEERING ANGLE SNSR-SIGNAL
DTC C1261 STEERING ANGLE SENSOR IS NOT CALIBRATED

COMPONENT LOCATION EABB4863

DTC DESCRIPTION E410EEFA

The Steering wheel angle sensor determines the direction of the rotation.
DTC DETECTING CONDITION E015A85F

<table>
<thead>
<tr>
<th>Item</th>
<th>Detecting Condition</th>
<th>Possible cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>DTC Strategy</td>
<td>Signal monitoring</td>
<td></td>
</tr>
<tr>
<td>Enable</td>
<td>1. LWS (steering angle sensor) offset monitoring: If the offset value exceeds a</td>
<td>• Faulty steering wheel sensor</td>
</tr>
<tr>
<td>Conditions</td>
<td>threshold of approximately 15 deg a LWS-fault is determined.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. LWS Gradient monitoring:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- signal gradient (steering angle velocity) from one 20 ms-cycle to another is</td>
<td></td>
</tr>
<tr>
<td></td>
<td>higher than 40° or</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- change of this gradient (steering angle acceleration) is higher than 15°</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. LWS range monitoring: If value is higher than possible range for more than 300</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ms a fault is determined.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. LWS Plausibility monitoring: Dependent on the driving conditions failures in</td>
<td></td>
</tr>
<tr>
<td></td>
<td>size of [10 + 60 m/s / FZREF (reference speed)] deg at steering angle are</td>
<td></td>
</tr>
<tr>
<td></td>
<td>recognized within 400 .. 4800 ms.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5. LWS Constant Signal Monitoring: If there is no change in the signal, but a</td>
<td></td>
</tr>
<tr>
<td></td>
<td>right AND left cornering has been recognized, a fault is determined.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(lateral acceleration £ 2 m/s² in combination with a yaw rate £ 6 °/s in both</td>
<td></td>
</tr>
<tr>
<td></td>
<td>directions).</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6. LWS Wrong Sign Monitoring: If the signals don’t fit and forwards driving</td>
<td></td>
</tr>
<tr>
<td></td>
<td>is detected, a fault is determined.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>7. LWS Message counter monitoring: If the message counter shows an increase higher</td>
<td></td>
</tr>
<tr>
<td></td>
<td>than 3 or lower than 1 in one 20 ms-cycle, a fault is stored after 160 ms.</td>
<td></td>
</tr>
<tr>
<td>Monitoring</td>
<td>1. Continuous during driving.</td>
<td></td>
</tr>
<tr>
<td>period</td>
<td>2. no under voltage and at least one LWS-message was sent in the current 20 ms-</td>
<td></td>
</tr>
<tr>
<td></td>
<td>cycle.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. After initialization and no under voltage detected.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Continuous during driving.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5. Initialization once in every ignition cycle.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6,7. Continuous during driving.</td>
<td></td>
</tr>
<tr>
<td>Effect</td>
<td>Reduced controller function caused by faulty LWS signal.</td>
<td></td>
</tr>
</tbody>
</table>

COMPONENT INSPECTION EACD1983

1. CHECK INSTALLATION OF STEERING ANGLE SENSOR
   Check if the steering angle sensor is properly installed. Is the installation proper?

   YES
   ▶ Check power of steering angle sensor.

   NO
   ▶ Reinstall the steering angle sensor properly.
1. Disconnect the steering angle sensor connector, and measure the voltage between terminal 3 and 4 of the steering angle sensor connector.

2. Measure the voltage between terminal 1 and 2 of the steering angle sensor connector.

Is the voltage within 8~16V?

**YES**

- Clear the DTC, and then drive a vehicle over 40 Km/h (24 MPH). If ESP warning lamp turn on, replace the steering wheel sensor. Then go to "Verification of Vehicle Repair" procedure.

**NO**

- Check harness and connector between the HECU and the steering angle sensor. If NG, replace the steering wheel sensor.

**VERIFICATION OF VEHICLE REPAIR**

Refer to DTC C1101.
GENERAL DESCRIPTION

The yaw-rate & Lateral G sensor are used for the stability of a vehicle. The yaw-rate is used to measure angular velocity while the Lateral G is to measure the force that moves the vehicle away from the center, when a vehicle is cornering.

DTC DESCRIPTION

This code sets when there is an open or short in the circuit of the yaw-rate & lateral G sensor.

DTC DETECTING CONDITION

<table>
<thead>
<tr>
<th>Item</th>
<th>Detecting Condition</th>
<th>Possible cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>DTC Strategy</td>
<td>Signal monitoring</td>
<td></td>
</tr>
<tr>
<td>Enable Conditions</td>
<td>1. The AY(Acceleration Sensor) sensor voltage is monitored for a is out of range value. A line fault is detected if $AY \leq 0.3$ V OR $AY \geq 4.7$ V for a time $t = 100$ ms.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Open line, short to GND and short to UZ are detected. The DRS sensor voltage is monitored for a is out of range value. A line fault is detected, if</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- $DRSS \leq 0.225$ V OR $DRSS \geq 4.774$ V for a time $t = 100$ ms.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- $DRSR \leq 2.1$ V OR $DRSR \leq 2.9$ V for a time $t = 200$ ms.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>※ $DRSS$ (Yaw sensor reference), $DRS$ (yaw sensor), $DRSR$ (Yaw sensor signal)</td>
<td></td>
</tr>
<tr>
<td>Monitoring period</td>
<td>Continuous</td>
<td></td>
</tr>
<tr>
<td>Effect</td>
<td>Reduced controller function caused by faulty DRS and AY signal.</td>
<td></td>
</tr>
</tbody>
</table>

TERMINAL & CONNECTOR INSPECTION

Refer to DTC C1101.
POWER SUPPLY CIRCUIT INSPECTION  E8EB60C9

1. Ignition "ON"  Engine "ON".

2. Measure voltage between terminal "3" of the Yaw Rate & Lateral G sensor harness connector and chassis ground.

   Specification : 11.75 ~ 12.25 V

   ![Diagram of connector terminals]

   Is the measured voltage within specifications?

   **YES**
   
   Go to "Ground Circuit Inspection" procedure.

   **NO**
   
   Check for open or short to GND in the Yaw Rate & Lateral G sensor harness between terminal "3" of the Yaw Rate & Lateral G sensor harness connector and terminal "16,20" of the HECU harness connector. Repair as necessary and then go to "Verification of vehicle Repair" procedure.

GROUND CIRCUIT INSPECTION  E25C0DCE

1. Ignition "OFF".

2. Disconnect Yaw Rate & Lateral G sensor connector.

3. Measure resistance between terminal "6" of the Yaw Rate & Lateral G sensor harness connector and chassis ground.

   Specification : Approx. below 1Ω
Is the measured resistance within specifications?

YES

- Go to “Signal Circuit Inspection” procedure.

NO

- Check for open or short in the Yaw Rate & Lateral G sensor harness between terminal "6" of the Yaw Rate & Lateral G sensor harness connector and terminal “15” of the HECU harness connector. Repair as necessary and then go to “Verification of vehicle Repair” procedure.

**SIGNAL CIRCUIT INSPECTION**

1. Ignition “OFF” & Engine “OFF”.

2. Measure voltage between terminal "4, 5" of the Yaw Rate & Lateral G sensor harness connector and chassis ground.

| Specification | Approx. 2.5V |

Is the measured voltage within specifications?

YES

- Go to “Component Inspection” procedure.
Check for open or short in the Yaw Rate Lateral G sensor harness between terminal "4, 5" of the Yaw Rate Lateral G sensor harness connector and terminal "16, 20" of the HECU harness connector. Repair as necessary and then go to "Verification of Vehicle Repair" procedure.

COMPONENT INSPECTION

1. Ignition "OFF".
2. Engine "ON".
   Does warning lamp remain On?

   YES

   Substitute with a known-good Yaw Rate Lateral G sensor and check for proper operation. If problem is corrected, replace Yaw Rate Lateral G sensor and then go to "Verification of Vehicle Repair" procedure.

   NO

   Fault is intermittent caused by open or short of Yaw Rate Lateral G sensor harness and/or faulty Yaw Rate Lateral G sensor or was repaired and HECU memory was not cleared. Go to the applicable troubleshooting procedure.

VERIFICATION OF VEHICLE REPAIR

Refer to DTC C1101.
DTC C1283 YAW RATE & LATERAL G SENSOR-SIGNAL

COMPONENT LOCATION

![Component Location Image]

GENERAL DESCRIPTION

The yaw-rate and Lateral G sensor are used for the stability of a vehicle. The yaw-rate is used to measure angular velocity while the Lateral G is to measure the force that moves the vehicle away from the center, when a vehicle is cornering.

