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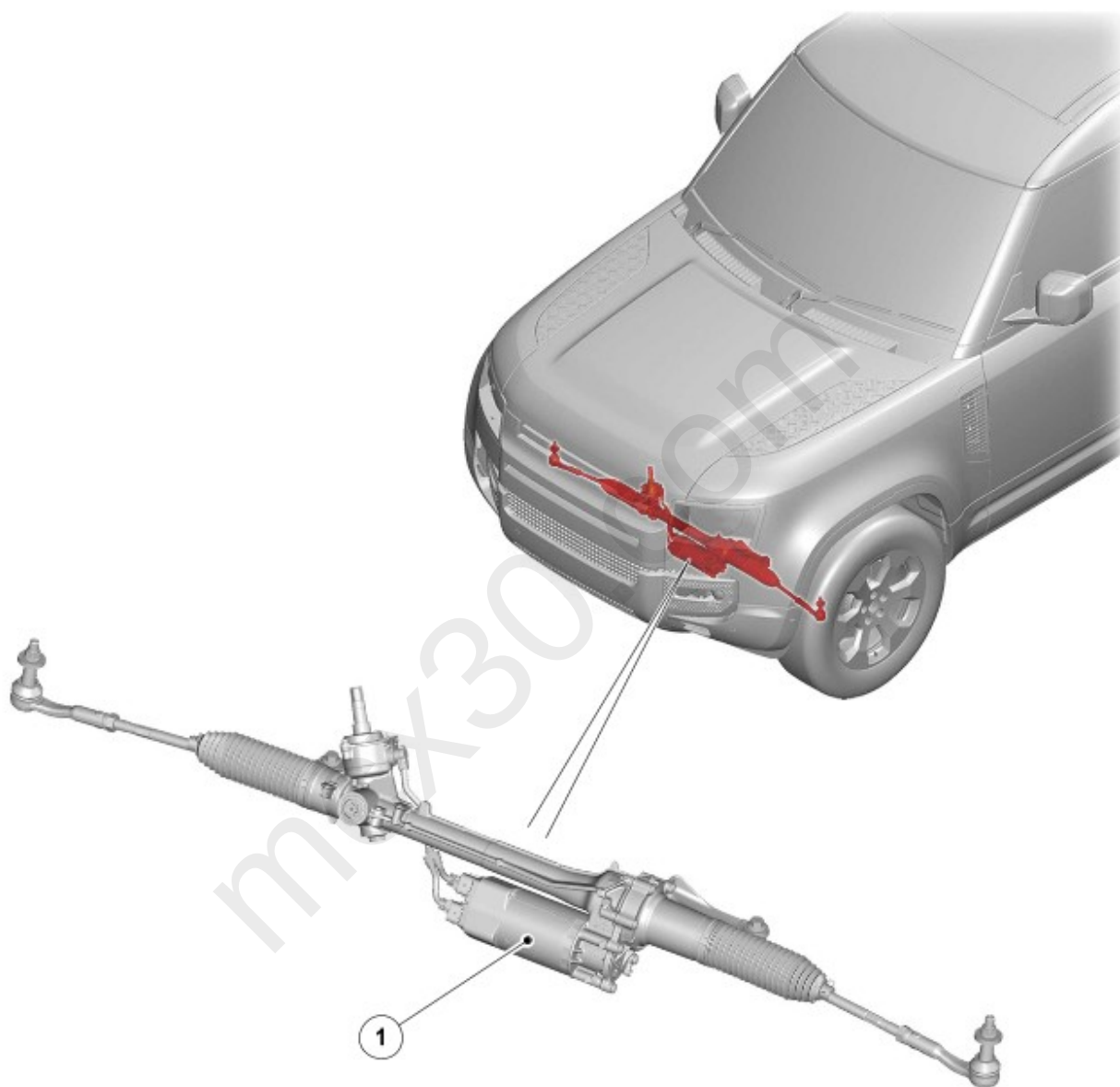
2020.0 DEFENDER (LE), 211-02

POWER STEERING (G2341735)

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DESCRIPTION AND OPERATION

COMPONENT LOCATION



E252754

ITEM	DESCRIPTION
1	Steering gear

OVERVIEW

The vehicle is installed with electric power steering, provided by a steering gear unit with variable ratio, rack and pinion steering and speed sensitive power assistance. Power assistance is from an electric motor attached to the steering gear.

