Bendix

Service Data

SD-27-5023V

Bendix® GSBC® (Global Scalable Brake Control) System and EBS-90™ Electronic Control Unit (ECU) for Volvo® Trucks

INTRODUCTION

The Bendix® GSBC® (Global Scalable Brake Control) is a 24V Electronic Braking System (EBS) that is comprised of both hardware and software components that work together to control the service braking system of the vehicle. The *GSBC* system utilizes electronic control systems but continues to use air to apply and release the brakes, and can be configured to provide brake control functionality such as the Bendix® Electronic Stability Program (ESP®) and Antilock Brake System (ABS) as desired by the vehicle manufacturer.

GSBC has been designed for the North American commercial vehicle market. This document is specifically for *GSBC* systems installed on Volvo® vehicles starting for model year 2024.

The GSBC system can support vehicles with up to five (5) sensed axles and ten (10) Wheel Speed Sensors (WSSs).

This document is designed to offer technicians and service personnel a brief overview of how the system works, provide technical information for how the Bendix® GSBC® EBS-90™ Electronic Control Unit (hereafter referred to as “Central ECU” or “GSBC Central ECU”) operates, and also provide troubleshooting information for both the *GSBC* system as a whole and the Central ECU, specifically.

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DESCRIPTION

In addition to service brake control of single and combination vehicles, *GSBC* as installed on Volvo vehicles also provides ABS, ESP, malfunction indicators, and other advanced braking system functionalities.

The *GSBC* ABS functionality automatically controls the degree of rotational wheel slip during braking by sensing the rate of angular rotation of the wheel using WSSs. The WSSs transmit signals to the Central ECU, which interprets the signals and generates a responsive controlling signal to the electro-pneumatic modules and modulators which deliver the pressure requested to each controlled foundation brake.

The *GSBC* ESP function augments vehicle directional stability by applying and adjusting vehicle brake torque individually at each wheel position to limit vehicle oversteer and understeer. ESP enhances rollover stability by adjusting vehicle brake torques in order to reduce lateral acceleration of the vehicle.

The Central ECU provides the ABS and ESP malfunction indicator signals to the dashboard by way of a CAN message.

The Central ECU can receive Power Line Carrier (PLC) signal(s) from connected towed vehicle(s) which indicate that one of those vehicle(s) has an active ABS malfunction or fault. The Central ECU then provides this towed vehicle ABS malfunction indicator signal to the dashboard by way of a CAN message.

GENERAL SAFETY GUIDELINES

WARNING! PLEASE READ AND FOLLOW THESE INSTRUCTIONS TO AVOID PERSONAL INJURY OR DEATH:

When working on or around a vehicle, the following guidelines should be observed AT ALL TIMES:

- **Park the vehicle on a level surface, apply the parking brakes, and always block the wheels. Always wear personal protection equipment.**
- **Stop the engine and remove the ignition key when working under or around the vehicle. When working in the engine compartment, the engine should be shut off and the ignition key should be removed. Where circumstances require that the engine be in operation, EXTREME CAUTION should be used to prevent personal injury resulting from contact with moving, rotating, leaking, heated, or electrically charged components.**
- **Do not attempt to install, remove, disassemble, or assemble a component until you have read, and thoroughly understand, the recommended procedures. Use only the proper tools and observe all precautions pertaining to use of those tools.**
- **If the work is being performed on the vehicle's air brake system, or any auxiliary pressurized air systems, make certain to drain the air pressure from all reservoirs before beginning ANY work on the vehicle. If the vehicle is equipped with a Bendix® AD-IS® air dryer system, a Bendix® DRM™ dryer reservoir module, a Bendix® AD-9si®, AD-HF®, or AD-HFi® air dryer, be sure to drain the purge reservoir.**
- **Following the vehicle manufacturer's recommended procedures, deactivate the electrical system in a manner that safely removes all electrical power from the vehicle.**
- **Never exceed manufacturer's recommended pressures.**
- **Never connect or disconnect a hose or line containing pressure; it may whip and/or cause hazardous airborne dust and dirt particles. Wear eye protection. Slowly open connections with care, and verify that no pressure is present. Never remove a component or plug unless you are certain all system pressure has been depleted.**
- **Use only genuine Bendix® brand replacement parts, components, and kits. Replacement hardware, tubing, hose, fittings, wiring, etc. must be of equivalent size, type, and strength as original equipment and be designed specifically for such applications and systems.**
- **Components with stripped threads or damaged parts should be replaced rather than repaired. Do not attempt repairs requiring machining or welding unless specifically stated and approved by the vehicle and component manufacturer.**
- **Prior to returning the vehicle to service, make certain all components and systems are restored to their proper operating condition.**
- **For vehicles with Automatic Traction Control (ATC), the ATC function must be disabled (ATC indicator lamp should be ON) prior to performing any vehicle maintenance where one or more wheels on a drive axle are lifted off the ground and moving.**
- **The power MUST be temporarily disconnected from the radar sensor whenever any tests USING A DYNAMOMETER are conducted on a vehicle equipped with a Bendix® Wingman® system.**
- **You should consult the vehicle manufacturer's operating and service manuals, and any related literature, in conjunction with the Guidelines above.**

IMPORTANT

Bendix®-brand Electronic Control Units (ECUs) are not designed to store data for purposes of accident reconstruction, and Bendix® ACom® Diagnostic Software is not intended to retrieve data for purposes of accident reconstruction. Bendix makes no representations as to the accuracy of data or video retrieved and interpreted from ECUs for purposes of accident reconstruction. Bendix does not offer accident reconstruction services or interpretation of stored data. Bendix ECUs are not protected from fire, loss of power, impact damage, or other conditions that may be sustained in a crash situation and may cause data to be unavailable or irretrievable.

SYSTEM OVERVIEW

GSBC is controlled and operated in a similar manner to previous Bendix brake control systems. Experienced drivers and technicians may notice more audible solenoid noises during service brake operation. This is normal and is an audible confirmation that the system is operating as expected.

IMPORTANT

The driver is always to be in control of the service brakes, which will be operated by the brake pedal under the driver's foot.

The *GSBC* system operates in two (2) modes: Electronic Primary Mode and Pneumatic Backup Mode.

ELECTRONIC PRIMARY MODE

In Electronic Primary Mode, the driver's movement of the brake pedal is translated into an electronic request for pressure. This is interpreted by the Central ECU and sent to the Bendix® GSBC® EPM-90™ (Electro-Pneumatic Modules, hereafter referred to as "EPMs") that have taken the place of the traditional relay valves. This electronic control allows the system to deliver the precise pressure requested to each controlled foundation brake. This ensures that the desired brake response is achieved and provides improved brake balance and feel for the driver across the range of vehicle loading conditions.

For a schematic showing how GSBC operates in primary mode, *refer to Figure 1 on page 6*.

WARNING

In the event of a serious system malfunction, the Central ECU may be unable to maintain electronic control of the system. In the event of this occurs, the system will revert to Pneumatic Backup Mode.

PNEUMATIC BACKUP MODE

In Pneumatic Backup Mode, the system will rely on the pneumatic pressure sent by the Bendix® GSBC® FBM-40™ (Foot Brake Module, hereafter referred to as "FBM") to the EPMs. This will ensure that the vehicle has all of the designed braking power available to bring the vehicle to a stop.

When the system is operating in this mode:

- A red warning lamp will appear on the dashboard accompanied by a "Truck Brake Failure" message.
- Some or all of the electronic driver safety features such as ABS, ESP, Automatic Traction Control (ATC), and other functions may be unavailable.
- The system may not be able to provide ABS, ESP, or other advanced functionalities or interventions.
- Brake pedal feel and response may be different as compared to operation in Electronic Primary Mode.

For a schematic showing how GSBC operates in Pneumatic Backup Mode, *refer to Figure 3 on page 7*.

DISPLAY AND STARTUP BEHAVIOR

When the *GSBC* system is first powered on at vehicle ignition, experienced technicians and operators may notice a few things that are different when compared to previous Bendix brake control products. For complete information on vehicle display and startup behavior, *refer to BW8207, GSBC System Operator's Manual, on B2Bendix.com.*

IMPORTANT

The service technician should verify the proper operation of all installed indicator lamps when applying ignition power and during vehicle operation. Lamps that do not illuminate as expected when ignition power is applied, or red/yellow lamps that remain illuminated after startup, indicate the need for service and/or maintenance.

PRE-TRIP INFORMATION

Drivers and technicians must perform a pre-trip inspection in accordance with federal, local, and regional regulations. The *GSBC* system differs from previous generations of brake control systems, which may result in some changes to a pre-trip inspection process:

Indicator Lamps: There is an additional lamp on the dashboard as compared to previous systems. This red "BRAKE" lamp should briefly illuminate for approximately three (3) seconds when the vehicle is first powered on, but the lamp should not stay illuminated. If this lamp stays illuminated, it indicates a fault with the system or function described by the lamp. For more information on indicator lamps in normal and faulted operation, *refer to BW8207, GSBC System Operator's Manual, on B2Bendix.com*.

Change in Components: *GSBC* is comprised of fewer components than previous systems. As a result, valves that an experienced technician may be accustomed to seeing during pre-trip inspections will not be present on the vehicle.

When conducting a pre-trip inspection, *use Table 1 on page 11* of this document to help locate the main components of a *GSBC* system.

