



# WABCO ABS, ATC, ESC

Matthew Munson 2019



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# OBJECTIVES

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- Antilock Braking System, function and system components
- Automatic Traction Control, function and system components
- Electronic Stability Control, function and system components



# ANTILOCK BRAKING SYSTEM



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# ABS DESCRIPTION

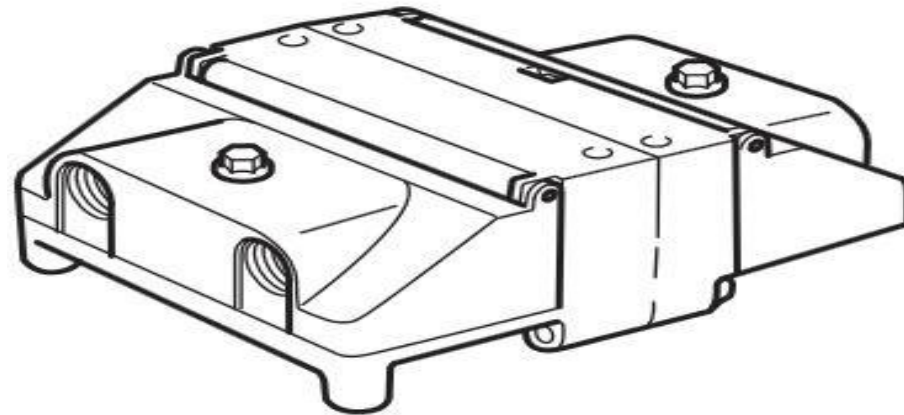
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- ABS is a system designed to provide and maintain the best possible traction and steering control during an extreme braking event.
- During a potential wheel lock event the ABS ECU will use information from the wheel speed sensors and send signals to the appropriate modulator valves to hold, apply or release the foundation brakes as needed.
- ABS works automatically with no driver input



# ABS SYSTEM COMPONENTS

- ABS ECU – command center of the ABS, ATC and ESC system
- Receives data from multiple sensors, processes response and sends signals to modulators and active braking valves

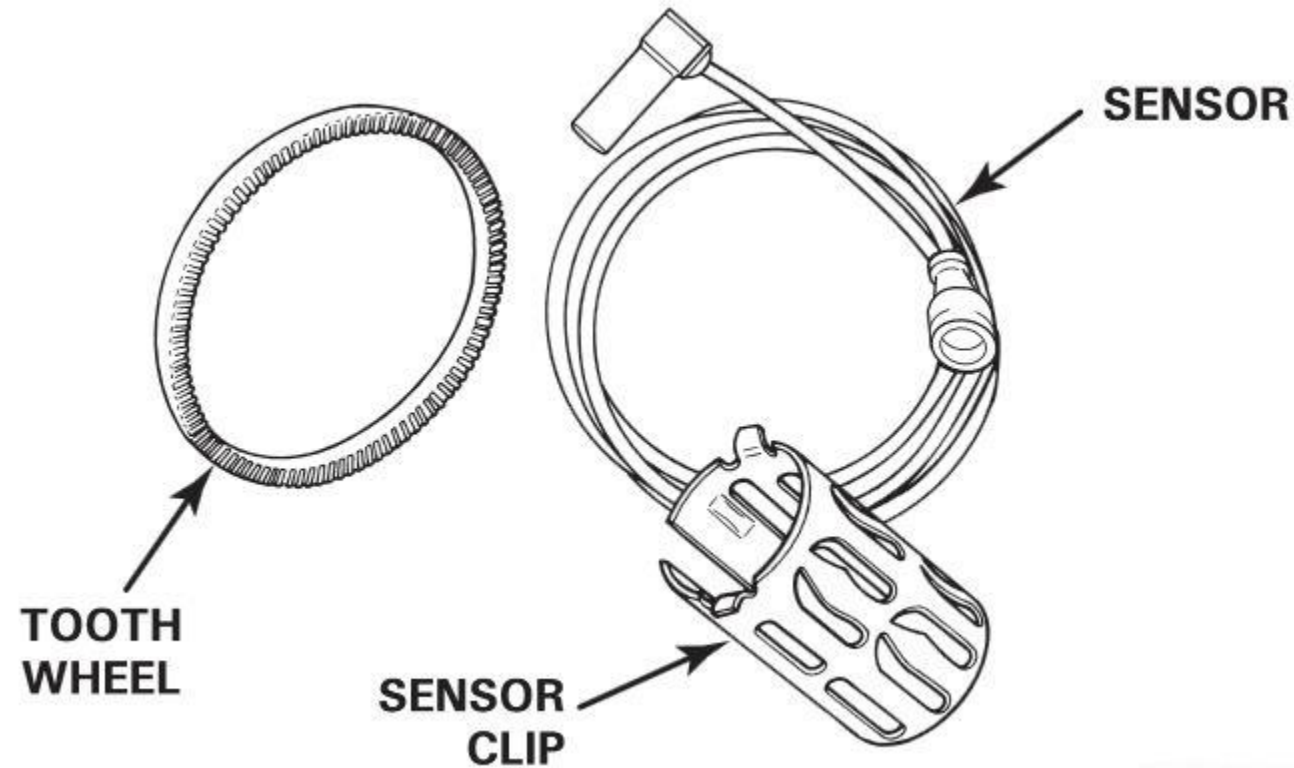


**FRAME-MOUNTED  
ECU**



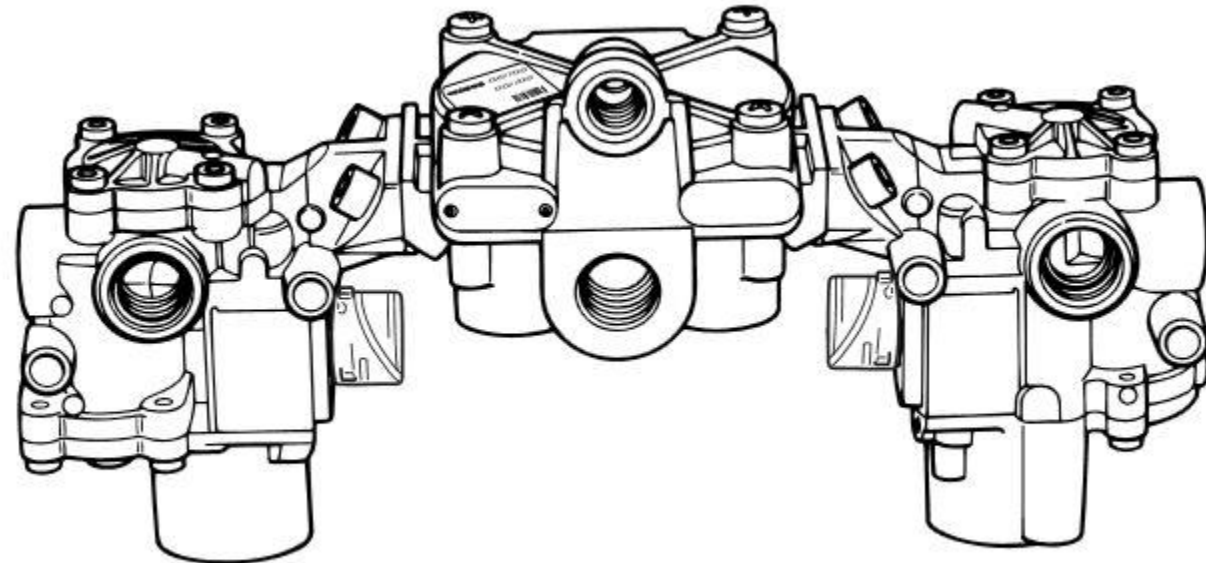
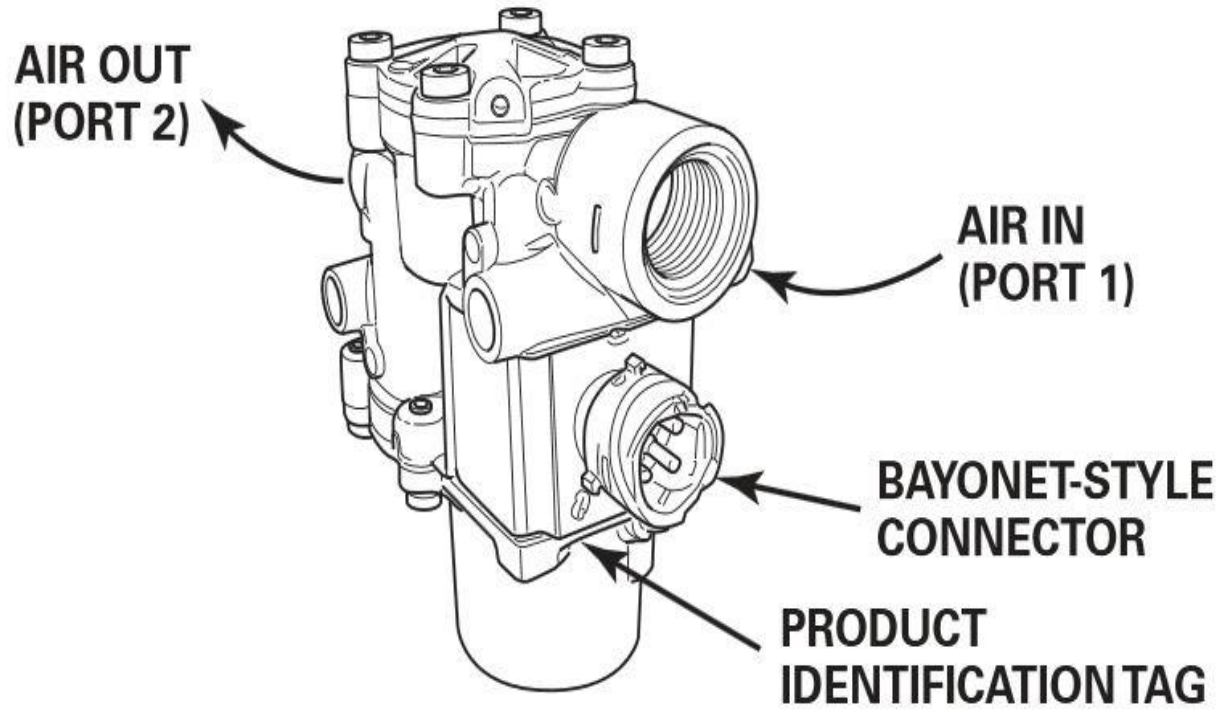
# ABS SYSTEM COMPONENTS

