
GROUP 35C

ACTIVE STABILITY CONTROL SYSTEM (ASC)

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GENERAL INFORMATION

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Active Stability Control System (ASC) has been installed.

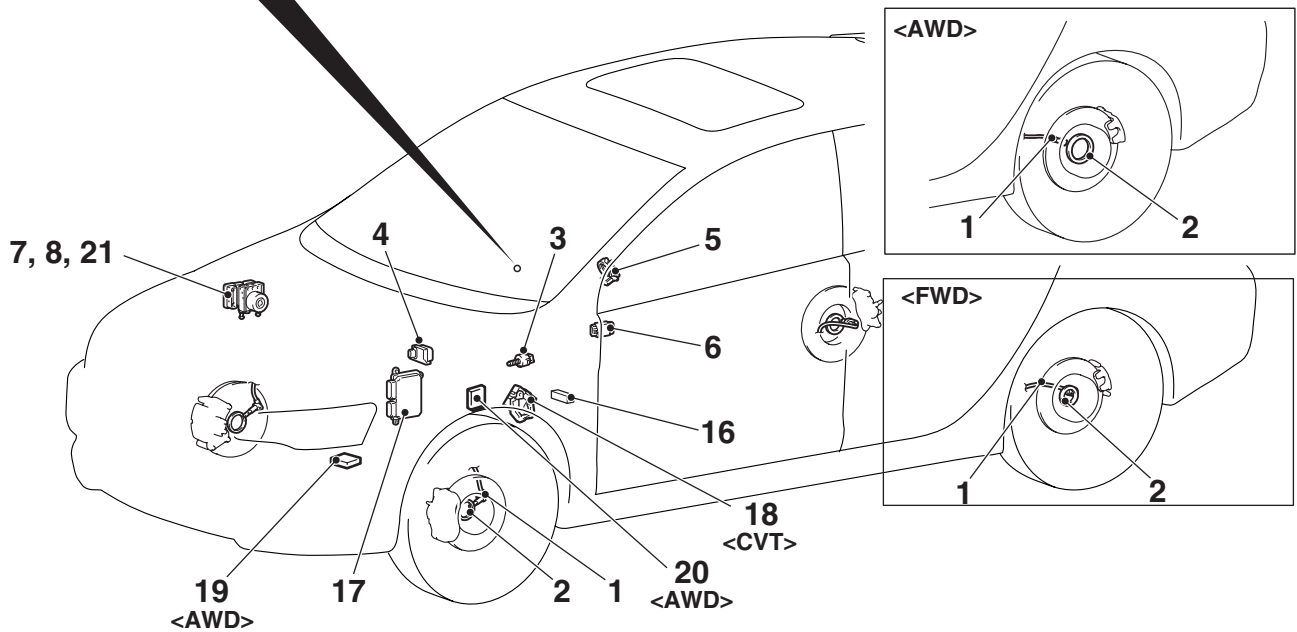
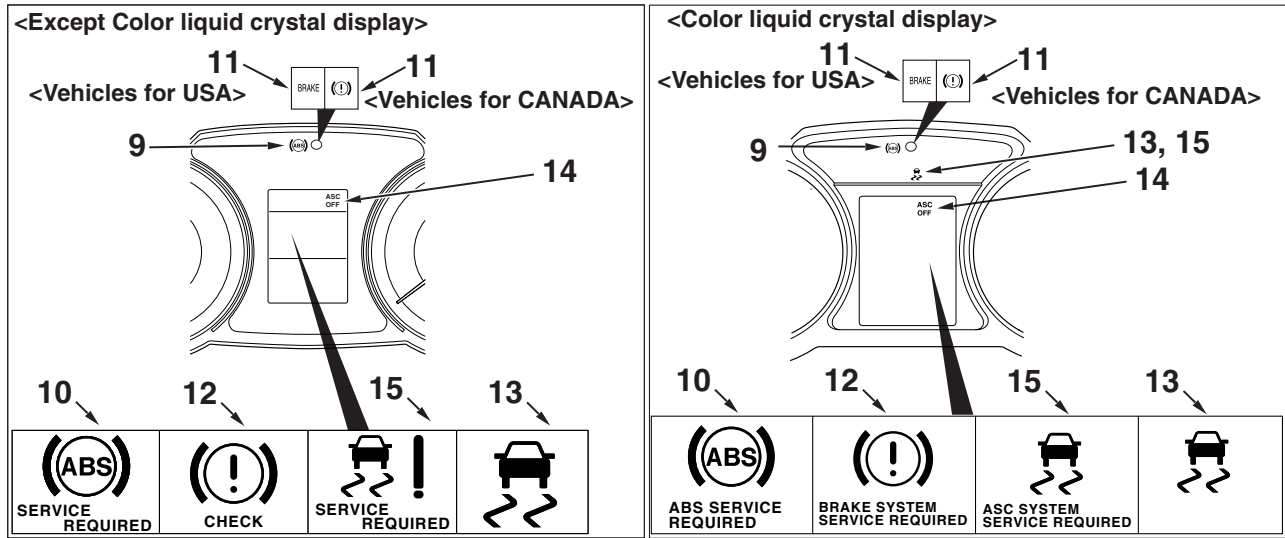
- The ASC system integrates the traction control (TCL) function and skid control function.
- When TCL detects the slip of the driving wheel (ex. during startup on low μ road), it automatically applies the brakes to the slipping driving wheel. At the same time, TCL reduces the engine output and prevents the wheel spin when it determines that the engine torque is too high for the road surface μ .
- When the ASC-ECU determines that the vehicle is in a dangerous condition, it reduces the engine output and applies brake force to four wheels independently to control the vehicle behavior, avoiding the critical state.
- ASC has been added to the transmission <twin clutch sport shift transmission (TC-SST)^{*1}> and active center differential (ACD)^{*2} control, and the controls are integrated to improve the vehicle stability <Vehicles with AWD>.

- Hill Start Assist (HSA) function has been adopted to hold and prevent the roll back of the vehicle when the vehicle is on a slope and the foot is transferred from the brake pedal to the accelerator pedal <Vehicles with HSA>.

NOTE:

- ^{*1}: For the details on twin clutch sport shift transmission (TC-SST), refer to GROUP 22B –Twin Clutch Sport Shift Transmission (TC-SST) [P.22B-2](#).
- ^{*2}: For the details on active center differential (ACD), refer to GROUP 22B –Active Center Differential (ACD) [P.22B-19](#).
- By the integrated control with the anti skid brake system (ABS), the system stabilizes the vehicle attitude and at the same time secures the driving force.

