ESP(Electronic Stability Program) SYSTEM

4892-01

GENERAL

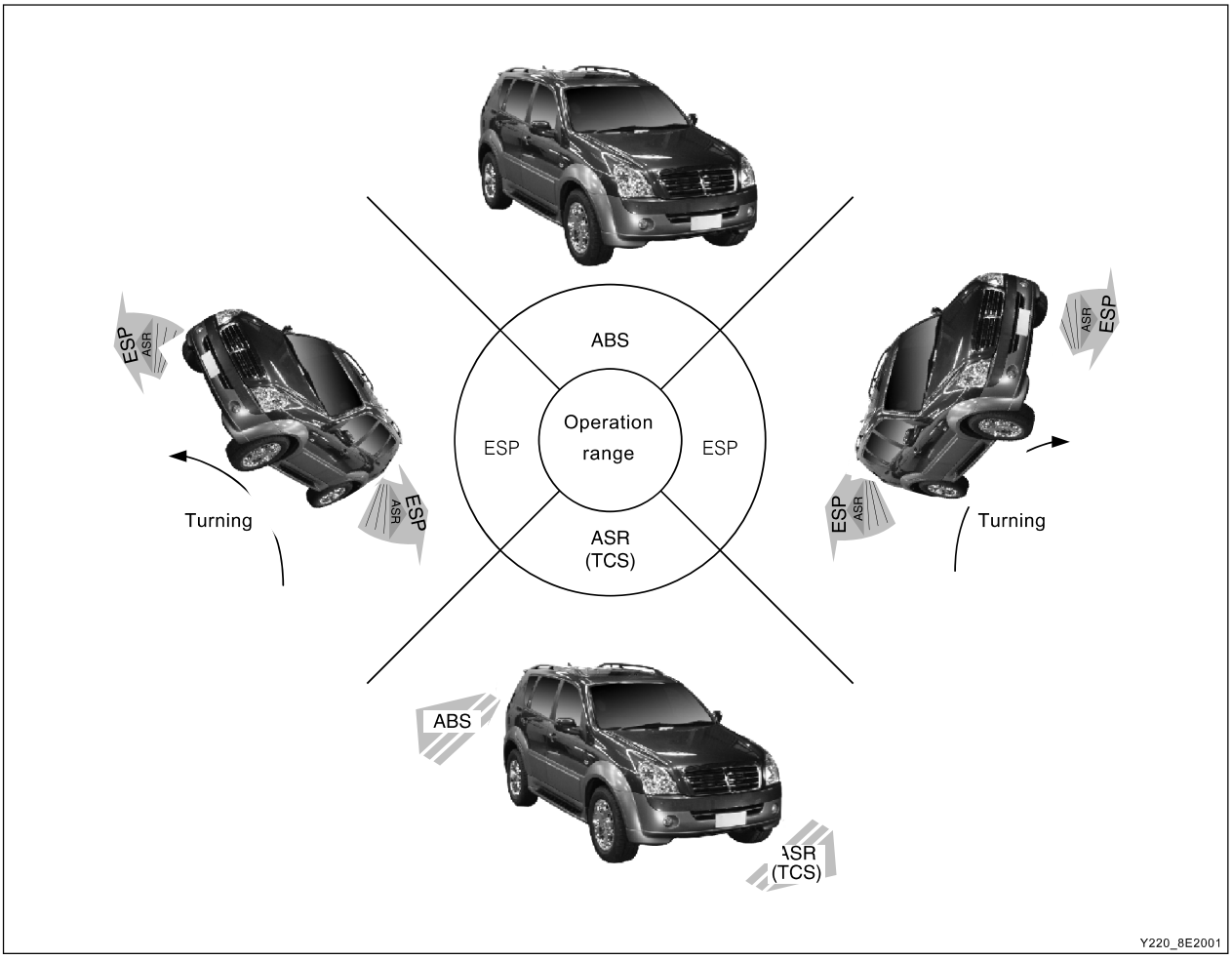
1. SPECIFICATIONSS

Name	Specifications		Reference
	ABS	ESP	
HECU	CPU: MCU60 (32 bit) Clock Frequency: 28 MHz Memory: 128 ~ 256 KB Switched Orifice	CPU: MCU60 (32 bit) Clock Frequency: 33 MHz Memory: 256 ~ 512 KB Switched Orifice	
Wheel speed sensor	Active Type	Active Type	Output: 7 ~ 14 mA
Steering wheel angle sensor	N/A	Maximum angular velocity: 1500°/Sec Working voltage: 9 ~ 12 V	Pulse duty: 50 ± 10 %
Sensor cluster	N/A	2WD: Yaw rate sensor + Lateral sensor 4WD: Yaw rate sensor + Lateral sensor + Longitudinal sensor	Directional (CAN communication)
Longitudinal accel-eration sensor	Integrated into HECU		
Pressure sensor	N/A	Analog Output	

OVERVIEW AND OPERATION PROCESS

1. SUMMARY

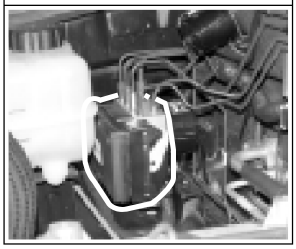
ESP (Electronic Stability Program) recognizes critical driving conditions, such as panic reactions in dangerous situations, and stabilizes the vehicle by wheel-individual braking and engine control intervention with no need for actuating the brake. This system is developed to help the driver avoid the danger of losing the control of the vehicle stability due to under-steering or over-steering during cornering. The yaw rate sensor, lateral sensor and longitudinal sensor in the sensor cluster and the steering wheel angle sensor under the steering column detect the spin present at any wheels during over-steering, under-steering or cornering. The ESP ECU controls against over-steering or under-steering during cornering by controlling the vehicle stability using the input values from the sensors and applying the brakes independently to the corresponding wheels. The system also controls during cornering by detecting the moment right before the spin and automatically limiting the engine output (coupled with the ASR system).