- Wheel speed sensors – send speed data to ECU by reading toothed tone ring



# ABS SYSTEM COMPONENTS

- Modulator Valve – controls air pressure to foundation brake(s) during a ABS, ATC and ESC event to prevent wheel lock up or reduce a wheel overspeed condition



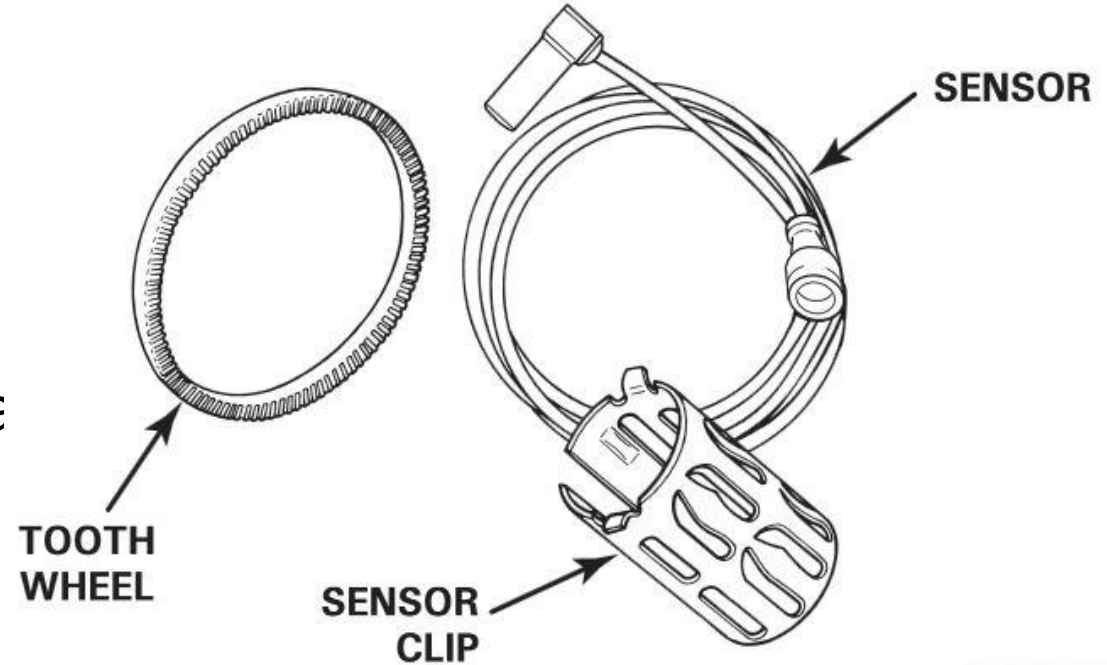
Combination Valve – used on rear axle



# COMMON SENSOR FAULTS

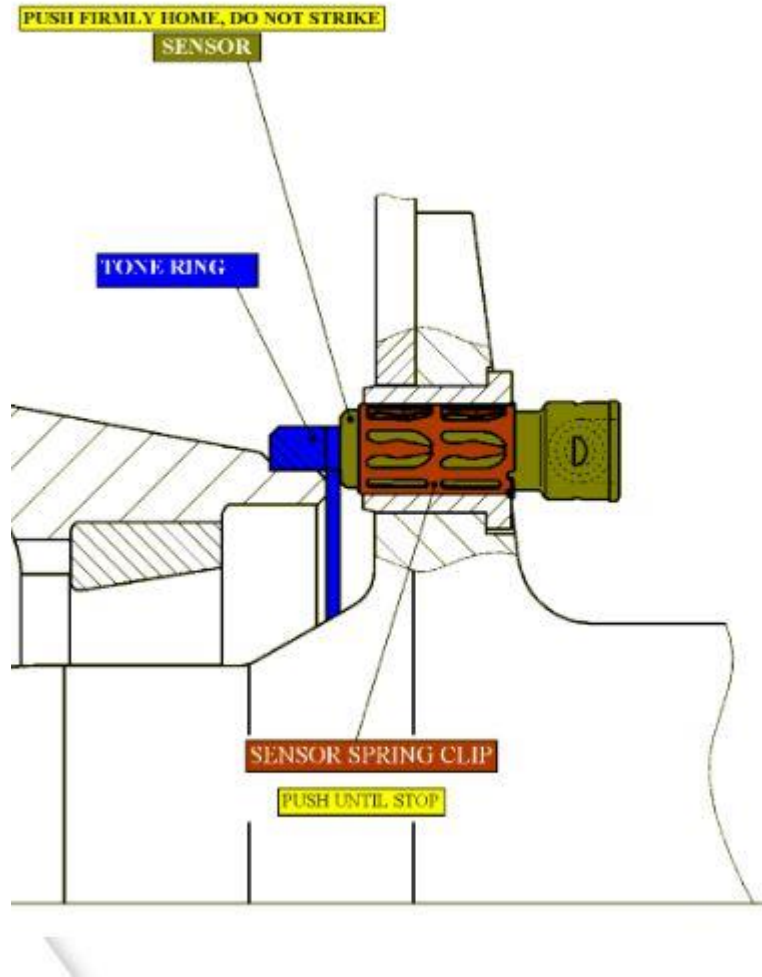
- Air gap
- Cable break
- Loose connections
- Spread connectors
- Pinched or cut wires from tie strap
- Sensor head short

Location	Measurement
Between sensor leads	900-2000 ohm
At ECU harness pins with sensor connected	Same as above, no more than 1 ohm difference
ECU harness by itself for DC voltage or ground	No continuity
Sensor output voltage	At least 0.2 volt AC at 30 rpm





# SENSOR INSTALL



To Avoid This:



# AUTOMATIC TRACTION CONTROL



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# ATC DESCRIPTION

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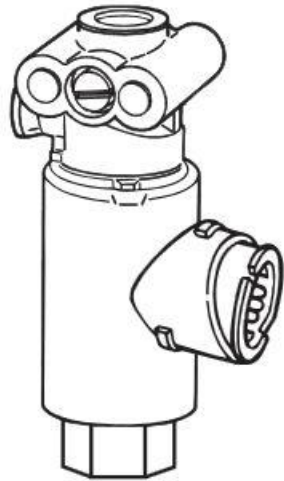
ATC helps improve traction in low traction situations two ways:

1. When one drive wheel is spinning at a different speed than the other drive wheels, ATC momentarily applies the brake on the spinning wheel until traction is regained.
  2. When both drive wheels are spinning on a slippery surface, ATC automatically reduces engine power until traction is regained.
- ATC will automatically function, when ATC is active a dash light will alert you
  - ATC switch (Mud/Snow) – slightly increases permissible wheel spin to aid in soft surfaces like mud, snow, sand or gravel. When switch is activated a flashing ATC light will flash on dash to inform driver.