CONSTRUCTION DIAGRAM



MAIN COMPONENTS AND FUNCTIONS

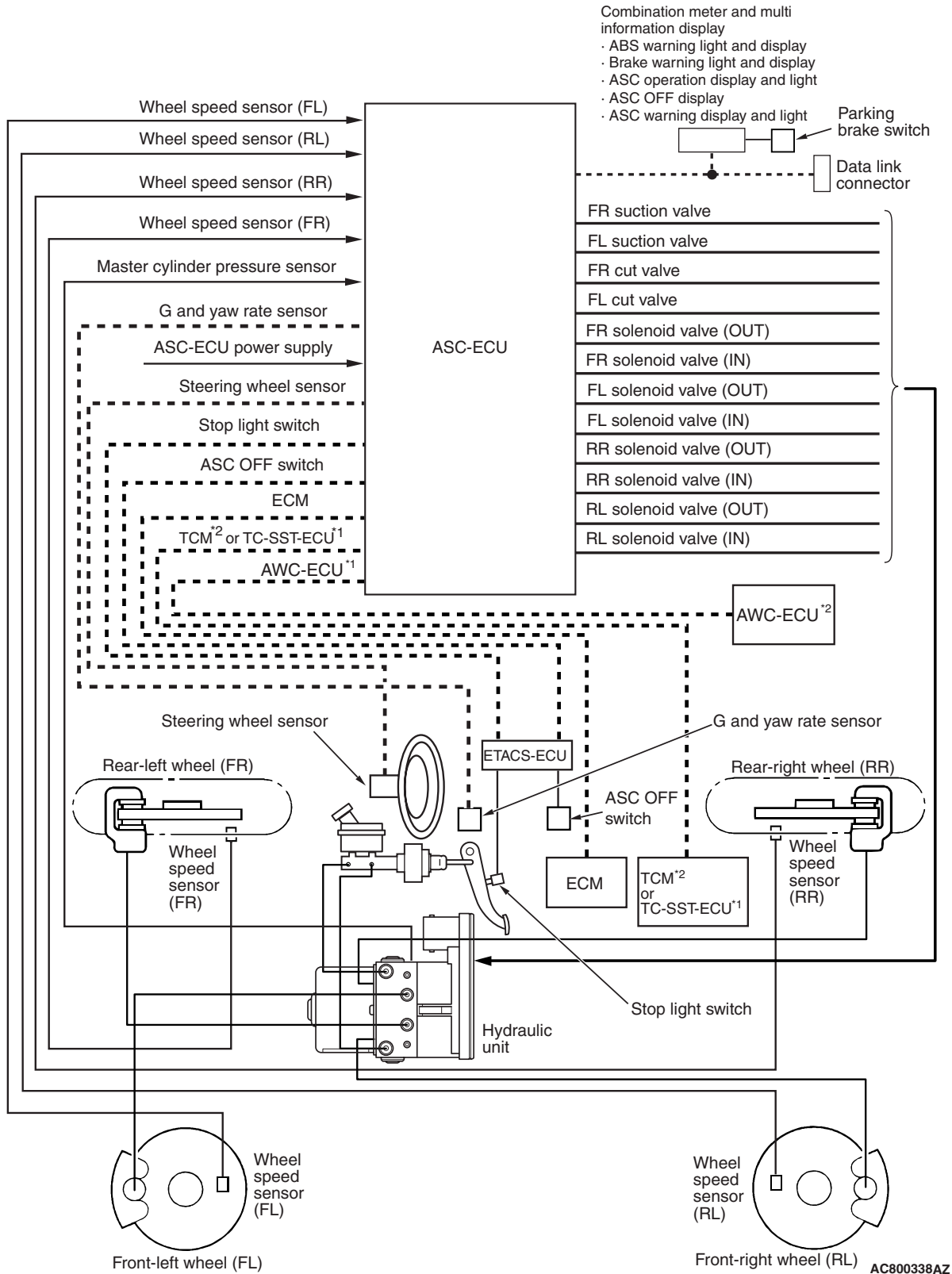
Name of part		No.	Functional description
Sensor	Wheel speed sensor	1	Outputs the frequency signal in proportion to the rotation speed of each wheel to ASC-ECU.
	Magnetic encoder for wheel speed detection	2	When the magnetic encoder for wheel speed detection (a plate on which north and south pole sides of the magnets are arranged alternately) rotates, the wheel speed sensor outputs frequency pulse signal in proportion to each wheel speed.
	Stop light switch	3	Outputs the signal indicating whether the brake pedal is depressed or not to ASC-ECU.
	G & yaw rate sensor	4	Detects the yaw rate, and longitudinal <AWD> and lateral acceleration of a vehicle, then outputs the signal to ASC-ECU via the CAN line.
	Steering wheel sensor	5	Detects the steering angle of the steering wheel, and outputs signal to ASC-ECU via the CAN bus line.
	ASC OFF switch	6	Outputs the ASC ON/OFF signal to ASC-ECU.
	Brake fluid pressure sensor	7	Integrated into the hydraulic unit, and outputs the signal for the brake fluid pressure in the master cylinder to ASC-ECU.
Actuator	Hydraulic unit	8	Drives the solenoid valve using the signal from ASC-ECU, and controls the brake fluid pressure for each wheel.
	ABS warning light	9	Informs the driver of the system status by illuminating, flashing, or turning off the ABS warning light according to the signal from ASC-ECU.
	ABS warning display	10	Informs the driver of the system status by illuminating or turning off the ABS warning display according to the signal from ASC-ECU.
	Brake warning light	11	Used as the brake warning light for the parking brake, brake fluid level, and EBD control. Informs the driver of the system status by illuminating or turning off the brake warning light according to the signal from ASC-ECU.
	Brake warning display	12	Used as the brake warning display for the brake fluid level, and EBD control. Informs the driver of the system status by illuminating or turning off the brake warning display according to the signal from ASC-ECU.
	ASC operation display and light ^{*3}	13	Informs the driver of the system status by flashing when the system operates according to the signal from ASC-ECU.
	ASC OFF display	14	Informs the driver of the system shutdown by illuminating by the signal from ASC-ECU. Informs the driver that the brake system overheats and the TCL control (brake control only) is disabled by flashing the ASC OFF display at a frequency of approximately 2 Hz.
	ASC warning display and light ^{*3}	15	TCL function and stability control function, HSA function use the same display and light ^{*3} . Depending on the signal from ASC-ECU, the ASC warning display and light ^{*3} informs the driver of the system status by illuminating when the system has malfunction (When the ASC warning display and light ^{*3} is illuminated, the HSA function does not operate).

Name of part	No.	Functional description
Data link connector	16	Sets the diagnostic trouble code and establishes the communication with scan tool.
Engine control module (ECM)	17	Controls the engine output based on the signal from ASC-ECU.
TCM ^{*2}	18 ^{*2}	TCM performs integrated control with ASC-ECU. Output the gear position to ASC-ECU.
TC-SST ECU ^{*1}	19 ^{*1}	TC-SST-ECU performs integrated control with ASC-ECU. Outputs the gear position to ASC-ECU.
AWC ECU ^{*1}	20 ^{*1}	Outputs the drive status to ASC-ECU. AWC-ECU performs integrated control with ASC-ECU.
ASC control unit (ASC-ECU)	21	Controls the actuators (hydraulic unit) based on the signals sent from sensors.
		Controls the self-diagnostic function and fail-safe function.
		Controls diagnostic function (Compatible with scan tool).

NOTE:

- ^{*1}: AWD
- ^{*2}: CVT
- ^{*3}: Color liquid crystal display

SCHEMATIC DIAGRAM



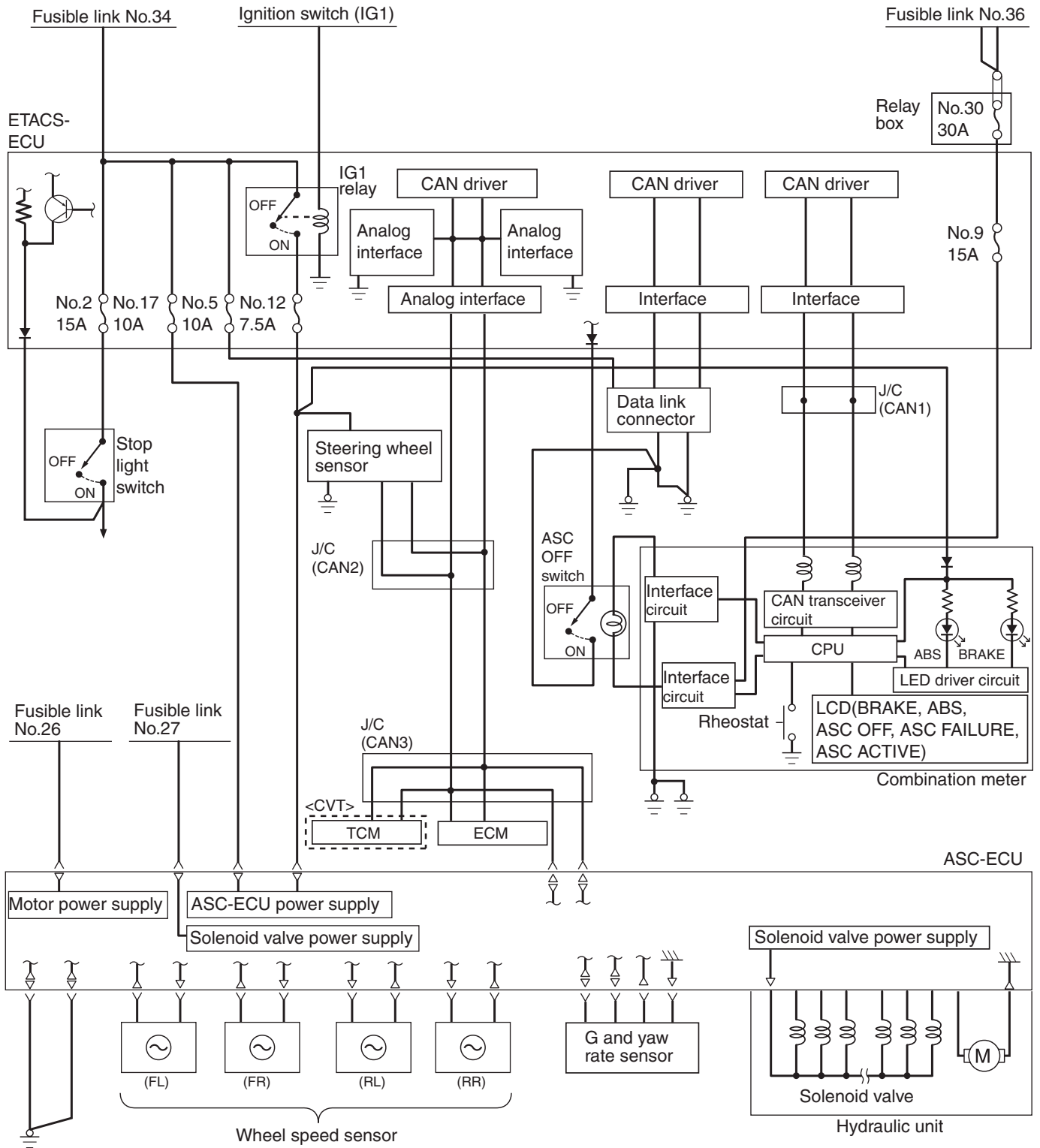
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NOTE:

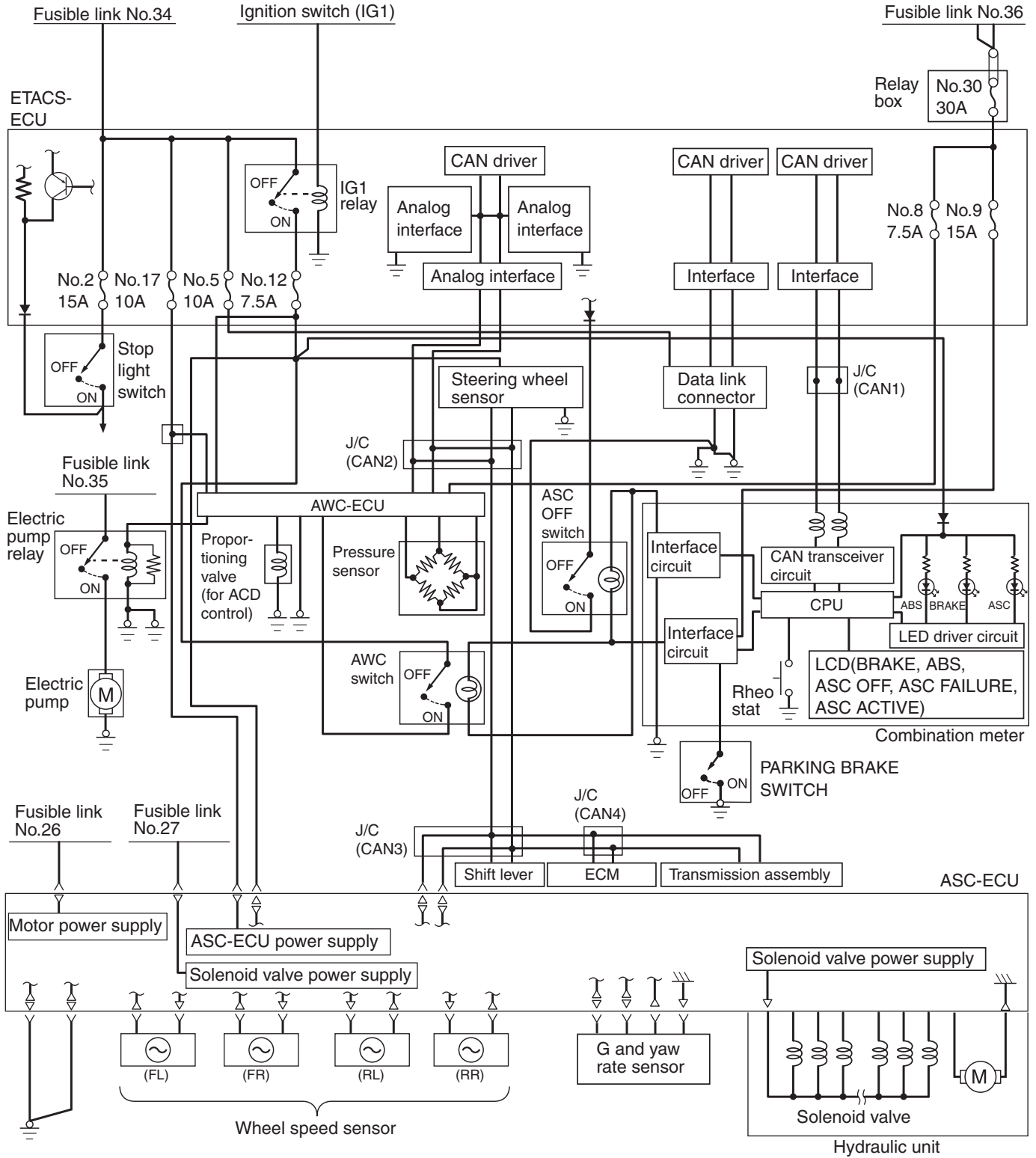
- Dashed lines indicate the CAN bus line.
- *1: AWD
- *2: CVT

ASC ELECTRICAL DIAGRAM

<FWD>



<AWD>



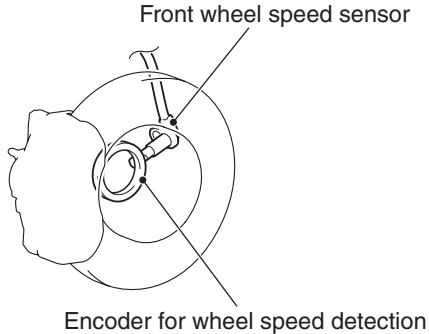
CONSTRUCTION DESCRIPTION

SENSOR

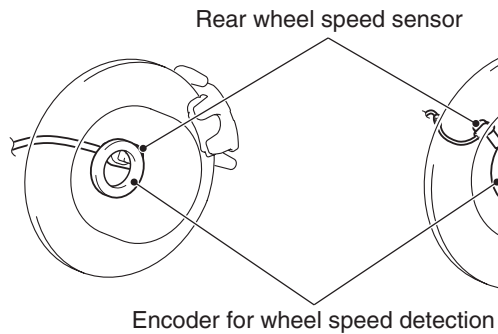
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WHEEL SPEED SENSOR

FRONT



REAR <FWD>



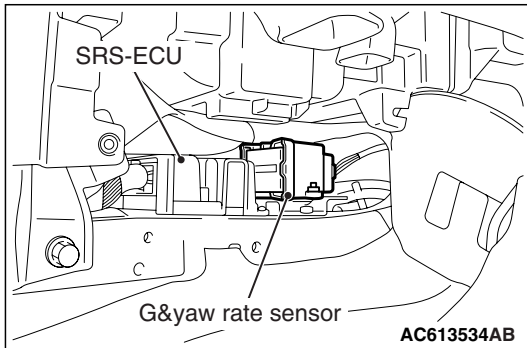
REAR <AWD>

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The wheel speed detecting section is a kind of a pulse generator. It consists of the magnetic encoder for wheel speed detection (a plate on which north and south pole sides of the magnets are arranged alternately) which rotates at the same speed of the wheel and the wheel speed sensor (semiconductor sensor). This sensor outputs frequency pulse signals in proportion to the wheel speed.

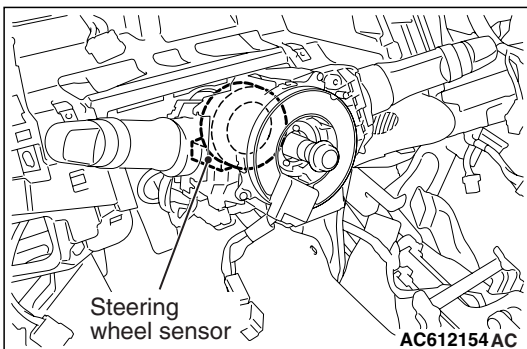
The front wheel speed detecting section consists of the front wheel speed sensor mounted on the knuckle and the magnetic encoder for wheel speed detection which is press-fitted together with the oil seal to the front wheel bearing. The rear wheel speed detecting section consists of the rear wheel speed sensor mounted on the trailing arm assembly and the magnetic encoder for wheel speed detection which is press-fitted together with the oil seal to the rear wheel bearing.

G AND YAW RATE SENSOR



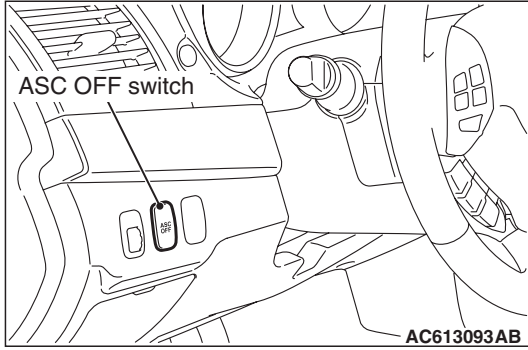
The G and yaw rate sensor is installed under the instrument panel console box, and detects the yaw rate, longitudinal acceleration <vehicles with AWD> and lateral acceleration of the vehicle.

STEERING WHEEL SENSOR



The steering wheel sensor is attached to the column switch, and detects the rotational angle of the steering wheel.

ASC OFF SWITCH



The ASC OFF switch is attached on the instrument panel to the left side of the driver's seat. ASC functions can be disabled by pressing this switch for 3 seconds. Pressing this switch again resumes the ON status. As a countermeasure for the stuck of the ASC OFF switch, pressing the ASC OFF switch for 15 seconds resumes the system to the ON status. When the ignition switch is turned from "LOCK" (OFF) to ON position, ASC functions are constantly in the ON status.

ASC OFF SWITCH OPERATION AND SYSTEM OPERATION

ASC OFF switch operation	TCL		Skid control
	Brake control	Engine control	
Not operated	Enabled	Enabled	Enabled
Operated (Press and hold for 3 seconds)	Prohibited	Prohibited	Prohibited

NOTE: The skid control is available when the vehicle speed is 15 km/h (9 mph) or more.

ACTUATOR

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HYDRAULIC UNIT

The hydraulic unit incorporates the ABS control and ASC control. The cut valve, pressure relief valve, suction valve, suction damper, and pressure sensor have been added to the unit for the ASC control.

NOTE: For the internal hydraulic circuit of the hydraulic unit, refer to P.35C-16.

ASC OPERATION DISPLAY AND LIGHT, ASC WARNING DISPLAY AND LIGHT, ASC OFF DISPLAY, ASC OFF LIGHT

The ASC system illuminates or flashes the ASC operation display and light, ASC warning display and light, or ASC OFF display in the following operation patterns, and informs the driver of the ASC system status.

ASC operation display and light

- Flashes in 2 Hz during the ASC control.

ASC warning display and light

- Turns ON when the system malfunction occurs.

ASC OFF display

- Illuminates when the system is stopped.
- ASC-ECU detects the overheat of the brake pads. When the brake TCL control is prohibited, the ASC OFF display flashes in approximately 2 Hz.