Modification basis	
Application basis	
Affected VIN	

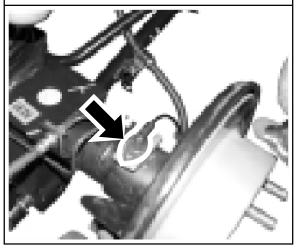
2. COMPONENTS LOCATION

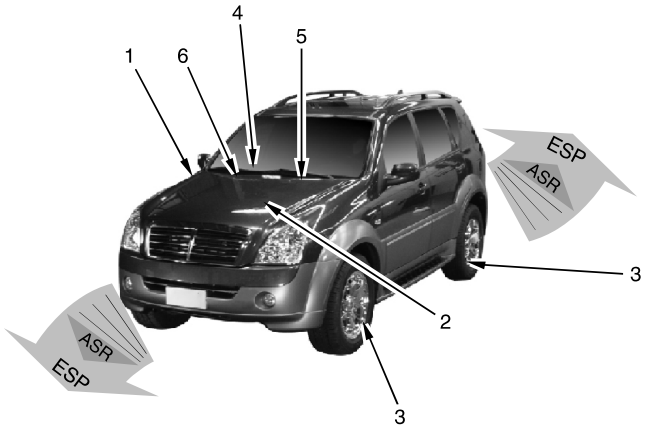
1. HECU



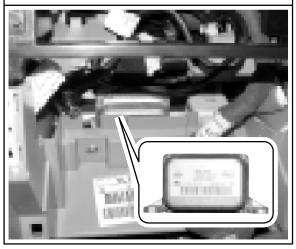
2. Pressure sensor

3. Wheel speed sensor

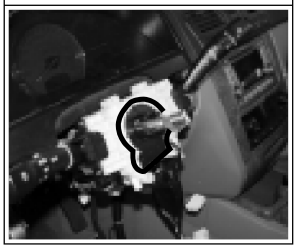




4. Sensor cluster



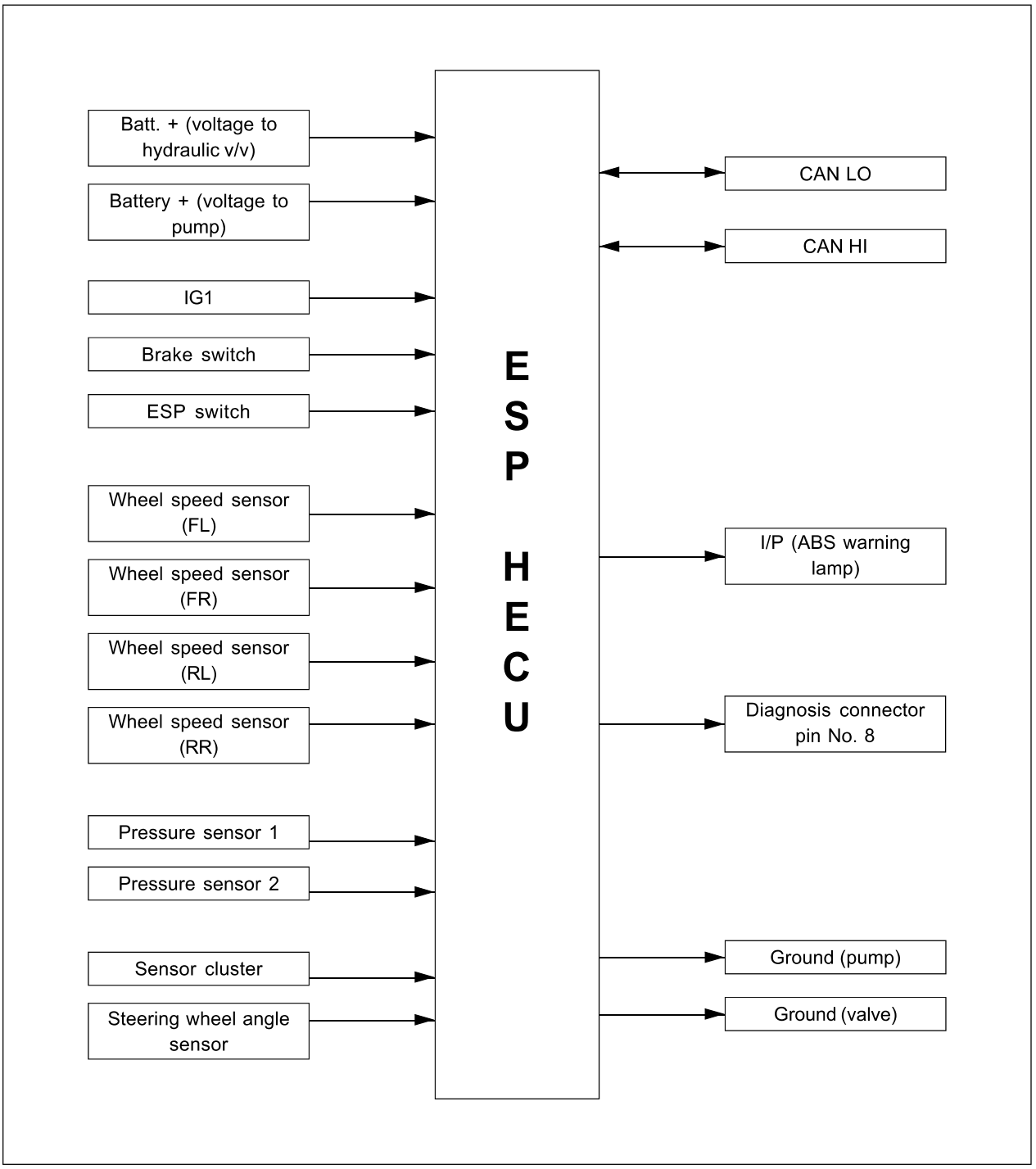
5. Steering wheel angle sensor



6. ESP OFF switch

	Name	Location
1	HECU	In front of RH dash panel in engine compartment
2	Pressure sensor	Under master cylinder (two)
3	Wheel speed sensor	Active wheel speed sensor (four)
4	Sensor cluster	Under center audio (directional)
5	Steering wheel angle sensor	Inside multifunction switch
6	ESP OFF switch	In center instrument panel

3. INPUT AND OUTPUT DIAGRAM OF ESP UNIT



Modification basis	
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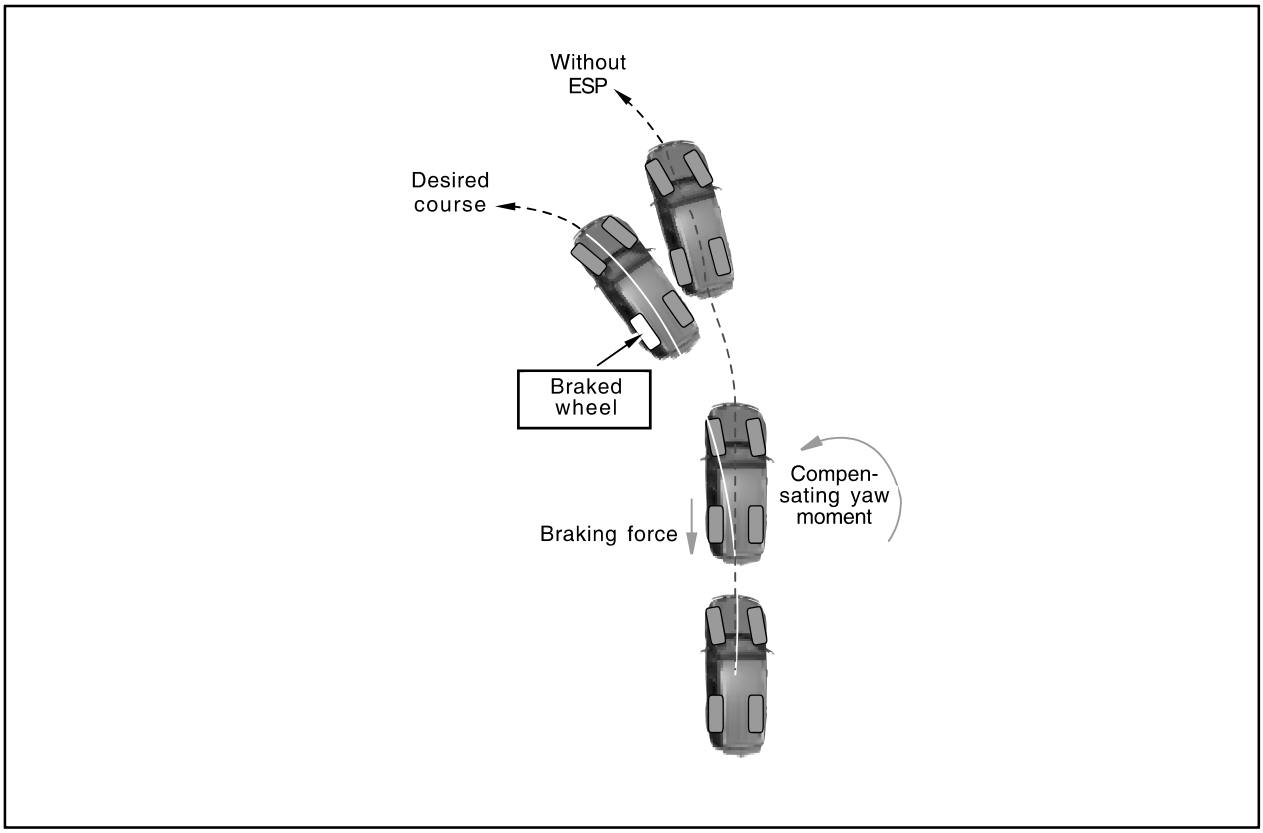
Affected VIN	

4. ESP CONTROL

The ESP system includes the ABS/EBD and ASR systems allowing the system to be able to operate depending to the vehicle driving conditions. For example, when the brakes are applied during cornering at the speed of 100 km/h, the ABS system will operate at the same time the ASR or ABD systems operate to reduce the power from the slipping wheel. And when yaw rate sensor detects the rate exceeding 4¡Æ/seconds, the ESP system is activated to apply the brake force to the corresponding wheel to compensate the yaw moment with the vehicle stability control function. When various systems operate simultaneously under a certain situation, there may be vehicle control problems due to internal malfunction of a system or simultaneous operations. In order to compensate to this problem, the ESP system sets the priority among systems. The system operates in the order of TCS (ASR or ABD), ESP and ABS. The order may be changed depending on the vehicle driving situations and driving conditions. As the single-track vehicle model used for the calculations is only valid for a vehicle moving forward, ESP intervention never takes place during backup.