VEHICLE INSPECTION

For experienced drivers familiar with Bendix brake control systems, a pre- or post-trip inspection on a vehicle with *GSBC* is similar to the inspection procedure for previous Bendix systems. For a thorough inspection procedure for a Bendix air brake system, refer to the following documents on B2Bendix.com:

- BW2676 (for components located outside the cab)
- BW2677 (for components located inside the cab)

For information specific to the *GSBC* system components and general locations, *refer to Table 1 on page 11*.

TRUCK CHASSIS MODIFICATIONS

If the vehicle's chassis components are altered (for example, a wheel base extension or reduction; tag axle addition or removal; a major body change such as conversion of a tractor into a truck; or an axle, suspension, or steering system component modification), the Central ECU must be updated to reflect these changes. Contact your vehicle OEM prior to making any modifications to your vehicle.

⚠ WARNING

If you modify your vehicle and do not update the *GSBC* Central ECU, the *GSBC* system may fail to function as intended. Serious vehicle braking and performance issues could result, including unnecessary ESP system interventions, exceeding regulated stopping distance, and/or system faults leading to loss of electronic functions. These types of failures can lead to a loss-of-control of the vehicle, potential collisions, property damage, serious injuries, and/or death.

⚠ WARNING

If replacement tires are used that are a different diameter from the OEM-specified tire size, the brake control system must be updated with the new tire size using the appropriate diagnostic tool. Contact the vehicle manufacturer for more information.

PRESSURE PLAUSIBILITY CHECKS

To check and confirm the operation of the pneumatic backup control system hardware, the GSBC system will occasionally disable parts of the electronic control system and monitor the operation of the pneumatic valves and air lines by running a series of self-tests referred to as “pressure plausibility checks.” These tests are intended to aid the driver or technician in identifying failures in air lines or control valves.

If the correct preconditions are met, the tests will run automatically and without notification to the driver. These tests are run only at standstill, and are automatically aborted under certain conditions, such as driver request for acceleration or parking brake activation. These tests are designed to operate in the background; no driver action is required to execute these tests unless indicated by the dashboard display. The dashboard display will prompt these tests ONLY IF the system does NOT get the opportunity to run these tests automatically.

Faults and Potential Causes

Pressure plausibility tests are monitoring functions designed to ensure that the mechanical components of the brake system are operating correctly. If the test is not run, a yellow warning lamp may be set on the dashboard, accompanied by a warning pop-up on the dashboard when the vehicle is started.

If a test runs and fails, it can result in a red or yellow EBS warning lamp on the dashboard. These failed tests are usually indicative of a problem that has been detected with the braking system such as a significant air leak, or a blocked or kinked air line.

Note to Technicians: If a vehicle is in the process of being repaired or diagnosed and the system displays a prompt on the dashboard to perform a pressure plausibility check, that check can be skipped by pressing the throttle. Running a pressure plausibility test on a faulted or partially disassembled air system may log additional Diagnostic Trouble Codes (DTCs) and/or dashboard warning lamps that are not indicative of additional system faults.

⚠ WARNING

Only press the throttle in a workshop scenario if the vehicle is safely immobilized, not in gear, and no personnel are in a position to be harmed by a running engine. Failure to do so can result in a vehicle movement that may cause property damage, serious injuries, and/or death.

For more information about pressure plausibility tests, *refer to BW8207, GSBC System Operator’s Manual, on B2Bendix.com.*

PREVENTIVE SYSTEM CHECKS

⚠ IMPORTANT

If the *GSBC* system detects a problem, the system will illuminate a warning indicator lamp on the dashboard, which will indicate which function(s) is/are impacted by the problem. While any warning indicator lamp is illuminated, system performance is likely affected, and the vehicle should be inspected by a qualified technician.

The system will also log a DTC which can be read with a compatible vehicle diagnostic software by a properly trained technician. *Refer to the DTC section starting on page 26 for more information.*

EQUIPMENT MAINTENANCE

⚠ IMPORTANT

GSBC System Maintenance – Optimal *GSBC* system braking performance requires a properly maintained and inspected system, without any active warning lamps or DTCs. Have a vehicle with any active warning indicator lamps diagnosed and repaired by a qualified technician.

Importance of Brake Maintenance – Optimal braking requires properly maintained foundation brakes, which meet appropriate safety standards and regulations. Brake performance also requires the vehicle be equipped with properly sized and inflated tires with a safe tread depth.

GSBC SYSTEM COMPARISON

GSBC differs from previous brake control system designs in a number of ways, but the most significant is the way that the vehicle receives and responds to the driver's request for braking. *GSBC* continuously monitors the position of the brake pedal using the FBM, and will electronically and pneumatically transmit the driver's demand for braking as soon as the driver moves the brake pedal. The electronic signal from the FBM is received by the Central ECU, which in turn commands "smart" relay valves known as EPMs over the private brake CAN communications link. The EPMs act on the request and electronically deliver a controlled pressure to the connected service brakes(s) or axle(s), fulfilling the driver's request for braking.

By transmitting signals electronically, brake response and control on an EBS-style system can be improved when compared with a purely pneumatic, previous generation brake control system. This added control also enables new *GSBC* functions, if equipped. For more information about functions for *GSBC* systems, *refer to BW8207, GSBC Operator's Manual, on B2Bendix.com.*

In comparison, most existing brake control systems in North America utilize air pressure for both the control signal pressure and the supply pressure used by the system. This pressure is then used to apply and release the service brakes, which makes the operation of the braking system a mostly pneumatic/mechanical process with electronic features such as ABS and ESP added as necessary.

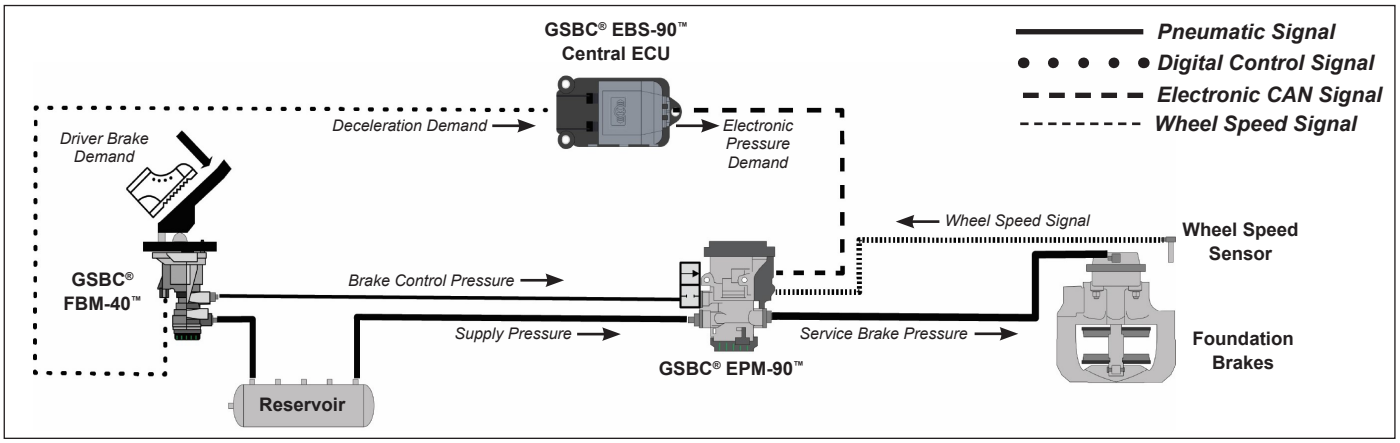


Figure 1 – GSBC System Electronic Primary Mode Example

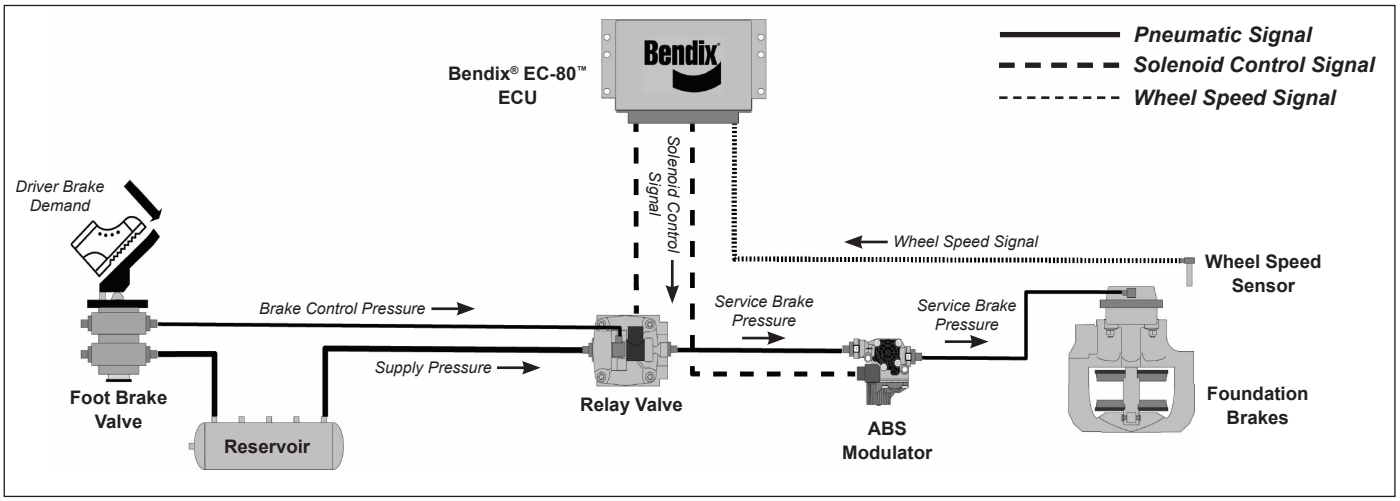


Figure 2 – ABS Normal Operation Example

Because air still supplies the necessary force to apply and release the service brakes, in the event of a serious fault or electrical failure, the system will still be able to control, apply, and release the brakes by falling back to the underlying, pneumatic/mechanical system that is capable of operating without electrical power using only air pressure.