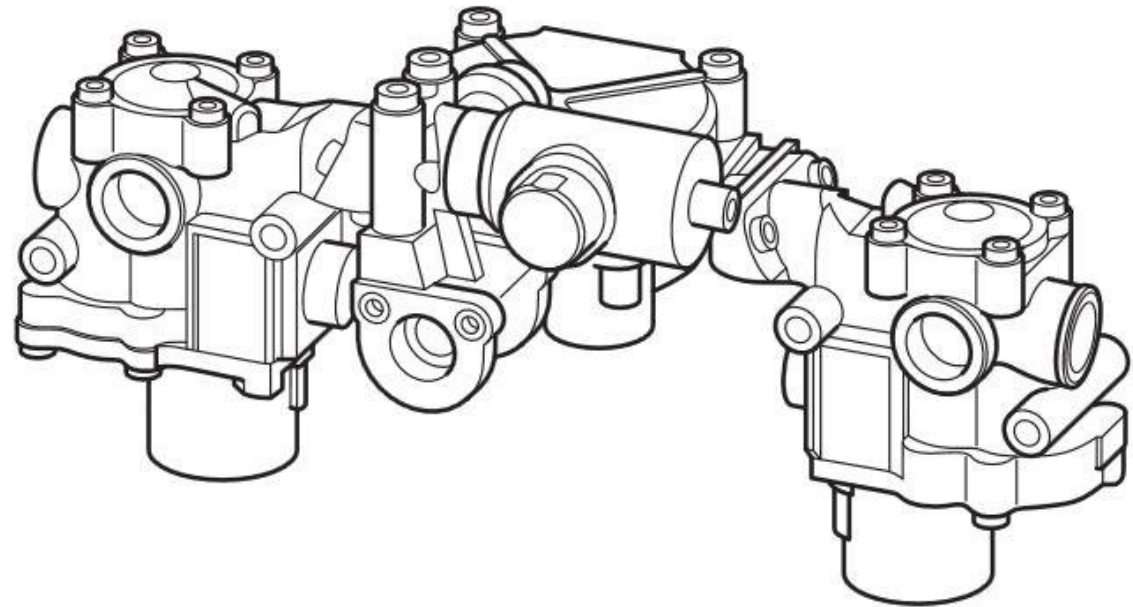


# ATC COMPONENTS

- The ABS components are the base for ATC (ECU, wheel speed sensors, modulator valves)
- ATC uses a Active Braking Valve (a.k.a. ATC Valve), that can be stand alone or attached to combination valve

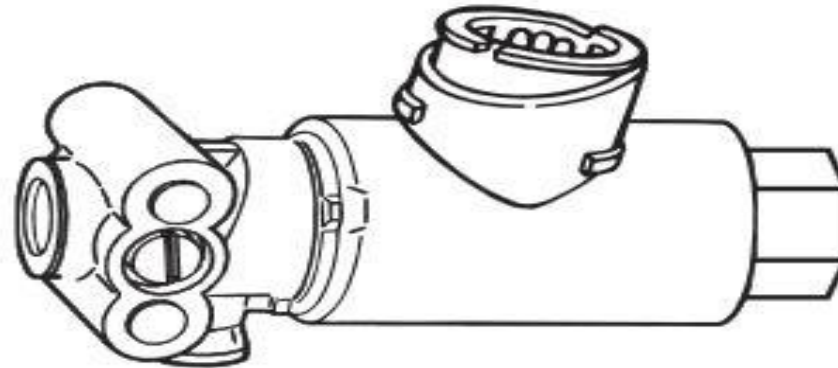


**SOLENOID VALVE  
(ACTIVE BRAKING VALVE)**



# ACTIVE BRAKING VALVE (ATC)

- The Active Braking Valve is a solenoid valve used for braking control during ATC events.
- It works with the ABS modulator valves to have full control over application and release of individual rear foundation brakes during a ATC event



# ELECTRONIC STABILITY CONTROL



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# ESC DESCRIPTION

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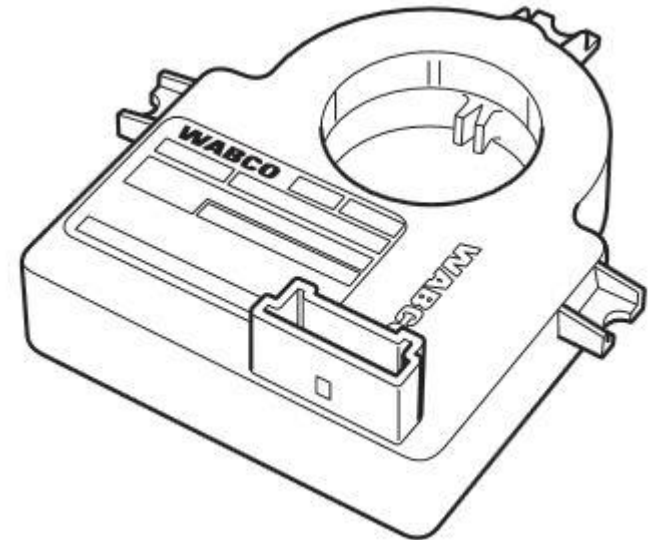
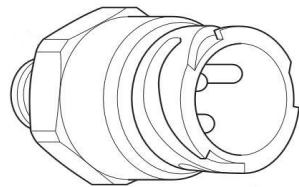
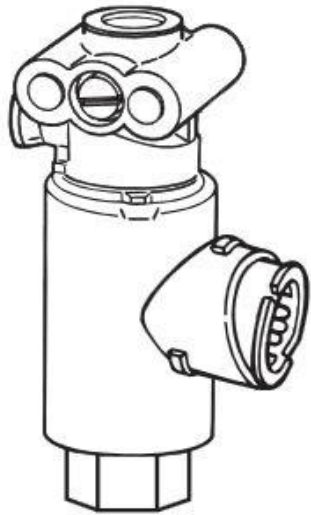
Electronic Stability Control keeps a vehicle traveling on its intended path by providing spinout and drift control.