DTC DESCRIPTION

This code sets when there is an open or short in the circuit of the yaw-rate & lateral G sensor.
**DTC DETECTING CONDITION**

<table>
<thead>
<tr>
<th>Item</th>
<th>Detecting Condition</th>
<th>Possible cause</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DTC Strategy</strong></td>
<td><strong>Signal monitoring</strong></td>
<td></td>
</tr>
</tbody>
</table>
| **Enable Conditions** | **This test detects internal AY(Acceleration sensor) sensor malfunctions.**  
1. During the POS measure window \((t = 100 \text{ ms})\) the AY signal must be for at least \(t = 60 \text{ ms}\) between \(0.2 \text{ V} \leq \text{AY} \leq 0.8 \text{ V}\)  
2. If during stable vehicle behavior an AY-Failure larger than approximately \(2.5 \text{ m/s relevant \(2.5 \text{ m/s} \leq \text{AY} \leq 5 \text{ m/s}\) occurs, the ESP controller will disregard the AY sensor information so that a false ESP intervention is prevented. A fault is recognized after \(1.6 \text{ s}\) during model validity.  
3. If the offset value exceeds a threshold of approximately \(2.25 \text{ m/s}^2\) an AY fault is determined.  
4. During standstill the plausible range of \(|\text{AY}|\) is below \(7 \text{ m/s}^2\). If the filtered value of \(|\text{AY}|\) is larger than \(7 \text{ m/s}^2\) for more than \(400 \text{ ms}\) a fault is set.  
5. If the lateral acceleration is higher than \(15 \text{ m/s}^2\) for more than \(800 \text{ ms}\) a suspected failure bit is set. After \(1.6 \text{ s}\) a fault is detected.  
6. Standstill compensation: Failure threshold \(5.25 \text{ °/s}\). Fast compensation (during driving if no standstill compensation could be completed): Failure threshold is \(7.5 \text{ °/s}\). Long-term ("normal") compensation (during driving after succeeded standstill or fast offset compensation): Failure threshold is \(7.5 \text{ °/s}\).  
7. The fault criteria is approx. \(25\%\) sensitivity failure.  
8. If the measured yaw rate deviates more than \(2.5 \text{ °/s}\) plus a dynamic threshold from the reference yaw rate during model validity, a failure is recognized after \(1.6 \text{ s}\). The dynamic threshold is between \(2.5 \text{ °/s}\) and more than \(5 \text{ °/s}\). A typical value is \(3 \text{ °/s}\).  
9. The measured yaw rate and the model yaw rates, calculated from the WSS and LWS are compared. If the signals don’t fit and forward driving is recognized, a fault is determined.  
10. In case of a YRS-failure, the YRS will send an abnormal yaw rate signal. | • Faulty Lateral Acceleration Sensor  
• Faulty Yaw Rate Sensor  
• Faulty HECU |
| Monitoring period | 1. Once after power up and no low voltage.  
2,3,8. Continuous during stable driving.  
4. Continuous during standstill.  
5. Continuous, if no under voltage is detected.  
6. Continuous, dependent on driving situation.  
7. During stable cornering after completed offset compensation.  
9. After every standstill  
10. Continuous |                                                                                                       |
| **Effect** | Reduced controller function caused by faulty DRS(yaw sensor) signal.                                                                                                                                                    |                                                                                                       |

**TERMINAL & CONNECTOR INSPECTION**

Refer to DTC C1101.
ABS (ANTI-LOCK BRAKE SYSTEM)

COMPONENT INSPECTION

1. Ignition "OFF".
2. Engine "ON".
3. Start and drive vehicle in gear and maintain vehicle speed is approx. 20 km/h or more(12 mph or more)
   Does warning lamp remain On?
   - **YES**
     - Substitute with a known-good Yaw Rate Lateral G sensor and check for proper operation. If problem is corrected, replace Yaw Rate Lateral G sensor and then go to "Verification of Vehicle Repair" procedure.
   - **NO**
     - Fault is intermittent caused by open or short of Yaw Rate Lateral G sensor harness and/or faulty Yaw Rate Lateral G sensor or was repaired and HECU memory was not cleared. Go to the applicable troubleshooting procedure.

VERIFICATION OF VEHICLE REPAIR

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

1. Connect scantool and select "Diagnostic Trouble Codes(DTCs)" mode.
2. Using a scantool, Clear DTC.
3. Operate the vehicle within DTC Detecting Condition in General Information.(Start and drive vehicle in gear and maintain vehicle speed is approx. 20 km/h or more(12 mph or more))
   Are any DTCs present?
   - **YES**
     - Go to the applicable troubleshooting procedure.
   - **NO**
     - A system performs normally at this time.
DTC C1503 ESP SWITCH ERROR

COMPONENT LOCATION

GENERAL DESCRIPTION

Driver can inhibit the ESP control by ESP switch. When switch signal send into HECU, ESP warning lamp go ON and ESP control is stopped and if next switch signal is inputted again, ESP control is ready. This function is used for sporty driving or vehicle inspection.

DTC DESCRIPTION

Trouble code is set when the condition that the level of ESP switch is high is continued for 60sec. When the ESP switch failure is set there is no signal in the warning lamp and HECU inhibit the ESP control and allow the ABS/EBD control.

DTC DETECTING CONDITION

<table>
<thead>
<tr>
<th>Item</th>
<th>Detecting Condition</th>
<th>Possible cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>DTC Strategy</td>
<td>Short circuit monitoring</td>
<td>• Open or short ESP switch</td>
</tr>
<tr>
<td>Enable Conditions</td>
<td>Trouble code is set when the condition that the level of ESP switch is high is continued for 60 sec.</td>
<td></td>
</tr>
<tr>
<td>Monitoring period</td>
<td>Continuous</td>
<td></td>
</tr>
</tbody>
</table>

TERMINAL & CONNECTOR INSPECTION

Refer to DTC C1101.

SIGNAL CIRCUIT INSPECTION

1. Ignition "ON" & Engine "OFF" & ESP Switch "ON".
2. Measure voltage between terminal "31" of the HECU harness connector and chassis ground.

Specification: Approx B+
Is the measured voltage within specifications?

**YES**

- Fault is intermittent caused by open or short in ESP switch line, faulty ESP switch or was repaired and HECU memory was not cleared. Go to the applicable troubleshooting procedure.

**NO**

- Check for damaged harness and poor connection in the power harness between the battery terminal (+) and the terminal "31" of the HECU harness connector. Check for open or blown 10A fuse referring to "Circuit Diagram". Repair as necessary and then go to "Verification of vehicle Repair" procedure.

**COMPONENT INSPECTION**

1. Ignition "OFF".
2. Disconnect ESP switch connector.
3. Press the ESP switch.
4. Measure resistance between terminal "2" of the ESP switch harness connector and terminal "5" of the ESP switch harness connector.

Specification: Approx below 1 Ω
Is the measured resistance within specifications?

**YES**

- Fault is intermittent caused by faulty ESP switch or was repaired and HECU memory was not cleared. Go to the applicable troubleshooting procedure.

**NO**

- Substitute with a known-good ESP switch and check for proper operation. If problem is corrected, replace ESP switch and then go to "Verification of Vehicle Repair" procedure.

**VERIFICATION OF VEHICLE REPAIR**

Refer to DTC C1101.
COMPONENT LOCATION  ED9CFA35

GENERAL DESCRIPTION  EC9AA2D

The brake light switch indicates brake pedal status to the ABS control unit. The switch is turned on when brake is depressed. The brake light switch is a normally-open contact which runs to battery voltage when active (brake depressed). When passive (brake not depressed), the cable is grounded via the brake light bulbs.

DTC DESCRIPTION  EF4392B0

The brake light signal is a reference to judge driver’s will for braking. ABS ECU monitor open circuit of brake light switch for normal ABS control.

DTC DETECTING CONDITION  EEACDAB7

<table>
<thead>
<tr>
<th>Item</th>
<th>Detecting Condition</th>
<th>Possible cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>DTC Strategy</td>
<td>Open circuit monitoring</td>
<td>• Open circuit in brake switch line</td>
</tr>
<tr>
<td>Enable Conditions</td>
<td>If the BLS-signals is high for 60 s, while the gas pedal is stepped,</td>
<td>• Faulty brake light switch</td>
</tr>
<tr>
<td></td>
<td>with vehicle speed $\geq$ 3 m/s, offset compensated $p_{\text{Vor}} \geq 5$ bar and</td>
<td>• Faulty input stage in HECU</td>
</tr>
<tr>
<td></td>
<td>no control is active, a fault is set.</td>
<td></td>
</tr>
<tr>
<td>Monitoring period</td>
<td>Continuous, if no under voltage is detected.</td>
<td></td>
</tr>
<tr>
<td>Effect</td>
<td>Reduced function caused by a faulty brake light switch.</td>
<td></td>
</tr>
</tbody>
</table>

TERMINAL & CONNECTOR INSPECTION  E50FCDE6

Refer to DTC C1101.

SIGNAL CIRCUIT INSPECTION  E5481F29

1. Ignition "ON" & Engine "OFF".
2. Press the brake pedal.
3. Measure voltage between the terminal “30” of the HECU harness connector and chassis ground.
Specification: Brake Light Switch - Approx. B+

Is the measured voltage within specifications?

