
GROUP 27

REAR AXLE

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REAR AXLE FWD

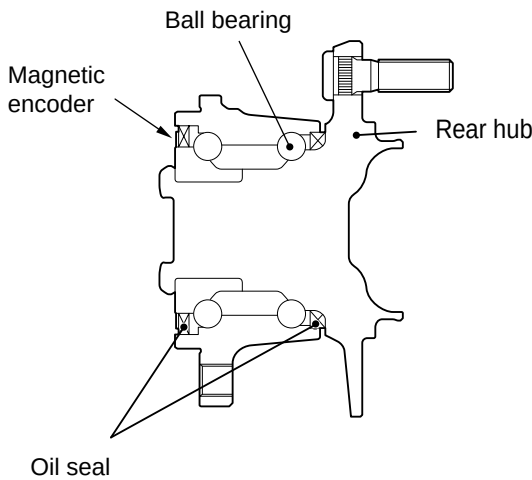
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- The rear axle has the following features:
- The wheel bearing is a unit ball bearing (double-row angular contact ball bearing) which incorporates the oil seals and is highly resistant to thrust loads.
 - The number of parts has been reduced by integrating the magnetic encoder for ABS wheel speed detection into the wheel bearing.

SPECIFICATIONS

Item		Specification
Wheel bearing	Type	Unit ball bearing (double-row angular contact ball bearing)

CONSTRUCTION DIAGRAM



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REAR AXLE AWD

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- For the rear axle, the unit bearing (double-row angular contact ball bearing) in which the hub and ball bearing are incorporated has been adopted for the wheel bearing, and the EUJ-ETJ type constant velocity joint for the driveshaft.

The following features are also available.

 - The lightweight and compact EUJ type constant velocity joint has been installed on the wheel side of the driveshaft, and the lightweight compact ETJ type constant velocity joint has been installed on the differential side.
- Adoption of the electronic control AWD optimizes the size of the driveshaft constant velocity joint and reduces weight.
 - Lead-free grease for the constant velocity joint has been adopted.
 - Hexavalent chromium has been eliminated from the dust cover material.

•The number of parts has been reduced by integrating the magnetic encoder for ABS wheel speed detection into the wheel bearing.

NOTE:

EUJ (High Efficiency Compact Undercut Joint): The lighter and smaller constant velocity joint compared

with the conventional BJ has been achieved by adopting the eight small balls.

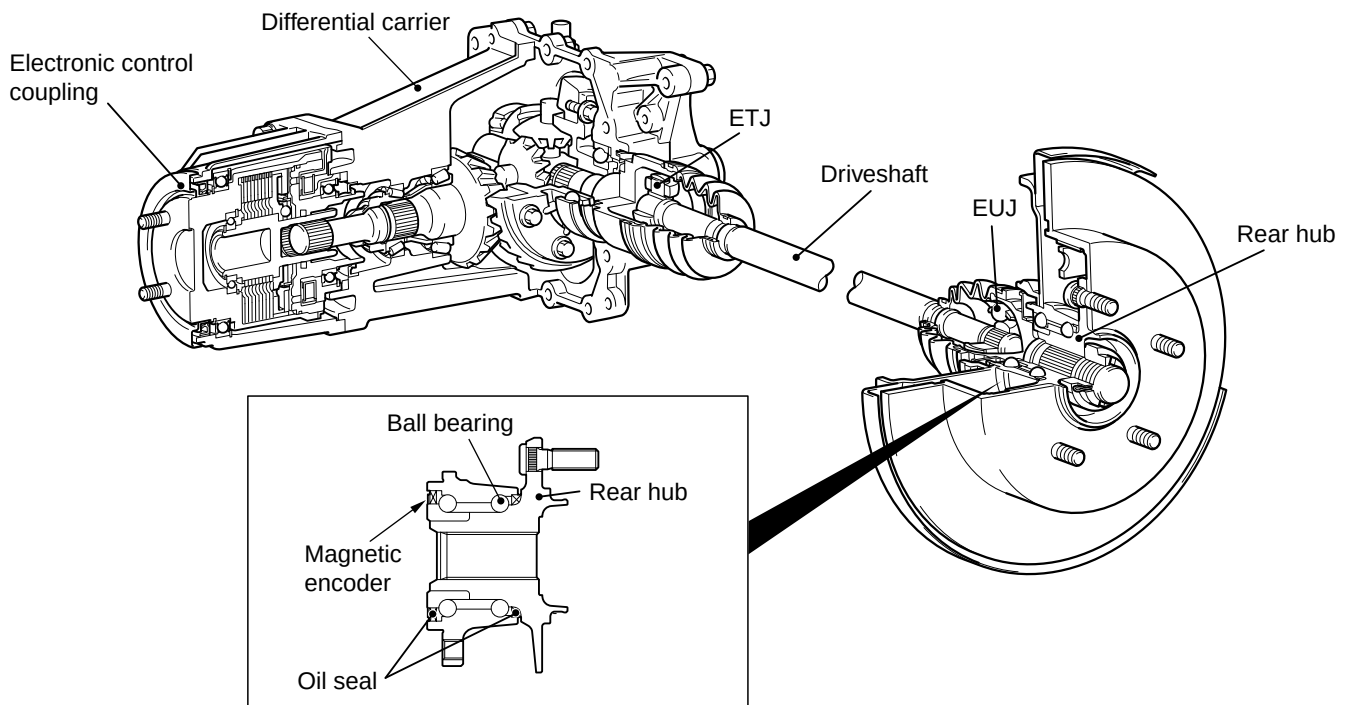
ETJ (High Efficiency Compact Tripod Joint): The lighter and smaller constant velocity joint compared with the conventional TJ has been installed.

SPECIFICATIONS

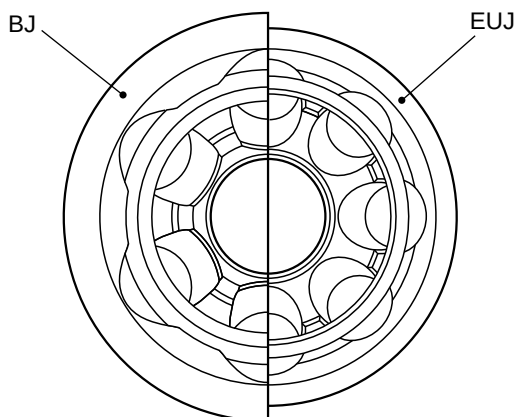
Item			Specification
Wheel bearing	Bearing type		Unit bearing (double-row angular contact ball bearing)
Driveshaft	Joint type	Outer	EUJ
		Inner	ETJ
	Shaft length* x Shaft diameter mm (in)	LH	505.5 × 23 (19.90 × 0.91)
		RH	586 × 23 (23.07 × 0.91)

NOTE: *: Indicates the distance between the center of each joint.