The steering gear also incorporates:

- A Power Steering Control Module (PSCM), on the end of the electric motor
- A reduction gear
- A torque sensor.

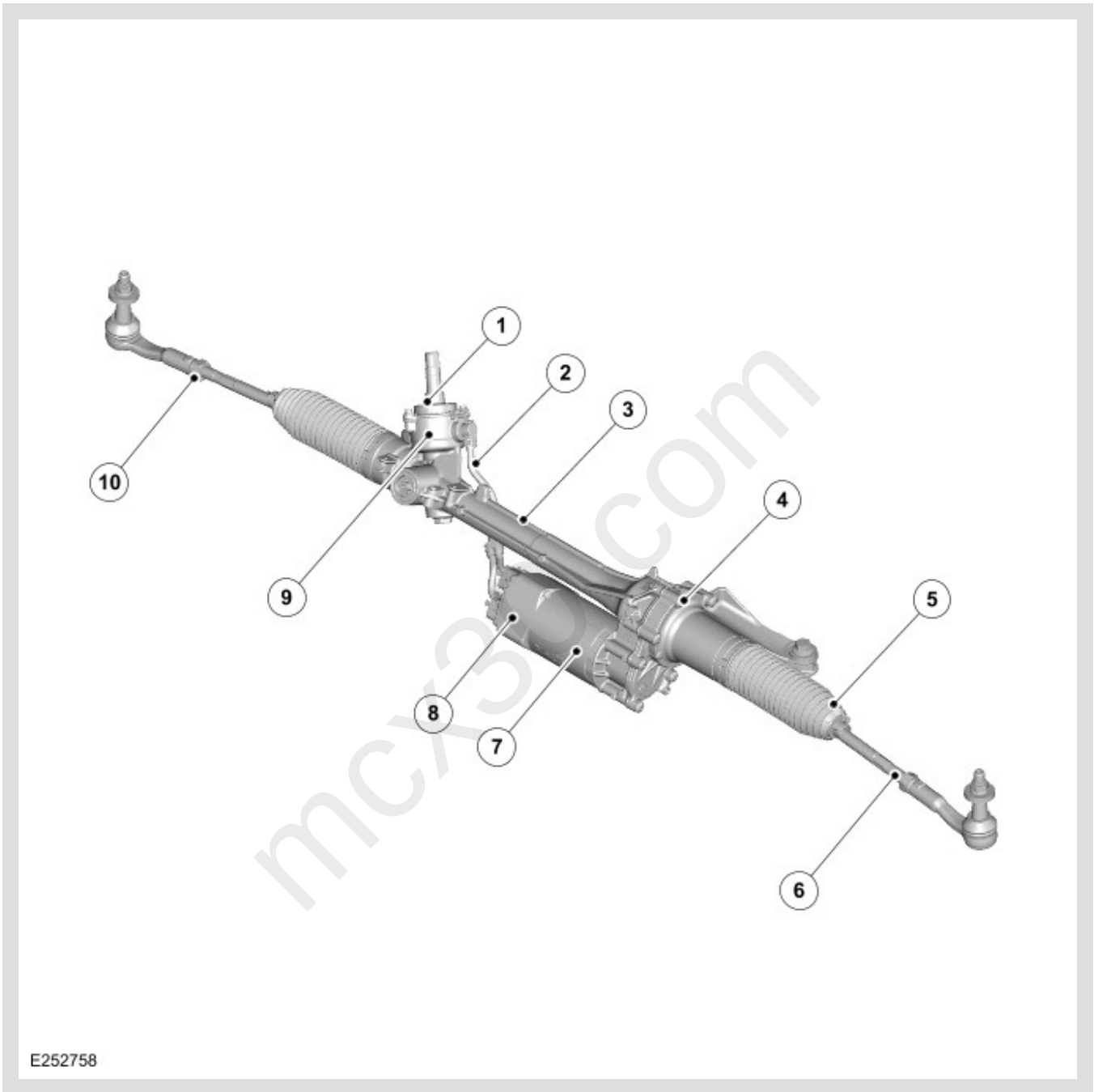
Power assistance is controlled by the PSCM, which uses the electric motor to apply an axial force on the steering gear through a reduction gear. The level of power assistance depends on the steering torque applied with the steering wheel, the vehicle speed and the terrain response mode selected.