If the *GSBC* system experiences an electrical or software malfunction that prevents it from operating in Electronic Primary Mode, the vehicle will be operating in Pneumatic Backup Mode where higher-level electronic functionality may be lost. Operation in this mode will be accompanied by one (1) or more warning indicator lamps on the dashboard.

Refer to BW8207, GSBC Operator's Manual, on B2Bendix.com as well as the vehicle owner's manual, for assistance with what specific warning indicator lamps mean and what actions should be taken in response.

⚠ WARNING

If a red warning lamp appears on the dashboard and stays illuminated, indicating that the system is in Pneumatic Backup Mode, pull over and safely stop the vehicle as soon as possible, and have the vehicle serviced immediately to identify and correct the reason for the malfunction. If the issue(s) is not corrected, serious vehicle braking and performance issues could result, including unnecessary ESP system interventions, exceeding regulated stopping distance, and/or system faults leading to loss of electronic functions. These types of failures can lead to a loss-of-control of the vehicle, potential collisions, property damage, serious injuries, and/or death.

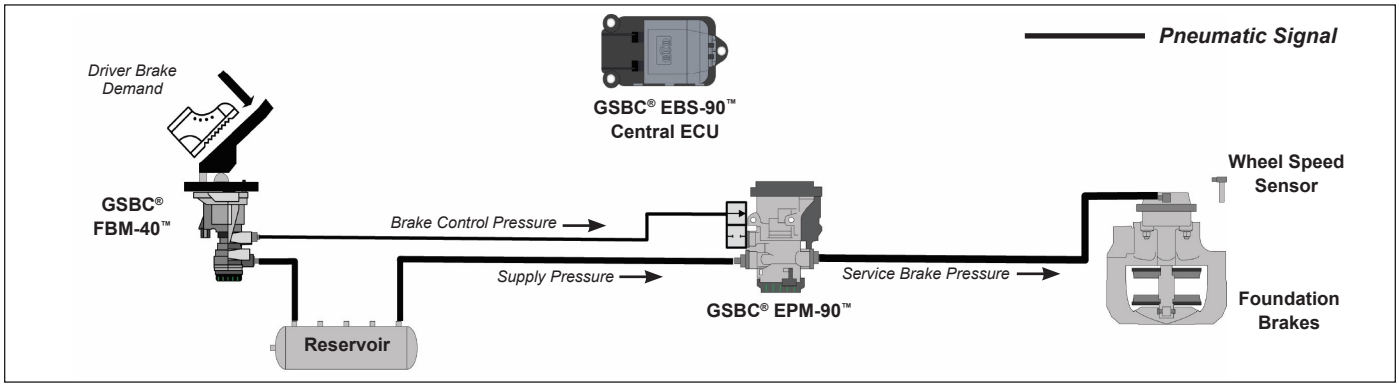


Figure 3 – GSBC System Pneumatic Backup Mode Example

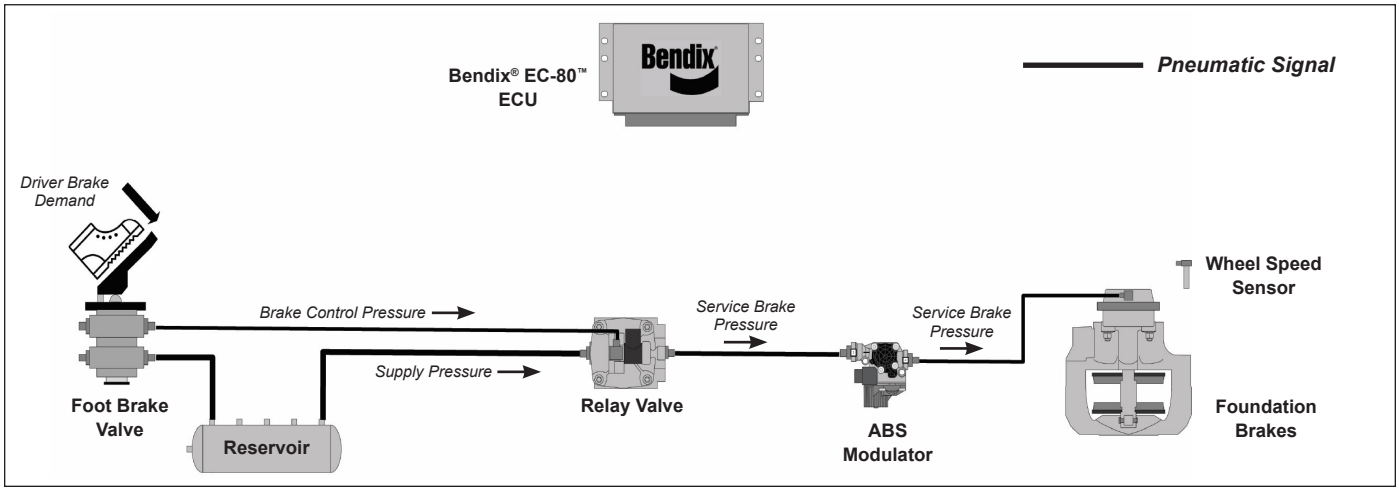


Figure 4 – ABS Faulted Operation Example

SYSTEM COMPONENTS

GSBC is comprised of fewer components than previous brake control systems. As a result, valves that an experienced driver or technician may be accustomed to seeing on a vehicle will not be present, or have been incorporated into other components.

Refer to Table 1 on page 11 for assistance in locating components on a vehicle equipped with GSBC.

GSBC CENTRAL ECU (BENDIX® GSBC® EBS-90™)

The *GSBC* Central ECU is a frame-mounted, ruggedized, weatherproof Electronic Control Unit (ECU). Unlike previous Bendix brake control ECUs with Bendix Electronic Stability Program (ESP), the Central ECU is located on the exterior of the vehicle on a rigid mount. It is important to ensure that the mounting location of the Central ECU is rigid as it also contains the Yaw Rate Sensor (YAS) used by the brake controller's ESP function. Loose mounting bolts or flexibility in the ECU mount can lead to poor system performance, faults, or unintended or unwanted ESP interventions.

The Central ECU is parameterized when the vehicle is built to match the mounting position and orientation on the vehicle. **Under no circumstances can the Central ECU be relocated, reoriented, or replaced without consulting the vehicle OEM.** For more information about the Central ECU, *refer to page 18 of this document.*

⚠ WARNING

The Central ECU in a *GSBC* system must not be relocated or reoriented on the vehicle. Relocation or reorientation of the Central ECU can cause improper stability control function and potential non-compliance to regulations.

⚠ WARNING

Bendix ESP is designed and optimized for trucks and for tractors that tow single trailers. If a tractor equipped with Bendix ESP is used to tow multiple trailer combinations (commonly known as "doubles" or "triples"), the effectiveness of Bendix ESP may be greatly reduced. Extremely careful driving is always required when towing multiple trailer combinations. Excessive speed and aggressive maneuvers – such as sharp turns, sudden steering inputs, or abrupt lane changes – should be avoided.

FOOT BRAKE MODULE (BENDIX® GSBC® FBM-40™)

The Foot Brake Module (FBM) provides driver control over the service brake system. The FBM incorporates the Foot Brake Valve (FBV) and brake demand sensors present in previous brake control systems. Pneumatically, the components are very similar. The FBM is supplied by both the primary and secondary pneumatic circuits and will always deliver pressure on both the primary and secondary circuits in response to driver demand if air is present in the service reservoirs.

To enable the advanced features and functions offered by the *GSBC* system, the FBM will continuously monitor the position of the brake pedal electronically. If the driver requests a change in braking force by moving the brake pedal, the FBM will electronically transmit that information to the Central ECU so that the system can respond appropriately.

For more information about the FBM, *refer to SD-27-5028, GSBC FBM Service Data Sheet, on B2Bendix.com.*

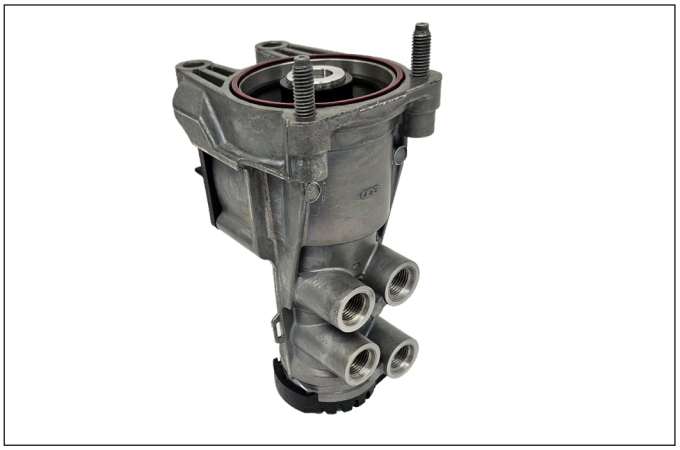


Figure 5 – GSBC FBM-40

ELECTRO-PNEUMATIC MODULE (BENDIX® GSBC® EPM-90™)

The Electro-Pneumatic Modules (EPMs) are electronically controlled proportional relay valves. They are available in either one channel (1C) or two channel (2C) variants. In comparison to previous brake control systems, the EPMs incorporate the traction control solenoid, relay valve, Hill Start Assist (HSA) solenoid valve assembly, and, in the case of the 2C EPM, modulators. Typically, 1C EPMs are used for steer axles and lift axles, and 2C EPMs are used for driven axle(s).