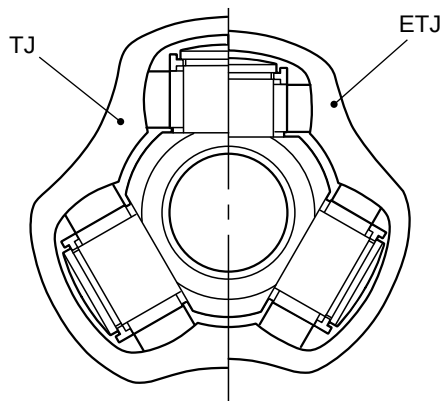
CONSTRUCTION DIAGRAM



EUJ compared with BJ



ETJ compared with TJ



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DIFFERENTIAL

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With the introduction of the electronic control AWD, the electronic control coupling has been installed in front of the differential.

The electronic control coupling transfers the drive force to the rear wheels by pushing the clutch in according to the strength of the magnetic attraction

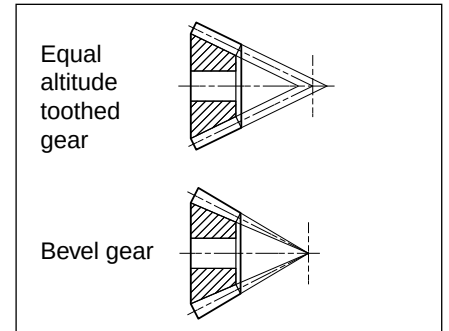
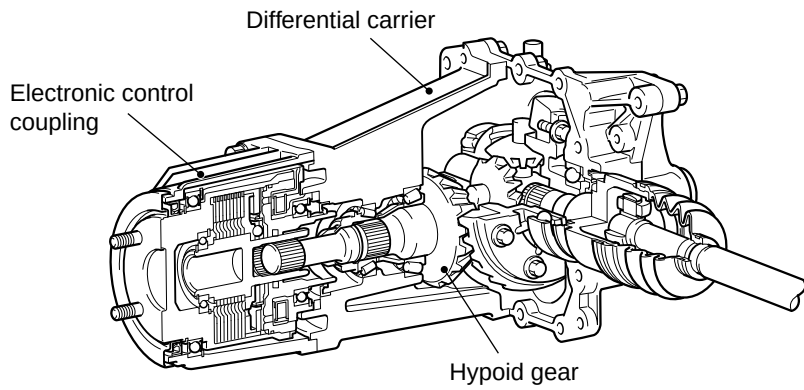
generated by the magnetic coil (For more details, refer to Electronic Control AWD P.27-18).

The following features are also available.

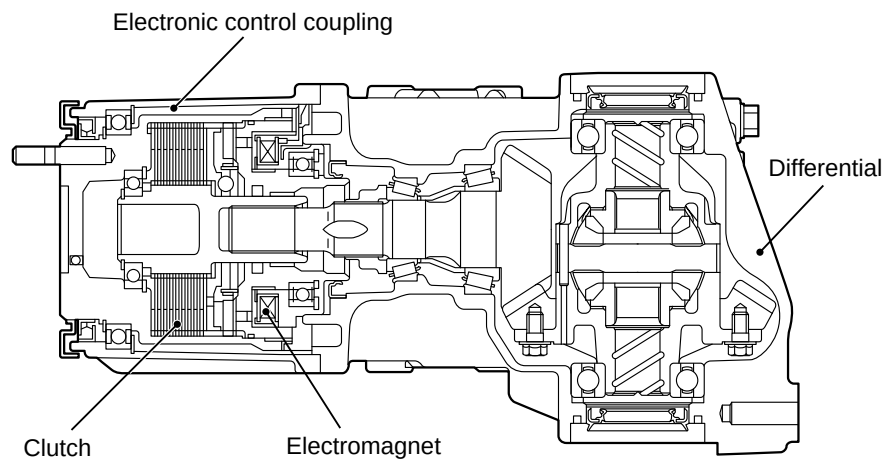
- Aluminum differential carrier reduces weight.
- Optimization of the hypoid gear ratio reduces the torque loss.
- Adoption of the hypoid gear with the same teeth height increases the strength of the coupling.

SPECIFICATIONS

Item		Specification
Reduction gear type		Hypoid gear
Reduction ratio		2.352
Differential gear type (Type × Quantity)	Side gear	Straight bevel gear x 2
	Pinion gear	Straight bevel gear x 2
Number of teeth	Drive gear	40
	Drive pinion	17
	Side gear	14
	Pinion gear	10
Bearing (Outside diameter × inside diameter) mm (in)	Side	72 × 35 (2.83 × 1.38)
	Front	55 × 30 (2.17 × 1.18)
	Rear	68 × 40 (2.68 × 1.57)
Differential gear oil	Type	Hypoid gear oil API classification GL-5 SAE 80W
	Amount dm ³ (qt)	0.5 (0.53)