ASC operation display and light, ASC warning display and light, ASC OFF display, illumination and flashing patterns

State		ASC operation display and light	ASC warning display and light	ASC OFF display
Normal	Normal	–	–	–
	Skid control operated	Flashing (2 Hz)	–	–
	TCL operated	Flashing (2 Hz)	–	–
ASC function is disabled by ASC OFF switch	ASC function disabled	–	–	Illuminates
When the brake pad temperature is high	ASC-ECU informs the driver that the TCL does not function.	–	–	Flashing (2 Hz)
Abnormal	Skid control malfunction	–	Illuminates	Illuminates
	TCL malfunction	–	Illuminates	Illuminates
	HSA malfunction	–	Illuminates	*
Scan tool connection	Actuator not operated	–	–	–
	Actuator operated	–	Illuminates	Illuminates

*NOTE: * Illuminates if the TCL function or skid control function is defective when the HSA function is defective. (HSA control prohibited)*

ASC-ECU

- This ECU incorporates the ABS function, EBD function, skid control function, and TCL function.

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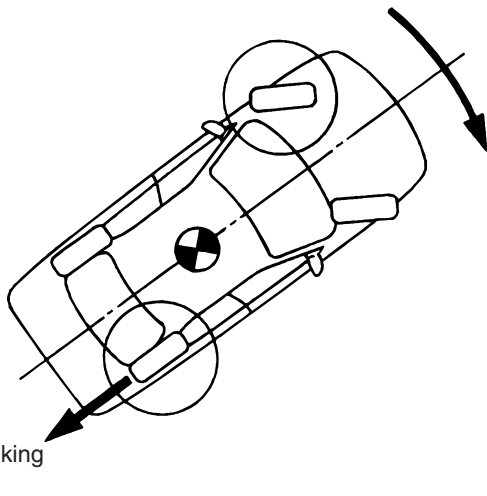
- The hydraulic unit of the ASC system employs the automatic pressurization function. This system also incorporates G and yaw rate sensor, steering wheel sensor, and master cylinder pressure sensor (integrated with hydraulic unit).

SKID CONTROL DESCRIPTION

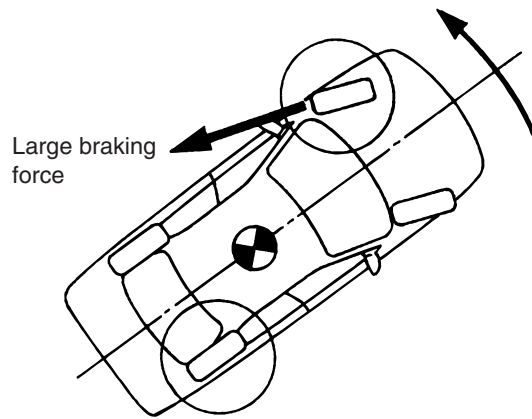
ASC-ECU detects vehicle movement based on information from various sensors and calculates a model of ideal vehicle movement. ASC-ECU compares the actual vehicle movement with the ideal vehicle model, and manages the brake of the specific wheel so that the actual vehicle movement gets close to the ideal vehicle mode. It also controls the understeer or oversteer condition by creating the yaw moment in the vehicle.

Example of Skid Control operation

Generation of rotating force



Generation of counter-rotating force

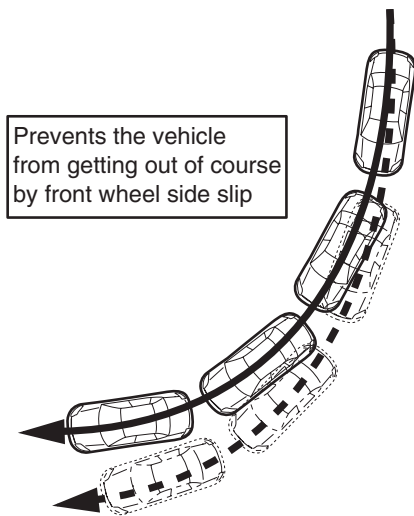


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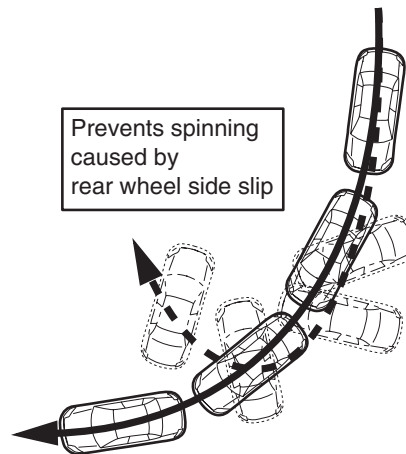
The Skid Control manages the vehicle attitude by creating a yaw moment from altering the balance between the cornering force and each wheel's braking mechanism.

Example of the effect of control

Suppression of front wheel side slip



Suppression of rear wheel side slip



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For example, on a slippery surface, if the vehicle tends to be under-steered contrary to the driver's intention, a yaw moment (a rotational moment) is created to restrain the under-steering by increasing the rear-inside braking force. On the other hand, when the vehicle tends to be oversteered, a yaw moment (a restorative moment) is created to restrain

the oversteering by increasing the front-outside wheel braking force. Furthermore, when it is determined that the vehicle is over-speeding, safe and stable cornering is enabled by deceleration from reducing the engine output.

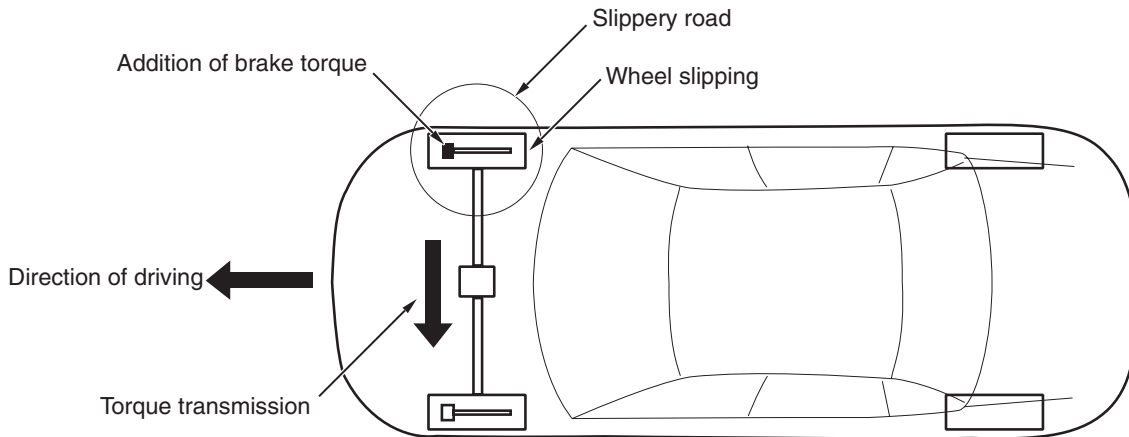
Integrated control

Skid control transmits data necessary for control of ABS and TCL, performing an integrated control.

Control system	Control content
ABS	Even during skid control operation, ABS performance is improved by synergy operation with the skid control.
TCL	During acceleration, engine output is governed through synergy operation with skid control.