NOTE: The *GSBC* system has a minimum of two (2) and a maximum of four (4) EPMs per vehicle.

EPMs are in constant communication with the Central ECU by a dedicated brake CAN communications link that is entirely separate from the other CAN networks on the vehicle. If the driver requests a change in brake force using the foot brake pedal, the EPMs will provide the requested amount of pressure to the wheel ends that they control. If the Central ECU makes a request for brake pressure (for example, to perform an ESP, ATC, or HSA intervention) the EPMs will respond in much the same way.

⚠ WARNING

Never splice, cut, extend, or otherwise disturb a brake CAN line. There are no diagnosable signals on brake CAN, and any modification to brake CAN wiring can result in EBS malfunction, faults, and warnings, up to and including those that disable required functions such as ESP and ABS.

On driven axles, the controlling EPM also provides ABS, ATC, and HSA functionalities. Unlike previous Bendix brake control systems, *GSBC* does not require additional mechanical valves or plumbing to enable these features.

EPMs are also equipped with a backup solenoid, which will prevent control air pressure supplied by the FBM from flowing into the EPM if the system is operating normally. This ensures that the electronic control system manages the braking effort of the vehicle in most scenarios.

If the system is in Pneumatic Backup Mode, the solenoids inside the EPMs are not powered, allowing the pneumatic signal from the FBM to flow into the EPM, which allows the EPM to operate as a mechanical relay valve.

For more information about EPMs, *refer to SD-27-5031, GSBC EPM Service Data Sheet, on B2Bendix.com.*

Figure 6 – GSBC EPM-90 (1C and 2C)

ELECTRONIC TRAILER PRESSURE CONTROL MODULE (BENDIX® GSBC® eTPCM-90™)

The Electronic Trailer Pressure Control Module (eTPCM) is an electronically controlled proportional relay valve. The eTPCM works with the Bendix® GSAT® (Global Scalable Air Treatment) system and *GSBC* system to provide trailer service brake (blue gladhand) air control as well as trailer emergency (red gladhand) air. For more information on *GSAT*, *refer to SD-24-250V, GSAT System Service Data Sheet, on B2Bendix.com.*

Unlike the EPM, the eTPCM does not communicate over a dedicated brake CAN communications link. Instead, it is directly connected to the Central ECU which provides analog control of the eTPCM solenoids.

The eTPCM receives pneumatic control input from both the primary and the secondary brake circuits via the FBM. The valve receives supply air from GSAT, which is used to supply the internal relay valve delivering pressure to trailer service brake control line, through the blue gladhand. The supply pressure is also allowed to pass through the valve to provide the emergency/supply (red) gladhand with air (when enabled).

When the system is operating in Electronic Primary Mode, the Central ECU will use the eTPCM solenoids to electronically control the pressure sent to the trailer service brake control. Similar to the EPMs, the eTPCM also has a backup solenoid that prevents pneumatic control air pressure from flowing from the FBM into the eTPCM relay valve when the system is operating in Electronic Primary Mode.

In the event of a critical system failure, the system will fall back to Pneumatic Backup Mode. In this mode, the backup solenoid will not close and the solenoids in the eTPCM will not be activated. As a result, control pressure will flow into the eTPCM from the FBM, which will operate the eTPCM as a mechanical relay valve.

For more information about the eTPCM, *refer to SD-27-5036, GSBC eTPCM Service Data Sheet, on B2Bendix.com.*

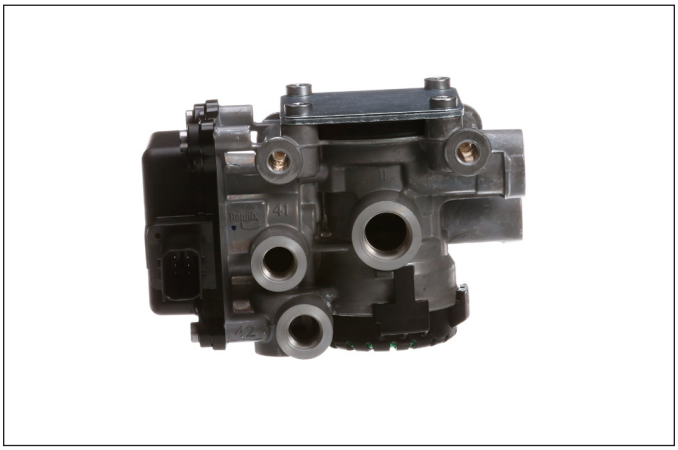


Figure 7 – GSBC eTPCM-90

MODULATOR (BENDIX® GSBC® M-50QR™)

The M-50QR modulator is a high-capacity, on/off pneumatic device that can help provide antilock control for the wheel(s) it controls. The modulator has both electrical and pneumatic connections, and is typically located close to the brake chamber(s) it is controlling. For Volvo vehicles with *GSBC*, there are two (2) modulators, located on each side of the vehicle near the brake chambers on the front axle. Antilock control for all other axles on the vehicle is provided by the EPM(s) controlling those axle(s).

The purpose of the modulator is to prevent the brakes that it controls from “locking up” or from becoming stationary while the vehicle is still in motion This is essential to the operation of the ABS function. More information about the ABS function and how it works can be found in *BW8207, GSBC System Operator’s Manual, or in Section 6 of BW5057, Bendix Air Brake Handbook, on B2Bendix.com.*

Depending on the situation, the modulator can hold off application pressure from the wheel end, hold a steady pressure at a wheel end relative to the pneumatic control signal, or exhaust the pressure at a wheel end relative to the pneumatic control signal, all by controlling two (2) solenoids electronically. The functionality of holding or decreasing pressure at an individual steer axle wheel end is a key component of maintaining vehicle stability under hard braking, or in adverse road or weather conditions.

For more information about the M-50QR modulator, *refer to SD-27-5170, GSBC M-50QR Service Data Sheet, on B2Bendix.com.*

Figure 8 – GSBC M-50QR

WHEEL SPEED SENSOR (BENDIX® WS-24™)

Wheel Speed Sensors (WSSs) detect the speed of an individual wheel end and transmit that information to the brake control system. The WSS is fixed to the axle of a vehicle and does not move as the wheel end itself rotates. The sensor is pointed towards a tone ring that is fixed to the spinning wheel, and as the wheel spins, the WSS detects the movement of the tone ring. The WSS turns this sensed rotational information into an analog signal, which is read by the EPM. The EPM translates this analog signal into a digital signal, which is in turn transmitted to the Central ECU over the brake CAN communications link.

For more information about the WSS, *refer to SD-13-4860, Bendix WS-24 Service Data Sheet, on B2Bendix.com.*

Figure 9 – Bendix WS-24 90° and Straight Variants

STEERING ANGLE SENSOR (BENDIX® SAS-80™)

The Steering Angle Sensor (SAS) is a 12V electronic sensor installed in the steering column. The SAS detects and transmits the angle to which the driver has turned the steering wheel over the CAN communications link to the Central ECU, which uses that information to help improve the performance of ESP and other advanced functions.

For more information about the SAS, *refer to SD-27-4709, Bendix SAS Service Data Sheet, on B2Bendix.com.*

Figure 10 – Bendix SAS-80

COMPONENT INSTALLATION/REPLACEMENT

Refer to the component-specific Service Data sheet on B2Bendix.com for troubleshooting, and installation and replacement procedures for that particular component.

COMPONENT LOCATION AND SERVICE DATA SHEET REFERENCE

This information is intended as a general guideline for *GSBC* system components and the location of components depending on the specific application the vehicle is built for. Contact the vehicle OEM for more information.

GSBC COMPONENT	GENERAL LOCATION	FUNCTION
Foot Brake Module (FBM-40) ***SD-27-5028***	Firewall, connected to the brake pedal	Converts driver input into pneumatic and electronic request for service braking.
Electro-Pneumatic Module (EPM-90, 1-Channel) ***SD-27-5031***	Above left frame rail in front of the cab, under hood; occasionally near accessory axles, such as lift axles	Smart relay valve to control service pressure on the steer axle or on undriven axle(s). Note: Vehicles may have between one (1) and three (3) 1C EPMs, depending on the axle configuration and layout.
Electro-Pneumatic Module (EPM-90, 2-Channel) ***SD-27-5031***	Frame rail or crossmember close to the controlled axle(s)	Smart relay valve to control service pressure on the drive axle(s) or undriven axle(s). Note: Vehicles may have between one (1) and three (3) 2C EPMs, depending on the axle configuration and layout.
GSBC Central ECU (EBS-90) ***SD-27-5023V*** (***This Document)***	Under or immediately behind the cab on the frame rail	Controls the entire *GSBC* system and provides an interface between the vehicle and the *GSBC* system.
Electronic Trailer Pressure Control Module (eTPCM-90) ***SD-27-5036***	Back of cab, close to the trailer air lines	An electro-mechanical relay valve to send control pressure to the trailer.
Modulator (M-50QR) ***SD-27-5170***	Frame rail near the left and right steer wheels	Provide steer wheel specific modulation of air pressure to avoid wheel lockup and provide vehicle stability.
Wheel Speed Sensor (WS-24) ***SD-13-4860***	On the axle near the brake rotor or hub	Provide individual wheel speed information to the EPM.
Steering Angle Sensor (SAS-80) ***SD-27-4709***	Within the steering column under the steering wheel	Provide driver steering wheel input information for ESP purposes.
GSAT System ***SD-24-250V***	On the chassis connected to the air dryer, reservoirs, and other pneumatic circuits	Cleans, controls, and distributes air to the brake reservoirs and air-operated accessories on the vehicle. Electronically controls parking brake and trailer supply air functions.