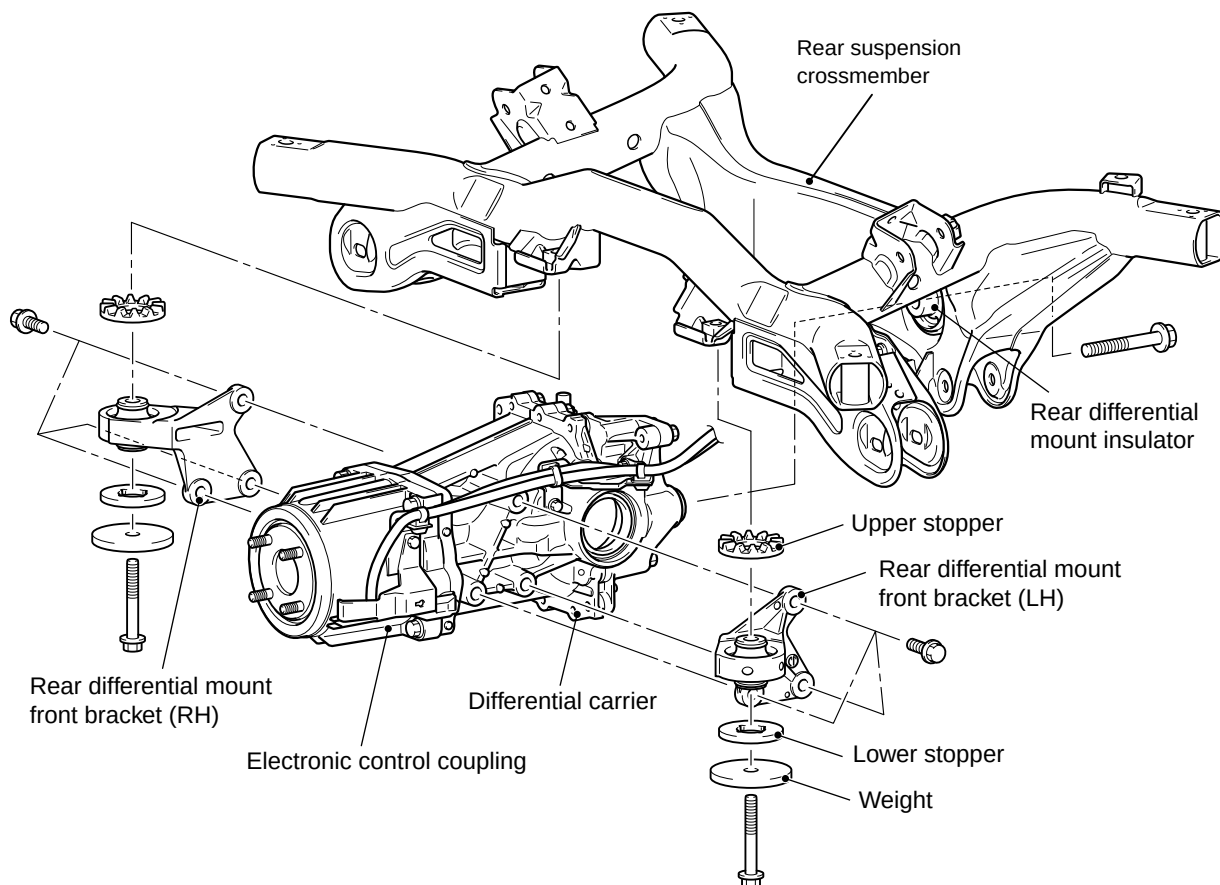


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DIFFERENTIAL MOUNT



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The front side of the differential carrier is installed to the rear suspension crossmember via rear differential mount front bracket (LH/RH). The rear side of the differential carrier is installed to the rear suspension

crossmember via rear differential mount insulator. In this way, the three-point support type differential mount and the optimization of the layout reduces vibration and noise.

ELECTRONIC CONTROL AWD

GENERAL INFORMATION

- Electronic control AWD ensures performance, lighter and smaller body, and better fuel economy.
- The electronic control AWD controls the torque of the electronic control coupling located between the propeller shaft and rear differential. This strategy is enabled by varying the torque distribution to the front and rear wheels from the status closer to the front wheel drive to the status closer to the direct coupling AWD and realizes the optimal drive force according to the various driving conditions.

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AIMS OF DEVELOPMENT

Lightweight and simple construction of the electronic control AWD achieves good fuel efficiency and provides enjoyment of selecting the drive mode.

FUNCTION

- The adoption of the electronic control coupling prevents the tight corner braking phenomenon* and satisfies the traction performance.

NOTE: *Tight corner braking indicates the following condition: When the AWD vehicle turns sharply on a pavement at low speed (ex. parallel parking), the rotational radius of the front and rear wheels differs, and this difference can no longer be compensated by the tire slippage. At this time, the driver feels as if the brake was applied.

- The electronic control AWD receives the signals of the throttle position and vehicle speed via CAN* communication protocol, detects the vehicle driving condition and operation of the driver, and distributes the proper torque to the rear wheels.

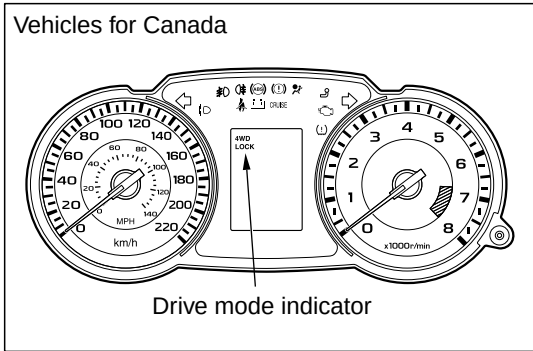
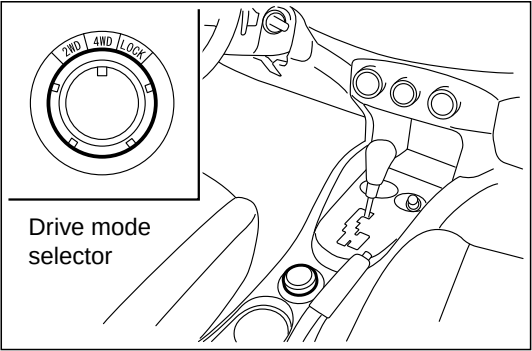
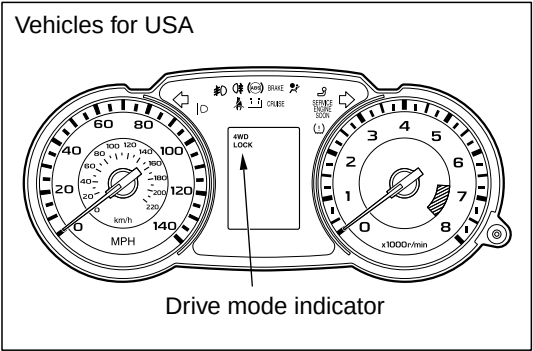
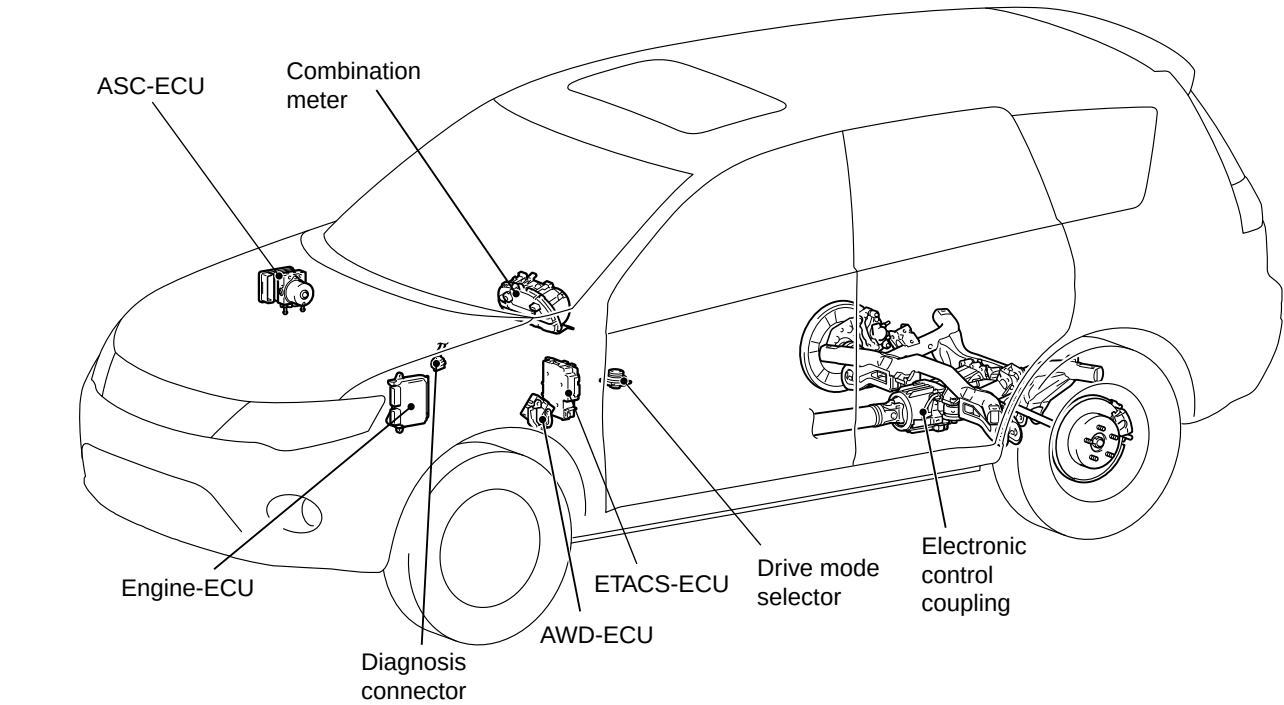
NOTE: *: For more information about CAN (Controller Area Network), refer to GROUP 54C.