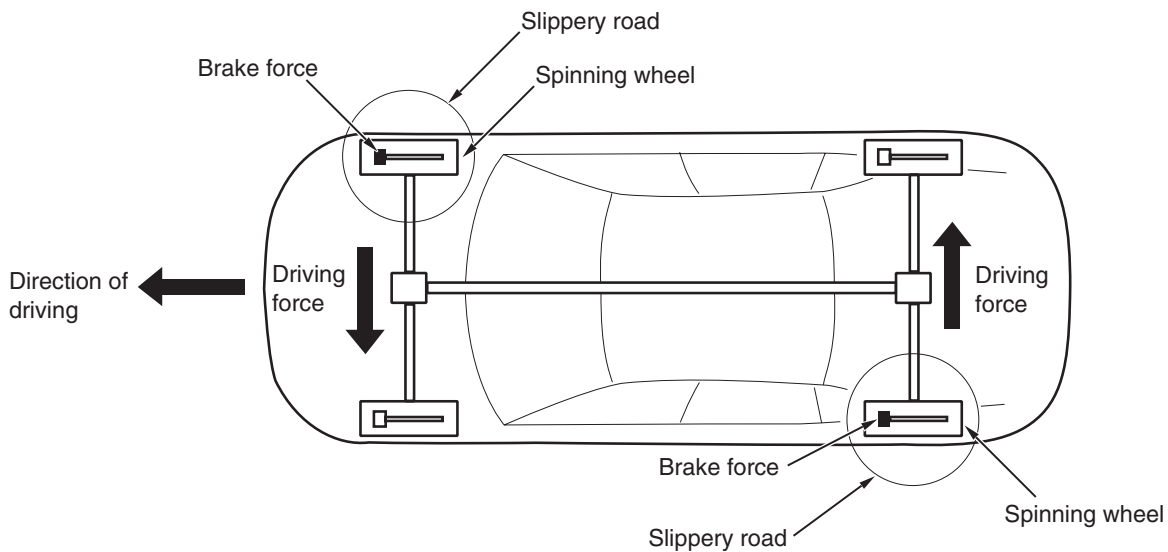
Example of TCL control

<FWD>



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<AWD>

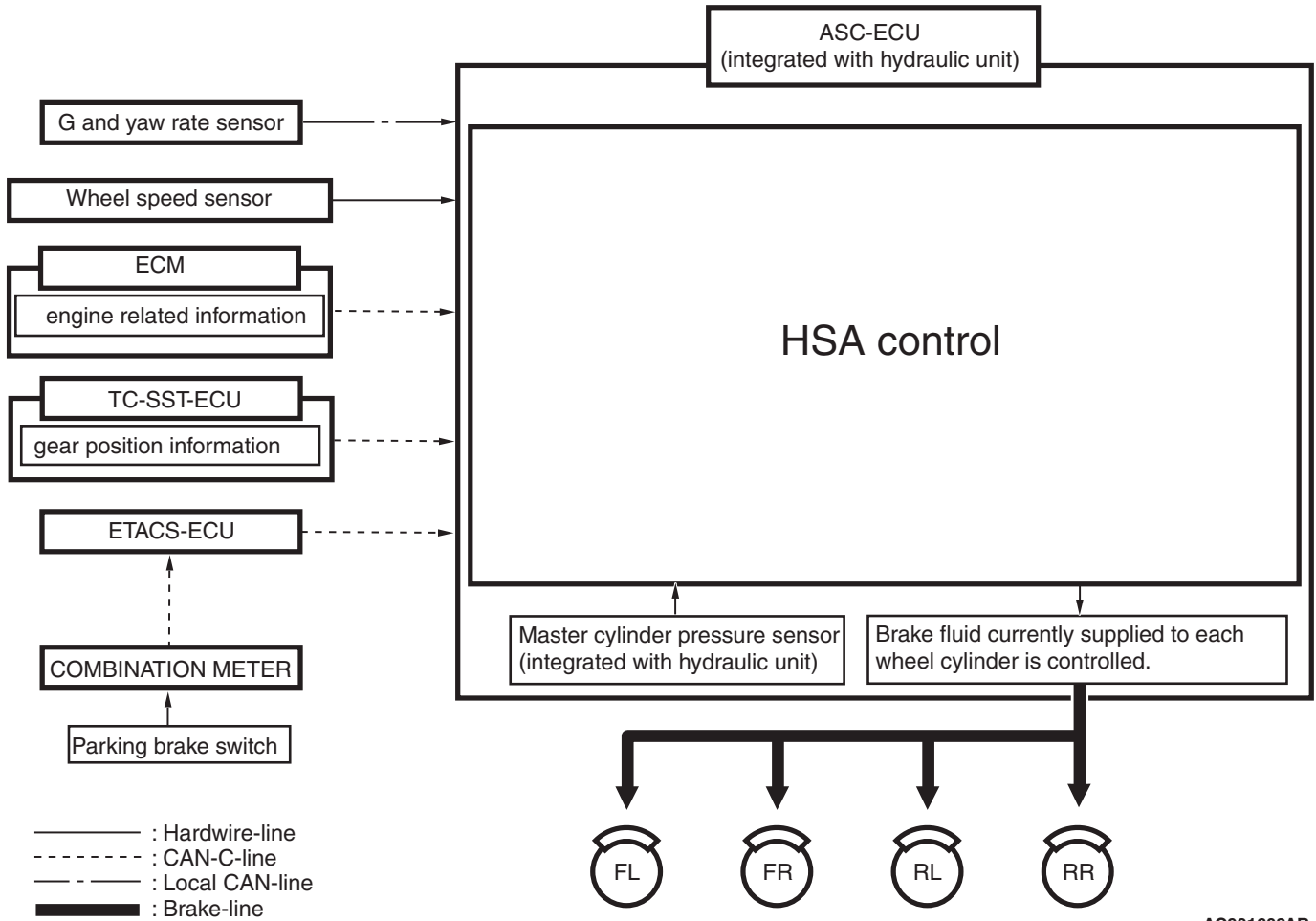


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When the driving wheels slip on the slippery road surface, TCL applies the brake automatically, sends the signal requesting engine speed reduction to the ECM, and prevents the loss of the driving force resulting from the slippage of the driving wheel.

Hill Start Assist (HSA) function

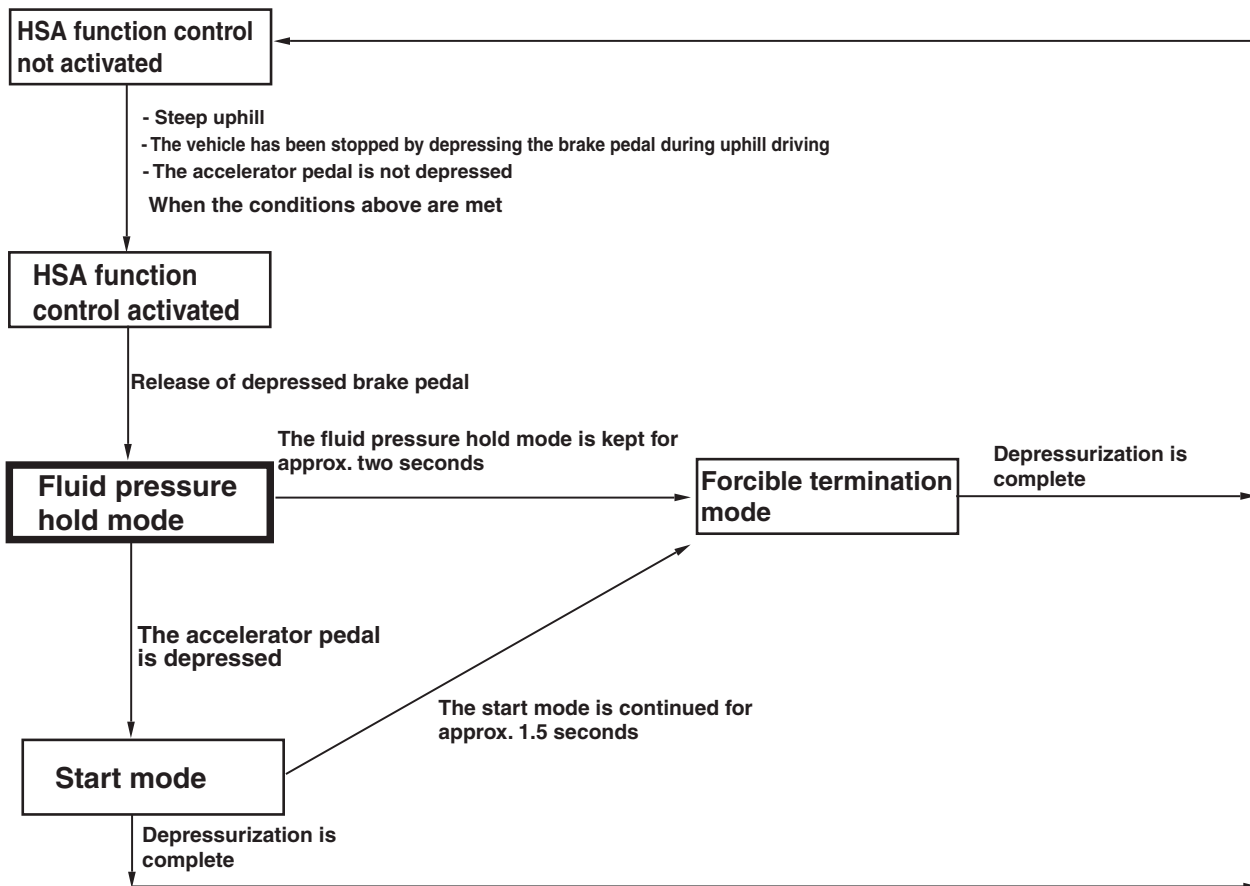
System configuration



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When the vehicle has completely stopped on a steep uphill by the service brake, ASC-ECU judges whether or not start the HSA function control in accordance with the signals (ETACS-ECU, TC-SST-ECU, G and yaw rate sensor, brake fluid pressure sensor, ECM, wheel speed sensor).

HSA function state transition diagram (Overview)



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NOTE:

- ASC-ECU judges the inclination angle of the slope according to the G and yaw rate sensor output.
- When either of the following conditions is satisfied, the mode is shifted to the forcible termination mode, and HSA function control is terminated.
 - The parking brake operation is detected.
 - The shift lever operation to the shift position other than the uphill direction driving is detected (Forward uphill driving: shift position other than "D", Reverse uphill driving: shift position other than "R").
 - The accelerator pedal and brake pedal are depressed at the same time.
 - The wheel speed sensor pulse is generated (When the vehicle moved)
 - The engine is stopped by engine stall, etc.

HSA FUNCTION CONTROL ACTIVATED

ASC-ECU judges that the HSA operation condition is satisfied. When the driver releases the brake pedal, ASC-ECU maintains the brake wheel cylinder pressure and waits.

FLUID PRESSURE HOLD MODE

By closing the cut valve, ASC-ECU maintains the brake wheel cylinder pressure of the time when the brake pedal is depressed, to prevent the vehicle from moving backward.

START MODE

ASC-ECU releases the brake wheel cylinder pressure maintained by the cut valve, depending on the engine torque generated by depressing the accelerator pedal.

FAIL-SAFE AND DIAGNOSTIC FUNCTIONS

ASC-ECU constantly monitors the input and output signals. If an error is detected in the system, ASC-ECU sends a fail signal and the corresponding indicator light is illuminated or blinks. Various controls are processed depending on the cause of malfunction as shown below.

ASC-ECU has the following functions for easier system checks.