- ESC is the combination of Roll Stability Control and direction stability (yaw)
- ESC is automatic and activates when roll or directional instabilities are sensed
- Reacts with throttle reduction, retarder (if equipped), individual or all brakes to keep vehicle under control



# ESC COMPONENTS

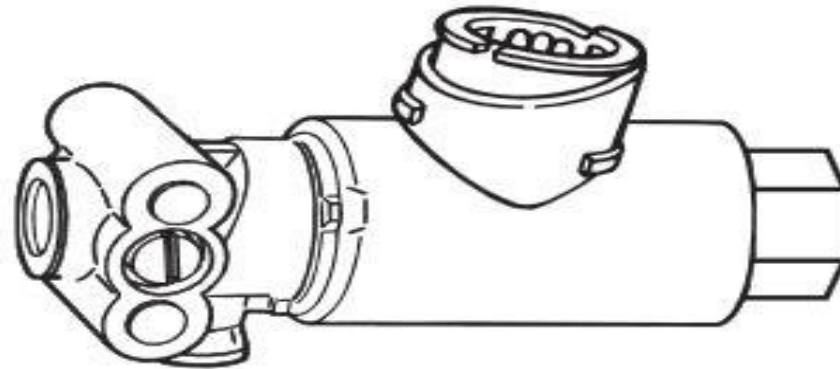
- The ABS components are the base for ESC (ECU, wheel speed sensors, modulator valves)
- ESC uses a active braking valve (a.k.a. ESC Valve), pressure sensor, ESC module and a Steering Angle Sensor (SAS)





# ACTIVE BRAKING VALVE (ESC)

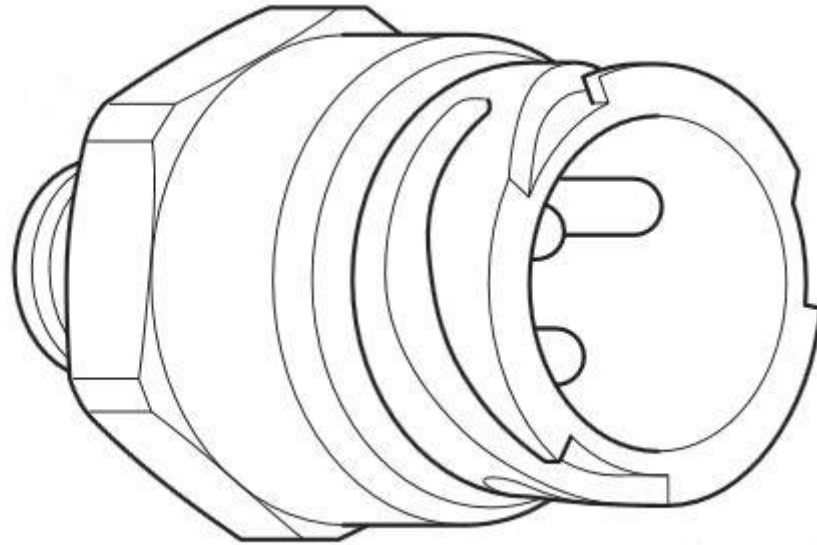
- The Active Braking Valve is a solenoid valve used for braking control during ESC events.
- It works with the ABS modulator valves to have full control over application and release of individual front foundation brakes during a ESC event



# BRAKE PRESSURE SENSOR (BPS)

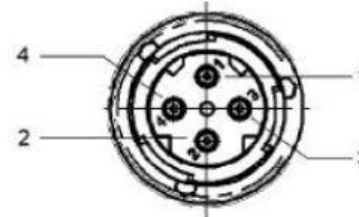
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- Provides the ECU with brake pressure demand from the driver
- Located on the primary system treadle valve delivery port



# ESC MODULE

- Contains parameter settings **specific** to a vehicle configuration
- Mounted in **specific** location, DO NOT MOVE
- ECU supplies ESC module with power and ground
- Must be calibrated using Wabco Tool Box



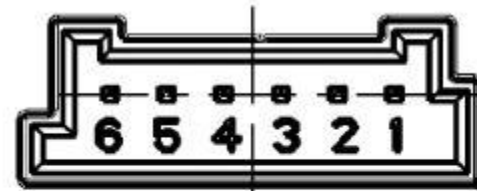
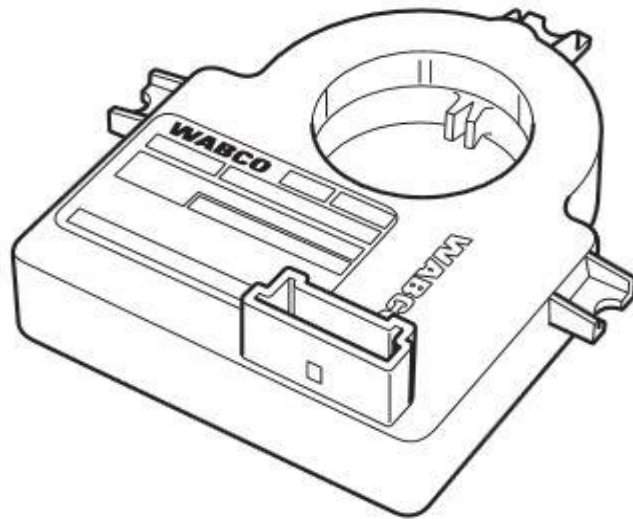
Pin 1 U<sub>B</sub>  
Pin 2 GND  
Pin 3 CAN-High  
Pin 4 CAN-Low

- Accelerometer
- Yaw rate sensor
- ESC logic
- CAN Data link



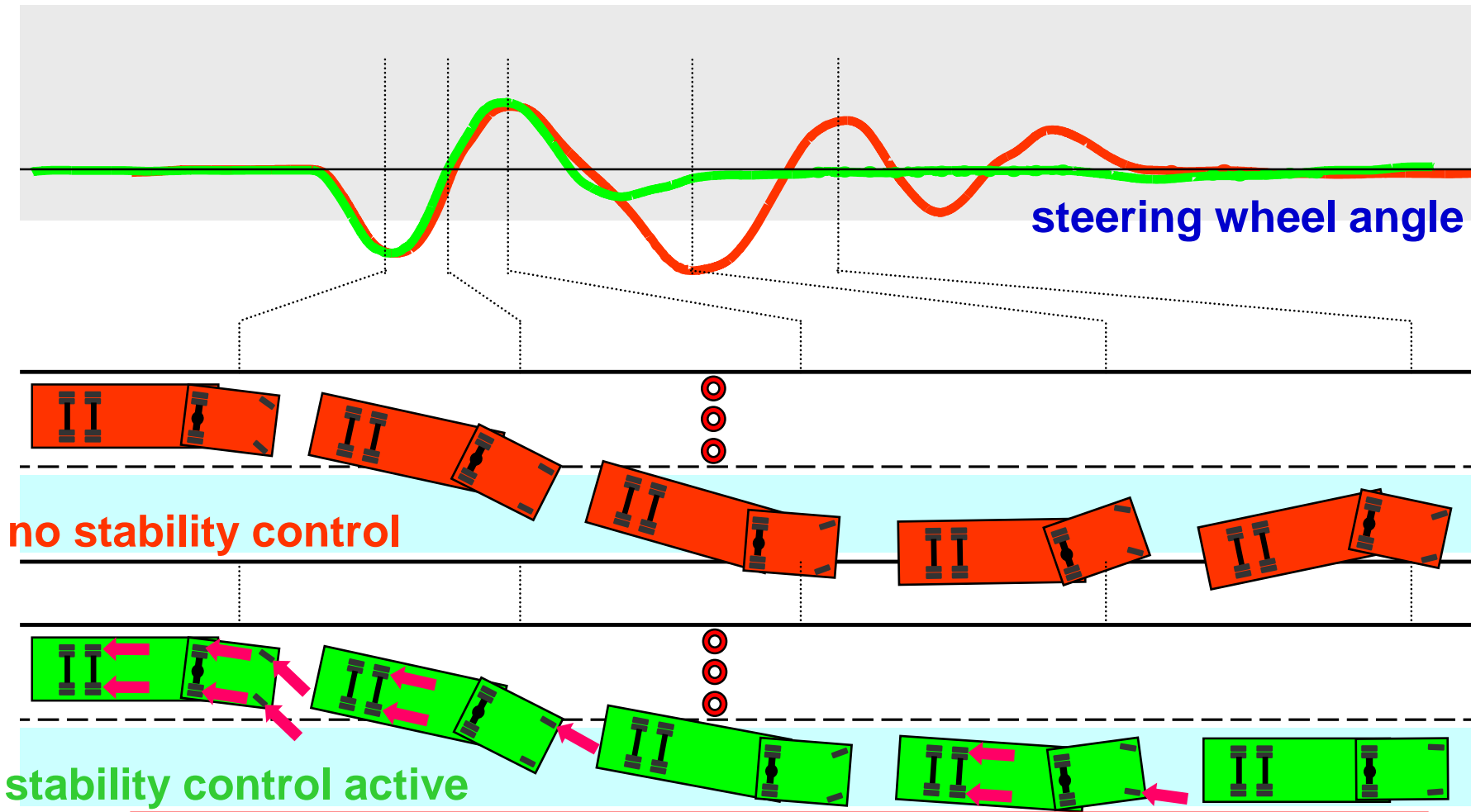
# STEERING ANGLE SENSOR (SAS)