1) Understeering



Modification basis	
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▶Understeering

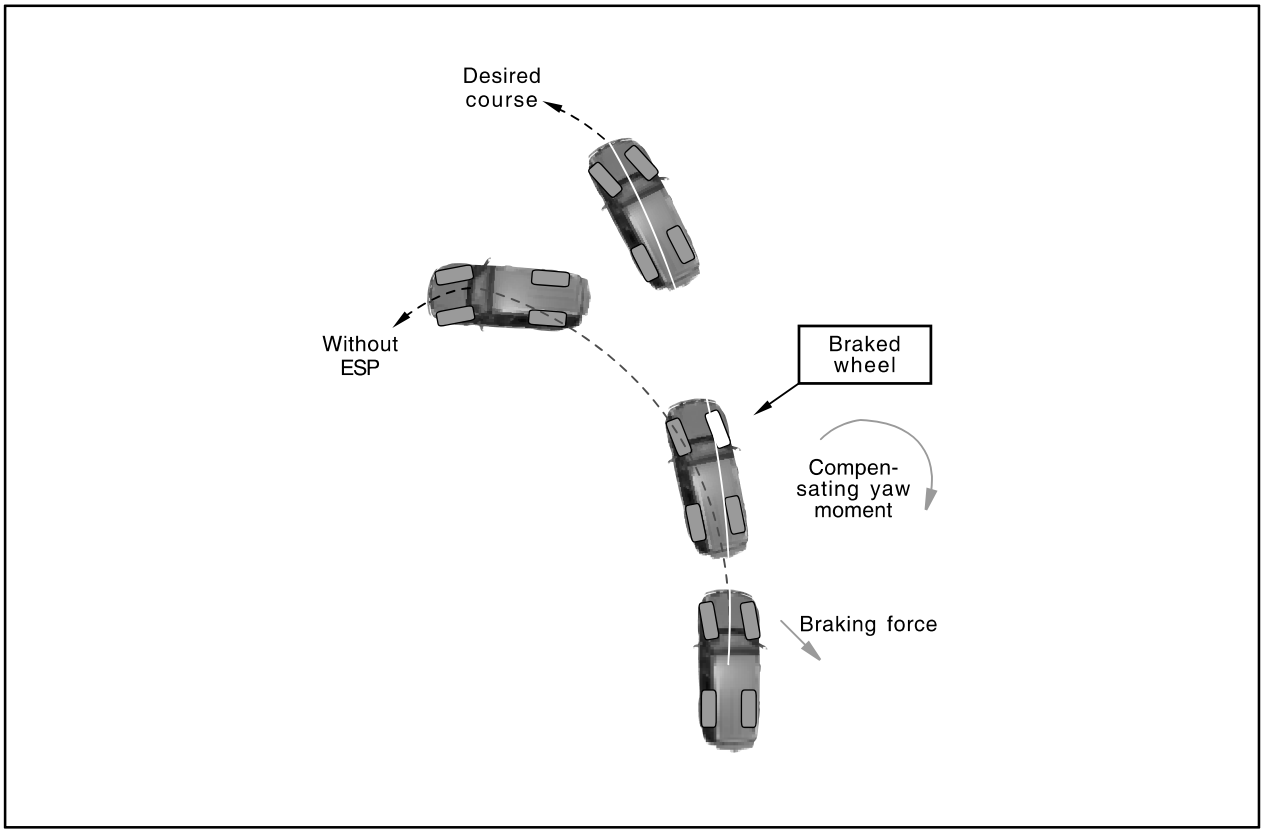
Understeering is when the steering wheel is steered to a certain angle during driving and the front tires slip toward the reverse direction of the desired direction. Generally, vehicles are designed to have under steering. The vehicle can return back to inside of cornering line when the steering wheel is steered toward the inside even when the vehicle front is slipped outward. As the centrifugal force increases, the tires can easily lose the traction and the vehicle tends to slip outward when the curve angle gets bigger and the speed increases.

▶ESP controls during under steering

The ESP system recognizes the directional angle with the steering wheel angle sensor and senses the slipping route that occurs reversely against the vehicle cornering direction during understeering with the yaw rate sensor and the lateral sensor. Then the ESP system applies the brake at the rear inner wheel to compensate the yaw moment value. In this way, the vehicle does not lose its driving direction and the driver can steer the vehicle as driver intends.

Modification basis	
Application basis	
Affected VIN	

2) Oversteering



▶Oversteering

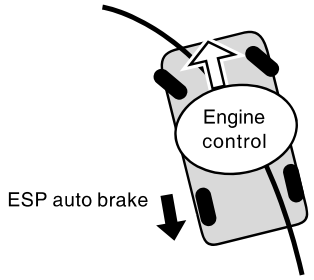
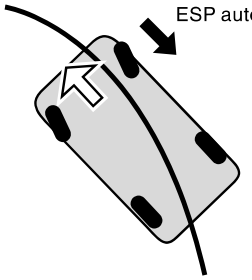
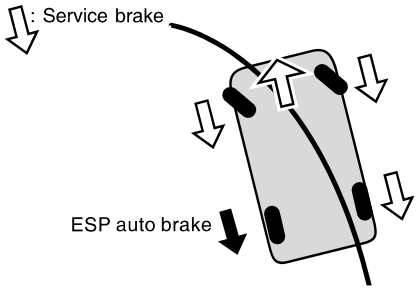
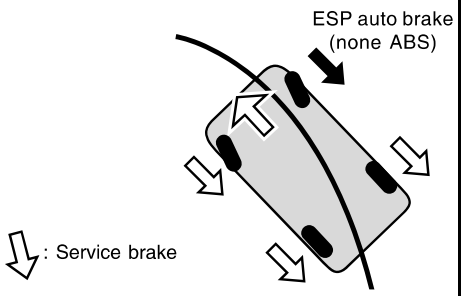
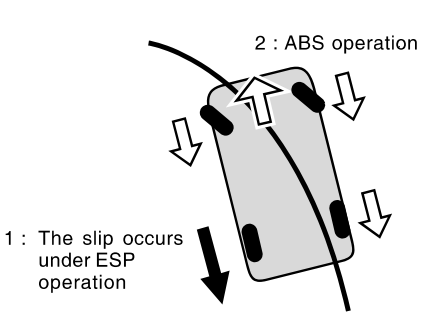
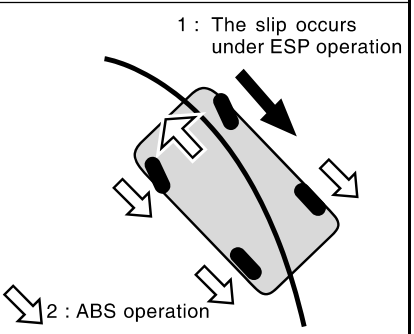
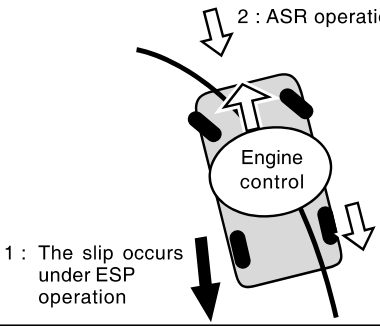
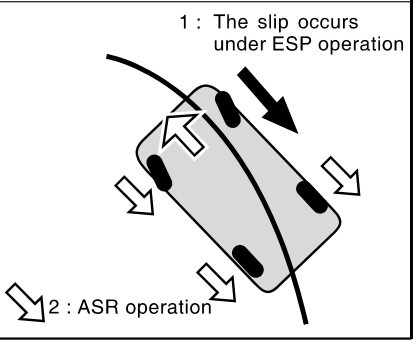
Oversteering is when the steering wheel is steered to a certain angle during driving and the rear tires slip outward losing traction. When compared with under steering vehicles, the controlling of the vehicle is difficult during cornering and the vehicle can spin due to rear wheel moment when the rear tires lose traction and the vehicle speed increases.

▶ESP controls during oversteering

The ESP system recognizes the directional angle with the steering wheel angle sensor and senses the slipping route that occurs towards the vehicle cornering direction during oversteering with the yaw rate sensor and the lateral sensor.
Then the ESP system applies the brake at the front outer wheel to compensate the yaw moment value. In this way, the vehicle does not lose its driving direction and the driver can steer the vehicle as he or she intends.