Table 1 – GSBC System Component Locations

SYSTEM COMPONENTS COMPARISON

For technicians familiar with previous generations of Bendix brake control systems, valves and components included with *GSBC* may not look familiar. The following table is provided to help compare the new *GSBC* components and the Bendix® EC-80® Electronic Control Unit (ECU) brake control system components:

EC-80 SYSTEM COMPONENTS	GSBC SYSTEM COMPONENTS	DIFFERENCES WITH GSBC
Foot Brake Valve (FBV)	Foot Brake Module (FBM-40)	FBM now includes sensing technology to detect brake requests from the driver. Includes dual-circuit brake control valve for Pneumatic Backup Mode.
Pressure Sensors (PS-60)		
Traction Relay Valve (ATR-6/AT-3, R-12, or R-14)	Electro-Pneumatic Module (EPM-90, 1C or 2C variant)	The EPM is available in 1C and 2C variants. The EPM integrates the ATC valve, relay valve functionality, and pressure sensors, and is capable of delivering air pressure requested by the driver or driver assistance system.
HSA/Traction Solenoid (AT-3, RV-3, DC-4)		
Electronic Control Unit (EC-80)	GSBC ECU (EBS-90)	The GSBC ECU (Central ECU) is a frame-mounted ECU. The YAS is now included in the Central ECU.
Yaw Rate Sensor (YAS-70)		
Modulator (M-40QR/M-40HF)	Modulator (M-50QR)	The modulator is now only used on the steer axle.
Steering Angle Sensor (SAS-80)	Steering Angle Sensor (SAS-80)	The SAS has not changed significantly for *GSBC*.
Wheel Speed Sensor (WS-24)	Wheel Speed Sensor (WS-24)	The WSS has not changed significantly for *GSBC* on Volvo vehicles.
Trailer Pressure Modulator (M-40QR/M-40HF)	Electronic Trailer Pressure Control Module (eTPCM-90)	The eTPCM is an electronically controlled relay valve and has replaced the trailer pressure modulator. In conjunction with *GSAT*, it also provides tractor protection system functionality.
Tractor Protection Valve (TP-3DC/TP-5)		
Air Dryer (AD-IP, AD-IS, AD-HF)	GSAT (Global Scalable Air Treatment) System	*GSAT* provides air treatment, governor, circuit isolation/protection, park control, tractor protection, trailer supply/emergency functionalities.
Governor (D-2)		
Intellipark		
Dash Valve (MV-3/PP-DC)		

Table 2 – Bendix EC-80 System and GSBC System Component Comparison

GSBC SYSTEM PNEUMATIC SCHEMATIC EXAMPLE (WITH GSAT)

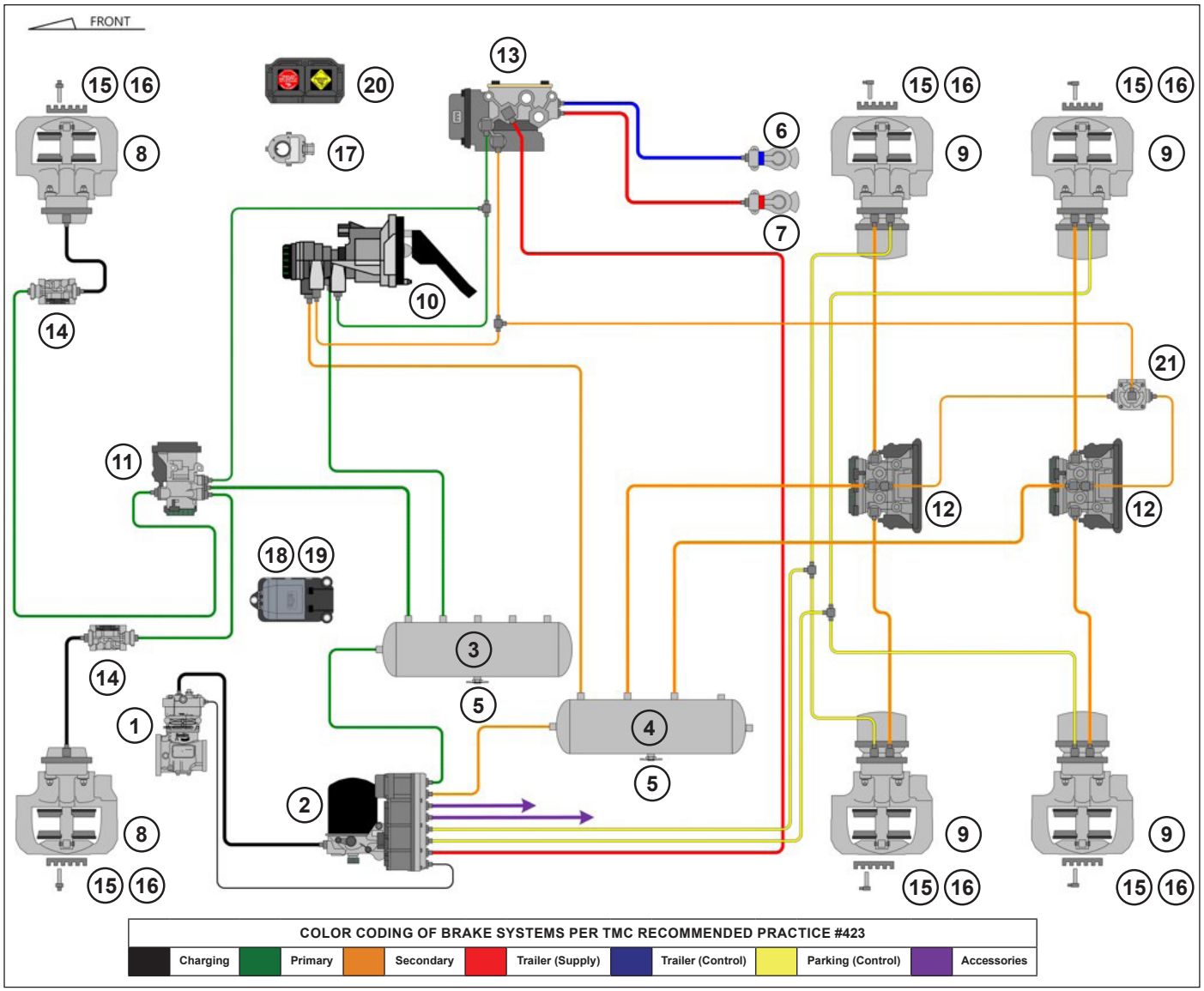


Figure 11 – GSBC System Pneumatic Schematic Example (With GSAT)*

This schematic is representative only and may differ from your vehicle. Verify your vehicle schematic with your OEM. NOTE: In most applications of GSBC, the primary circuit is connected to the steer axle, and the secondary circuit is connected to the drive axle(s) unlike most conventional U.S. plumbing configurations.

ITEM	COMPONENT	ITEM	COMPONENT	ITEM	COMPONENT
1	AIR COMPRESSOR	8	FOUNDATION BRAKE WITH SERVICE CHAMBER	15	BENDIX® WS-24™ WSS
2	BENDIX® GSAT® AIR TREATMENT MODULE	9	FOUNDATION BRAKE WITH SPRING BRAKE CHAMBER	16	WSS CLAMPING SLEEVE
3	PRIMARY RESERVOIR	10	BENDIX® GSBC® FBM-40™ FOOT BRAKE MODULE	17	BENDIX® SAS-80™ STEER ANGLE SENSOR
4	SECONDARY RESERVOIR	11	BENDIX® GSBC® EPM-90™ ONE CHANNEL ELECTRO-PNEUMATIC MODULE (EPM-1C)	18	BENDIX® GSBC® EBS-90™ CENTRAL ECU
5	DRAIN VALVE	12	BENDIX® GSBC® EPM-90™ TWO CHANNEL ELECTRO-PNEUMATIC MODULE (EPM-2C)	19	BENDIX® GSBC® EBS-90™ CENTRAL ECU MUD COVER
6	TRAILER CONTROL GLADHAND	13	BENDIX® GSBC® ETPCM-90™ ELECTRONIC TRAILER PRESSURE CONTROL MODULE	20	ELECTRONIC PARKING BRAKE HAND CONTROL UNIT (HCU)
7	TRAILER SUPPLY GLADHAND	14	BENDIX® GSBC® M-50QR™ QUICK RELEASE ANTILOCK MODULATOR	21	QUICK RELEASE VALVE (OPTIONAL)