- Under severe driving conditions, the system is protected by minimizing the limitation force of the differential.
- During high-speed driving, the fuel efficiency is improved by reducing the limitation force of the differential.

- The following drive modes are available according to the drivers' preference to provide the enjoyment of selecting functions.

Drive mode	Control content	Appeal points
FWD	Minimizes the limitation force of the differential.	High fuel efficiency mode which enables smoother turning performance of the FWD vehicle
AWD	Increases the limitation force of the differential according to the different rotation speed of the front and rear wheels and the throttle position.	Universal mode which automatically distributes the drive force to the rear wheels as necessary
LOCK	Further increases the limitation force of the differential compared to the AWD mode.	Mode which has an excellent driving performance when driving on rough roads or in stuck situation and enables powerful driving

CONSTRUCTION DIAGRAM



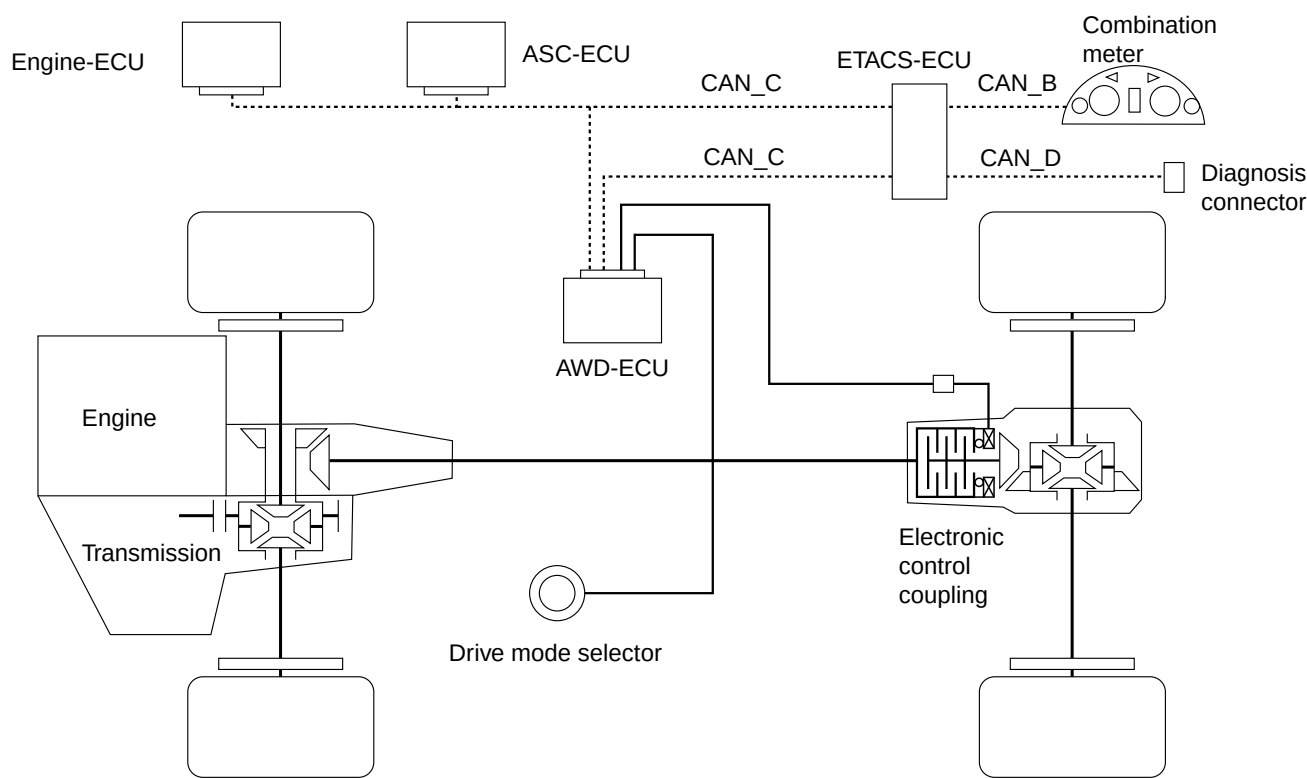
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System component and function

Parts name	Functional description
Engine ECU	Sends the following signals required by AWD-ECU via CAN communication.