The PSCM also uses the electric motor to provide the following assistance functions:

- Assistance changes during auto stop/start functions (if equipped).
- Assistance reduction if system overheats.
- Assistance reduction if low or high voltage.
- Park assist (if equipped). For additional information, refer to: [Parking Aid](#) (413-13 Parking Aid, Description and Operation).

DESCRIPTION	

STEERING GEAR



E252758

ITEM	DESCRIPTION
1	Input shaft
2	Signal and power wiring harness for torque sensor
3	Steering gear housing
4	Reduction gear

ITEM	DESCRIPTION
5	Boot (quantity 2)
6	Tie rod (quantity 2)
7	Electric motor
8	PSCM
9	Torque sensor
10	Tie rod to tie rod end locking nut (quantity 2)

The steering gear is installed on the front subframe. The 2 bosses on the rear of the steering gear are attached direct to the subframe with M14 bolts and captive washers. The 2 bosses on top of the steering gear are attached to Noise, Vibration and Harshness (NVH) brackets on the subframe with M8 bolts and washers. A mass damper is attached to the steering gear with an M6 bolt and washer.

The input shaft of the steering gear connects to the pinion extension of the steering column lower shaft. For additional information, refer to: [Steering Column](#) (211-04 Steering Column, Description and Operation).

The steering gear is installed in a steering gear housing that also contains the pinion shaft and the torque sensor. A torsion bar connects the pinion shaft to the input shaft. Ball jointed tie rods connect the ends of the steering gear to the knuckles of the front suspension. The ends of the steering gear are protected by corrugated boots.

The steering gear housing incorporates a mounting for the electric motor. A reduction gear housing, on the end of the steering gear housing, contains a recirculating ball nut installed on a threaded section of the steering gear. A toothed belt transmits drive from the electric motor to the recirculating ball nut to provide the power assistance. The ratio of electric motor revolutions to steering wheel revolutions is approximately 20:1.