Table 3 – GSBC System Schematic Example Components

GSBC WIRING SCHEMATIC WITH COMPONENT PINOUTS

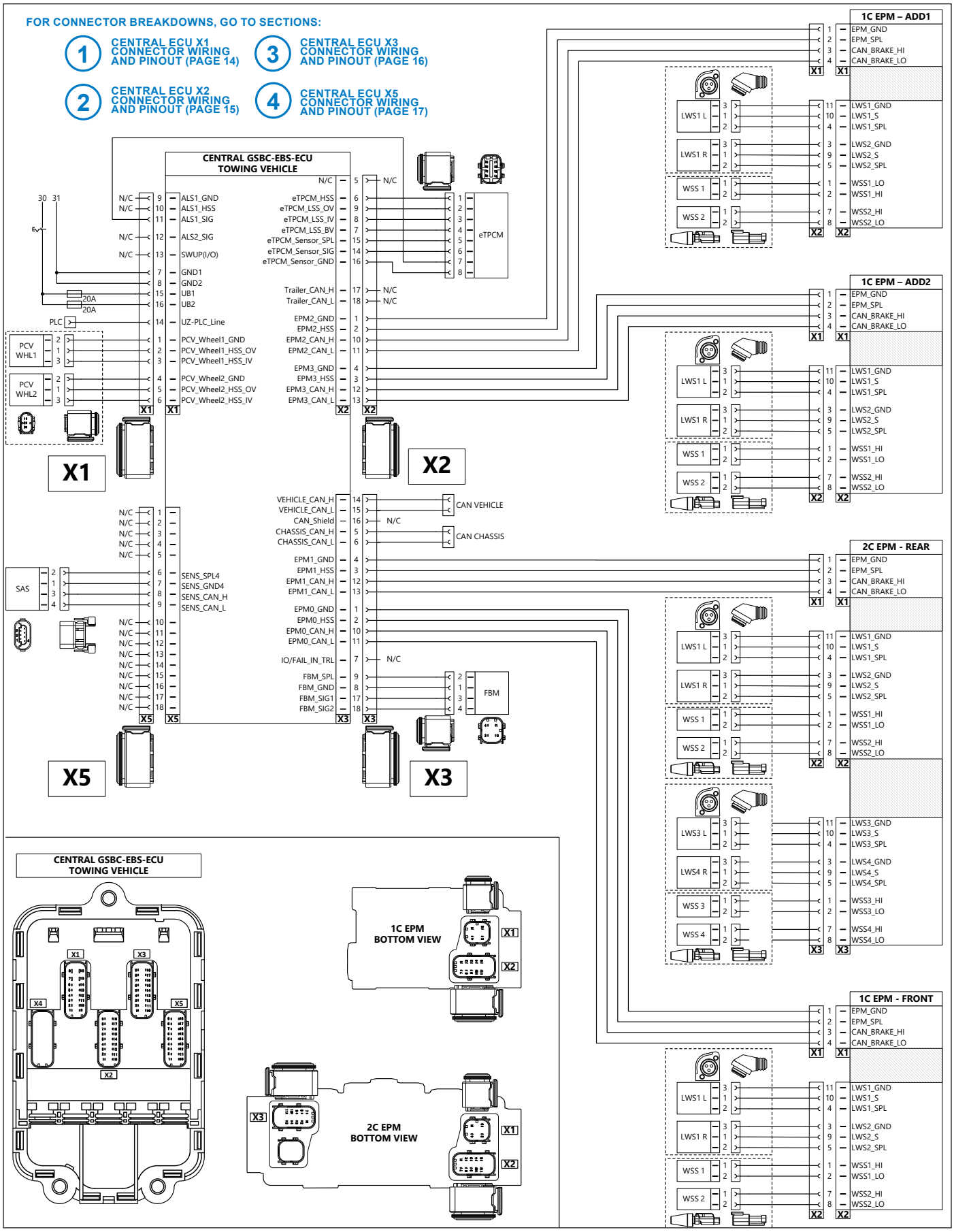


Figure 12 – GSBC System Wiring Schematic Example

GSBC WIRING SCHEMATIC WITH COMPONENT PINOUTS (CONT.)

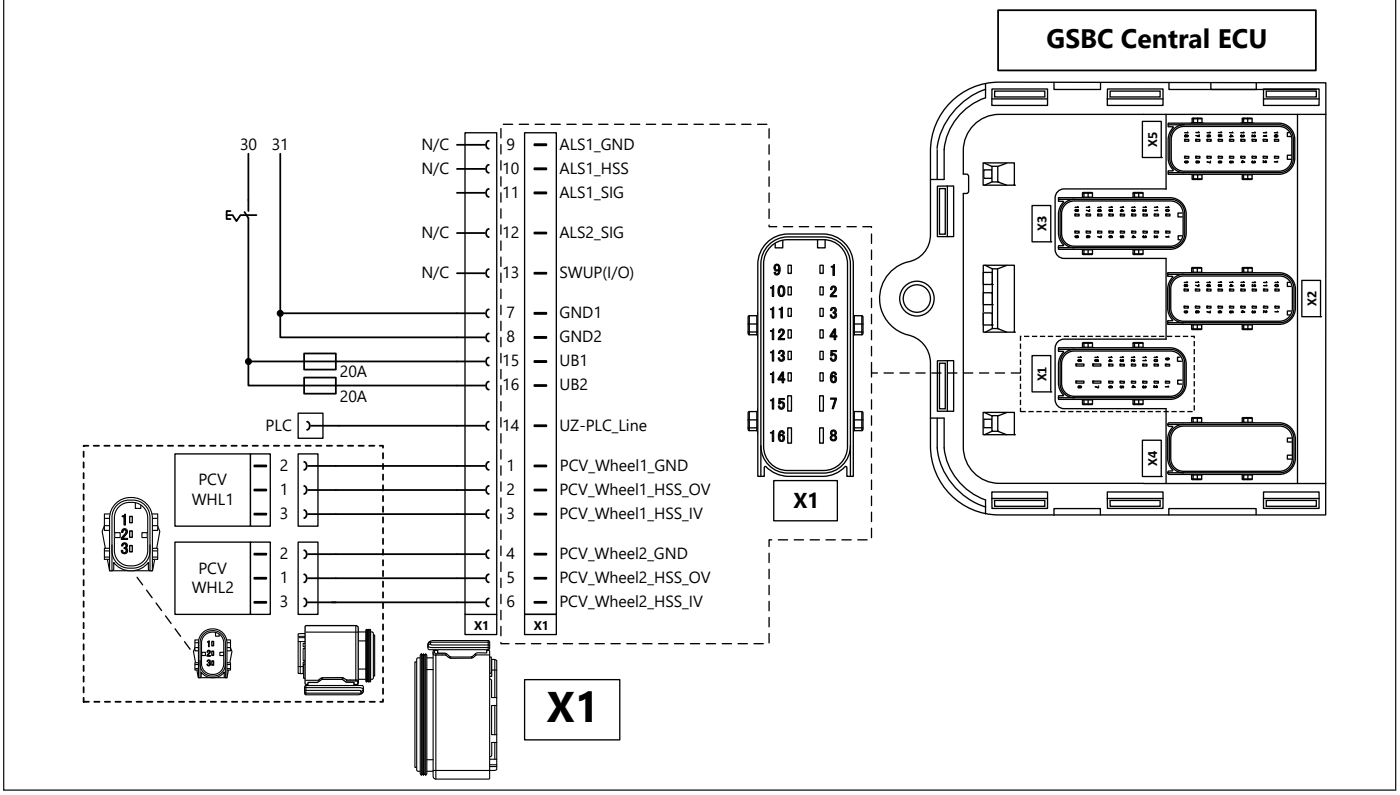
ELECTRICAL INTERFACES

Electrical Configuration

Tables 4-7 show which electrical pins on the Central ECU (**PIN** column) are connected to which electrical pins on the other GSBC components (**DEVICE** and **PIN MATCH** columns) for each of the Central ECU's electrical connectors. These tables may be useful for diagnosing DTCs for specific components or potential issues within the vehicle electrical harness. For full pinout information of the Central ECU, *see the GSBC Central ECU Electrical Connectors section starting on page 20*.

1. CENTRAL ECU X1 CONNECTOR WIRING AND PINOUT

CENTRAL ECU X1 CONNECTOR



X1 CONNECTOR PIN MATCH					
PIN	**DEVICE**	**PIN MATCH**	**PIN**	**DEVICE**	**PIN MATCH**
1	PCV	2	**9**	-	-
2	PCV	1	**10**	-	-
3	PCV	3	**11**	eTPCM	7
4	PCV	2	**12**	-	-
5	PCV	1	**13**	-	-
6	PCV	3	**14**	-	-
7	-	-	**15**	-	-
8	-	-	**16**	-	-