**YES**

- Fault is intermittent caused by open harness in brake lamp switch and brake switch line, faulty brake lamp switch was repaired and HECU memory was not cleared. Go to the applicable troubleshooting procedure.

**NO**

- Check for damaged harness and poor connection in the power harness between the battery terminal (+) and the terminal "30" of the HECU harness connector. Check for open or blown 15A STOP fuse. Repair as necessary and then go to "Verification of Vehicle Repair" procedure.

**COMPONENT INSPECTION**

1. Connect a ohmmeter to the connector of brake light switch, and check whether or not there is continuity when the plunger of the brake light switch is pushed in and when it is released. The switch is in good condition if there is no continuity when the plunger is pushed.

2. Is there no continuity when the plunger is pushed?

**YES**

- Fault is intermittent caused by open harness in brake light switch line, faulty brake lamp switch or was repaired and HECU memory was not cleared. Go to the applicable troubleshooting procedure.

**NO**

- Substitute with a known-good brake lamp switch and check for proper operation. If problem is corrected, replace brake lamp switch and then go to "Verification of Vehicle Repair" procedure.

**VERIFICATION OF VEHICLE REPAIR**

Refer to DTC C1101.
COMPONENT LOCATION

![Component Location Diagram]

GENERAL DESCRIPTION

The HECU is composed of an ECU (Electronic Control Unit) and an HCU (Hydraulic Control Unit), so the HECU hardware includes all solenoid valves inside the unit as well as the ECU.

DTC DESCRIPTION

The HECU monitors the operation of the IC components such as memory, register, A/D converter, and so on. The HECU sets this code when the EEPROM data read by the master processor is different than prior data written, or when the master/slave processor detects abnormal operation in RAM, Status Register, Interrupt, Timer, A/D converter, or cycle time.

DTC DETECTING CONDITION

<table>
<thead>
<tr>
<th>Item</th>
<th>Detecting Condition</th>
<th>Possible cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>DTC Strategy</td>
<td>Internal monitoring</td>
<td></td>
</tr>
</tbody>
</table>
| Enable Conditions  | 1. Internal control unit failures of the Micro controller and peripheral integrated circuits will be continuous monitored for proper function.  
                        2. After EEPROM-values have been read from EEPROM, the values are monitored for corrupt data. Failure is set if:  
                            a) Checksum not correct or  
                            b) PSW-EEPROM-Handler reported unknown failure during EEPROM-value reading.  
                        3. Evaluate EEPROM reading sequence. If EEPROM reading sequence take longer then 3 s, a failure is set. | Faulty HECU |
| Monitoring period  | 1. Continuous  
                        2,3. Directly after ignition on, during reading of EEPROM-values. |                |
| Effect             | No control is available.                                                            |                |
COMPONENT INSPECTION

1. Ignition "OFF".

2. Engine "ON".
   Does warning lamp remain On?
   - **YES**
     - Substitute with a known-good HECU and check for proper operation. If problem is corrected, replace HECU and then go to "Verification of Vehicle Repair" procedure.
   - **NO**
     - Fault is intermittent caused by faulty HECU or was repaired and HECU memory was not cleared. Go to the applicable troubleshooting procedure.

VERIFICATION OF VEHICLE REPAIR

Refer to DTC C1101.
DTC C1605 CAN CONTROL HARDWARE ERROR

COMPONENT LOCATION

![Component Location Diagram]

GENERAL DESCRIPTION

The CAN is for sending and receiving the information for TCS(ESP) control, between the HECU and EMS/TCU.

DTC DESCRIPTION

This code shows in case that there is an error on the CAN hardware. In this case, replace the HECU and check.

DTC DETECTING CONDITION

<table>
<thead>
<tr>
<th>Item</th>
<th>Detecting Condition</th>
<th>Possible cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>DTC Strategy</td>
<td>CAN RAM monitoring</td>
<td></td>
</tr>
</tbody>
</table>
| Enable Conditions  | 1. Monitoring whether the initialization software has write access to the configuration registers of the CAN-controller module. Faults are detected immediately.  
2. Monitoring includes line short to ground, line short to supply voltage and mutual line short. Line interruptions are detected by CAN message monitor. After detecting a BUSOFF failure the transmission is reinitialized. A BUSOFF fault is established if re-initialization is tried for 15 times in sequence without success. | • Faulty HECU |
| Monitoring period  | 1. immediate during start up.  
2. Continuous                                                             |                                  |
| Effect             | 1. CAN-Controller is not initialized correctly. Possibly no reception or transmission of messages.  
2. CAN messages can not be processed. BLS is not controlled. |                                  |
COMPONENT INSPECTION  EF616370

1. Ignition "OFF".

2. Engine "ON".
   Does warning lamp remain On?
   
   **YES**
   
   ► Substitute with a known-good HECU and check for proper operation. If problem is corrected, replace HECU and then go to "Verification of Vehicle Repair" procedure.

   **NO**
   
   ► Fault is intermittent caused by short harness in CAN line and/or faulty HECU or was repaired and HECU memory was not cleared. Go to the applicable troubleshooting procedure.

VERIFICATION OF VEHICLE REPAIR  EFCF02FE

Refer to DTC C1101.
**ABS (ANTI-LOCK BRAKE SYSTEM)**

**DTC C1611 CAN TIME OUT-ECM**
**DTC C1612 CAN TIME OUT-TCU**
**DTC C1623 CAN TIMEOUT STEERING ANGLE SENSOR**

**COMPONENT LOCATION**
E6626A8C

---

**GENERAL DESCRIPTION**

The CAN is for sending and receiving the information for TCS(ESP) control, between the HECU and EMS/TCU.

**DTC DESCRIPTION**

This code shows in case that there is an error on the CAN hardware. In this case, replace the HECU and check.

**DTC DETECTING CONDITION**

<table>
<thead>
<tr>
<th>Item</th>
<th>Detecting Condition</th>
<th>Possible cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>DTC Strategy</td>
<td>CAN RAM monitoring</td>
<td></td>
</tr>
</tbody>
</table>
| Enable Conditions | 1. Purpose is to monitor if transmitted message was not transmitted by CAN controller of ABS8/ESP8 ECU, Faults are detected after filtering. Filtering has to be customized. 2. Purpose is to monitor if transmitted message has the expected data length. Actually the monitoring is reduced the check for too short messages. A message with oversized data length causes no fault. Faults are detected immediate. | Faulty HECU  
Faulty ECM  
Faulty TCU  
Faulty Steering angle sensor |
| Monitoring period | Continuous                                                                        |                                                    |
| Effect        | 1. CAN messages are not correct sent. 2. CAN messages are not according to what was expected at compile time of the software. |                                                    |
1. Ignition "OFF".

2. Engine "ON".
   Does warning lamp remain On?

   **YES**
   - Substitute with a known-good ECM(C1611)[TCU(C1612)/Steering angle sensor(C1623)] and check for proper operation. If problem is corrected, replace ECM(C1611)[TCU(C1612)/Steering angle sensor(C1623)] and then go to "Verification of Vehicle Repair" procedure. If NG, replace HECU and then go to "Verification of Vehicle Repair" procedure.

   **NO**
   - Fault is intermittent caused by faulty ECM(C1611)[TCU(C1612)/Steering angle sensor(C1623)] and/or faulty HECU or was repaired and HECU memory was not cleared. Go to the applicable troubleshooting procedure.

**VERIFICATION OF VEHICLE REPAIR**

Refer to DTC C1101.
**DTC C1616 CAN BUS OFF**

**COMPONENT LOCATION**

![Component Location Diagram]

**GENERAL DESCRIPTION**

The CAN is for sending and receiving the information for TCS(ESP) control, between the HECU and EMS/TCU.

**DTC DESCRIPTION**

The HECU checks the CAN communication lines for normal TCS control, and sets this code if CAN BUS OFF status is detected for more than 100 ms.

**DTC DETECTING CONDITION**

<table>
<thead>
<tr>
<th>Item</th>
<th>Detecting Condition</th>
<th>Possible cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>DTC Strategy</td>
<td>Open or short circuit monitoring</td>
<td></td>
</tr>
<tr>
<td>Enable Conditions</td>
<td>Monitoring includes line short to ground, line short to supply voltage and mutual line short. Line interruptions are detected by CAN message monitor. After detecting a BUSOFF failure the transmission is reinitialized. A BUSOFF fault is established if re-initialization is tried for 15 times in sequence without success.</td>
<td>Open or short circuit in CAN line</td>
</tr>
<tr>
<td>Monitoring period</td>
<td>Continuous</td>
<td></td>
</tr>
<tr>
<td>Effect</td>
<td>CAN messages can not be processed. BLS(Brake light switch) is not controlled.</td>
<td></td>
</tr>
</tbody>
</table>

**TERMINAL & CONNECTOR INSPECTION**

Refer to DTC C1101.
1. Ignition "OFF".

2. Measure resistance between terminal “35” of the HECU harness connector and terminal "14" of the HECU harness connector.