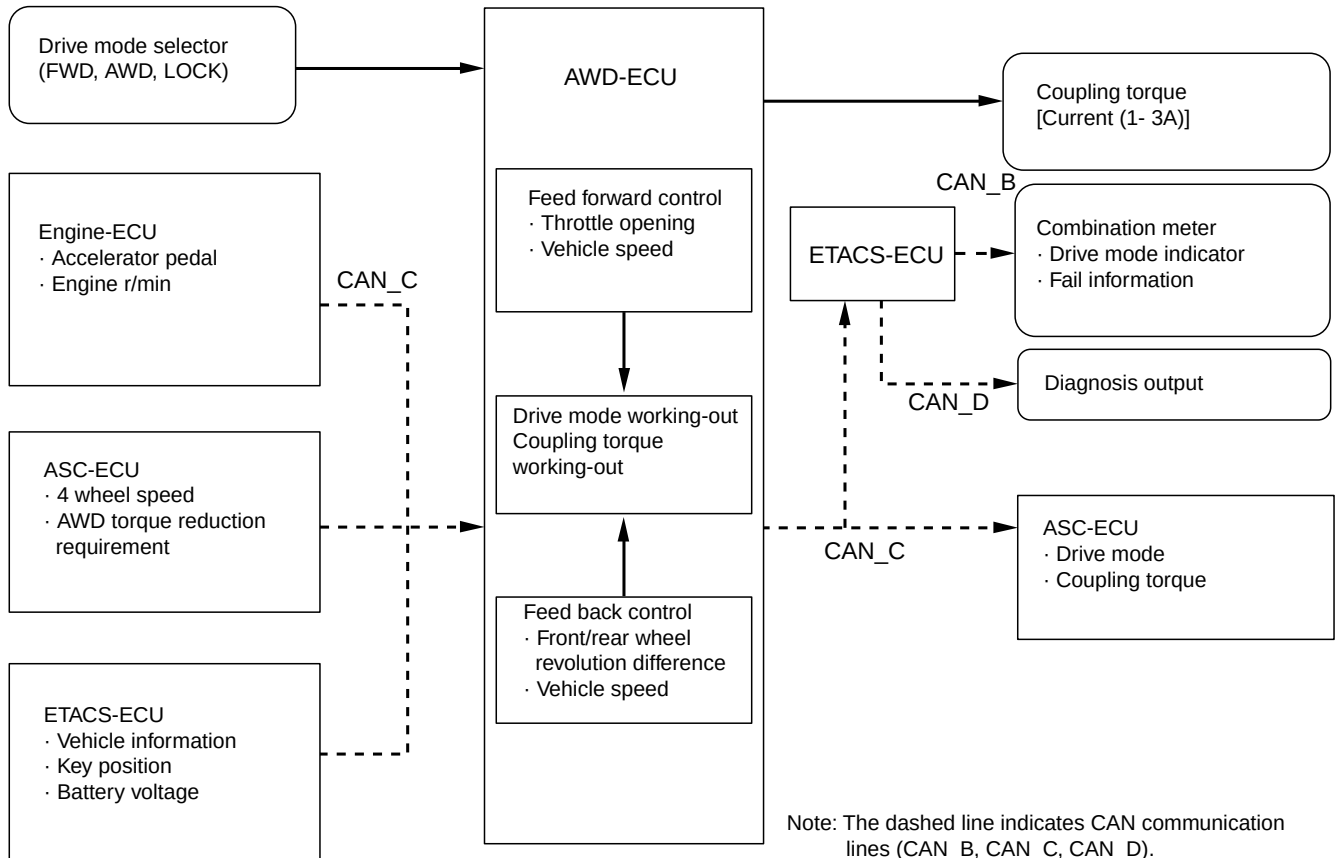
Parts name	Functional description
	▪Engine torque signal ▪Throttle position signal ▪Engine speed signal
ASC-ECU	Sends the following signals required by AWD-ECU via CAN communication. ▪ABS sensor signal (wheel speed signal) [4 wheels] ▪ABS operation signal ▪AWD limitation torque signal
Drive mode selector	Sends the drive mode switch signal [FWD/AWD/LOCK] to AWD-ECU.
ETACS-ECU	▪Receives the drive mode switch signal [FWD/AWD/LOCK] from AWD-ECU and flashes the indicators (AWD operation indicator and LOCK indicator) in the combination meter. ▪Flashes the indicators (AWD operation indicator and LOCK indicator) in the combination meter in case of failure.
	Controls diagnostic function (Compatible with scan tool).
AWD-ECU	Calculates the optimum differential limitation force judging from the vehicle condition and present drive mode based on the signals from each ECU and switch, and controls the current value flown to the electronic control coupling.
	Controls the indicators (AWD operation indicator and LOCK indicator) in the combination meter.
	Controls the self-diagnostic function and fail-safe function.
	Controls diagnostic function (Compatible with scan tool).
Electronic control coupling	Transmits the torque corresponding to the current value controlled by AWD-ECU to the rear wheels.
Drive mode indicator ▪AWD operation indicator ▪LOCK indicator	Integrated in the combination meter, and indicates the selected drive mode (Not displayed in FWD mode). ▪When the AWD operation indicator and LOCK indicator flash alternately, the system automatically enters the front wheel drive mode to protect the drive system components, and the drive mode changeover with the drive mode selector becomes unavailable. ▪When the drive system generates heat, the AWD operation indicator flashes. ▪The indicator lamp operation signal from AWD-ECU is sent to the combination meter via ETACS-ECU using CAN communication.
Data link connector	Outputs the diagnostic trouble code and establishes the communication with scan tool.

SYSTEM CONFIGURATION

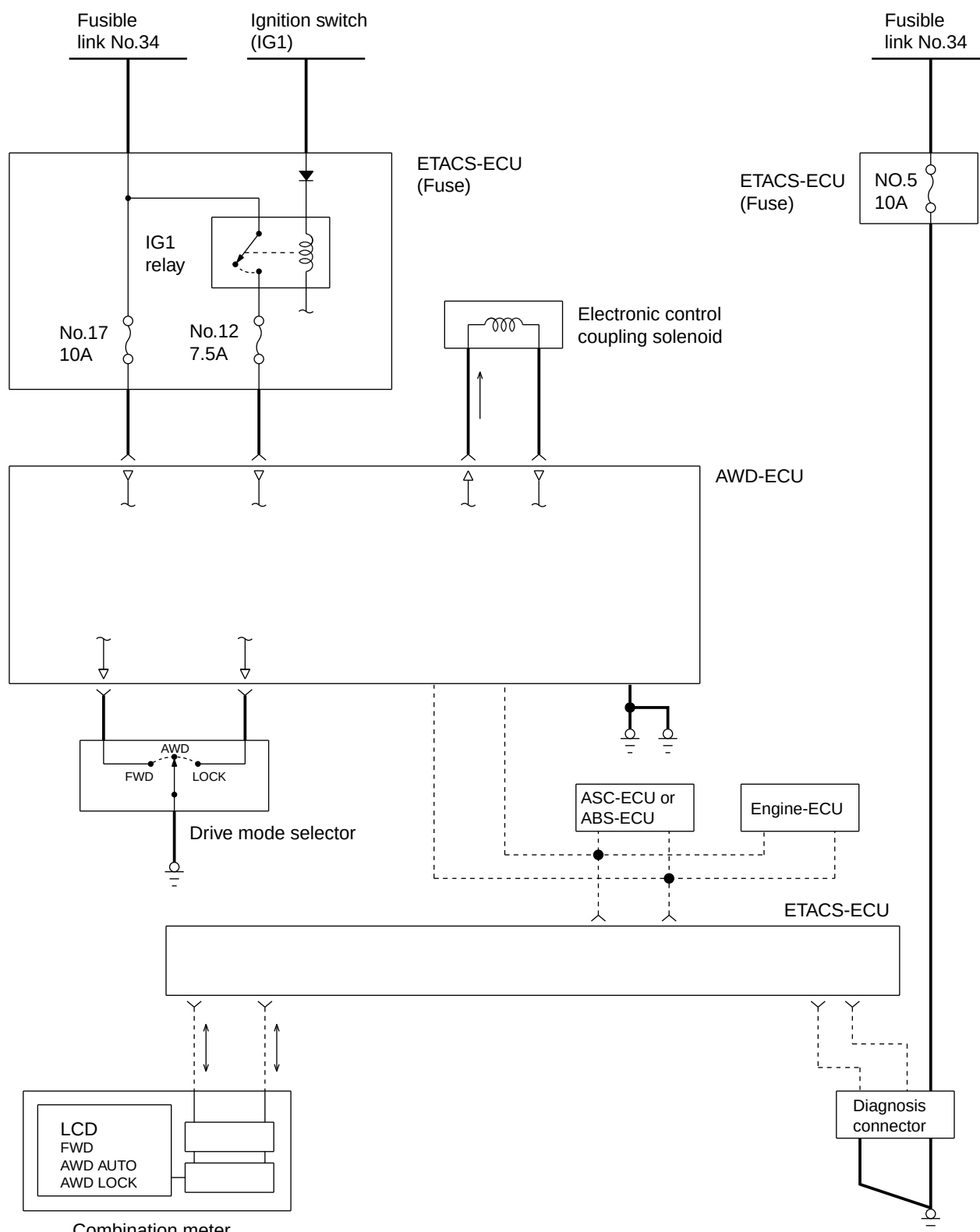


Note: The dashed line indicates CAN communication lines (CAN_B, CAN_C, CAN_D).