- Diagnostic trouble code set
- Service data output
- Actuator test

FORCIBLE TERMINATION MODE

ASC-ECU immediately releases the brake wheel cylinder pressure maintained by the cut valve and terminates HSA function control.

- Freeze frame data output

All the above items can be diagnosed using scan tool.

CALIBRATION

After the G and yaw rate sensor and steering wheel sensor have been replaced with new ones, calibration must be performed using scan tool*.

NOTE:

- *Scan tool uses the ABS data list.*
- **: For calibration, refer to Workshop Manual.*

DESCRIPTION OF CONSTRUCTION AND OPERATION

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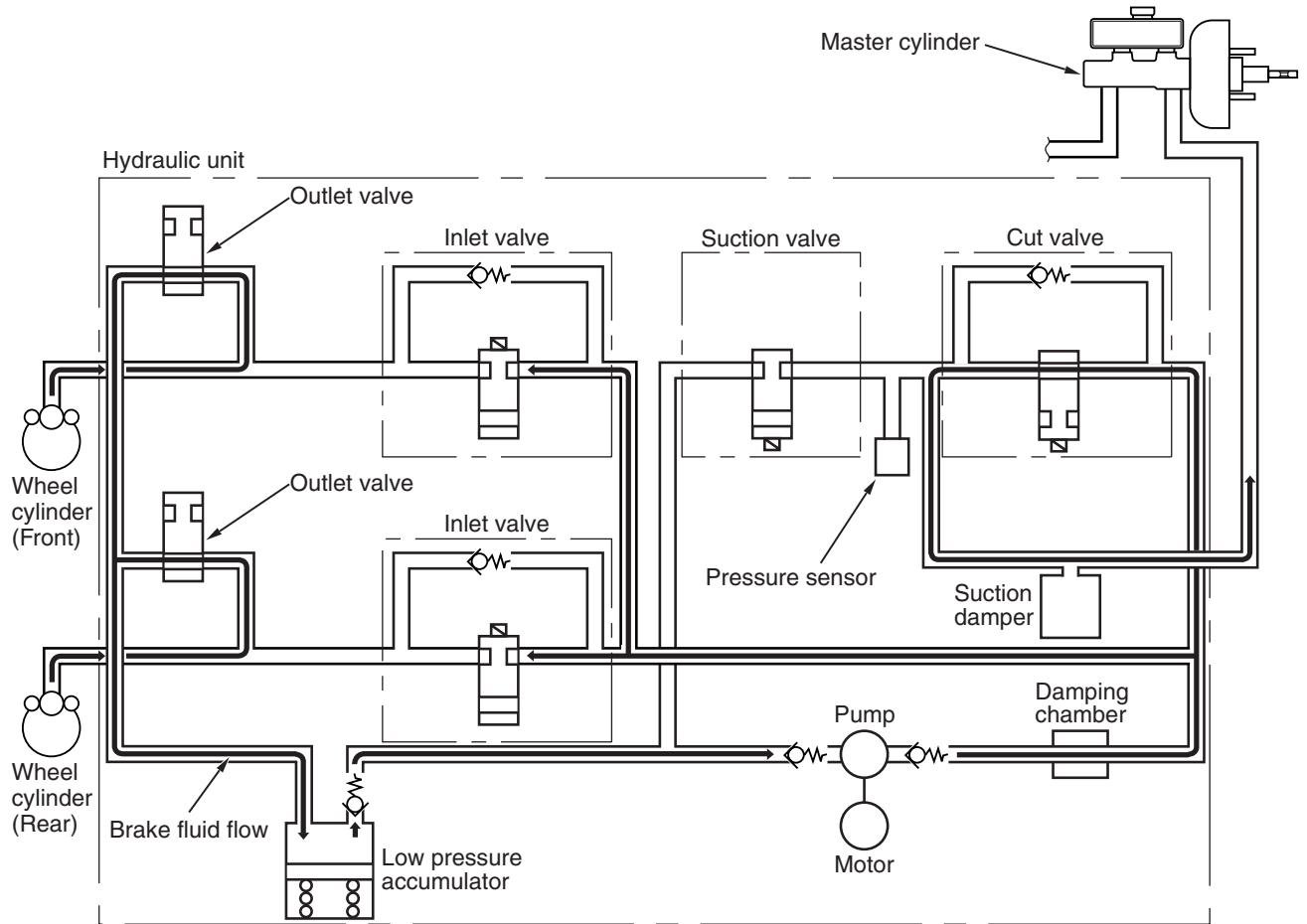
SKID CONTROL OPERATION

ASC-ECU, ECM, TCM*¹, TC-SST-ECU*² and AWC-ECU*² communicate with each other via CAN. When the accelerator pedal is depressed too far, a signal requesting the reduction of engine output is sent to the ECM. Also, an integrated control with TCM*¹, TC-SST-ECU*² or AWC-ECU*² is performed to enhance the skid control controllability.

NOTE:

- *¹: CVT
- *²: AWD

When brake fluid pressure decreases during ABS operation



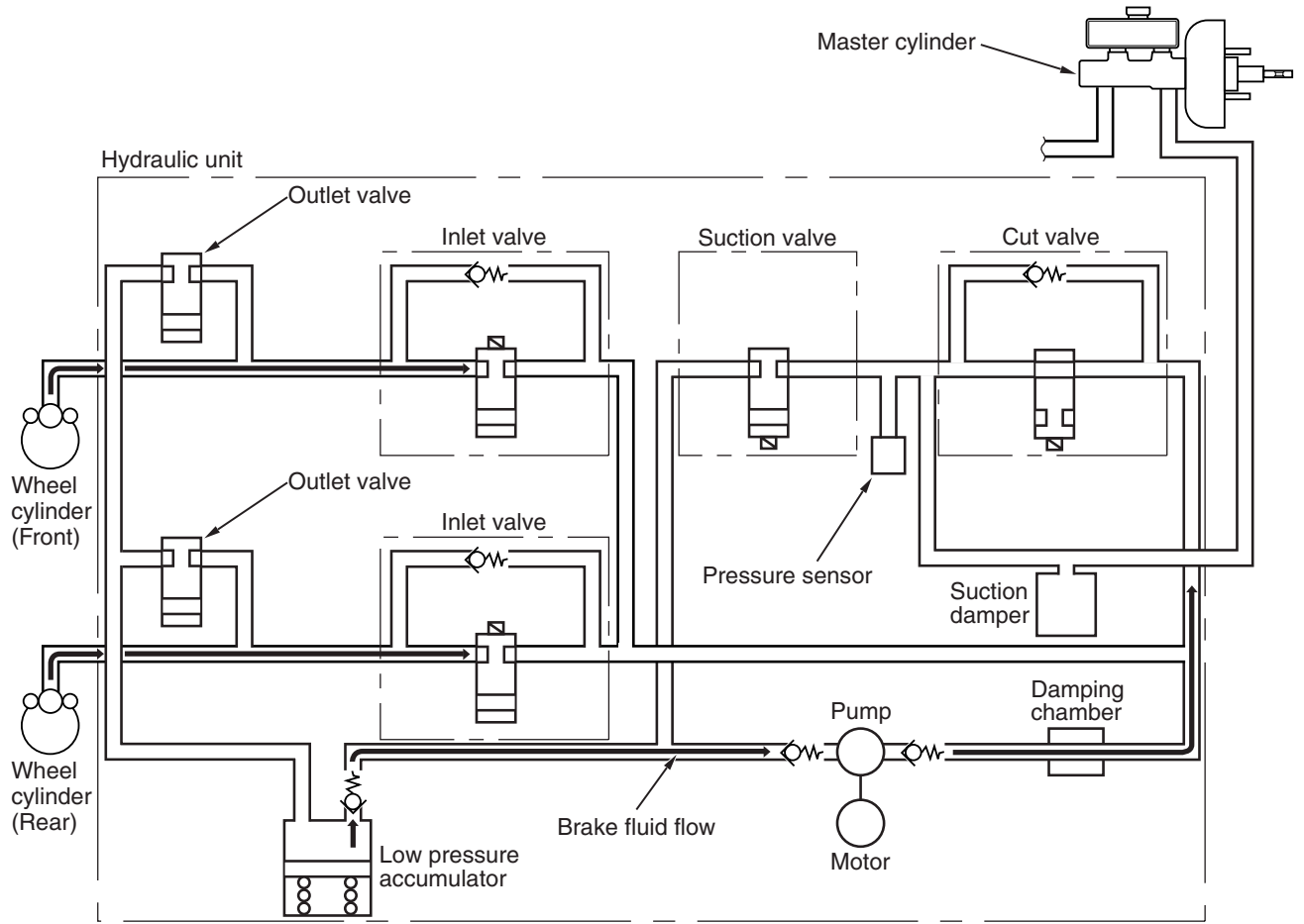
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The brake fluid supplied from the wheel cylinder is stored in the low pressure accumulator. Then, the stored brake fluid is returned to the master cylinder by driving the pump using the motor.