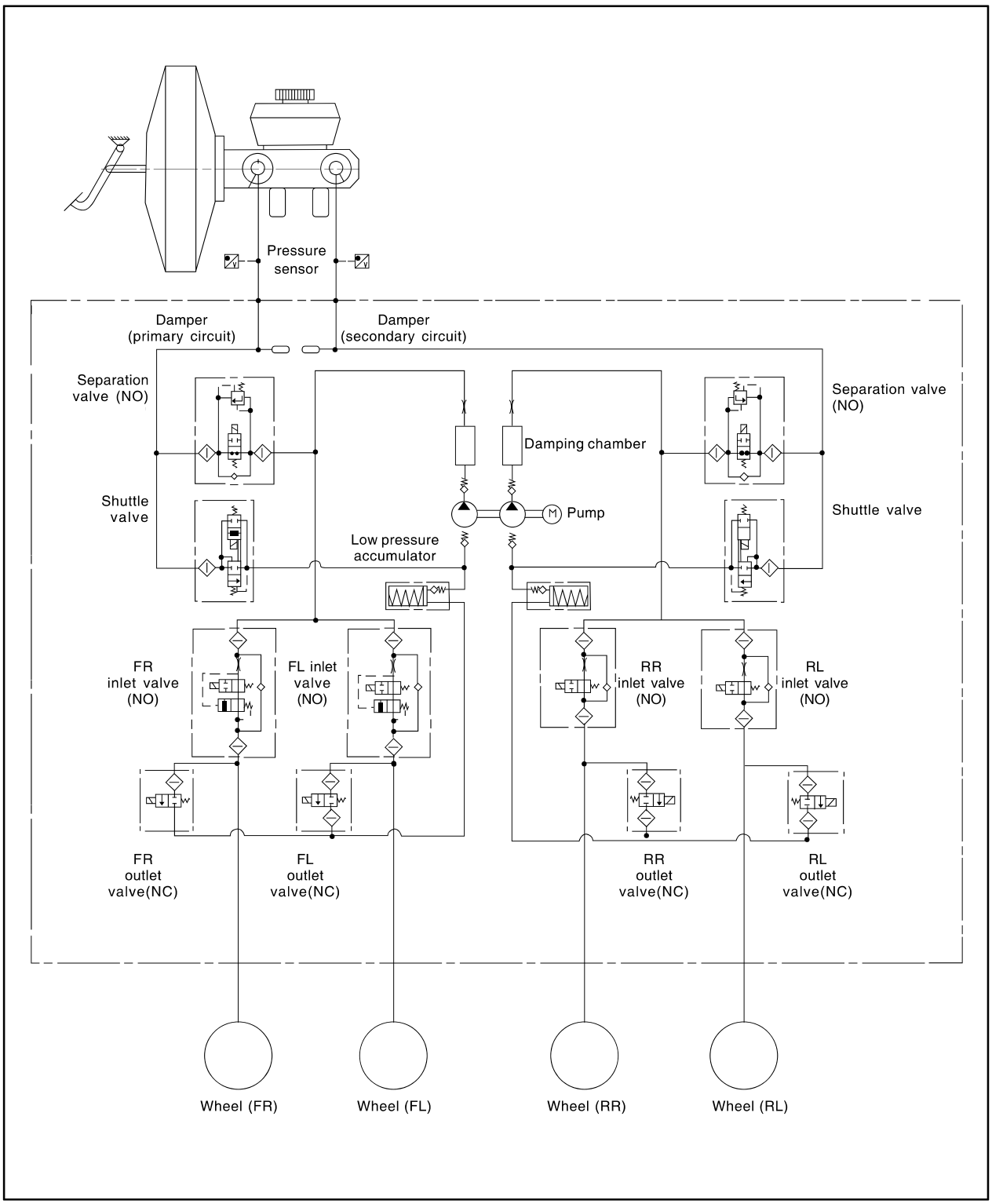
3) Vehicle Control During Cornering

The figure below shows the vehicle controls by ESP system under various situations such as when the brake pedal is pressed (or not pressed) during cornering and when the ABS is operating or when just the conventional brake is operating during braking. It also includes the vehicle conditions when the TCS that is included in the ESP system is operating.

Operations	Understeering Control	Oversteering Control
Only ESP operating No braking by driver		
ESP + Conventional brake (ABS not operating)		
ESP + ABS brake		
ESP + ASR		

Modification basis	
Application basis	
Affected VIN	

5. HYDRAULIC DIAGRAM OF ESP



Modification basis	
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When equipped with ABS, the braking force at each wheel will be controlled with 3-channel 4-sensor method. And when equipped with ESP, 4 wheels will be controlled independently with 4-channel method. (When controlling ABS system only, it will be operated with 3-channel method.) When compared to the vehicle equipped with ABS/EBD only, the internal hydraulic circuit has a normally-open separation valve and a shuttle valve in primary circuit and in secondary circuit. When the vehicle brakes are not applied during engine running or when applying the non-ABS operating brakes, the normally-open separation valve and the inlet valve are open, whereas the normally-closed shuttle valve and the outlet valve are closed. When the ESP system is operating, the normally-open separation valve will be closed by the solenoid valve operation and the hydraulic circuit will be established by the shuttle valve. Then, the inlet and outlet valves will be closed or open depending on the braking pressure increase, decrease or unchanged conditions. For details, refer to "Hydraulic circuit by ESP operation range".

▶The warning lamp comes on and warning beep sounds when the ESP is operating

When the ESP operates during vehicle movement, the ESP warning lamp on the instrument panel flickers and beep comes on every 0.1 seconds. The ESP operation shows that the vehicle stability is extremely unstable and it is used to warn the driver. The ESP system is just a supplementary system for the vehicle motion and it cannot control the vehicle when it exceeds the physical limits. Do not solely rely on the system but be advised to drive the vehicle safely.

▶Driving feeling when the ESP is operating

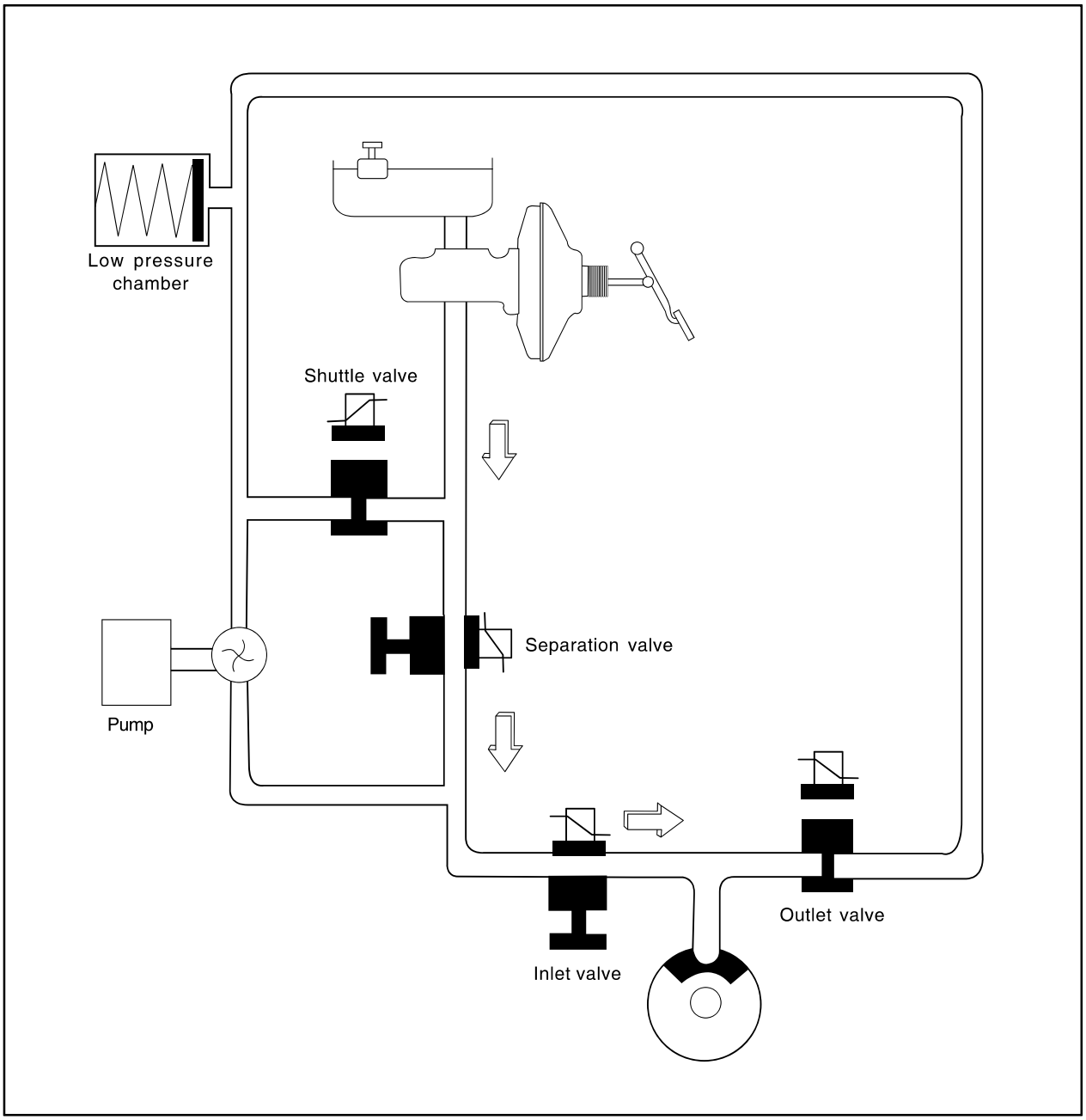
When the ESP system activates, the driving feeling can be different depending on vehicle driving conditions. For example, you will feel differently when the ESP system is activated during when ABS is operating with the brakes applied and when brakes are not applied on a curve. Thus, the ESP system would make the driver feel more abruptly when the brakes are applied during the ESP system activation.