Electric Motor



E252756

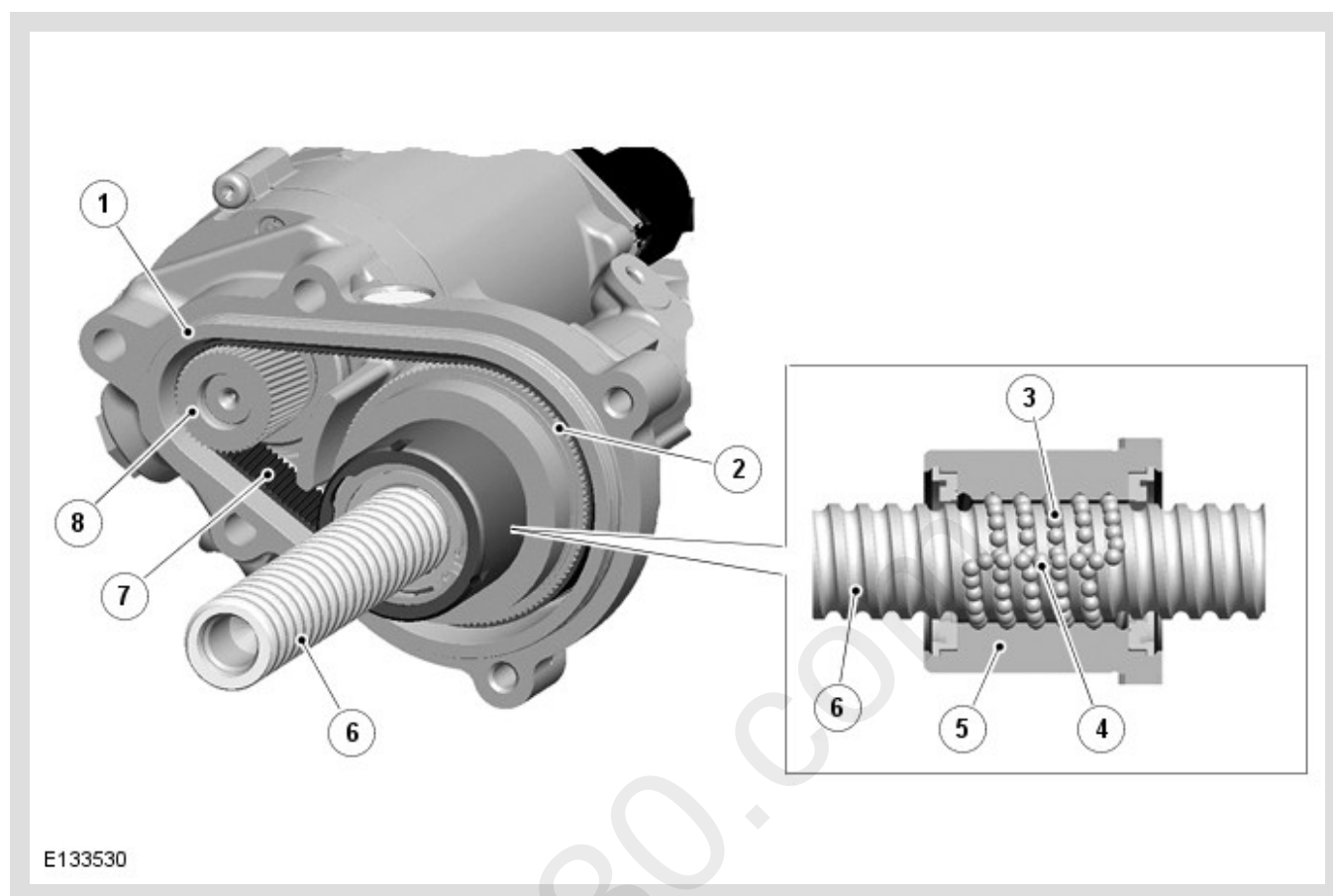
ITEM	DESCRIPTION
1	Electric motor

The electric motor is a brushless Direct Current (DC) motor. The electronics that convert the DC power supply into phase voltages are contained in the power steering control module.

Motor position is detected by 2 Hall effect sensors in the PSCM, adjacent to rotating magnets on the electric motor shaft. The 2 sensors have different resolutions, which allows the PSCM to monitor both fast and slow movement effectively. From the position of the electric motor, the PSCM can deduce the position of the road wheels and the steering angle.

After first calibrating the straight-ahead position using the steering angle sensor, the PSCM subsequently uses the motor position sensor inputs for control of the power steering.