VALVE CONDITION

Item	Power status	Open/Close
Cut valve	OFF	Open
Suction valve	OFF	Closed
Inlet valve	ON	Closed
Outlet valve	ON	Open

When brake fluid pressure is held by ABS



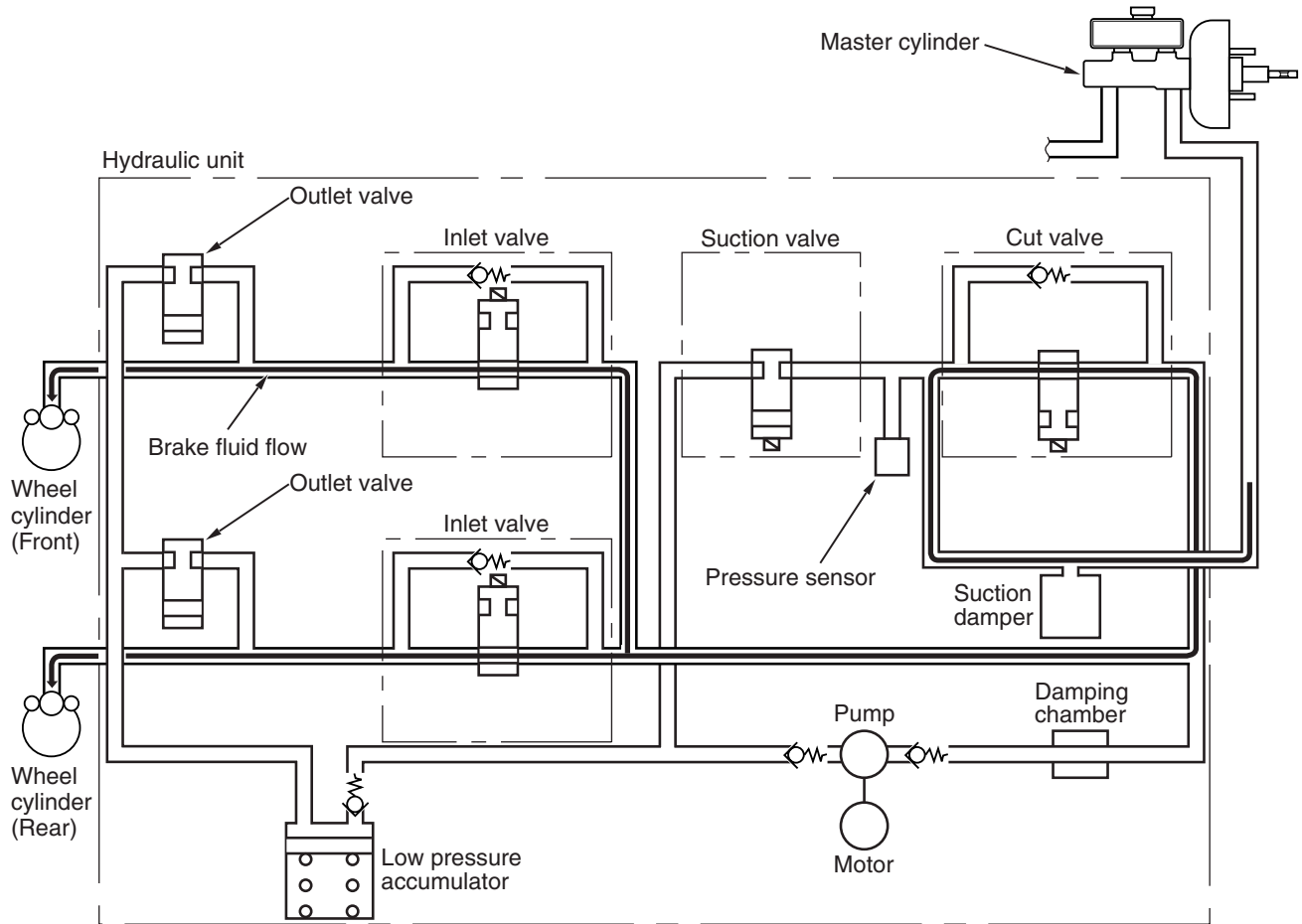
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The system closes the inlet valve and outlet valve to hold the brake fluid pressure in the wheel cylinder. If the brake fluid is stored in the low pressure accumulator, the brake fluid is returned to the master cylinder by driving the pump using the motor.

VALVE CONDITION

Item	Power status	Open/Close
Cut valve	OFF	Open
Suction valve	OFF	Closed
Inlet valve	ON	Closed
Outlet valve	OFF	Closed

When brake fluid pressure is increased by normal braking or ABS



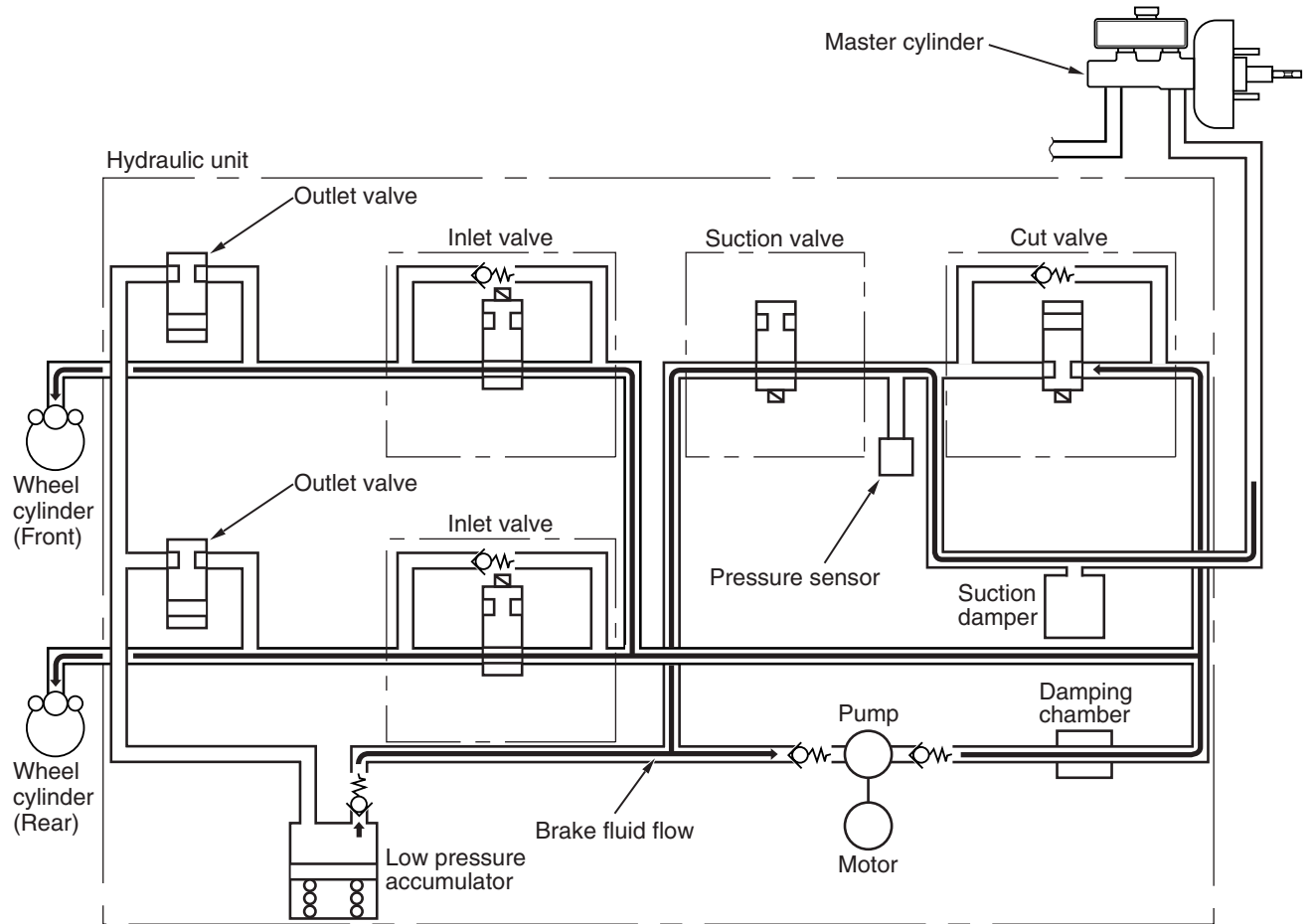
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The system opens the inlet valve while closing the outlet valve to increase the brake fluid pressure in the wheel cylinder.