CONTROL SCHEMATIC DIAGRAM



ELECTRONIC CONTROL AWD ELECTRIC CIRCUIT DIAGRAM



Note: The dashed line indicates CAN communication lines.

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AWD-ECU

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FUNCTION

The main functions of AWD-ECU are as follows:

1. Communication function
 - CAN communication with other ECUs (Engine ECU, ASC-ECU, ETACS)
 - Communication with drive mode switch: The signal from the drive mode switch changes the drive mode.
 - Combination meter display: Drive mode is displayed.
2. Coupling control function
 - Current output: Differential control function of the electronic control coupling according to the vehicle conditions
3. ECU self-diagnosis function
 - Initial check: ROM check, relay check, etc.
 - Recording function of diagnosis codes and freeze frame data in case of failure
 - System shutdown function after failure detection and AWD/LOCK indicator lamp warning display function
 - Normal control: Malfunction of CPU power supply, relay check, open or short circuit of the I/O signal, abnormal CAN communication

FAIL-SAFE FUNCTION

FAILURE DETECTION

ECU performs the following checks at a timing shown in the chart below. ECU determines the malfunction

occurred when the failure detection conditions are met, and it sets the diagnostic trouble code and executes the countermeasures for trouble. When the failure resume conditions are met, ECU determines the status is normal, and resumes the system.

Start-up (Initial check just after the ignition switch is turned ON.)

1. CPU check
 - Performs the ROM and RAM check.
2. Actuator check
 - After CPU check has been completed, check the driving voltage with the actuator relay OFF.

Always (During ignition ON status other than initial check operation)

1. CPU check
 - Performs CAN communication and interactive check between CPUs.
2. Power supply check
 - Monitors the CPU supply voltage and checks if the voltage is within specifications.
3. Actuator check
 - Checks if the actuator relay turns ON according to the control.
 - Compares the command current value from CPU with the monitored current and checks if they agree.
4. External wire connection check
 - Checks if the input and output of each external wire connection is open, shorted, or stuck.

FAIL-SAFE SPECIFICATIONS

Diagnostic trouble code No.	Diagnostic item	Fail-safe				
		Detection timing	Countermeasures for failure			Cancel condition
			AWD control	Combination meter (AWD operation indicator, LOCK indicator, driving system oil temperature warning lamp)	Actuator relay inside AWD-ECU	
C1078	Different size tire installation	Always	Gradually to FWD	AWD and LOCK indicators flash alternately.	ON	Ignition switch: OFF
C1456	Harness, coupling coil overcurrent abnormality	Always	Immediately to FWD	AWD and LOCK indicators flash alternately.	OFF	Ignition switch: OFF
C145A	Harness, coupling coil short circuit abnormality	Always	Immediately to FWD	AWD and LOCK indicators flash alternately.	OFF	Ignition switch: OFF
C145D	Harness, coupling coil break abnormality	Always	Immediately to FWD	AWD and LOCK indicators flash alternately.	OFF	Ignition switch: OFF
C145F	Coupling overload	Always	Gradually to FWD	Drive system oil temperature warning lamp turns ON.	ON	Estimated temperature of coupling is at specification or less.
C1460	Drive mode selector circuit abnormality	FWD switch: ON LOCK switch: ON	Changes into AWD AUTO mode.	AWD and LOCK indicators flash alternately.	ON	Coupling: Resumes the normal state.

Diagnostic trouble code No.	Diagnostic item	Fail-safe				
		Detection timing	Countermeasures for failure			Cancel condition
			AWD control	Combination meter (AWD operation indicator, LOCK indicator, driving system oil temperature warning lamp)	Actuator relay inside AWD-ECU	
C2100	Battery voltage abnormality (Low voltage)	When the engine speed is 1500 r/min, IG1 voltage is less than 8 V, and battery voltage is less than 8 V.	Gradually to FWD	AWD and LOCK indicators flash alternately.	ON	Ignition switch: OFF
C2101	Battery voltage abnormality (High voltage)	IG1 voltage and battery voltage are more than 17 V.	Gradually to FWD	AWD and LOCK indicators flash alternately.	ON	Ignition switch: OFF
C211C	IG1 power supply voltage abnormality (Low voltage)	IG1 voltage is less than 8 V.	Gradually to FWD	AWD and LOCK indicators flash alternately.	ON	Ignition switch: OFF
C211D	IG1 power supply voltage abnormality (High voltage)	IG1 voltage is more than 17 V.	Gradually to FWD	AWD and LOCK indicators flash alternately.	ON	Ignition switch: OFF
C211E	Power supply voltage abnormality (Low voltage)	IG1 voltage is 7.5 V or more.	Immediately to FWD	AWD and LOCK indicators flash alternately.	OFF	Ignition switch: OFF
C211F	Power supply voltage abnormality (High voltage)	Power supply voltage is 17 V or more	Gradually to FWD	AWD and LOCK indicators flash alternately.	ON	Battery power supply voltage is 16 V or less.

REAR AXLE
ELECTRONIC CONTROL AWD

Diagnostic trouble code No.	Diagnostic item	Fail-safe				
		Detection timing	Countermeasures for failure			Cancel condition
			AWD control	Combination meter (AWD operation indicator, LOCK indicator, driving system oil temperature warning lamp)	Actuator relay inside AWD-ECU	
C2208	AWD-ECU internal abnormality	Always	Immediately to FWD	AWD and LOCK indicators flash alternately.	OFF	Ignition switch: OFF
U0001	Bus off abnormality	When bus-off interruption is detected	Control using the data value just before the bus-off detection.	AWD and LOCK indicators flash alternately.	Turns ON/OFF depending on the data value just before the bus-off detection.	Ignition switch: OFF
U0100	Engine CAN time out	Always	Gradually to AWD AUTO mode	AWD and LOCK indicators flash alternately.	ON	Ignition switch: OFF
U0121	ABS CAN time out	ABS signal cannot be received.	Gradually to FWD	AWD and LOCK indicators flash alternately.	ON	Ignition switch: OFF
U0141	ETACS CAN time out	ETACS signal cannot be received.	Retains the last normal status.	AWD and LOCK indicators flash alternately.	ON	Ignition switch: OFF
U0401	Engine CAN data abnormality	Always	Gradually to AWD AUTO mode	AWD and LOCK indicators flash alternately.	ON	Ignition switch: OFF

Diagnostic trouble code No.	Diagnostic item	Fail-safe				
		Detection timing	Countermeasures for failure			Cancel condition
			AWD control	Combination meter (AWD operation indicator, LOCK indicator, driving system oil temperature warning lamp)	Actuator relay inside AWD-ECU	
U0415	ABS CAN data abnormality	One or more wheel speed data has abnormality.	Gradually to FWD	AWD and LOCK indicators flash alternately.	ON	Ignition switch: OFF
U113C	Wheel speed sensor abnormality	ABS signal cannot be received. Diagnostic trouble code U0121 has not been detected yet.	Gradually to FWD	AWD and LOCK indicators flash alternately.	ON	Ignition switch: OFF

DIAGNOSTIC FUNCTION

AWD-ECU has the following functions for easier system checks. All of the following items can be diagnosed using the scan tool.