   **Specification**: Approx. 60 Ω

   Is the measured resistance within specifications?

   **YES**

   ▶ Fault is intermittent caused by open or short in CAN signal harness or was repaired and HECU memory was not cleared. Go to the applicable troubleshooting procedure.

   **NO**

   ▶ Check for open or short in CAN signal harness between terminal “35” of the HECU harness connector and terminal “14” of the HECU harness connector. Repair as necessary and then go to “Verification of vehicle Repair” procedure.

**VERIFICATION OF VEHICLE REPAIR**

Refer to DTC C1101.
The CAN is for sending and receiving the information for TCS(ESP) control, between the HECU and EMS/TCU.

<table>
<thead>
<tr>
<th>Item</th>
<th>Detecting Condition</th>
<th>Possible cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>DTC Strategy</td>
<td>Open or short circuit monitoring</td>
<td>• Open or short circuit in CAN line</td>
</tr>
<tr>
<td>Enable Conditions</td>
<td>Purpose is to monitor if receive message was not received on time by the CAN controller of ABS8/ESP8 ECU. Faults are detected after filtering.</td>
<td>• Faulty HECU</td>
</tr>
<tr>
<td>Monitoring period</td>
<td>Continuous</td>
<td></td>
</tr>
<tr>
<td>Effect</td>
<td>CAN messages are not received on time.</td>
<td></td>
</tr>
</tbody>
</table>

**TERMINAL & CONNECTOR INSPECTION**

Refer to DTC C1101.

**SIGNAL CIRCUIT INSPECTION**

1. Check for open or short in CAN signal harness between terminal “35” of the HECU harness connector and PCM harness connector.

2. Check for open or short in CAN signal harness between terminal “14” of the HECU harness connector and PCM harness connector.

Is it normal?

**YES**

- Replace the HECU. Then go to "Verification of vehicle Repair" procedure.
NO

- Repair or replace harness and connector.

VERIFICATION OF VEHICLE REPAIR  E4CD4A94

Refer to DTC C1101.
DTC DETECTING CONDITION

<table>
<thead>
<tr>
<th>Item</th>
<th>Detecting Condition</th>
<th>Possible cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>DTC Strategy</td>
<td>Internal error</td>
<td></td>
</tr>
</tbody>
</table>
| Enable Conditions | 1. Under normal conditions, the inlet valves of all four wheels are not closed during control for longer than 1.28 s. If the controller requests pressure-hold or pressure-decrease for longer than 1.28 s, a fault is stored.  
2. The monitoring reports a failure if continuous ESP control occurs for a time period $T = 10$ s. A continuous ESP control for longer than 10 s is not possible under normal conditions. | Faulty HECU                     |
| Monitoring period | 1. Continuous  
2. detected under voltage and a fault is not already detected. |                                 |
| Effect            | 1. Reduced function as all wheel valves will remain in pressure build-up position.  
2. Reduced function of the ESP system, no more ESP, no more ABS. |                                 |
COMPONENT INSPECTION

1. Ignition "OFF".

2. Engine "ON".
   Does warning lamp remain On?
   
   **YES**
   
   ► Replace the HECU. Then go to "Verification of vehicle Repair" procedure.

   **NO**
   
   ► Fault is intermittent caused by faulty HECU or was repaired and HECU memory was not cleared. Go to the applicable troubleshooting procedure.

VERIFICATION OF VEHICLE REPAIR

Refer to DTC C1101.
DTC C1702 VARIANT CODING

GENERAL DESCRIPTION

A hardware difference of ECU does not exist according to the specification of the vehicle, but a software changes according to deference of vehicle parameter. The ESP stores variant code (data of engine, displacement volume, T/M) at the ECU memory. Since then a ESP uses the stored data.

COMPONENT INSPECTION

*Variant Coding
1. Install a EMS/TCU/ESP normally.
2. Connect a scanner to the vehicle.
3. IGN On
4. Scanner On
5. Select a brake mode.
6. Push the Variant Coding button.
7. Scanner Off
8. IGN Off
9. Remove the scanner.
10. IGN On
11. Finish the Variant Coding.
DTC C2112 VALVE RELAY MAL.

COMPONENT LOCATION

GENERAL DESCRIPTION

The ABS ECU supplies battery power to all solenoid valves by way of a valve relay which is controlled by the Electronic Control UNIT(ECU). The valve relay and all solenoid valves are installed inside the HECU (Hydraulic and Electronic Control Unit).

DTC DESCRIPTION

ABS ECU monitors voltage of the valve relay to check if ABS ECU can perform ABS control normally. When the valve relay is switched to ON, the HECU will set this code if the solenoid drive voltage is below permissible voltage ranges for a period of time. When the valve relay is switched to OFF, the HECU sets this code if the solenoid drive voltage is over the permissible voltage range for a period of time.

DTC DETECTING CONDITION

<table>
<thead>
<tr>
<th>Item</th>
<th>Detecting Condition</th>
<th>Possible cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>DTC Strategy</td>
<td>Battery Voltage Monitoring</td>
<td></td>
</tr>
<tr>
<td>Enable Conditions</td>
<td>1. Watchdog and VR(valve relay) function is tested during startup. FSA test (Fail Save Circuit test) detects if the VR/Enable remains in off position when it is turned on and vice versa. Reason could be short to GND or UZ(ECU voltage supply), interrupted lines or a defective output stage etc.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. A Fault is detected if UVR(valve relay voltage) $\leq 0.8\times UZ$ for a time t $\geq 500$ ms.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. This test evaluates the function of the VR (valve relay) periodically. The VR is switched off and back on. VR malfunction and UVR short to UZ or UBVR(supply solenoid valves) and medium or high ohmic short of UVR (or a valve) to UZ, UBVR(supply solenoid valves) or GND are detected.</td>
<td></td>
</tr>
<tr>
<td>Monitoring period</td>
<td>1. Once during startup. 2,3. Continuous</td>
<td></td>
</tr>
<tr>
<td>Effect</td>
<td>No valve actuation possible.</td>
<td></td>
</tr>
</tbody>
</table>

- Open or short of power supply circuit
- Faulty HECU
ABS (ANTI-LOCK BRAKE SYSTEM)

TERMINAL & CONNECTOR INSPECTION

Refer to DTC C1101.

POWER SUPPLY CIRCUIT INSPECTION

1. Ignition "OFF"
2. Disconnect HECU connector.
3. Ignition "ON" — Engine "OFF".
4. Measure voltage between terminal "3" of the HECU harness connector and chassis ground.

<table>
<thead>
<tr>
<th>Specification</th>
<th>Approx. B+</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>14</td>
</tr>
</tbody>
</table>

V

Is the measured voltage within specifications?

YES

Go to "Ground Circuit Inspection" procedure.

NO

Check for open or short in power harness between battery terminal(+) and terminal "3" of the HECU harness connector. Check for open or blown 20A fuse. Repair as necessary and then go to "Verification of vehicle Repair" procedure.
GROUND CIRCUIT INSPECTION  E250IDCE

1. Ignition "OFF".
2. Disconnect HECU connector.
3. Measure resistance between terminal "4" of the HECU harness connector and chassis ground.

   Specification : Approx. below 1 Ω

   Is the measured resistance within specifications?

   **YES**
   - Go to "Component Inspection" procedure.

   **NO**
   - Check for damaged harness and poor connection between terminal "4" of the HECU harness connector and chassis ground. Repair as necessary and then go to "Verification of vehicle Repair" procedure.

COMPONENT INSPECTION  E97D585

1. Ignition "OFF".
2. Engine "ON".
   - Does warning lamp remain On?

   **YES**
   - Substitute with a known-good HECU and check for proper operation. If problem is corrected, replace HECU and then go to "Verification of Vehicle Repair" procedure.

   **NO**
   - Fault is intermittent caused by open or short of power harness and/or faulty HECU or was repaired and HECU memory was not cleared. Go to the applicable troubleshooting procedure.

VERIFICATION OF VEHICLE REPAIR  EB6A1AAB

Refer to DTC C1101.
DTC C2308 FL INLET VALVE MAL.
DTC C2312 FL OUTLET VALVE MAL.
DTC C2316 FR INLET VALVE MAL.
DTC C2320 FR OUTLET VALVE MAL.
DTC C2324 RL INLET VALVE MAL.
DTC C2328 RL OUTLET VALVE MAL.
DTC C2332 RR INLET VALVE MAL.
DTC C2336 RR OUTLET VALVE MAL.

COMPONENT LOCATION

GENERAL DESCRIPTION

The ABS HECU is composed of an ECU (Electronic Control Unit) and a HCU (Hydraulic Control Unit), so the HECU hardware includes all solenoid valves inside the unit as well as the ECU. Solenoid valves are switched to ON, OFF by HECU when the ABS is activated. Solenoid valves function is to increase, decrease or maintain the hydraulic pressure supplied to a wheel cylinder.