▶Noise and vibration that driver senses when the ESP is operating

The ESP system may transfer noise and vibration to the driver due to the pressure changes caused by the motor and valve operations in a very short period of time. Extreme cornering will trigger the ESP operation and this will make the driver feel noise and vibration due to sudden brake application. Also, the ESP system controls the engine output. So, the driver may notice the engine output decrease even when the accelerator pedal is being applied.

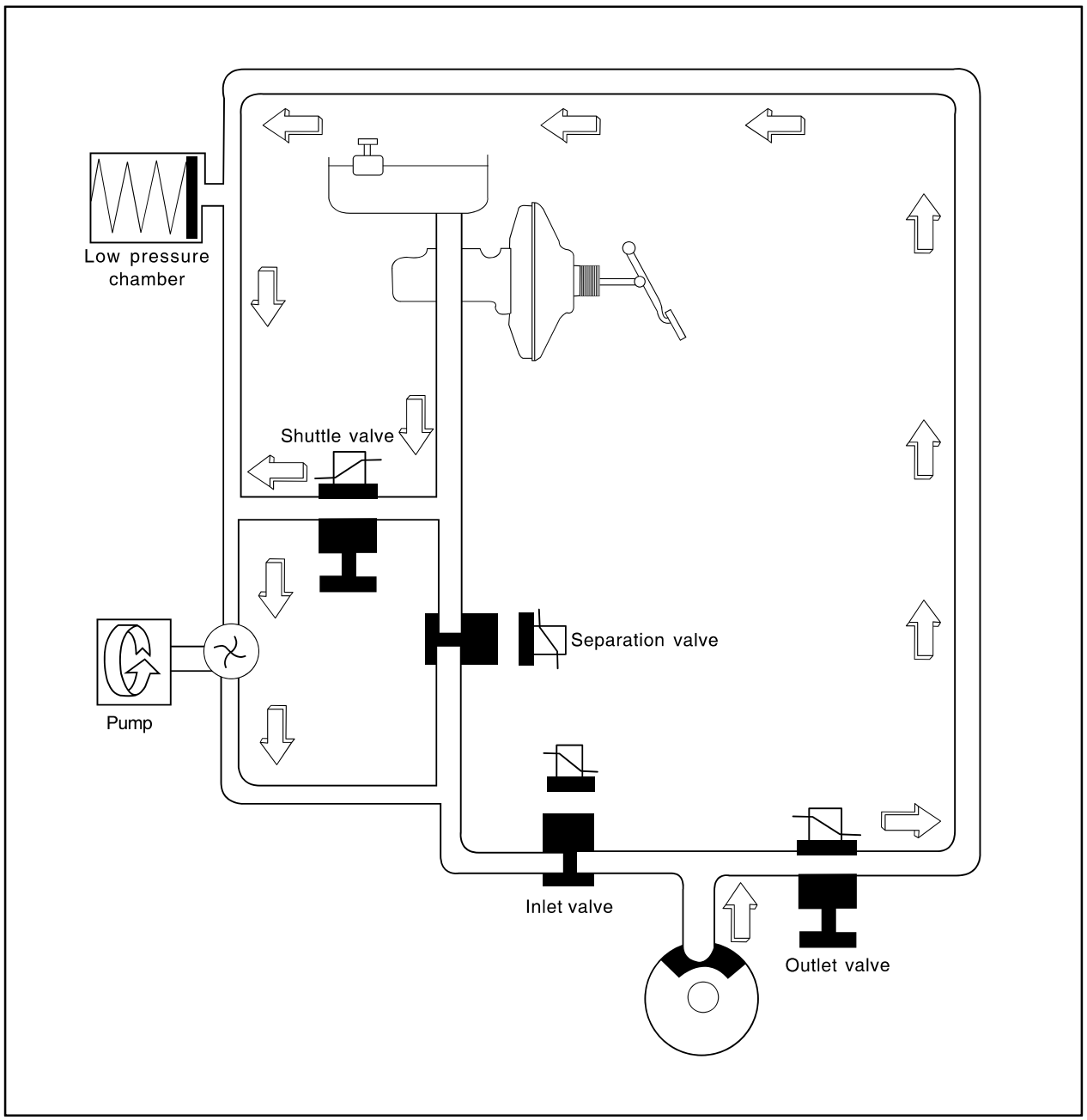
Modification basis	
Application basis	
Affected VIN	

1) ESP HYDRAULIC UNIT IN IDLING AND NORMAL BRAKING POSITION



In this position, the separation valve and the inlet valve are open (normal open), the electrically operated shuttle valve and the outlet valve are closed. When the brake is applied under these conditions, the brake fluid will be sent to each wheel via the separation valve and inlet valve.