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

DIAGNOSTIC TROUBLE CODE SET

Using scan tool, the diagnostic trouble code (information of failures generated in the electronic control AWD system) can be read. When a failure occurs, AWD-ECU sets the diagnostic trouble code for that failure in the nonvolatile memory (EEPROM*), so the recorded information will not be erased even if the battery is disconnected.

NOTE:

- *EEPROM (Electrical Erasable & Programmable ROM): Special type of memory that can be programmed or erased electrically
- For the diagnostic trouble code output items of the electronic control AWD, refer to Workshop Manual.

SERVICE DATA OUTPUT

Using scan tool, the data (input data from each ECU and switch) used for control by the electronic control AWD system can be read.

NOTE: For each service data item, refer to Workshop Manual.

ACTUATOR TEST

Scan tool can forcibly drive the actuators (electronic control coupling solenoid and drive mode indicator) controlled by the electronic control AWD system.

NOTE: For the actuator test specification, refer to Workshop Manual.

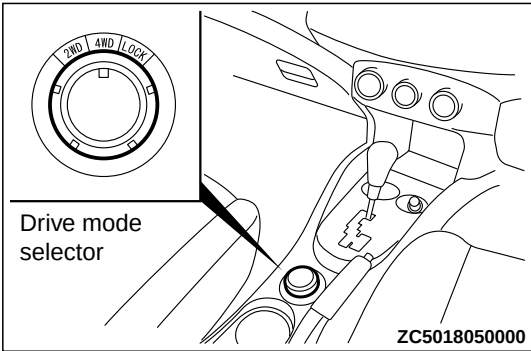
FREEZE FRAME DATA OUTPUT

Scan tool can read the freeze frame data (driving conditions when the failure occurs) set when the diagnostic trouble code is detected.

NOTE: For freeze frame data items, refer to Workshop Manual.

DRIVE MODE SELECTOR

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The drive mode selector has been installed on the floor console. When the dial is rotated with the ignition switch turned to ON position, you can select the drive mode from FWD (2WD), AWD (4WD), or LOCK modes.

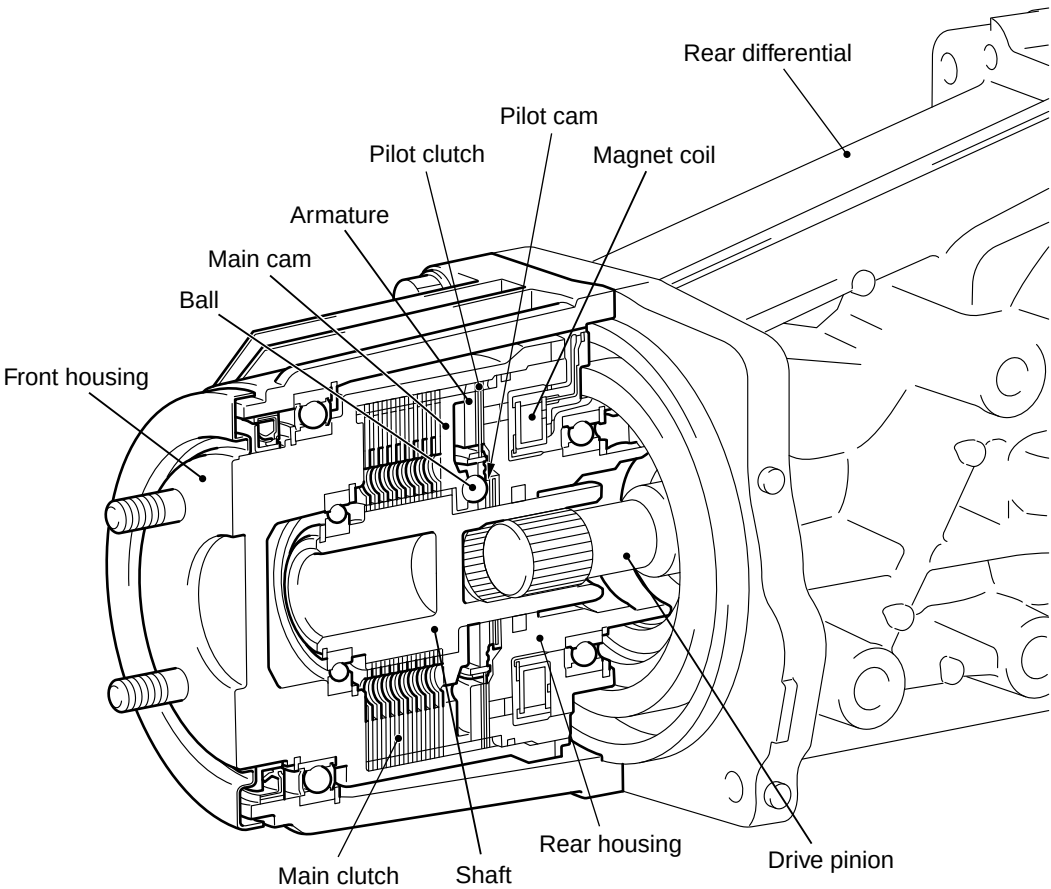
ELECTRONIC CONTROL COUPLING

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FEATURES

The electronic control coupling realizes the highly reliable AWD system with lighter weight and simpler construction.

CONSTRUCTION



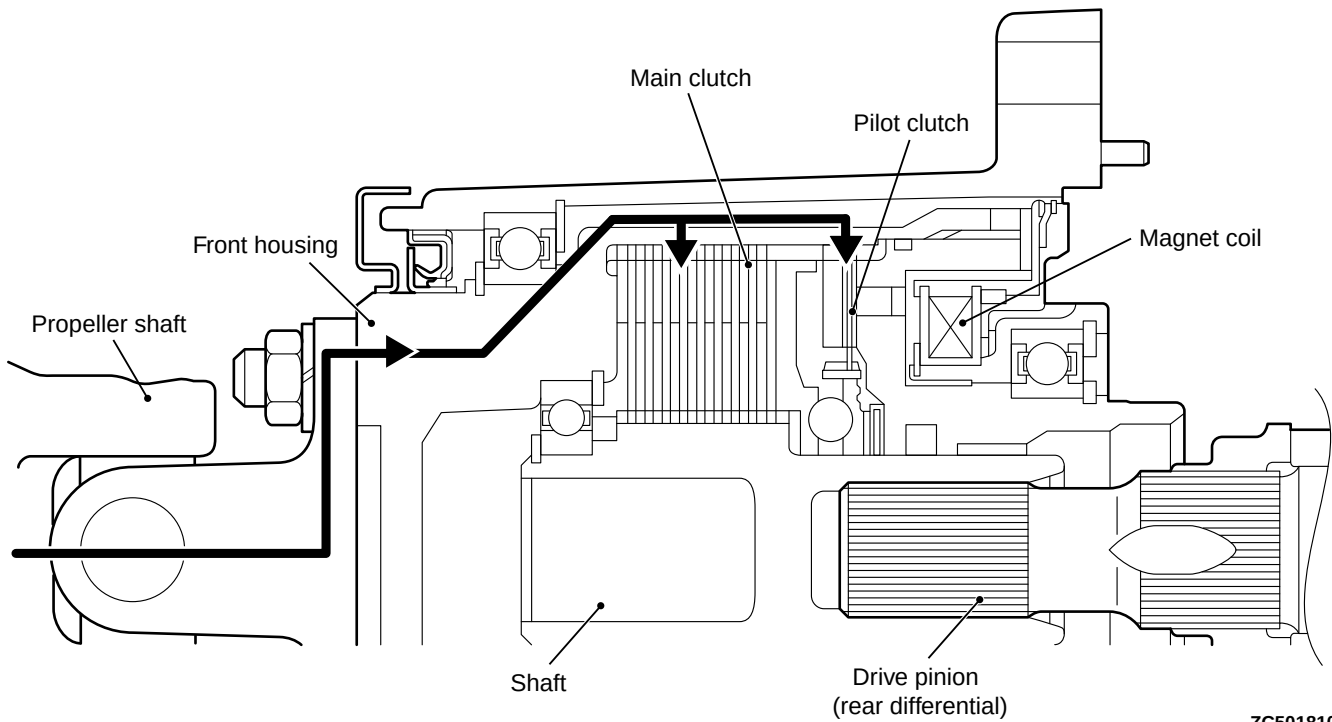
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The electronic control coupling is comprised of the front housing, main clutch, main cam, ball, pilot cam, armature, pilot clutch, rear housing, magnetic coil, and shaft.