- Delivers steering wheel position to the ECU via internal data link
- Mounted on base of steering column
- ECU supplies the Steering Angle Sensor with power and ground
- Must be calibrated using Wabco Tool Box when replaced
- Replacement of steering components may require calibration



Pin	Name	Comment
1	CAN_L	CAN-Low
2	CAN_TERM	CAN termination resistor (to be connected to CAN_H)
3	CAN_H <sub>1</sub>	CAN-High (internally connected to pin 4)
4	CAN_H <sub>2</sub>	CAN-High (internally connected to pin 3)
5	V <sub>bat</sub>	Power supply SAS
6	GND	Ground connection

# ESC Drive Test: Obstacle Avoidance



no stability control

stability control active

Single lane change with  $\mu$ -transition high to low  $\mu$ , no driver braking  
roll stability control and oversteering yaw control



**ESC Off**



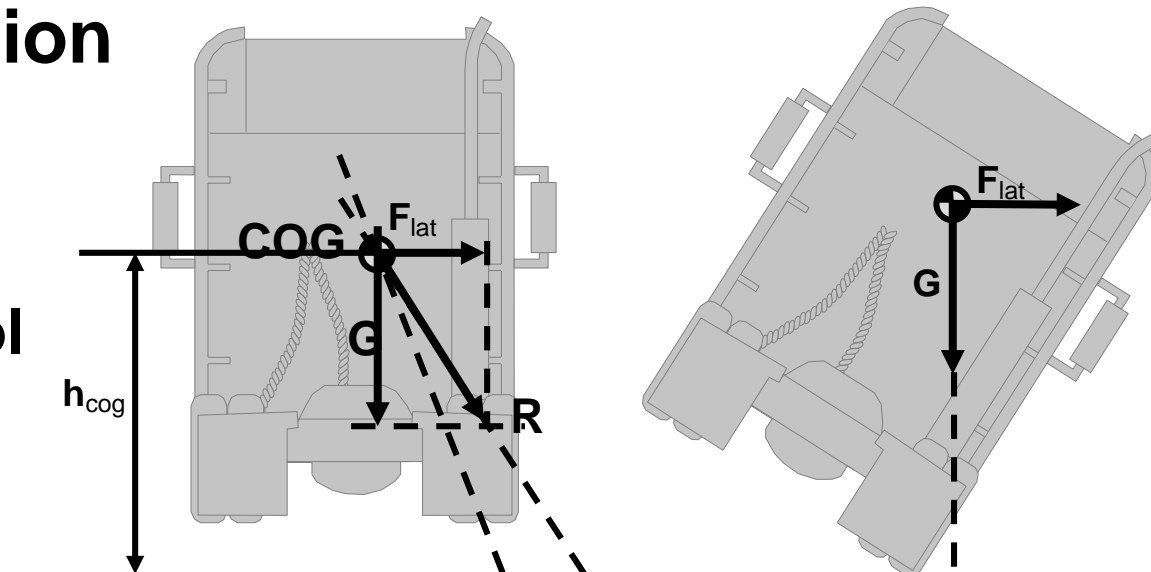
**ESC On**



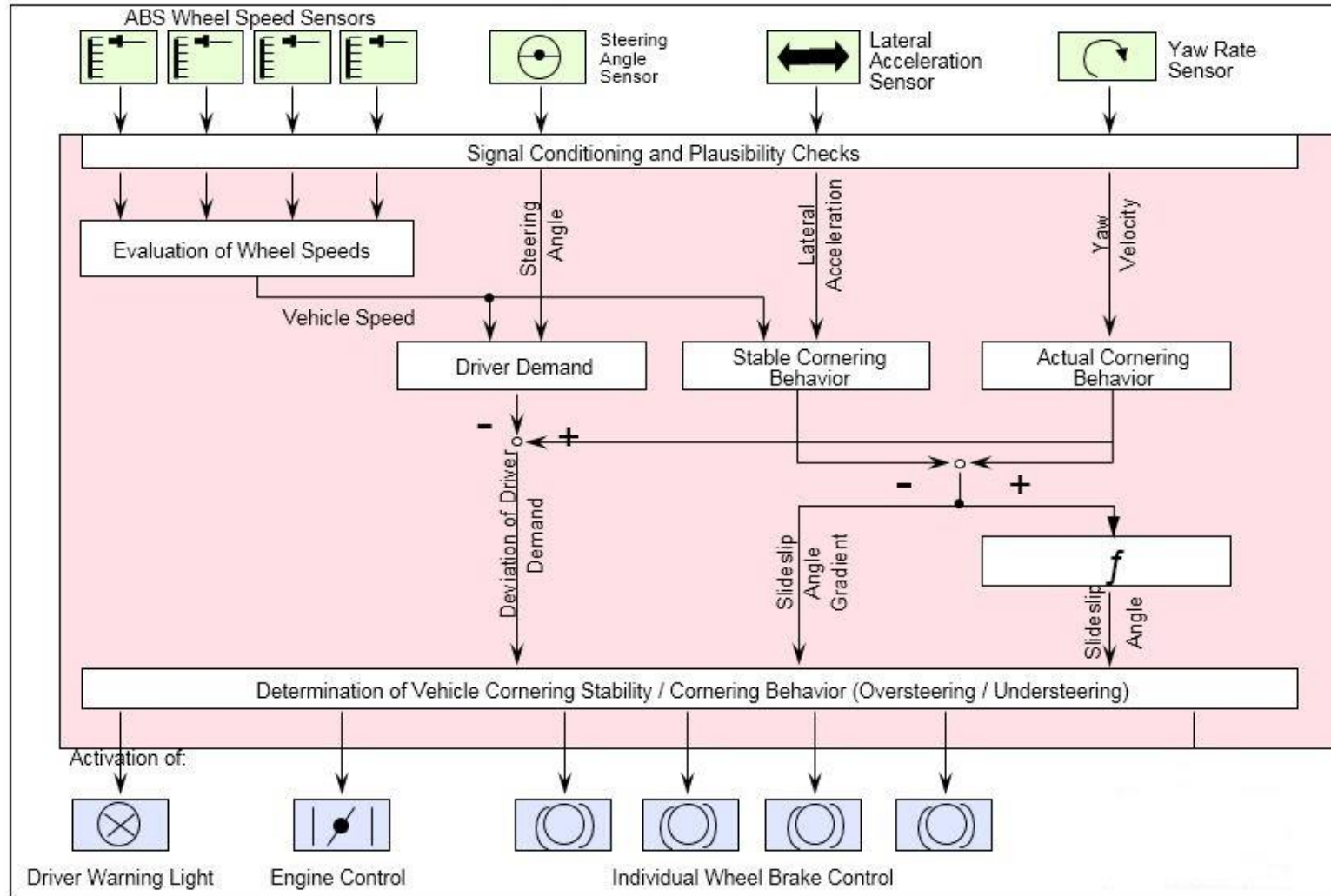
# Functional Elements of RSC

- **Measurement & processing of lateral acceleration**
- **Calculation of critical acceleration limit**
- **Rollover risk detection**
- **RSC intervention**