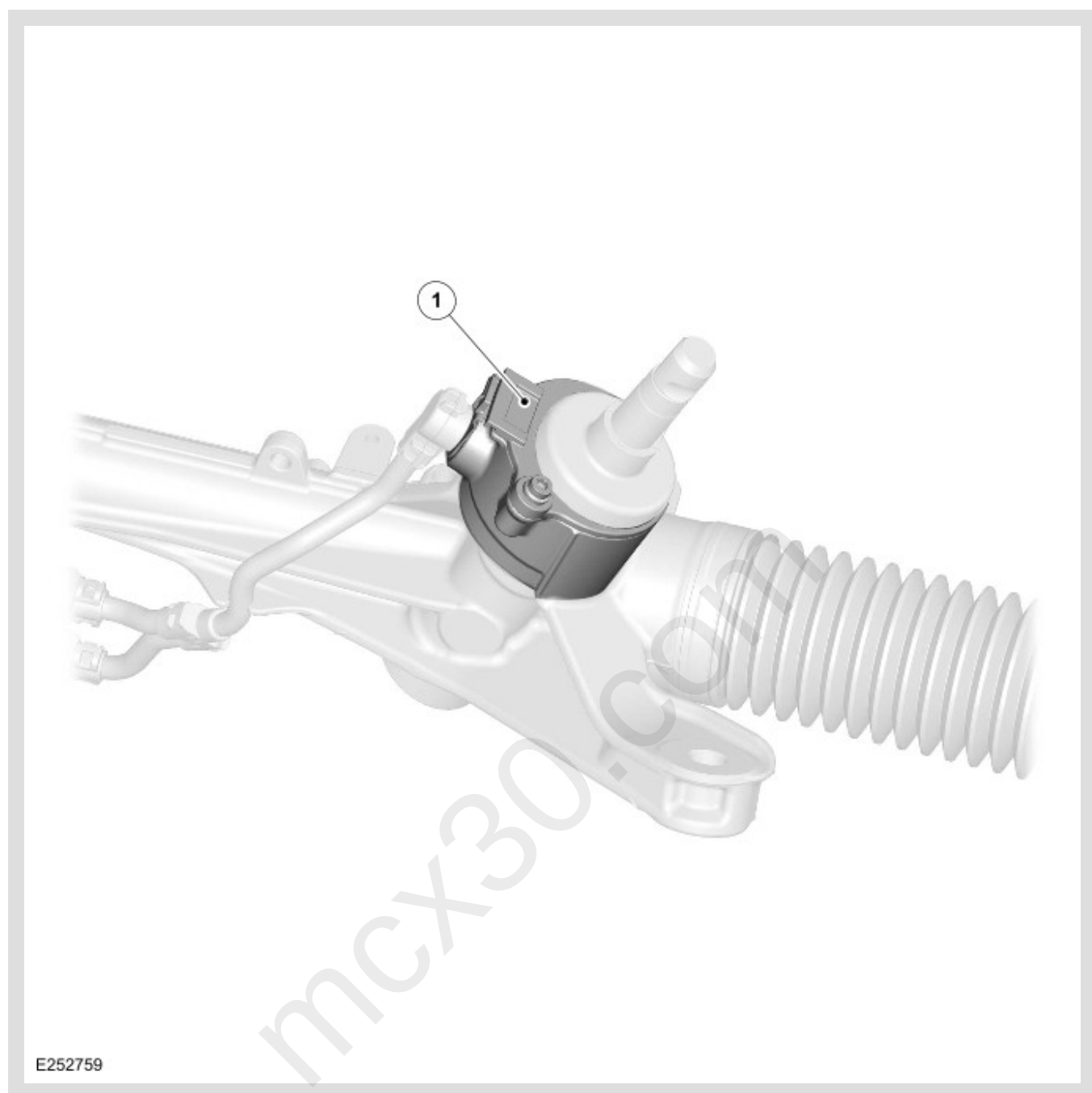
Reduction Gear



ITEM	DESCRIPTION
1	Reduction gear housing
2	Ball nut drive pulley
3	Ball train
4	Ball return channel
5	Ball nut
6	Steering gear ball channel
7	Drive belt
8	Motor drive pulley

The recirculating ball nut in the reduction gear housing is held in a bearing race, allowing the nut to rotate but preventing it from moving axially. As the electric motor rotates the nut, the balls are driven along the channels in the nut and the steering gear. This produces an axial force on the steering gear. A ball return channel in the nut and mechanisms at either end of the bearing race, recirculate the balls from one side of the nut to the other.

Torque Sensor



ITEM	DESCRIPTION
1	Torque sensor

The torque sensor provides the PSCM with inputs of the steering torque, applied by the driver. The torque sensor is installed at the junction between the input shaft and the pinion shaft, inside the steering gear housing.

Torque applied to the input shaft is transferred to the pinion shaft through the torsion bar, which twists under load. The torque sensor calculates the amount of twist in the torsion bar using 2 Hall effect sensors. The sensors monitor the angular position of the input shaft in relation to the pinion shaft, then transmits the result as a digital signal to the PSCM.

Power Steering Control Module



ITEM	DESCRIPTION
1	PSCM

The PSCM is located on the end of the electric motor, under a hermetically sealed cover. A diaphragm in the cover, made from a waterproof breathable seat, maintains the interior of the cover at ambient pressure, avoiding the need for an open vent.

The PSCM contains the control circuits and the power electronics for operating the electric motor.

Power assistance is provided when the following are present:

- A switched power supply from the ignition relay in the Engine Junction Box (EJB).

- The power mode Controller Area Network (CAN) and FlexRay signals are set to Power Mode 7 (engine running).

Electrical power for operation of the electric motor is provided by 2 fused power supplies from the Auxiliary Junction Box (AJB). The FlexRay module within the PSCM is powered from fuse 6A and the CAN module within the PSCM is powered from fuse 7A. For 100% nominal power assistance, supply voltage must be between 10.5V and 18V. If supply voltage is outside of these limits, power assistance is either reduced or discontinued.

The PSCM receives hardwired digital inputs from the torque sensor.

The PSCM also receives input signals on the FlexRay and High Speed (HS) CAN Underbody (UN) systems buses from the following:

- Steering angle, from the Steering Angle Sensor Module (SASM).
- Engine speed, from the Powertrain Control Module (PCM).
- Vehicle speed, from the Anti-Lock Brake System Control Module (ABS) control module.
- Automatic steering requests, from the Near Field Sensing Module (NFSM).
- Terrain mode request from the Terrain Response switchpack (TR) switchpack.
- Power mode status from the Body Control Module (BCM)/ Gateway Module A (GWM).
- Auto stop/start system stop request from the BCM/ GWM.
- Lane Keep Assist (LKA) and Lane Departure Warning (LDW) from the Driver Assistance Domain Controller (DADC)

The PSCM uses the input data and software algorithms to control electric motor operation. If required, the PSCM can also transmit outputs, on the HS CAN UN systems and FlexRay buses, of:

- Warning status, to the Instrument Panel Cluster Control Module (IPC).
- Steering status, to the NFSM and TR switchpack.
- Auto stop/start system inhibit requests to the PCM.
- Tie rod load forces.