Table 4 – Central ECU X1 Connector Pin Match

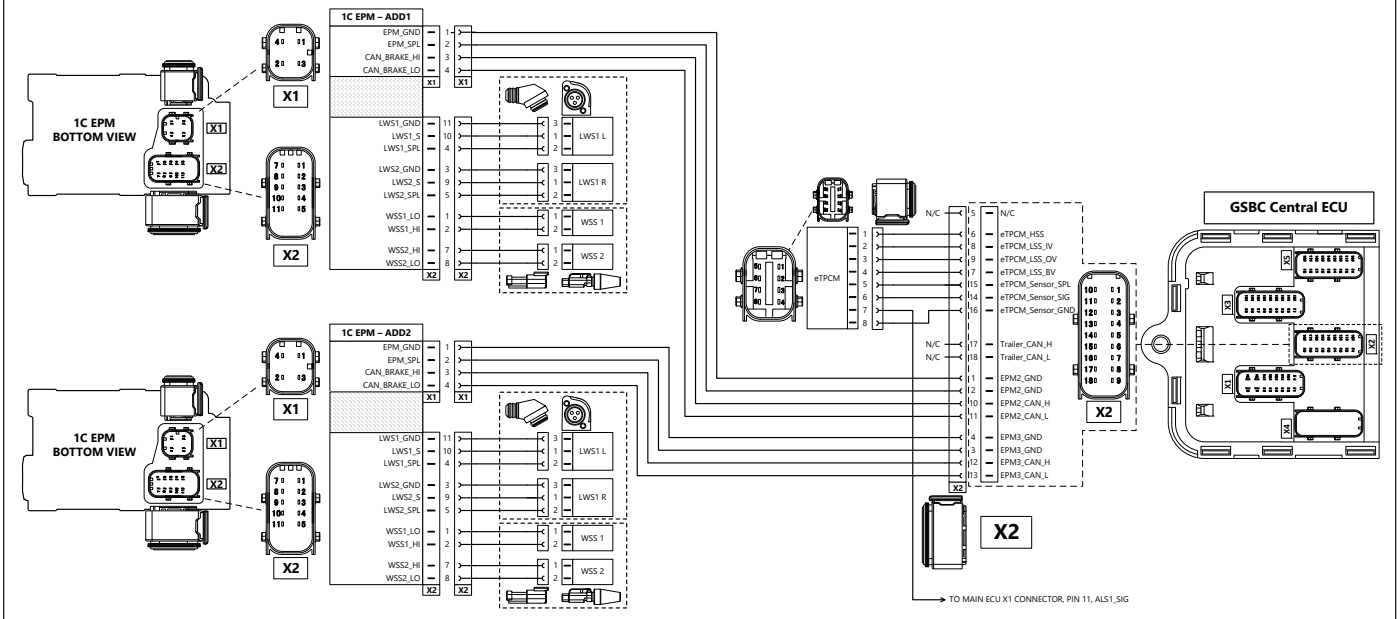
DEVICE KEY	
REFERENCE	**DEVICE**
PCV	GSBC M-50QR
eTPCM	GSBC eTPCM-90
EPM0-3	GSBC EPM-90
FBM	GSBC FBM-40
SAS	SAS-80

GSBC WIRING SCHEMATIC WITH COMPONENT PINOUTS (CONT.)

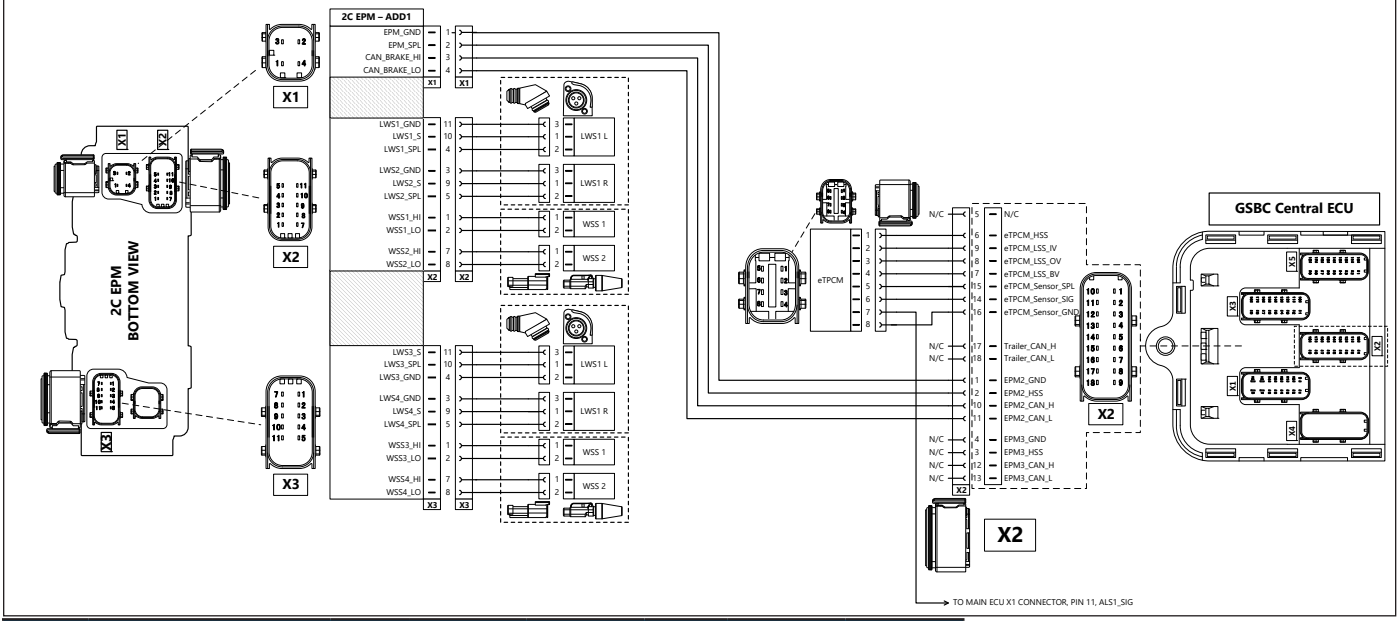
2. CENTRAL ECU X2 CONNECTOR WIRING AND PINOUT

CENTRAL ECU X2 CONNECTOR

X2 CONNECTOR TO 2 ADDITIONAL 1C EPM(s)



X2 CONNECTOR TO 1 ADDITIONAL 2C EPM



X2 CONNECTOR PIN MATCH

PIN	DEVICE	PIN MATCH	PIN	DEVICE	PIN MATCH	PIN	DEVICE	PIN MATCH
1	EPM2	X1:1	7	eTPCM	4	13	EPM3	X1:4
2	EPM2	X1:2	8	eTPCM	3	14	eTPCM	6
3	EPM3	X1:2	9	eTPCM	2	15	eTPCM	5
4	EPM3	X1:1	10	EPM2	X1:3	16	eTPCM	8
5	-	-	11	EPM2	X1:4	17	-	-
6	eTPCM	1	12	EPM3	X1:3	18	-	-

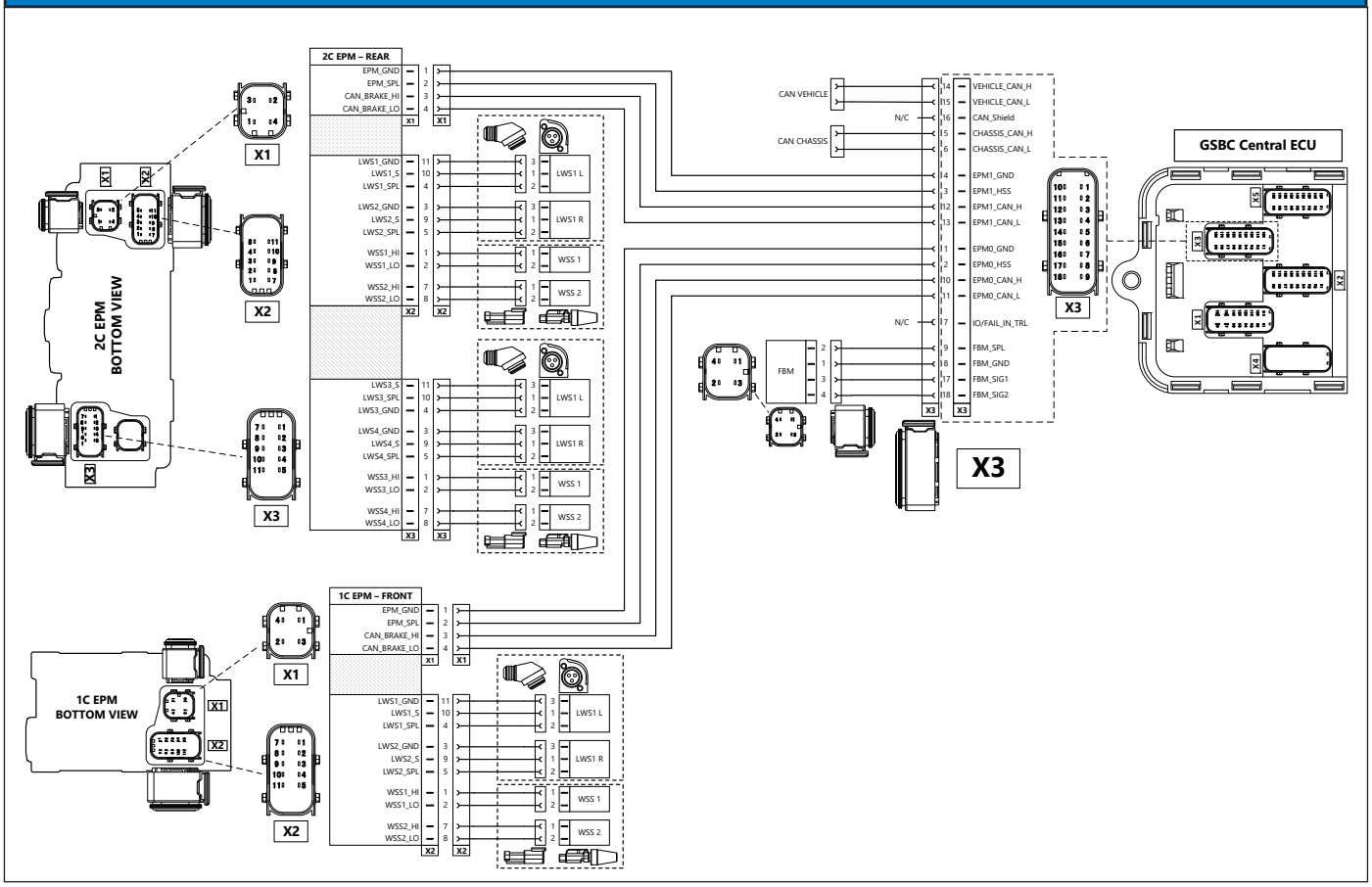
Table 5 – X2 Pin Match

DEVICE KEY	
REFERENCE	DEVICE
PCV	GSBC M-50QR
eTPCM	GSBC eTPCM-90
EPM0-3	GSBC EPM-90
FBM	GSBC FBM-40
SAS	SAS-80

GSBC WIRING SCHEMATIC WITH COMPONENT PINOUTS (CONT.)