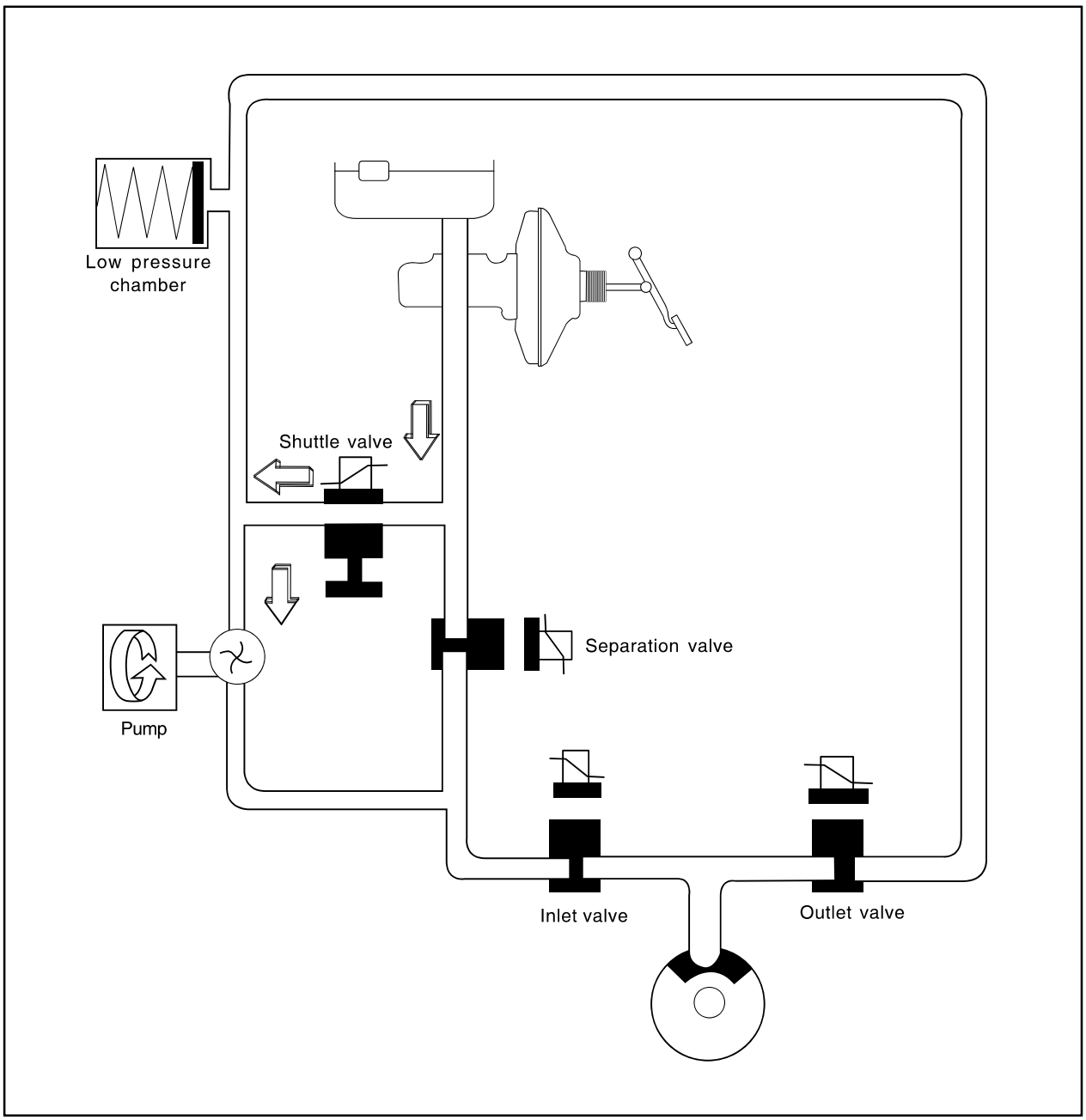
2) When applied ABS (decreased pressure)



The pressure decreases just before the wheel speed drops and the wheels. The inlet valve closes and the outlet valve opens as in the ABS HECU and the oil is gathered at the low pressure chamber while no additional oil is being supplied. Then the pump operates to allow fast oil drainage .

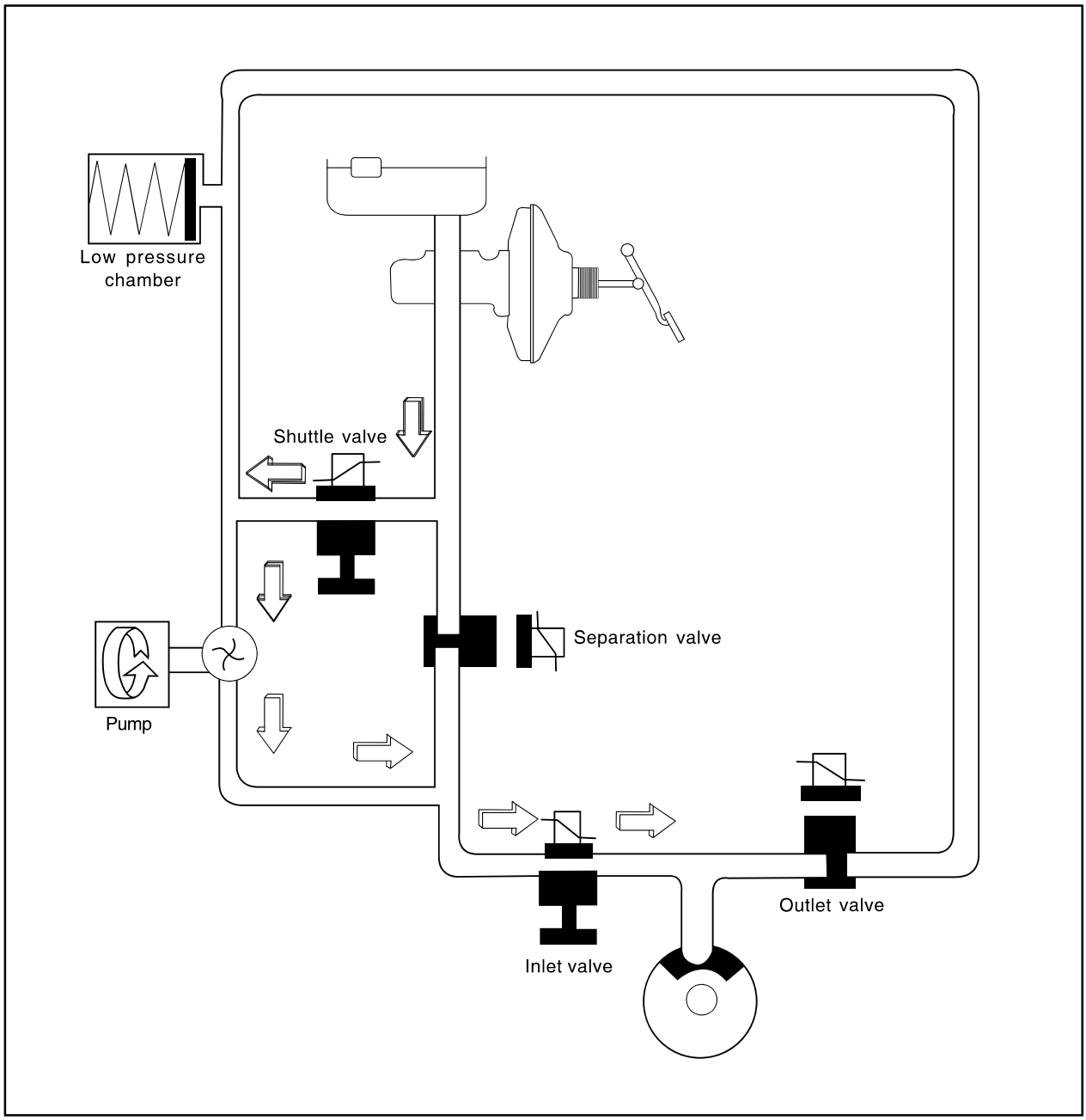
Modification basis	
Application basis	
Affected VIN	

3) When applied ABS (maintained pressure)



The Inlet valve and outlet valve will be closed to maintain the pressure in the hydraulic circuit applied at the wheels. By closing the valves, the hydraulic pressure at the wheels will not be lost or supplied any more. During ESP operation, the separation valve closes and only the shuttle valve at the pump opens.

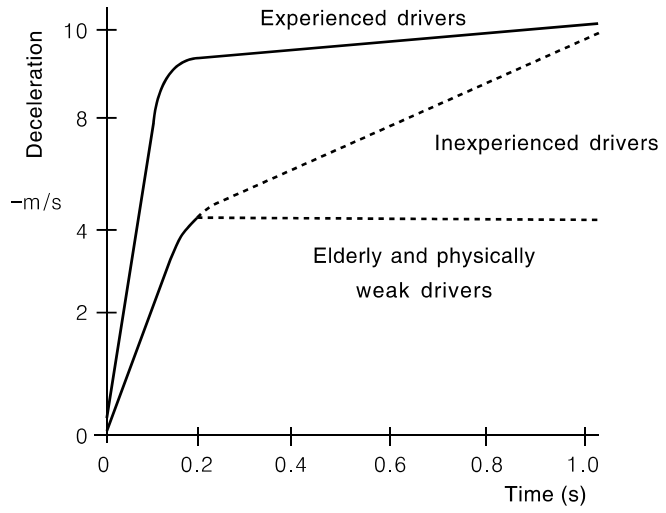
4) When applied ABS (increased pressure)



The shuttle valve and inlet valve will be open and the separation valve and outlet valve will be closed. Then, the pump is operated.
When ESP operates while the ABS is operating, the pressure will be increased continuously until just before the corresponding wheel gets locked.