DTC DESCRIPTION

The HECU monitors the operation of the valves by checking the drive circuit of the solenoid valves, and then sets this code when the unexpected drive voltage is detected. For example, the HECU sets the DTC if an unexpected high drive voltage is detected when the valve relay is switched to OFF.
**DTC DETECTING CONDITION**

**EEABSB72**

<table>
<thead>
<tr>
<th>Item</th>
<th>Detecting Condition</th>
<th>Possible cause</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DTC Strategy</strong></td>
<td>Battery Voltage Monitoring</td>
<td></td>
</tr>
<tr>
<td><strong>Enable Conditions</strong></td>
<td>1. The electrical feedback signal does not match the actuation signal for the corresponding valve: Actuation Signal $\neq$ Feedback Signal Fault filter time is $t = 30$ ms (for current controlled valves and under voltage conditions: $t = 80$ ms)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Cyclic Valve and Relay Test (CVRT):</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• A Fault is found if UVR (Valve relay voltage) is not within $0.1 \cdot UZ$ (Ignition voltage) $\leq UVR \leq 0.8 \cdot UZ$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• A Fault is found if UVR is not $UVR \leq 0.2 \cdot UZ$ and the Valve Feedback is not act. Valve $= \text{FALSE}$, not act. Valve $= \text{TRUE}$ At least VR is switched on again.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. The valve and pump motor test detects electrical actuation malfunction of ABS valves. The test actuates all valves in series (to detect short cuts or shunts between the valve lines). Faults are detected by monitoring the valve response signals.</td>
<td></td>
</tr>
<tr>
<td><strong>Monitoring period</strong></td>
<td>1. Continuous</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. CVRT is executed immediately after power on and then periodic every $t = 20$ s. The Test is canceled if any control/valve actuation takes place or if the Vehicle is in motion and the BLS is on.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. The Valve and Pump motor Test is performed once after ignition on if vehicle speed is $\geq 15$ km/h (9 MPH).</td>
<td></td>
</tr>
<tr>
<td><strong>Effect</strong></td>
<td>Valve cannot be actuated or valve is incorrectly actuated. This may result in locked wheels or wheels without pressure.</td>
<td></td>
</tr>
</tbody>
</table>

**COMPONENT INSPECTION**

1. Ignition "OFF".
2. Engine "ON".
3. Start and drive vehicle in gear and maintain vehicle speed is approx. 15 km/h or more (9 mph or more) Does warning lamp remain On?

**YES**

- Substitute with a known-good HECU and check for proper operation. If problem is corrected, replace HECU and then go to "Verification of Vehicle Repair" procedure.

**NO**

- Fault is intermittent caused by faulty HECU or was repaired and HECU memory was not cleared. Go to the applicable troubleshooting procedure.
After a repair, it is essential to verify that the fault has been corrected.

1. Connect scantool and select "Diagnostic Trouble Codes(DTCs)" mode.

2. Using a scantool, Clear DTC.

3. Operate the vehicle within DTC Detecting Condition in General Information. (Start and drive vehicle in gear and maintain vehicle speed is approx. 15 km/h or more(9 mph or more))

Are any DTCs present ?

**YES**

▶ Go to the applicable troubleshooting procedure.

**NO**

▶ A system performs normally at this time.
DTC C2366 TC VALVE PRIMARY(USV1) ERROR
DTC C2370 TC VALVE SECONDARY(USV2) ERROR
DTC C2372 ESP VALVE 1(HSV1) ERROR
DTC C2374 ESP VALVE 2(HSV2) ERROR

COMPONENT LOCATION

GENERAL DESCRIPTION
The ESP HECU is composed of an ECU (Electronic Control Unit) and a HCU (Hydraulic Control Unit), so the HECU hardware includes all solenoid valves inside the unit as well as the ECU. Solenoid valves are switched to ON, OFF by HECU when the ABS/ESP is activated. Solenoid valves function is to increase, decrease or maintain the hydraulic pressure supplied to a wheel cylinder.

DTC DETECTING CONDITION

<table>
<thead>
<tr>
<th>Item</th>
<th>Detecting Condition</th>
<th>Possible cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>DTC Strategy</td>
<td>Battery Voltage Monitoring</td>
<td></td>
</tr>
<tr>
<td>Enable Conditions</td>
<td>The valve and pump motor test detects electrical actuation malfunction of USV and HSV valves. The test actuates all valves in series (to detect shorts or shunts between the valve lines). Faults are detected by monitoring the valve response signals.</td>
<td>Faulty HECU</td>
</tr>
<tr>
<td>Monitoring period</td>
<td>The USV Test is performed once after ignition on at standstill if the BLS is off and at vehicle speed is ( v \geq 15 \text{ km/h}(9 \text{ MPH}) ) if the BLS is on.</td>
<td></td>
</tr>
<tr>
<td>Effect</td>
<td>Valve cannot be actuated or valve is incorrectly actuated. This may result in locked wheels or wheels without pressure.</td>
<td></td>
</tr>
</tbody>
</table>

COMPONENT INSPECTION
Refer to DTC C2308.

VERIFICATION OF VEHICLE REPAIR
Refer to DTC C2308.
The ABS ECU supplies battery power to the electric motor by way of a motor relay which is controlled by the Electronic Control Unit (ECU). The electric motor pump supplies hydraulic pressure to all wheel brake calipers by operating the piston inside the pump.

The ABS/ESP ECU monitors the pump motor relay or fuse open, open or short in motor or motor lock and then sets this code if a malfunction is detected.
DTC DETECTING CONDITION E1ADBDCB

<table>
<thead>
<tr>
<th>Item</th>
<th>Detecting Condition</th>
<th>Possible cause</th>
</tr>
</thead>
<tbody>
<tr>
<td>DTC Strategy</td>
<td>Battery Voltage Monitoring</td>
<td></td>
</tr>
<tr>
<td>Enable Conditions</td>
<td>1. A failure is detected if the voltage UM (Pump motor voltage) $\leq 2.0$ V for a time $t = 1$ s.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. A failure is detected if the voltage UM (Pump motor voltage) $\leq (UZ$ (battery voltage) - 4.0 V) for a time $t = 100$ ms.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. After the end of the actuation of the motor relay has, the pump motor is still in motion and is generating a Voltage during its slowdown. The generated UM is monitored for a certain time on high level. The time depends on the supply voltage and is in the range of $t = 30$ ms to $t = 125$ ms. If the slowdown condition isn’t met, the pump is activated again (see actuation times below) and the slowdown time is measured again. This is repeated for maximum $n = 3$ times. If, after the last pump activation, the pump motor slowdown time is still too short, a failure is detected. Actuation times: 1st actuation: 200 ms 2nd actuation: 1000 ms 3rd actuation: 3000 ms</td>
<td></td>
</tr>
<tr>
<td>Monitoring period</td>
<td>1. Stop monitor is active if the pump is off i.e. not actuation and no Slowdown.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. The monitor is active if the pump is switched on .</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Monitor is always active in the transition &quot;pump on -&gt; pump off&quot;.</td>
<td></td>
</tr>
<tr>
<td>Effect</td>
<td>1. The return pump does not work correct.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Pressure decrease (outlet valve) is no longer possible (wheels block).</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Pressure decrease (outlet valve) is no longer possible (wheels lock).</td>
<td></td>
</tr>
</tbody>
</table>

TERMINAL & CONNECTOR INSPECTION E18D0CB

Refer to DTC C1101.

POWER SUPPLY CIRCUIT INSPECTION E01E65C8

1. Ignition "OFF"
2. Disconnect HECU connector.
3. Ignition "ON" Engine "OFF".
4. Measure voltage between terminal "2" of the HECU harness connector and chassis ground.

Specification : Approx. B+
Is the measured voltage within specifications?

**YES**

- Go to "Ground Circuit Inspection" procedure.

**NO**

- Check for open or short in power harness between battery terminal(+) and terminal "2" of the HECU harness connector. Check for open or blown 40A fuse. Repair as necessary and then go to "Verification of vehicle Repair" procedure.

### GROUND CIRCUIT INSPECTION

1. Ignition "OFF".
2. Disconnect HECU connector.
3. Measure resistance between terminal "1" of the HECU harness connector and chassis ground.

Specification :Approx. below 1 Ω

Is the measured resistance within specifications?

**YES**

- Go to "Component Inspection" procedure.
Check for damaged harness and poor connection between terminal "1" of the HECU harness connector and chassis ground. Repair as necessary and then go to "Verification of vehicle Repair" procedure.

COMPONENT INSPECTION  EC1BE7C

Refer to DTC C2308.