- **Engine control**
- **Retarder control**
- **Brake control**

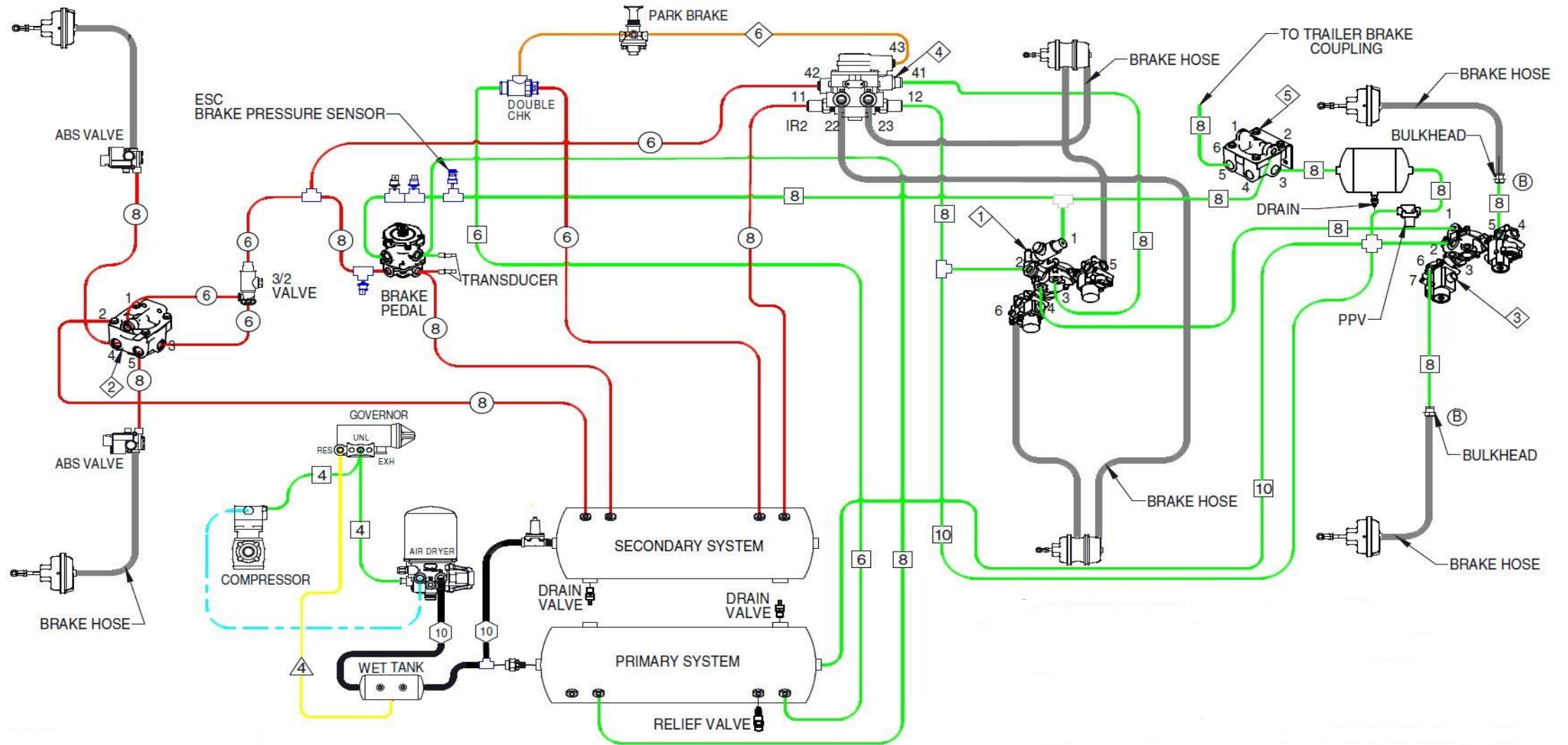


# ESC ELECTRICAL COMPONENT FLOW





# ESC PNEUMATIC FLOW



# ESC END OF LINE PROCEDURE

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- Required for new trucks and when ESC components are exchanged, (ESC module, ABS ECU or SAS sensor)
- Supported by Wabco Toolbox
- Divided into 2 sections
  - SAS calibration (straight line driving)
  - ESC Initialization (left/right circles)
- The SAS calibration must be done prior to the ESC initialization



# WABCO TOOLBOX

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- Necessary if diagnosing ABS,ATC and ESC problems
- Necessary to calibrate ESC module and S.A.S.
- Displays both static and dynamic information
- Displays active and stored faults, along with repair procedures
- Activates system components to verify system integrity, correct component operation and installation wiring



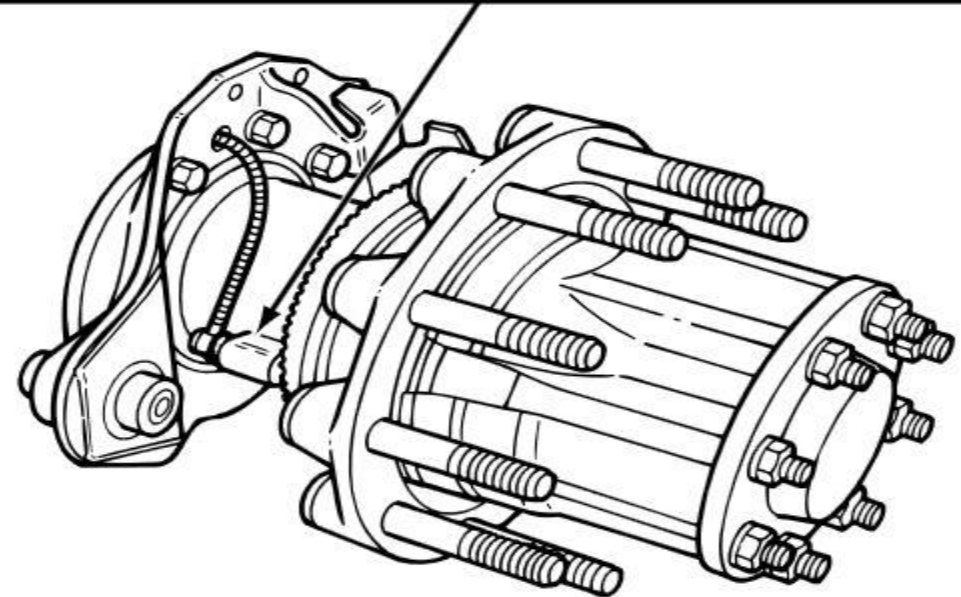
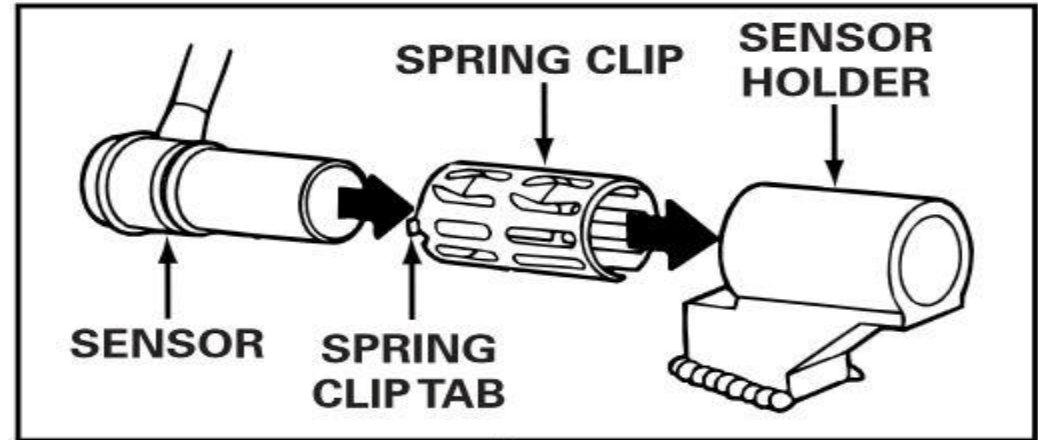
# COMPONENT INFORMATION AND TESTING



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# WHEEL SPEED SENSOR INFORMATION

- Push sensor to contact tone ring, should have no more than .004 gap
- Wabco approved lubricant on retaining clip (Mobilith SHC-220, TEK 662, Staburags NBU 30 PTM and Valvoline EP633)
- Always replace retaining clip with sensor



# WHEEL SPEED SENSOR TESTING

## Testing

### Wheel Speed Sensor Testing

#### Sensor Adjustment

- Push the sensor in until it contacts the tooth wheel.
- Do not pry or push sensors with sharp objects.
- Sensors will self-adjust during wheel rotation.