REDUCED ASSISTANCE WARNING INDICATOR

If there is a significant reduction in power assistance, the amber general warning indicator illuminates and a warning message 'Power steering assistance reduced' is displayed in the message center. When the warning message is first displayed, the IPC produces a single alert chime.

Freezing Prevention Warning Indicator

If the PSCM has detected that water has penetrated the steering gear and is beginning to freeze, an electric power steering motor vibration is initiated. When the vibration is present the amber general warning indicator illuminates and a warning message 'Steering vibration activated. 'Drive with care' is displayed in the message center. When the warning message is first displayed, the IPC produces a single alert chime.

For additional information, refer to: [Message Center](#) (413-08 Message Center, Description and Operation).

The approved diagnostics tool must be used to diagnose electric power steering faults, only if directed by diagnostic tools should a gear be replaced.

If the steering gear is replaced, the correct vehicle specific calibration must be loaded using the Jaguar Land Rover (JLR) approved diagnostic equipment.

OPERATION

The electric power steering will only operate when the vehicle is in Power Mode 7 (engine running).

If a fault occurs which affects control of the electric motor, the PSCM disables the electric motor. The driver no longer benefits from power assisted steering, but incorrect control of the electric motor is prevented. The vehicle remains fully steerable, although with greater physical effort.

VARIABLE POWER ASSISTANCE

At low speeds, when tire resistance to steering inputs is highest, more assistance is applied to reduce the steering wheel torque to comfortable levels. At higher speeds, when tire resistance to steering inputs is less, less assistance is applied.

PULL DRIFT COMPENSATION

This feature aids the driver by compensating for the accumulated effects of various factors that contribute to the pull /drift of the vehicle. The feature reduces the steering wheel torque offset that the driver feels while driving in a straight line, by applying a counter torque.

ASSISTANCE CHANGES DURING AUTO STOP/START FUNCTIONS

This feature actively controls the steering torque feedback to the driver during the engine auto stopping and starting activities. It integrates the main steering assistance feature with starter motor events, this makes sure that smooth, progressive, yet timely decreases and increases in power assistance. It is also designed to remove unwanted steering wheel movement during these events, which are not directly instigated by the driver.

ASSISTANCE REDUCTION IF SYSTEM OVERHEATS OR VOLTAGE IS TOO HIGH OR LOW

This feature makes sure that the steering requirements of the driver continue to be supported during various extreme conditions including:

- Extreme voltage fluctuations (over and under voltage).
- Extreme high temperature.

A temperature sensor is installed in the PSCM for overload protection of the electric motor. The PSCM reduces the level of power assistance if the temperature of the electric motor is too high, to reduce the amount of heat generated.

Temperature overload can occur at high ambient temperatures combined with high levels of steering activity, especially when stationary. A temperature overload can also occur if an attempt is made to repeatedly turn the front wheels against a solid object.

Power assistance begins to reduce at a PSCM temperature of approximately 110°C (230°F) and reduces to zero at a temperature of 125°C (257°F). At a given level of reduction in the power assistance, the PSCM records a Diagnostic Trouble Code(s) (DTC) and signals the IPC to produce a warning that assistance has been reduced. When the PSCM has cooled, normal power assistance is restored and the related IPC warnings are extinguished.