VERIFICATION OF VEHICLE REPAIR  ECD40451

Refer to DTC C2308.
ANTI-LOCK BRAKING SYSTEM
CONTROL MODULE

COMPONENTS

1. Front-left tube
2. Front-right tube
3. Rear-left tube
4. Rear-right tube
5. MC2
6. MC1
7. ABS control module connector (26P)
8. ABS control module (HECU)
9. Damper
10. Bracket

TORQUE : N·m (kgf·cm, lb-ft)

16.66~25.48 N·m (170~260, 12.36~18.9)
REMOVAL

1. Disconnect the brake tube from the HECU by unlocking the nuts counterclockwise with a spanner.

2. Lift up the vehicle.

3. Disconnect the connector(A) from the HECU.

4. Remove the two HECU brake mounting bolts(B), and then disassemble the HECU with the bracket.

CAUTION

1. *Never attempt to disassemble the HECU.*
2. *The HECU must be transported and stored in a shock-free environment.*
3. *Never shock to the HECU.*

5. Remove the two HECU mounting nuts and washer, and then remove the bracket.

INSTALLATION

1. Installation is the reverse of removal.

2. Tighten the HECU mounting bolts and brake tube nuts to the specified torque.

<table>
<thead>
<tr>
<th>Tightening torque</th>
</tr>
</thead>
<tbody>
<tr>
<td>HECU mounting nut :</td>
</tr>
<tr>
<td>5.88<del>9.8 Nm (60</del>100 kgf-cm, 4.36~7.27 lb-ft)</td>
</tr>
<tr>
<td>HECU bracket mounting bolt:</td>
</tr>
<tr>
<td>16.66<del>25.48 Nm (170</del>260 kgf-cm, 12.36~18.9 lb-ft)</td>
</tr>
</tbody>
</table>
1. Front wheel speed sensor connector
2. Front wheel speed sensor
**REMOVAL**

1. Remove the front wheel speed sensor mounting bolt(A).
2. Remove the front wheel guard.
3. Remove the front wheel speed sensor after disconnecting the wheel speed sensor connector(A).

**INSPECTION**

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

   **CAUTION**
   
   In order to protect the wheel speed sensor, when measuring output voltage, a 75Ω resistor must be used as shown.

   - **V_low**: 0.44 V ~ 0.63 V
   - **V_high**: 0.885 V ~ 1.26 V
   - Frequency range: 1~2,500 Hz
REAR WHEEL SPEED SENSOR

COMPONENTS

1. Rear wheel speed sensor connector
2. Rear wheel speed sensor
REMOVAL  EAE1450B

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

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

INSPECTION  EC85D750

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

   **CAUTION**
   
   *In order to protect the wheel speed sensor, when measuring output voltage, a 75Ω resistor must be used as shown.*

   ![Diagram](EJRF501Z)

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

   - \( V_{low} : 0.44 \text{ V} \sim 0.63 \text{ V} \)
   - \( V_{high} : 0.885 \text{ V} \sim 1.26 \text{ V} \)
   - Frequency range : 1~2,500 Hz
The EBD system (Electronic Brake force Distribution) as a sub-system of the ABS system is to control the effective adhesion utilization by the rear wheels.

It further utilizes the efficiency of highly developed ABS equipment by controlling the slip of the rear wheels in the partial braking range.

The brake force is moved even closer to the optimum and controlled electronically, thus dispensing with the need for the proportioning valve.

The proportioning valve, because of a mechanical device, has limitations to achieve an ideal brake force distribution to the rear wheels as well as to carry out the flexible brake force distribution proportioning to the vehicle load or weight increasing. And in the event of malfunctioning, driver cannot notice whether it fails or not.

EBD controlled by the ABS Control Module, calculates the slip ratio of each wheel at all times and controls the brake pressure of the rear wheels not to exceed that of the front wheels.

If the EBD fails, the EBD warning lamp (Parking brake lamp) lights up.

**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]**

<table>
<thead>
<tr>
<th>Rear pressure</th>
<th>Front pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed distribution</td>
<td>EBD starting point</td>
</tr>
<tr>
<td>Ideal distribution</td>
<td>EBD starting point</td>
</tr>
<tr>
<td>Cut-in point</td>
<td>EBD starting point</td>
</tr>
</tbody>
</table>

**[With EBD]**

<table>
<thead>
<tr>
<th>Rear pressure</th>
<th>Front pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed distribution</td>
<td>EBD starting point</td>
</tr>
<tr>
<td>Ideal distribution</td>
<td>EBD starting point</td>
</tr>
<tr>
<td>EBD starting point</td>
<td>EBD starting point</td>
</tr>
</tbody>
</table>
ESP(ELECTRONIC STABILITY PROGRAM) SYSTEM

DESCRIPTION OF ESP

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

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 ESP 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.

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)
A hardware difference of ECU does not exist according to the specification of the vehicle, but a software changes according to deference of vehicle parameter. The ESP stores variant code (data of engine, displacement volume , T/M) at the ECU memory. Since then an ESP uses the stored data.

**PROCEDURE**

1. Install a EMS/TCU/ESP normally.
2. Connect a scanner to the vehicle.
3. IGN On
4. Scanner On
5. Select a brake mode.
6. Push the Variant Coding button.
7. Scanner Off
8. IGN Off
9. Remove the scanner.
10. IGN On
11. Finish the Variant Coding.
ESP (ELECTRONIC STABILITY PROGRAM) SYSTEM

INPUT AND OUTPUT DIAGRAM

Input

- Active Wheel speed sensor (FL)
- Active Wheel speed sensor (FR)
- Active Wheel speed sensor (RL)
- Active Wheel speed sensor (RR)
- Steering Wheel Angle sensor
- Yaw-rate & Lateral Acceleration sensor
- Master cylinder pressure sensor
  - Primary
  - Secondary
- Brake switch
- ESP OFF switch

ESP HECU

Output

- Hydraulic unit
  - Integrated with HECU
- Warning Lamp
  - (ABS, EBD, ESP)
- Diagnosis
  - K-Line
- Function Lamp
  - (ESP)
- Wheel speed sensor output
- CAN
- ECU
- TCU
ESP OPERATION MODE

1. STEP 1
   The ESP analyzes the intention of the driver.
   
   Position of steering wheel
   + Vehicle speed
   + Acceleration pedal

   ECU decides the intention of the driver.

2. STEP 2
   It analyzes the movement of the ESP vehicle.
   
   Vehicle rotation speed
   + Operated power to the side

   ECU decides movement of the ESP vehicle.

3. STEP 3
   It controls a vehicle posture control through the ESP braking power.
   
   - The ECU calculates the needed countermeasure.
   - The hydraulic unit controls independently the braking power of each wheel.
   - The ESP adjusts an engine output through an engine and communication line to be connected.
ESP OPERATION MODE

1. ESP Non-operation-Normal braking.

<table>
<thead>
<tr>
<th>Inlet valve (EV)</th>
<th>Outlet valve (AV)</th>
<th>Pilot valve (USV)</th>
<th>High pressure switch valve (HSV)</th>
<th>Pump motor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal braking</td>
<td>Open</td>
<td>Close</td>
<td>Open</td>
<td>Close</td>
</tr>
</tbody>
</table>

ESP (ELECTRONIC STABILITY PROGRAM) SYSTEM
2. **ESP INCREASE MODE**

<table>
<thead>
<tr>
<th></th>
<th>Inlet valve(EV)</th>
<th>Outlet valve(AV)</th>
<th>Pilot valve(USV)</th>
<th>High pressure switch valve(HSV)</th>
<th>Pump motor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal braking</td>
<td>Open</td>
<td>Close</td>
<td>Close(Partial)</td>
<td>Open</td>
<td>ON(Motor speed control)</td>
</tr>
</tbody>
</table>
ESP (ELECTRONIC STABILITY PROGRAM) SYSTEM

3. ESP HOLD MODE (FR is only controlled.)

<table>
<thead>
<tr>
<th>Inlet valve (EV)</th>
<th>Outlet valve (AV)</th>
<th>Pilot valve (USV)</th>
<th>High pressure switch valve (HSV)</th>
<th>Pump motor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Close</td>
<td>Close</td>
<td>Close (Partial)</td>
<td>Open</td>
<td>ON (Motor low speed control)</td>
</tr>
</tbody>
</table>

Diagram: ESP Hold Mode Circuit Diagram.
4. ESP DECREASE MODE (FR is only controlled)

<table>
<thead>
<tr>
<th>Normal braking</th>
<th>Inlet valve (EV)</th>
<th>Outlet valve (AV)</th>
<th>Pilot valve (USV)</th>
<th>High pressure switch valve (HSV)</th>
<th>Pump motor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Close</td>
<td>Open</td>
<td>Close (Partial)</td>
<td>Open</td>
<td>ON (Motor low speed control)</td>
</tr>
</tbody>
</table>
COMPONENTS

ESP Control module (HECU)
- Yaw-late & lateral G sensor
- Front wheel speed sensor
- Steering wheel angle sensor
- Rear wheel speed sensor
- Parking/EBD warning lamp
- ESP OFF Warning lamp
- ESP Operation lamp
- ABS Warning lamp
ESP(ELECTRONIC STABILITY PROGRAM) SYSTEM

ESP CIRCUIT DIAGRAM(2)