#### Electrical Checks

- Check wheel speed sensor by itself for resistance.
- Check ECU harness and sensor together for resistance. Figure 3.14 and Figure 3.15.
- Verify no change in resistance or open circuit between sensor by itself and through harness.
- Check harness by itself for any shorts to battery and shorts to ground.
- Measurements should read as follows:

Location	Measurement
Between sensor leads	900-2000 ohm
At ECU harness pins with sensor connected	Same as above, no more than 1 ohm difference
ECU harness by itself for DC voltage or ground	No continuity
Sensor output voltage	At least 0.2 volt AC at 30 rpm

**NOTE:** Sensor resistance can change with temperature. All readings should be taken at the same time and before vehicle is driven.



# WHEEL SPEED SENSOR ECU PIN OUT

ECU	Sensor	Connector	Pins	ECU	Sensor	Connector	Pins
Frame-Mounted Non-ESC	LF	X2-Black	7 and 8	Frame-Mounted With ESC	LF	X2-Green	17 and 18
	RF	X2-Black	5 and 6		RF	X2-Green	5 and 6
	LR	X3-Green	1 and 2		LR	X3-Green	1 and 2
	RR	X3-Green	3 and 4		RR	X3-Green	3 and 4
	LR (3rd axle)	X4-Brown	3 and 4		LR (3rd axle)	X4-Brown	3 and 4
	RR (3rd axle)	X4-Brown	5 and 6		RR (3rd axle)	X4-Brown	5 and 6



# MODULATOR VALVE TESTING

## Modulator Valve Testing

### Electrical Checks

- Check modulator valve by itself for resistance. Figure 3.16 and Figure 3.17.
- Check ECU harness and modulator valve together for resistance. Figure 3.18 and Figure 3.19.
- Verify no change in resistance or open circuit between valve by itself and through harness.
- Check harness by itself for any shorts to battery and shorts to ground.
- Measurements should read as follows:

Location	Measurement
Inlet valve pin to Ground	4.0-9.0 ohm for 12V system 11.0-21.0 ohm for 24V system
Outlet valve pin to Ground	4.0-9.0 ohm for 12V system 11.0-21.0 ohm for 24V system
At ECU harness pins with modulator valve connected	Same as above, no more than 1 ohm difference
ECU harness by itself for battery voltage or ground	No continuity

**NOTE:** If resistance exceeds 9.0 ohm for 12V system (21.0 ohm for 24V system), verify the reading was not taken between the inlet and outlet. If the correct pins were tested, clean the electrical contacts at the modulator and retest.





# MODULATOR VALVE ECU PIN OUT

Frame-Mounted Non-ESC	LF IV	X2-Black	2
	LF OV	X2-Black	10
	LF Common	X2-Black	11
	RF IV	X2-Black	4
	RF OV	X2-Black	3
	RF Common	X2-Black	9
	LR IV	X3-Green	12
	LR OV	X3-Green	10
	LR Common	X3-Green	11
	RR IV	X3-Green	9
	RR OV	X3-Green	7
	RR Common	X3-Green	8
	LR (3rd Axle) IV	X4-Brown	12
	LR (3rd Axle) OV	X4-Brown	10
	LR (3rd Axle) Common	X4-Brown	11
	RR (3rd Axle) IV	X4-Brown	9
	RR (3rd Axle) OV	X4-Brown	7
	RR (3rd Axle) Common	X4-Brown	8

Frame-Mounted With ESC	LF IV	X2-Green	2
	LF OV	X2-Green	15
	LF Common	X2-Green	14
	RF IV	X2-Green	4
	RF OV	X2-Green	3
	RF Common	X2-Green	16
	LR IV	X3-Green	12
	LR OV	X3-Green	10
	LR Common	X3-Green	11
	RR IV	X3-Green	9
	RR OV	X3-Green	7
	RR Common	X3-Green	8
	LR (3rd Axle) IV	X4-Brown	12
	LR (3rd Axle) OV	X4-Brown	10
	LR (3rd Axle) Common	X4-Brown	11
	RR (3rd Axle) IV	X4-Brown	9
	RR (3rd Axle) OV	X4-Brown	7
	RR (3rd Axle) Common	X4-Brown	8



# ACTIVE BRAKING VALVE TESTING

## Active Braking Valves (ABV) Testing

### Electrical Checks

- Check ABV 3/2 solenoid by itself for resistance.
- Check ECU harness and ABV 3/2 solenoid together for resistance. Figure 3.23 and Figure 3.24.
- Verify no change in resistance or open circuit between ABV by itself and through harness.
- Check harness by itself for any shorts to battery and shorts to ground.
- Measurements should read as follows:

Location	Measurement
ABV Supply to ABV Common	7.0-14.0 ohm for 12V system 26.3-49.0 ohm for 24V system
At ECU harness pins with ABV connected	Same as above, no more than 1 ohm difference
ECU harness by itself for battery voltage or ground	No continuity



# ACTIVE BRAKING ECU PIN OUT

Frame-Mounted Non-ESC	Drive Axle ABV Supply	X3-Green	5	Frame-Mounted With ESC	Drive Axle ABV Supply	X3-Green	5
	Drive Axle ABV Common	X3-Green	6		Drive Axle ABV Common	X3-Green	6
	Trailer ABV Supply	X2-Black	1		Steer Axle ABV Supply	X2-Green	12
	Trailer ABV Common	X2-Black	12		Steer Axle ABV Common	X2-Green	11
					Trailer ABV Supply	X1-Black	9
					Trailer ABV Common	X1-Black	8



# BRAKE PRESSURE SENSOR TESTING

## Brake Pressure Sensor Testing

### Electrical Checks

For the following check, all of the ECU connectors must be plugged in as the ECU provides voltage and ground to the BPS.

- Take measurements at the pressure sensor harness connector. Figure 3.29.
- Measure Voltage Supply to Ground on Pin 1 of the BPS Connector Key ON.

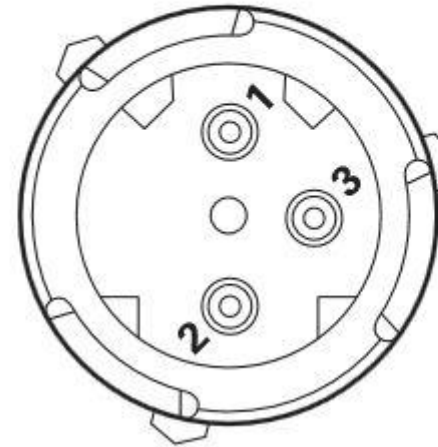
With ECU and BPS disconnected:

- Verify continuity end to end on all 3 lines.
- Verify no shorts to ground or battery on all 3 lines.
- Verify no continuity between pins.

Measurements should read as below.

Location	Measurement
Voltage Supply to Ground	8.0-16.0V
Pressure Signal or Ground Line short to battery or ground	No continuity

### PRESSURE SENSOR CONNECTOR



Pin	Circuit
1	Voltage Supply
2	Ground
3	Pressure Signal



# STEERING ANGLE SENSOR TESTING

## Steering Angle Sensor (SAS) Testing

### Electrical Checks

The following tests are for Meritor WABCO SAS Only.

- Disconnect SAS and check terminating resistance across Pin 1 and Pin 2 of the SAS. Figure 3.39 and Figure 3.40.

For the following checks, all the ECU and ESC module connectors must be plugged in as the ECU provides all voltage, ground and CAN communications. Figure 3.42 and Figure 3.43.

- Take measurements at the SAS harness connector side. Figure 3.41.
  - Check Key On CAN Low voltage on Pin 1.
  - Check Key On CAN High voltage on Pin 4.
  - Check Key On Voltage Supply on Pin 5.
  - Check Key Off resistance across CAN low Pin 1 and CAN High Pin 4.