- The front housing is joined to the propeller shaft and rotates along with the shaft.
- The main clutch and pilot clutch are assembled to the front housing on the outer side and to the shaft on the inner side (The pilot clutch is installed via the pilot cam).
- The shaft is engaged via serrations with the drive pinion of the rear differential.

OPERATION

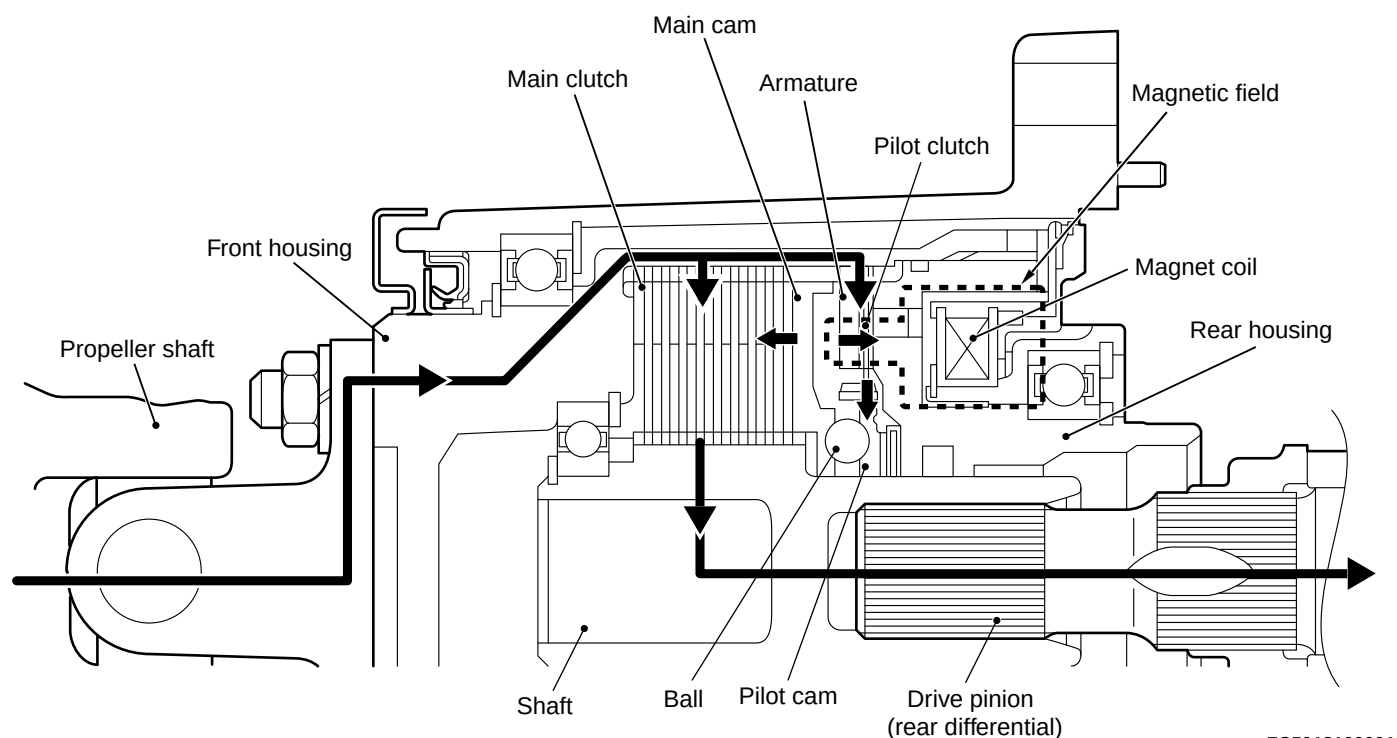
COUPLING STOPS (FWD: MAGNETIC COIL DE-ENERGIZED.)



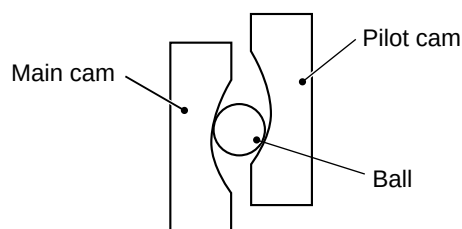
The drive force from the transfer is transmitted to the front housing connected to the propeller shaft. The drive force is also transferred to the pilot clutch and the outer side of the main clutch assembled to the

front housing. Because the pilot clutch and the main clutch are not engaged with the magnetic coil de-energized, the drive force is not transferred to the shaft and the drive pinion of the rear differential.

COUPLING OPERATES (AWD: MAGNETIC COIL ENERGIZED)



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▪ The drive force from the transfer is transmitted to the front housing connected to the propeller shaft. The drive force is also transferred to the pilot clutch and the outer side of the main clutch assembled to the front housing. When the magnetic coil is energized, the magnetic field is generated among the rear housing, pilot clutch, and armature. The magnetic field induces the pilot clutch and armature to engage the pilot clutch. When the pilot clutch is engaged, the drive force is transferred to the pilot cam. When there is a difference in wheel angle between the front and rear wheels (i.e. rotation speed of the propeller shaft is different from that of the drive pinion), the rotation speed of the pilot cam applied with the drive force and that of the main cam not applied with the drive force become different.

The ball slides along the curved space between the pilot cam and main cam by the rotational speed difference and pushes the pilot cam and main cam. Then, the main clutch is pushed toward the main cam to engage. When the main clutch is engaged, the drive force is transferred to the rear wheels via the shaft and the drive pinion of the rear differential.

▪ By controlling the current applied to the magnetic coil, the amount of the drive force transferred to the rear wheels can be controlled within the range of 0 to 100%.