- ESP CONTROL MODULE
- ESP UNIT
- Yaw rate sensor
- ACC.
- Lateral
- CAN (High)
- CAN (Low)
- Ground
- Yaw rate sensor signal
- Yaw rate sensor reference
- Yaw rate sensor test

Stop lampswitch

From Fuse 27(1)

See Stop Lamps

Closed with brake pedal depressed

A

Open with brake pedal depressed

B

High

Low

On/Start

Input

MachineSoft.com
09120146259
<table>
<thead>
<tr>
<th>Connector Terminal</th>
<th>Signal name</th>
<th>Specifications</th>
<th>Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1</strong> Ground(Pump)</td>
<td>GND</td>
<td>Current range : Min-10 A Max-20~39 A</td>
<td>Always</td>
</tr>
<tr>
<td><strong>4</strong> Ground(Valve,ECU)</td>
<td>GND</td>
<td>Current range : Min-2.5A Max-5~15A</td>
<td>Always</td>
</tr>
<tr>
<td><strong>2</strong> Supply voltage(Pump)</td>
<td>Vb MOTOR</td>
<td>Battery voltage</td>
<td>Always</td>
</tr>
<tr>
<td><strong>3</strong> Supply voltage(Valve)</td>
<td>Vb VALVE</td>
<td>Battery voltage</td>
<td>Always</td>
</tr>
<tr>
<td><strong>26</strong> Wheel sensor voltage(FL)</td>
<td>WP FL</td>
<td>Battery voltage</td>
<td>IG ON</td>
</tr>
<tr>
<td><strong>9</strong> Wheel sensor voltage(FR)</td>
<td>WP FR</td>
<td>Battery voltage</td>
<td>IG ON</td>
</tr>
<tr>
<td><strong>6</strong> Wheel sensor voltage(RL)</td>
<td>WP RL</td>
<td>Battery voltage</td>
<td>IG ON</td>
</tr>
<tr>
<td><strong>8</strong> Wheel sensor voltage(RR)</td>
<td>WP RR</td>
<td>Battery voltage</td>
<td>IG ON</td>
</tr>
<tr>
<td><strong>5</strong> Wheel sensor signal(FL)</td>
<td>WS FL</td>
<td>Battery voltage</td>
<td>IG ON</td>
</tr>
<tr>
<td><strong>10</strong> Wheel sensor signal(FR)</td>
<td>WS FR</td>
<td>Voltage(High) : 0.89<del>1.26 V Voltage(Low) : 0.44</del>0.63 V</td>
<td>RUNNING</td>
</tr>
<tr>
<td><strong>27</strong> Wheel sensor signal(RL)</td>
<td>WS RL</td>
<td>Voltage(High) : 0.89<del>1.26 V Voltage(Low) : 0.44</del>0.63 V</td>
<td>RUNNING</td>
</tr>
<tr>
<td><strong>29</strong> Wheel sensor signal(RR)</td>
<td>WS RR</td>
<td>Voltage(High) : 0.89<del>1.26 V Voltage(Low) : 0.44</del>0.63 V</td>
<td>RUNNING</td>
</tr>
<tr>
<td><strong>11</strong> Diagnosis Input/output</td>
<td>DIAG’K’</td>
<td>Voltage(High) : 0.8 * IG ON more Voltage(Low) : 0.2 * IG ON lower</td>
<td>HI-SCAN Communication</td>
</tr>
<tr>
<td><strong>28</strong> Ignition</td>
<td>IG.KEY</td>
<td>Battery voltage</td>
<td>KEY ON/OFF</td>
</tr>
<tr>
<td><strong>31</strong> ESP Passive switch</td>
<td>ESP Passive switch</td>
<td>Voltage(High) : 0.6 * IG ON more Voltage(Low) : 0.4 * IG ON lower</td>
<td>Switch ON/OFF</td>
</tr>
<tr>
<td><strong>36</strong> Hand brake switch</td>
<td>Hand brake switch</td>
<td>Voltage(High) : 0.7 * IG ON more Voltage(Low) : 0.3 * IG ON lower</td>
<td>Switch ON/OFF</td>
</tr>
<tr>
<td><strong>37</strong> Yaw Rate Sensor Test</td>
<td>Yaw Rate Sensor Test</td>
<td>Voltage(High) : 4.1 V more Voltage(Low) : 1 V lower</td>
<td>IG ON</td>
</tr>
<tr>
<td><strong>18</strong> Yaw Rate Sensor Reference</td>
<td>Yaw Rate Sensor Reference</td>
<td>Offset voltage :2.5 V range : 0.35 V ~ 4.65 V(-100~100 ° /s)</td>
<td>IG ON</td>
</tr>
<tr>
<td><strong>16</strong> Yaw Rate Sensor Signal</td>
<td>Yaw Rate Sensor Signal</td>
<td>Offset voltage :2.5 V range : 0.35 V ~ 4.65 V(-1.8g ~ 1.8g)</td>
<td>IG ON</td>
</tr>
<tr>
<td><strong>20</strong> Acceleration Sensor Signal</td>
<td>Acceleration Sensor Signal</td>
<td>Offset voltage :2.5 V range : 0.35 V ~ 4.65 V(-1.8g ~ 1.8g)</td>
<td>IG ON</td>
</tr>
<tr>
<td><strong>15</strong> Yaw Rate Sensor Ground</td>
<td>Yaw Rate Sensor Ground</td>
<td>GND LEVEL</td>
<td>Always</td>
</tr>
<tr>
<td>No</td>
<td>Description</td>
<td>Signal name</td>
<td>Specifications</td>
</tr>
<tr>
<td>----</td>
<td>-------------------</td>
<td>-----------------</td>
<td>----------------------------------------------------</td>
</tr>
<tr>
<td>35</td>
<td>CAN High</td>
<td>CAN High</td>
<td>not communication: 2.5 ± 0.5 V</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>communication: [Volts]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Bus Level</td>
</tr>
<tr>
<td>14</td>
<td>CAN Low</td>
<td>CAN Low</td>
<td>recessive, dominant, recessive, recessive</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Time</td>
</tr>
<tr>
<td>30</td>
<td>BRAKE LIGHT SWITCH</td>
<td>BRAKE LIGHT SWITCH</td>
<td>voltage(High) : 0.8 * IG ON more</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>voltage(Low) : 0.3 * IG ON lower</td>
</tr>
</tbody>
</table>
# NF ABS/ESP Sensor Output List

<table>
<thead>
<tr>
<th>No.</th>
<th>DISPLAY (Hi-DS Scanner)</th>
<th>Abbreviation</th>
<th>Unit</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ENGINE SPEED</td>
<td>ENG. SPD</td>
<td>RPM</td>
<td>ESP ONLY</td>
</tr>
<tr>
<td>2</td>
<td>VEHICLE SPEED</td>
<td>VEH. SPD</td>
<td>Km/h</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>THROTTLE P. SNSOR</td>
<td>TP. SNSR</td>
<td>%</td>
<td>ESP ONLY</td>
</tr>
<tr>
<td>4</td>
<td>SHIFT LEVER POSITION</td>
<td>SHIFT POSI.</td>
<td>-</td>
<td>ESP ONLY</td>
</tr>
<tr>
<td>5</td>
<td>BATTERY VOLTAGE</td>
<td>BATT. VOL</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>WHEEL SPEED SNSR-FL</td>
<td>FL WHEEL</td>
<td>Km/h</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>WHEEL SPEED SNSR-FR</td>
<td>FR WHEEL</td>
<td>Km/h</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>WHEEL SPEED SNSR-RL</td>
<td>RL WHEEL</td>
<td>Km/h</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>WHEEL SPEED SNSR-RR</td>
<td>RR WHEEL</td>
<td>Km/h</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>ABS WARNING LAMP</td>
<td>ABS LAMP</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>EBD WARNING LAMP</td>
<td>EBD LAMP</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>ESP FUNCTION LAMP</td>
<td>ESP LAMP</td>
<td>-</td>
<td>ESP ONLY</td>
</tr>
<tr>
<td>13</td>
<td>ESP OFF LAMP</td>
<td>ESP OFF</td>
<td>-</td>
<td>ESP ONLY</td>
</tr>
<tr>
<td>14</td>
<td>ESP OFF SWITCH</td>
<td>ESP SW</td>
<td>-</td>
<td>ESP ONLY</td>
</tr>
<tr>
<td>15</td>
<td>BRAKE LAMP SWITCH</td>
<td>B/LAMP</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>PUMP RELAY STATE</td>
<td>PUMP RLY</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>VALVE RELAY STATE</td>
<td>VALVE RLY</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>MOTOR</td>
<td>MOTOR</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>FL VALVE (IN)</td>
<td>FL INLET</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>FR VALVE (IN)</td>
<td>FR INLET</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>RL VALVE (IN)</td>
<td>RL INLET</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>RR VALVE (IN)</td>
<td>RR INLET</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>FL VALVE (OUT)</td>
<td>FL OUTLET</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>FR VALVE (OUT)</td>
<td>FR OUTLET</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>RL VALVE (OUT)</td>
<td>RL OUTLET</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>RR VALVE (OUT)</td>
<td>RR OUTLET</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>TCS VALVE (USV)1</td>
<td>USV1</td>
<td>-</td>
<td>ESP ONLY</td>
</tr>
<tr>
<td>28</td>
<td>TCS VALVE (USV)1</td>
<td>USV2</td>
<td>-</td>
<td>ESP ONLY</td>
</tr>
<tr>
<td>29</td>
<td>ESP VALVE (HSV)1</td>
<td>HSV1</td>
<td>-</td>
<td>ESP ONLY</td>
</tr>
<tr>
<td>30</td>
<td>ESP VALVE (HSV)2</td>
<td>HSV2</td>
<td>-</td>
<td>ESP ONLY</td>
</tr>
<tr>
<td>31</td>
<td>STEERING ANGLE SNSR</td>
<td>SAS</td>
<td>deg</td>
<td>-720 ~ 720° (ESP ONLY)</td>
</tr>
<tr>
<td>32</td>
<td>YAW RATE SNSR-LATERAL</td>
<td>LATERAL</td>
<td>g</td>
<td>-1.8 ~ 1.8 G (ESP ONLY)</td>
</tr>
<tr>
<td>33</td>
<td>YAW RATE SNSR-YAW</td>
<td>YAW</td>
<td>deg/S</td>
<td>-200 ~ 200 deg/s (ESP ONLY)</td>
</tr>
<tr>
<td>34</td>
<td>PRESSURE SENSOR</td>
<td>PRES. SNSR</td>
<td>bar</td>
<td>-42.5 ~ 425 bar (ESP ONLY)</td>
</tr>
<tr>
<td>35</td>
<td>PARKING BRAKE SIGNAL</td>
<td>P/ BRAKE</td>
<td>-</td>
<td>ESP ONLY</td>
</tr>
<tr>
<td>36</td>
<td>SAS CALIBRATED</td>
<td>SAS CALI.</td>
<td>-</td>
<td>ESP ONLY</td>
</tr>
<tr>
<td>37</td>
<td>YAW RATE SENSOR TEST PASSED</td>
<td>YAW TEST</td>
<td>-</td>
<td>ESP ONLY</td>
</tr>
</tbody>
</table>