Modification basis	
Application basis	
Affected VIN	

6. HBA (Hydraulic Brake Assist System)



1) Purpose

HBA (Hydraulic Brake Assist) system helps in an emergency braking situation when the driver applies the brake fast, but not with sufficient pressure, which leads to dangerously long braking distance. ECU recognizes the attempt at full braking and transmits the signal calling for full brake pressure from the hydraulic booster. An inexperienced, elderly or physically weak driver may suffer from the accident by not fully pressing the brake pedal when hard braking is required under emergency. The HBA System increases the braking force under urgent situations to enhance the inputted braking force from the driver.

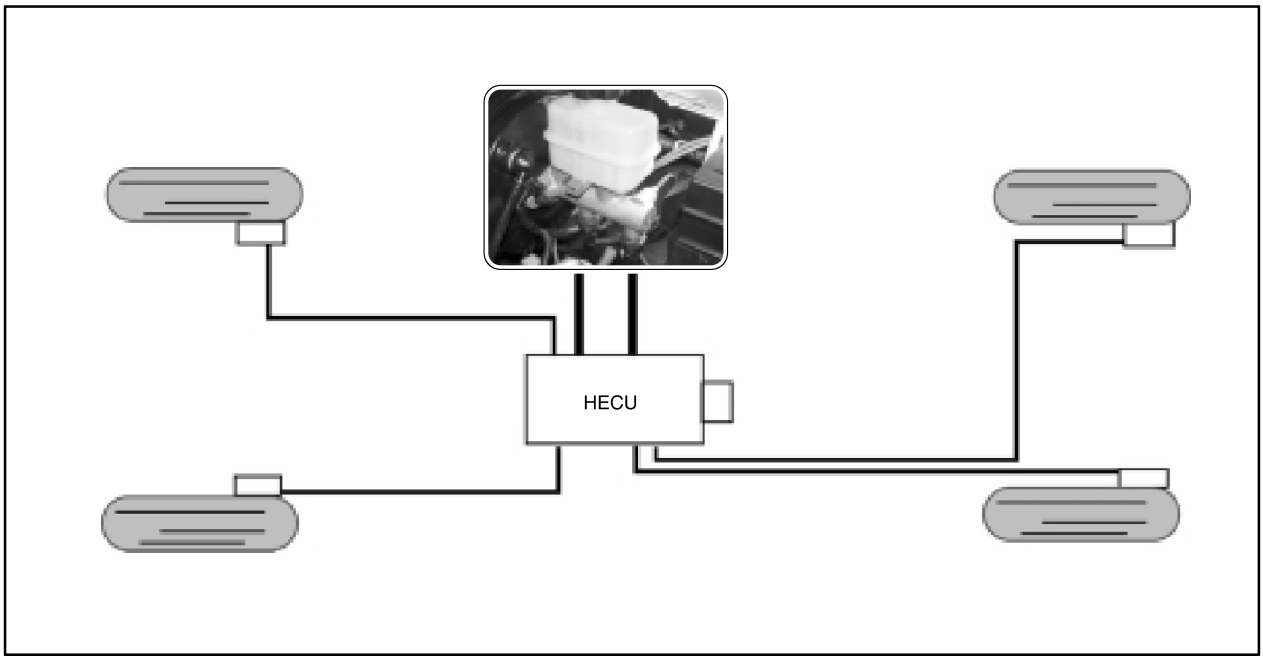
Based on the fact that some drivers depress the brake pedal too soft even under when hard braking is necessary, the HECU system is a safety supplementary system that builds high braking force during initial braking according to pressure value of the brake pressure sensor and the pressure changes of the pressure sensor intervals.

When the system is designed to apply high braking force when brake pedal is depressed softly by an elderly or physically weak driver, the vehicle will make abrupt stopping under normal braking situation due to high braking pressure at each wheels.

2) Operation

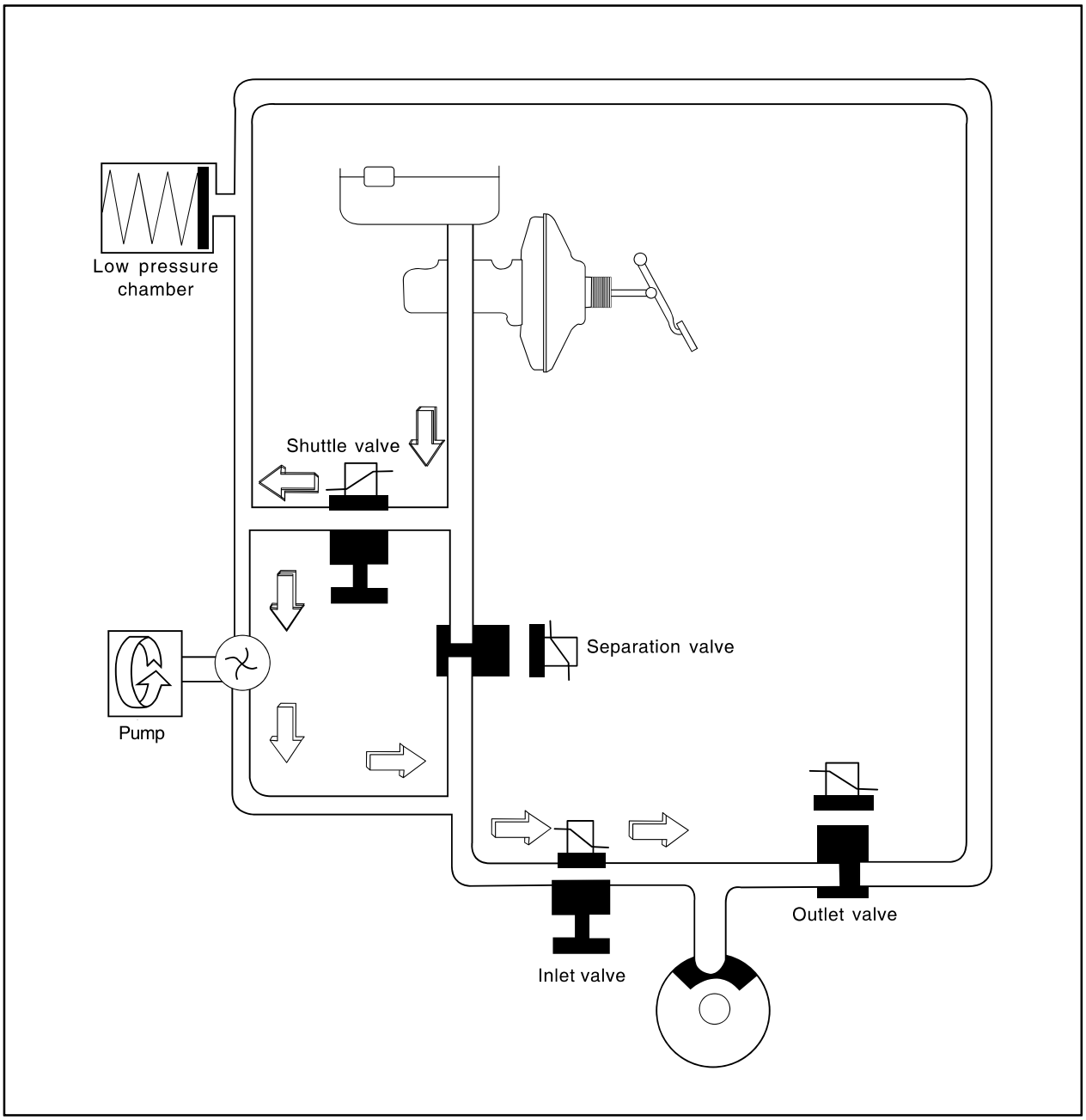
The brake pressure value and the changed value of the pressure sensor are the conditions in which the HBA System operates. There are 2 pressure sensors under the master cylinder. When the ESP ECU system determines that emergency braking is present, the pump operates, the brake fluid in the master cylinder is sent to the pump and the braking pressure is delivered to the wheels via the inlet valves .

If the drive depress the brake pedal slowly, the pressure change is not high. In this case, only the conventional brake system with booster is activated.