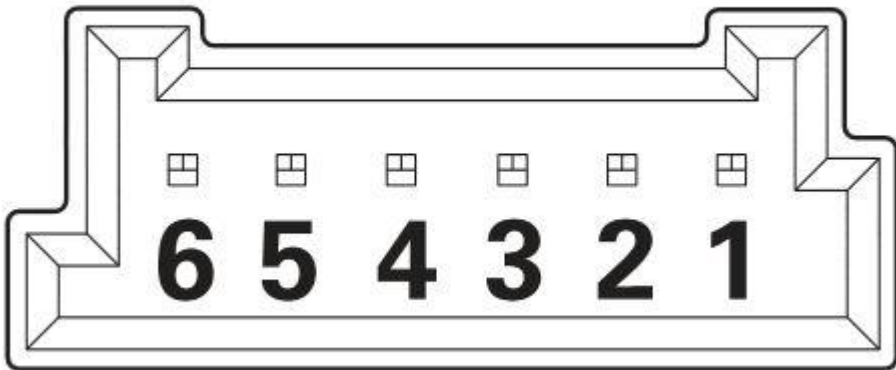
Location	Measurement
Meritor Wabco SAS terminating resistor on sensor	Approximately 180 ohms
CAN High Voltage	2.5-5.0V
CAN Low Voltage	0.1-2.4V
Voltage Supply to Ground	8.0-16.0V
ESC CAN-High to ESC CAN-Low	Approximately 90 ohm
SAS harness jumper (Pin 2 to Pin 4 or Pin 2 to Pin 3)	Continuity
ESC CAN-High or CAN-Low to Power or Ground (with ECU, ESC Module and SAS unplugged)	No continuity

**NOTE:** For correct sensor operation, there must be a jumper wire on the harness side across either Pin 2 to Pin 3 or Pin 4 so terminating resistor is connected as shown in Figure 3.40.



# S.A.S. CONNECTOR PIN OUT

## STEERING ANGLE SENSOR CONNECTOR



Pin	Circuit
1	CAN-Low
2	Terminating Resistor
3	CAN-High
4	CAN-High
5	Power
6	Ground

**NOTE:** Do not load test across power and ground at the SAS.



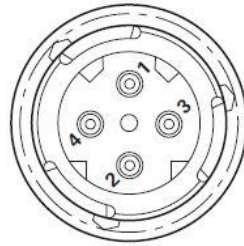
# ESC MODULE TESTING

## ESC Module Testing

### Electrical Checks

For the following checks, all of the ECU connectors must be plugged in as well as the SAS. The ECU provides voltage, ground and CAN communication to ESC module.

- Take measurements at the ESC module harness connector. Figure 3.34 and Figure 3.35.
- Measure voltage supply Key ON.
- Measure CAN High voltage Key ON.
- Measure CAN Low voltage Key ON.
- Measure terminating resistance across CAN High and Low with Key OFF.
- Frame-mounted ECU only: Measure ground resistance Key OFF to chassis ground.



With ECU and ESC Module disconnected:

- Verify continuity end to end on each line
- Verify no shorts to ground or battery on all lines.
- Verify no continuity between pins.

Measurements should read as follows:

Pins	Circuit	Measurement
1	Voltage Supply to Chassis Ground	8.0-16.0V
2	(Frame-mounted only) ESC Ground to Chassis Ground	Less than 1 ohm resistance
2	(Cab-mounted only) ESC Ground to Chassis Ground	Should have continuity but will not be less than 1 ohm
3 and 4	Terminating Resistance between ESC CAN-High to ESC CAN-Low	Approximately 90 ohms
1	With ECU disconnected, check power supply for battery voltage or ground.	No continuity
2	With ECU disconnected, check ground for battery voltage or ground.	No continuity
3 and 4	With ECU disconnected, check CAN lines for battery voltage or ground.	No continuity
3	CAN High Voltage to Chassis Ground	2.5-5.0V
4	CAN Low Voltage to Chassis Ground	0.1-2.4V

**NOTE:** Do not load test across power and ground at the ESC Module.

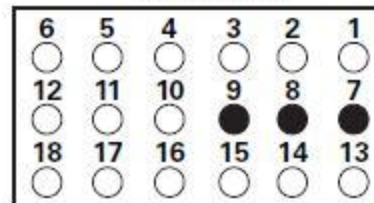


# ESC MODULE ECU PIN OUT

Frame-Mounted With ESC	Power Supply	X2-Green	9
	Ground	X2-Green	External
	ESC CAN-Low	X2-Green	7
	ESC CAN-High	X2-Green	8

**FRAME MOUNT ECU  
WITH ESC:  
LOOKING INTO WIRE  
HARNESS CONNECTOR**

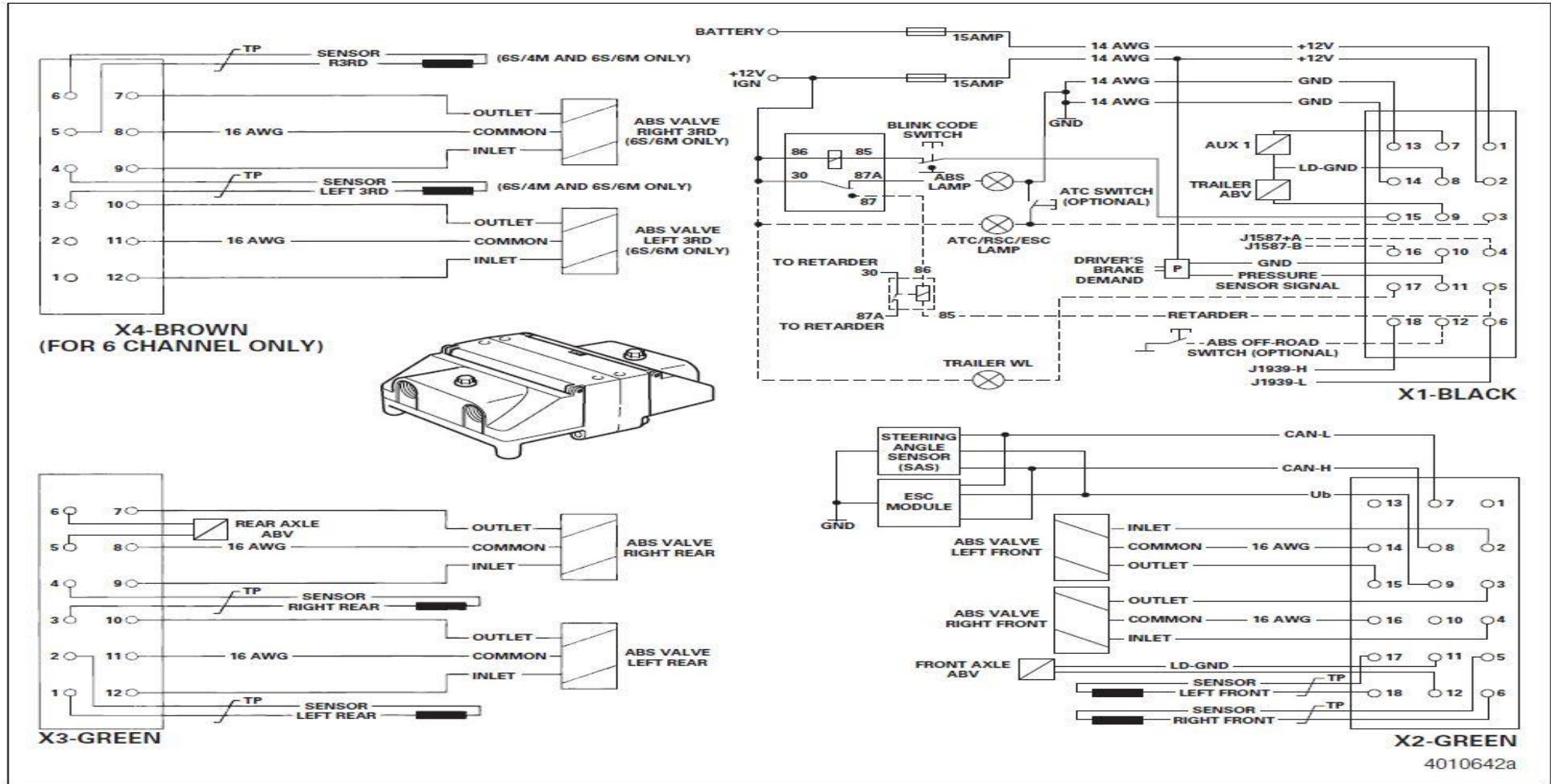
**X2-GREEN**





# ECU CONFIGURATION

6S/6M Frame-mounted ECU with ESC (6S/4M and 4S/4M Configurations are also available)



# QUESTIONS, COMMENTS, CONCERNS?





**THANK YOU**