*ESP (Electronic Stability Program)*
FAILURE DIAGNOSIS

1. In principle, ESP and TCS controls are prohibited in case of ABS failure.
2. When ESP or TCS fails, only the failed system control is prohibited.
3. However, when the solenoid valve relay should be turned off in case of ESP failure, refer to the ABS fail-safe.
4. Information on ABS fail-safe is identical to the fail-safe in systems where 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 5 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 failure 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. ESP operation lamp turns on when ESP is fail.

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

DESCRIPTION

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.
3. The sensor is located in the crash pad lower floor on vehicle.

SPECIFICATION

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>SPECIFICATION</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal supply voltage</td>
<td>11.5 ~ 12.5 V</td>
<td></td>
</tr>
<tr>
<td>Supply voltage range</td>
<td>8 ~ 16 V</td>
<td></td>
</tr>
<tr>
<td>Supply current</td>
<td>Max. 120 mA Typ. 75 mA</td>
<td></td>
</tr>
<tr>
<td>Reference Voltage Output</td>
<td>2.464 ~ 2.536 V Typ. 2.5 V</td>
<td></td>
</tr>
<tr>
<td>Operating temperature range</td>
<td>-40 ~ 85 °C</td>
<td></td>
</tr>
</tbody>
</table>

yaw-late sensor

<table>
<thead>
<tr>
<th>Measurement range</th>
<th>SPECIFICATION</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>+w direction, left turn</td>
<td>Min.100 °/s Typ. 111°/S</td>
<td></td>
</tr>
<tr>
<td>-w direction, right turn</td>
<td>Min.100 °/s Typ. 111°/S</td>
<td></td>
</tr>
<tr>
<td>Non-linearity</td>
<td>-1 ~ 1 %</td>
<td></td>
</tr>
<tr>
<td>Offset (within life,within operating temperature)</td>
<td>3.75 °/S</td>
<td></td>
</tr>
<tr>
<td>Upper cut-off frequency</td>
<td>Min. 45 Hz Typ. 60 Hz</td>
<td></td>
</tr>
</tbody>
</table>

Lateral G sensor

<table>
<thead>
<tr>
<th>Measurement range</th>
<th>SPECIFICATION</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>+y direction, left turn</td>
<td>Min.1.8 g Typ. 2 g</td>
<td></td>
</tr>
<tr>
<td>-y direction, right turn</td>
<td>Min. -1.8 g Typ. 2 g</td>
<td></td>
</tr>
<tr>
<td>Non-linearity</td>
<td>-4 ~ 4 %</td>
<td></td>
</tr>
<tr>
<td>Offset (within life,within operating temperature)</td>
<td>-0.09 ~ 0.09 g</td>
<td></td>
</tr>
<tr>
<td>Upper cut-off frequency</td>
<td>Min. 20 Hz Typ. 40 Hz</td>
<td></td>
</tr>
</tbody>
</table>
OUTPUT CHARACTERISTIC

- Yaw-rate $w$ in $\text{rad/s}$
- Acceleration $a$ in $\text{g}$

CIRCUIT DIAGRAM (YAW-RATE & LATERAL G SENSOR)

- ESP HECU Yaw-rate & lateral G sensor
- [Yaw-rate & lateral G sensor connector]
ESP SWITCH

DESCRIPTION

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

1. Remove the ESP OFF switch from the switch panel on the crushpad of the driver’s side.
2. Check the continuity between the switch terminals as the ESP OFF switch is engaged.

<table>
<thead>
<tr>
<th>Position</th>
<th>Terminal</th>
</tr>
</thead>
<tbody>
<tr>
<td>ON</td>
<td>2 5 3 4</td>
</tr>
<tr>
<td>OFF</td>
<td></td>
</tr>
</tbody>
</table>
STEERING WHEEL ANGLE SPEED SENSOR

DESCRIPTION

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 (Multifunction Switch) under the steering wheel.

GENERAL DATA

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 (Multifunction Switch) under the steering wheel.

MEASUREMENT PRINCIPLE

A non-contact, analog angle sensor carrying out absolute measuring by the use of the Anisotropic-Magneto-Resistive effect (AMR). Measuring of the absolute angle by means of a toothed measuring gear with magnetic properties in combination with different ratios. Corresponding AMR elements that change their electrical resistance according to the magnetic field direction detect the angle position of the measuring gears. A micro-controller decodes the measured voltage signals after A/D converting with the help of a mathematical function. Output of the digital angle value and velocity via CAN-interface.

SPECIFICATION

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>SPECIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating voltage</td>
<td>8 ~ 16 V</td>
</tr>
<tr>
<td>Operating temperature</td>
<td>-40 ~ 85 °C</td>
</tr>
<tr>
<td>Current consumption</td>
<td>Max. 150 mA</td>
</tr>
<tr>
<td>Steering angle velocity</td>
<td>Max. ±2000 °/sec</td>
</tr>
<tr>
<td>Connection delay time</td>
<td>t ≤ 200 ms</td>
</tr>
<tr>
<td>Reverse voltage</td>
<td>-13.5 V</td>
</tr>
<tr>
<td>Measuring range Angle</td>
<td>-780 ° ~ 779 °</td>
</tr>
<tr>
<td>Angular velocity</td>
<td>0 ~ 1016 °/s</td>
</tr>
<tr>
<td>Nonlinearity angle</td>
<td>-2.5 ° ~ +2.5 °</td>
</tr>
<tr>
<td>Hysteresis angle</td>
<td>0 ° ~ 5 °</td>
</tr>
<tr>
<td>Rotational friction torque measuring</td>
<td>10 °/s</td>
</tr>
</tbody>
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CIRCUIT DIAGRAM (STEERING WHEEL SPEED ANGLE SENSOR)
STEERING ANGLE SENSOR (SAS) CALCULATION

1. PURPOSE OF CALCULATION
   - On vehicle control, a ESP analyzes the intention of the driver.
   - A ESP recognizes a steering angle which a driver rotates through the steering angle sensor.
   - A steering angle sensor used in ESP8 adjusts 0° setting of steering wheel through K-line or CAN communication.

2. STEERING ANGLE SENSOR (SAS) CALIBRATION METHOD

   1) Align the wheel to the straight line. (steering wheel $\pm 5^\circ$)
      ex) Perform the wheel alignment first.
      Align the wheel to the straight line.
      A driver moves the vehicle to the front and back about 5 meters twice or three times.

   2) Connect Hi-scan to the vehicle.

   3) Select Brake system.

   4) Select Steering angle sensor(SAS) calculation.

   5) Perform the Steering angle sensor(SAS) calculation.

   6) Scanner OFF.

   7) Remove the scanner from the vehicle.

   8) Confirm the Steering angle sensor(SAS) calculation as driving the vehicle. (turn left once, turn right once)