Modification basis	
Application basis	
Affected VIN	

3) Hydraulic Diagram of HBA

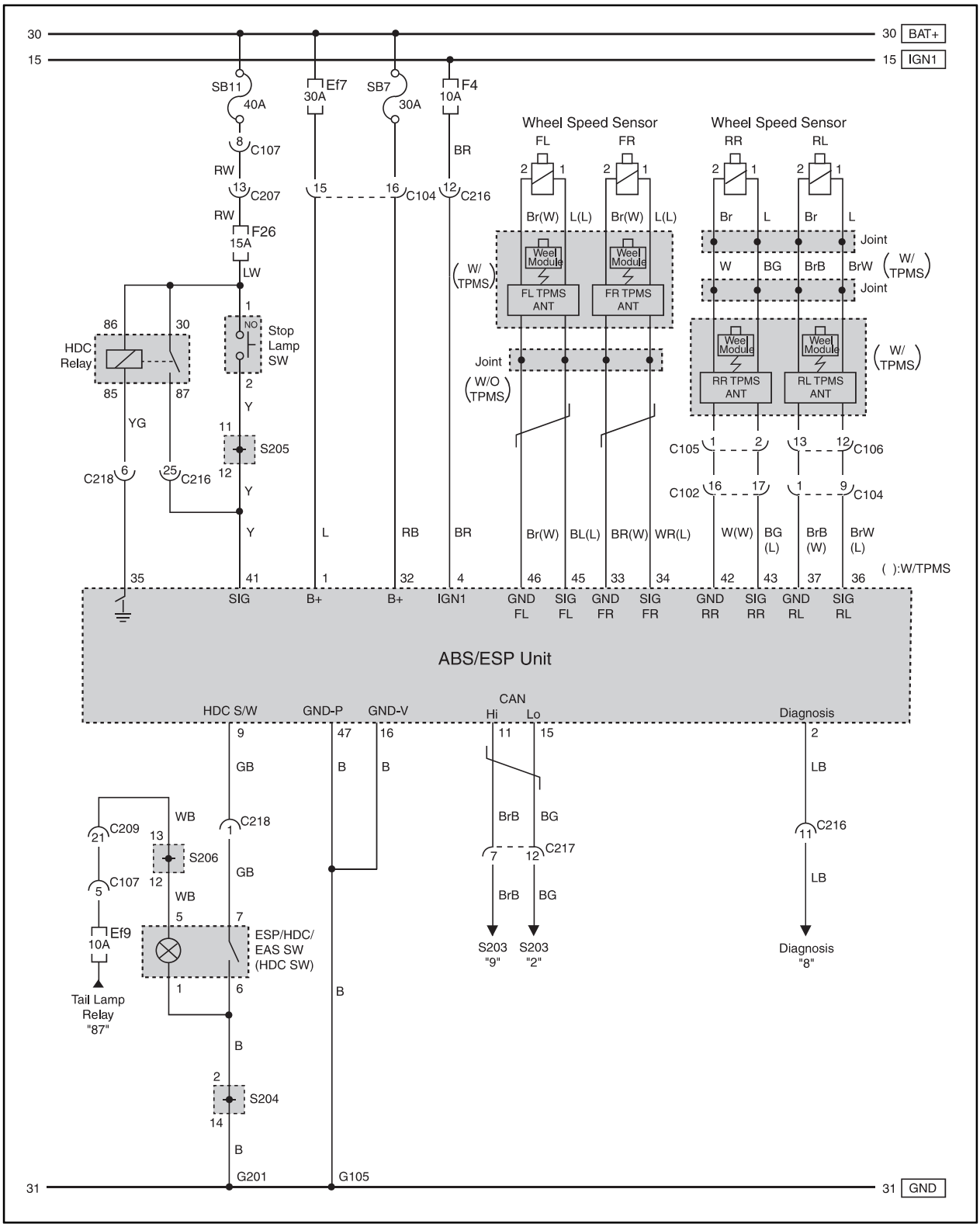


The above figure shows one front and one rear wheel and the same hydraulic circuit forms as in the ESP operation.

When HECU recognizes that it is an emergency and it is required for hard braking, depending on the pressure value of the brake pressure sensor and pressure changes caused by the pressure sensor timing, it operates the pump immediately to apply the brake pressure at the wheels. Then, the pressure in the pump increases until just before the corresponding wheel gets locked. The motor still keeps rotating and the outlet valve and the separation valve are will stay closed. When the wheel starts to lock, the HBA function cancels and switches to ABS operation

7. ELECTRIC CIRCUIT DIAGRAM

▶ Wheel Speed Sensor, Stop Lamp Switch, Diagnostic Connector, Warning Lamp (ABS/ESP)



Modification basis	
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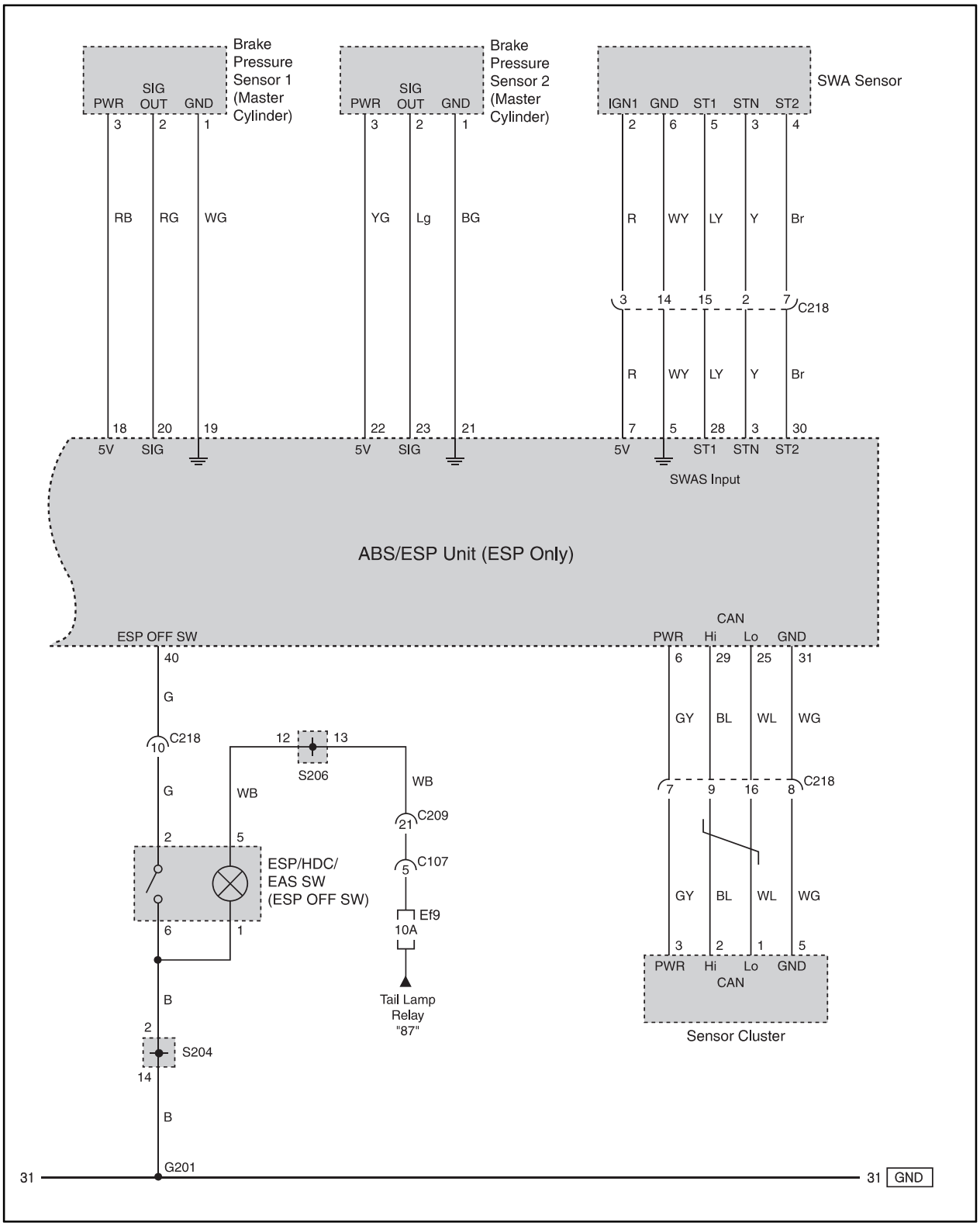
▶ Brake Pressure Sensor, Steering Wheel Angle Sensor, Sensor Cluster, ESP OFF Switch



Modification basis	
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Affected VIN	