VALVE CONDITION

Item	Power status	Open/Close
Cut valve	OFF	Open
Suction valve	OFF	Closed
Inlet valve	OFF	Open
Outlet valve	OFF	Closed

When brake fluid pressure is increased by skid control (or increased by TCL)



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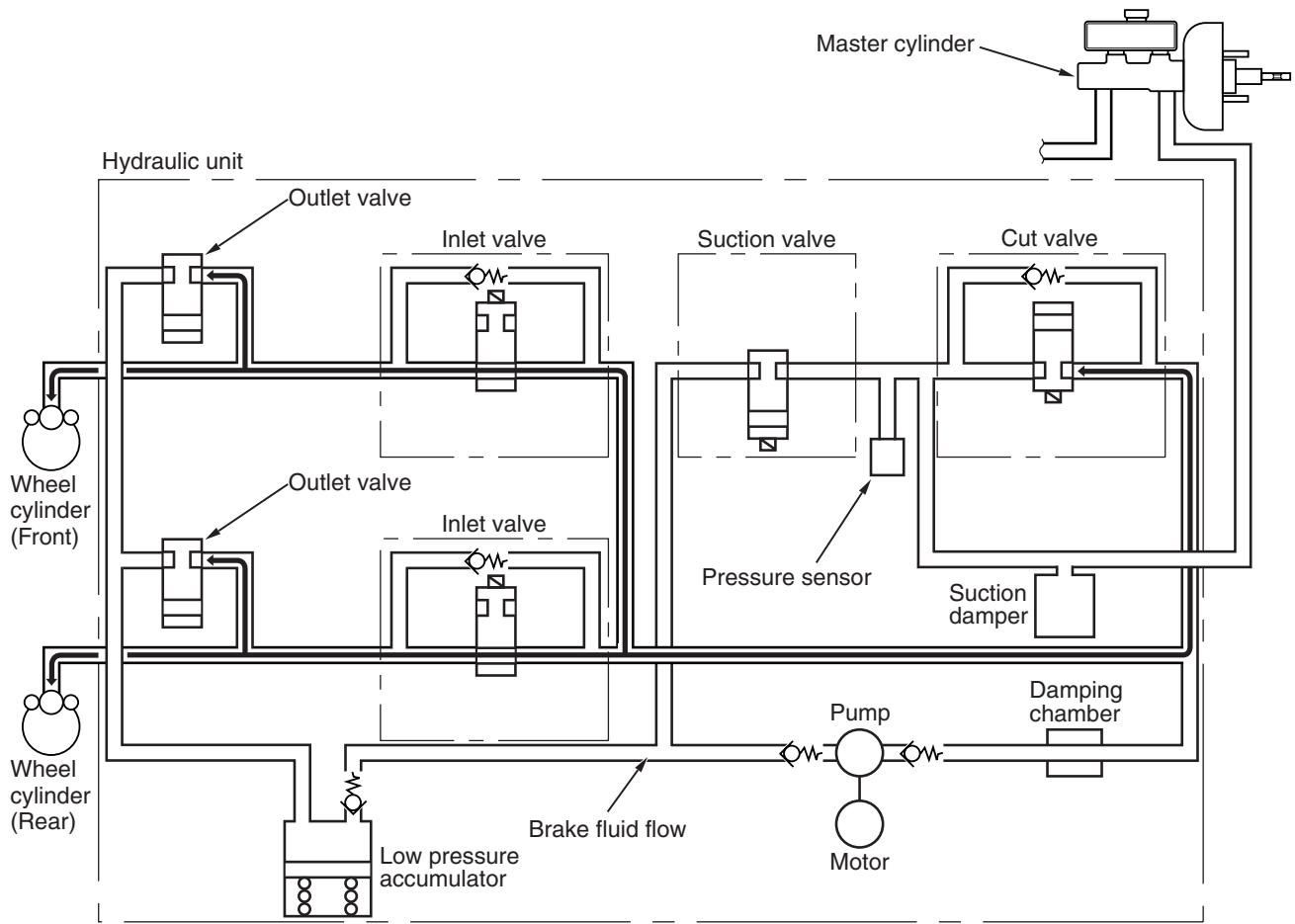
The system closes the cut valve to block the passage from the pump outlet to the master cylinder, and opens the suction valve, connecting the passage from the master cylinder to the pump inlet. The brake fluid from the master cylinder is supplied to the wheel cylinder.

VALVE CONDITION

Item	Power status	Open/Close
Cut valve	ON	Closed
Suction valve	ON	Open
Inlet valve*	OFF	Open
Outlet valve*	OFF	Closed

*NOTE: * The inlet valve and the outlet valve close or open depending on driving conditions to control the brake fluid pressure at each wheel.*

When brake fluid pressure is held by skid control, TCL or HSA (Hill Start Assist) function



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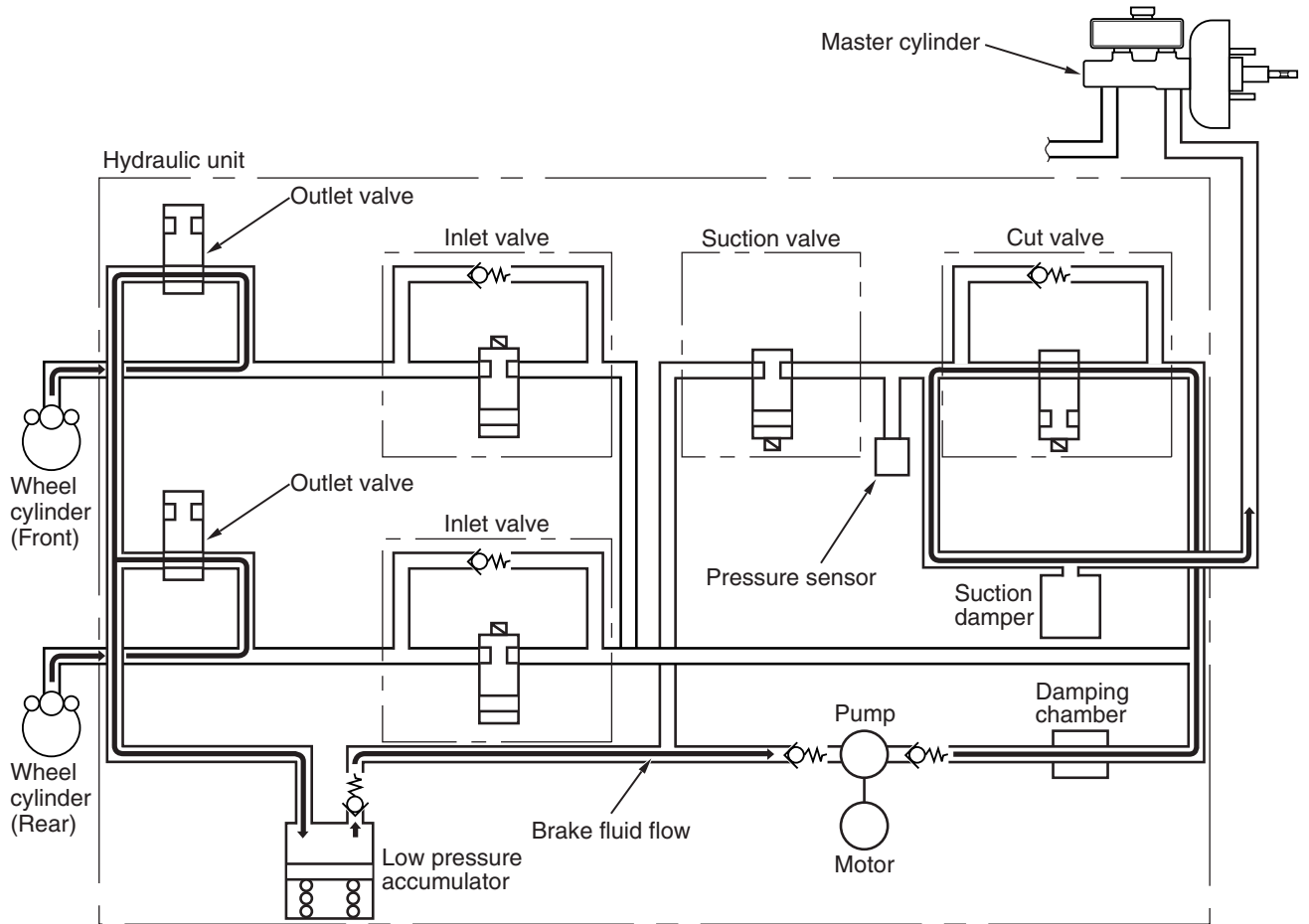
The system closes the cut valve, suction valve and outlet valve to hold the brake fluid pressure in the wheel cylinder.

VALVE CONDITION

Item	Power status	Open/Close
Cut valve	ON	Closed
Suction valve	OFF	Closed
Inlet valve*	OFF	Open
Outlet valve*	OFF	Closed

*NOTE: * The inlet valve and the outlet valve close or open depending on driving conditions to control the brake fluid pressure at each wheel.*

When brake fluid pressure is decreased by skid control (or decreased by TCL)



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The system opens the outlet valve while closing the inlet valve to store the brake fluid filled in the wheel cylinder in the low pressure accumulator. The brake fluid stored in the low pressure accumulator returns to the master cylinder through the suction valve.

VALVE CONDITION

Item	Power status	Open/Close
Cut valve	OFF	Open
Suction valve	OFF	Closed
Inlet valve*	ON	Closed
Outlet valve*	ON	Open

*NOTE: * The inlet valve and the outlet valve close or open depending on driving conditions to control the brake fluid pressure at each wheel.*

TCL OPERATION

ASC-ECU receives various kinds of information from the ECM, TCM^{*1}, TC-SST-ECU^{*2}, AWC-ECU^{*2}, steering wheel sensor, G and yaw rate sensor, and wheel speed sensor. When ASC-ECU determines that the driving wheel is slipping, it suppresses the wheel slippage. At this time, ASC-ECU controls the brake fluid pressure of the driving wheel determined to be slipping so that the torque is transferred to another driving wheel. Basically, the operations of ABS solenoid valve and ASC valve are the same as with the skid control. ASC-ECU, ECM, and TCM^{*1} or

TC-SST-ECU^{*2} communicate with each other via the CAN bus lines. When the accelerator pedal is depressed too far, a signal requesting to reduce the engine output is sent to the ECM. Also, an integrated control with TCM^{*1}, TC-SST-ECU^{*2} or AWC-ECU^{*2} is performed to enhance the TCL controllability.

NOTE:

- ^{*1}: CVT
- ^{*2}: AWD

NOTES