SOFT END STOPS

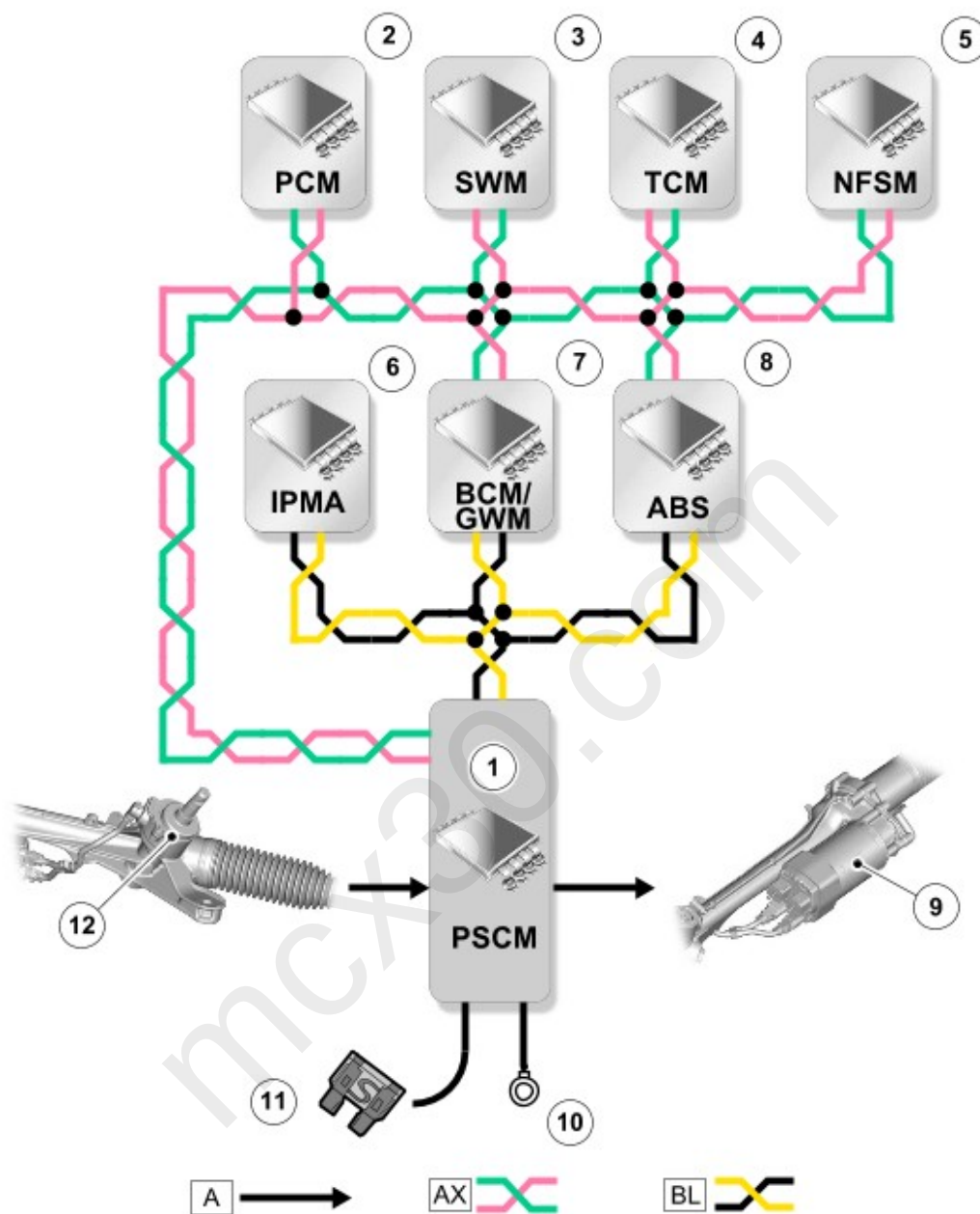
The soft end stop feature reduces the level of power assistance shortly before the mechanical end stops are reached. Although the driver will perceive this as increased steering resistance, it makes turning the wheels into full lock much smoother. In addition, this feature reduces the stresses on the mechanical and electrical components of the steering system.

PARK ASSIST SYSTEM – IF EQUIPPED

When the park assist system is active, steering trajectory requests from the NFSM are processed by the PSCM. The request is applied to the electric motor. This feature assists the driver, during parallel parking maneuvers, by selectively applying turning forces to the steering system to automatically steer the vehicle.

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CONTROL DIAGRAM



E252755

A = HARDWIRED: AX = FLEXRAY: BL = HS CAN UNDERBODY (UN) SYSTEMS BUS.

ITEM	DESCRIPTION
1	PSCM
2	PCM
3	Steering Wheel Module (SWM)
4	Transmission Control Module (TCM)

ITEM	DESCRIPTION
5	NFSM
6	Image Processing Module 'A' (IPMA)
7	BCM/ GWM
8	ABS control module
9	Electric motor
10	Ground
11	Power supply
12	Torque sensor

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