3. CENTRAL ECU X3 CONNECTOR WIRING AND PINOUT

CENTRAL ECU X3 CONNECTOR



X3 CONNECTOR PIN MATCH

PIN	DEVICE	PIN MATCH	PIN	DEVICE	PIN MATCH	PIN	DEVICE	PIN MATCH
1	EPM0	X1:1	7	-	-	13	EPM1	X1:4
2	EPM0	X1:2	8	FBM	1	14	-	-
3	EPM1	X1:2	9	FBM	2	15	-	-
4	EPM1	X1:1	10	EPM0	X1:3	16	-	-
5	-	-	11	EPM0	X1:4	17	FBM	3
6	-	-	12	EPM1	X1:3	18	FBM	4

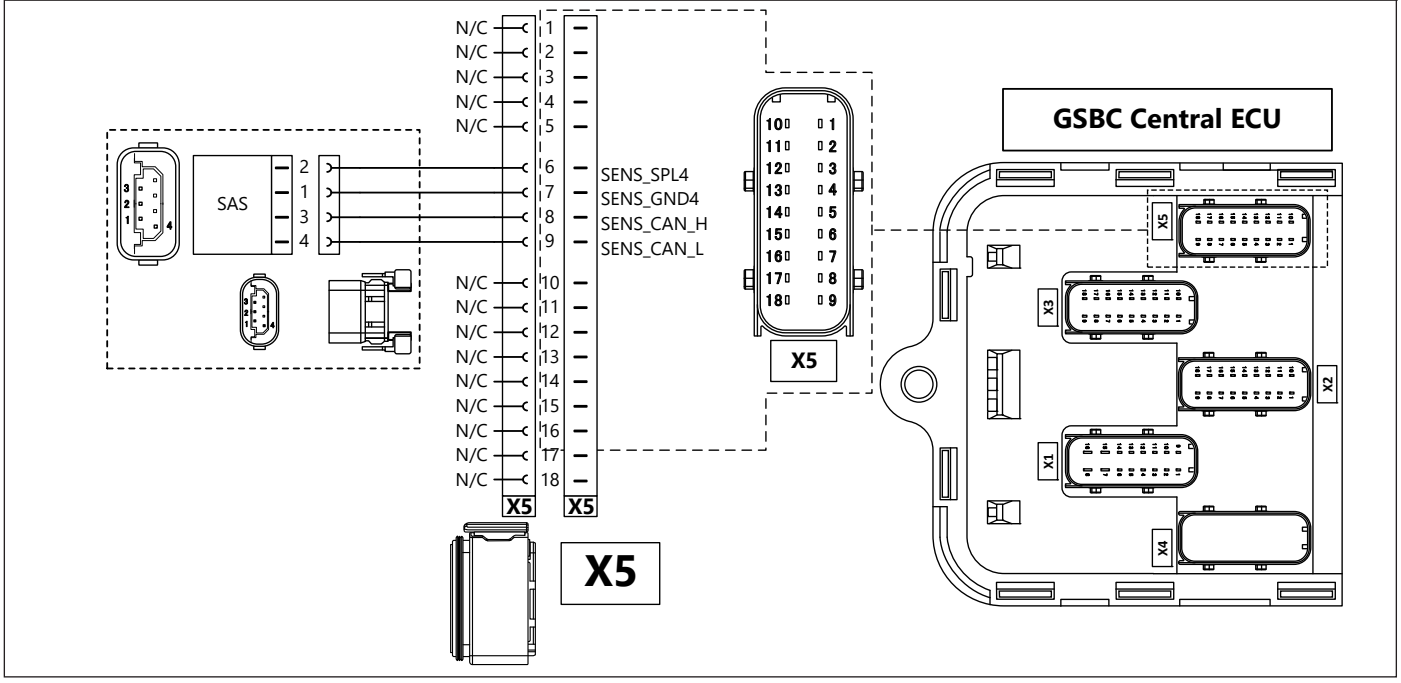
Table 6 – Central ECU X3 Connector Pin Match

DEVICE KEY	
REFERENCE	**DEVICE**
PCV	GSBC M-50QR
eTPCM	GSBC eTPCM-90
EPM0-3	GSBC EPM-90
FBM	GSBC FBM-40
SAS	SAS-80

GSBC WIRING SCHEMATIC WITH COMPONENT PINOUTS (CONT.)

4. CENTRAL ECU X5 CONNECTOR WIRING AND PINOUT

CENTRAL ECU X5 CONNECTOR



X5 CONNECTOR PIN MATCH								
PIN	DEVICE	PIN MATCH	PIN	DEVICE	PIN MATCH	PIN	DEVICE	PIN MATCH
1	-	-	7	SAS	1	13	-	-
2	-	-	8	SAS	3	14	-	-
3	-	-	9	SAS	4	15	-	-
4	-	-	10	-	-	16	-	-
5	-	-	11	-	-	17	-	-
6	SAS	2	12	-	-	18	-	-

Table 7 – Central ECU X5 Connector Pin Match

DEVICE KEY	
REFERENCE	DEVICE
PCV	GSBC M-50QR
eTPCM	GSBC eTPCM-90
EPM0-3	GSBC EPM-90
FBM	GSBC FBM-40
SAS	SAS-80

GSBC CENTRAL ECU

Figure 13 – Central ECU Parts and Full Assembly

This section is specifically aimed at providing information about the Central ECU, as well as diagnosing, troubleshooting, and addressing potential issues with the Central ECU.

DESCRIPTION

The Bendix EBS-90 ECU (referred to as Central ECU or GSBC Central ECU) is a 24V electronic control unit that is the main controller for the *GSBC* system. This controller provides for driver control over the braking characteristics of air-braked heavy- and medium- duty trucks, tractors, and buses.

The Central ECU is connected to and controls all other components that comprise the *GSBC* system, in addition to interfacing between the *GSBC* system and the rest of the vehicle.

COMPONENT OVERVIEW

The Central ECU is comprised of two (2) main parts. The first is the ECU and housing, which contains the ECU circuitry, mounting points, electrical connectors, wire guides, and housing. The second part is the Central ECU Mud Cover, which is a plastic shell that snaps on to the top of the Central ECU. The Mud Cover protects the wiring harness and electrical connectors that are connected to the Central ECU from dirt, debris, road spray, and impact.

The Central ECU is only available from the vehicle OEM, as each ECU is programmed specifically to the VIN of each vehicle. The Mud Cover is a generic part which is available without special restrictions.

The Central ECU operates at a normal voltage of approximately 24V-28V. The ECU will not operate below 18.5V or above 32V.

CONDITION	24V OPERATION		
	Min	Nom	Max
Operation Voltage Range	18.5V	28V	32V
Overvoltage	-	-	>36V
Undervoltage	<18.5V	-	-

Table 8 – Central ECU Operating Voltage

It includes the lateral acceleration sensor, which is used as one (1) of the inputs to the Central ECU's ESP functionality.

There are five (5) electrical connectors on the Central ECU, numbered X1-X5. Four (4) of them are populated with pins: X1, X2, X3, X5. The X4 connector does not have any pins present by design.

⚠ WARNING

If you modify a vehicle and do not update the Central ECU, the *GSBC* system may fail to function as intended. Serious vehicle braking and performance issues could result, including unnecessary ESP system interventions, exceeding regulated stopping distance, and/or system faults leading to loss of electronic functions. These types of failures can lead to a loss-of-control of the vehicle, potential collisions, property damage, serious injuries, and/or death.

GSBC CENTRAL ECU MAINTENANCE

The Central ECU itself is not designed to need periodic maintenance. The Central ECU can detect both internal (related to the ECU) and external (related to other *GSBC* components, the vehicle, or possibly the electrical harness) faults, and provide notification through warning indicator lamps. For more information about GSBC warning indicator lamps, *refer to BW8207, GSBC System Operator's Manual, on B2Bendix.com.*

Mechanical or Physical Damage

It is not possible to repair a physically damaged Central ECU. If the Central ECU needs to be replaced, contact the vehicle manufacturer for replacement information.

If the Central ECU Mud Cover is damaged or missing, the replacement is available from an authorized Bendix retailer. *Refer to the Replacement section on page 22.*

⚠ WARNING

The Mud Cover must always be installed on the Central ECU, and if the Mud Cover is damaged, it should be replaced. Failure to use the Mud Cover on a Central ECU can result in a wiring harness failure, damage to the electrical connectors, and/or damage to the Central ECU. Serious vehicle braking and performance issues could result, including unnecessary ESP system interventions, exceeding regulated stopping distance, and/or system faults leading to loss of electronic functions. These types of failures can lead to a loss-of-control of the vehicle, potential collisions, property damage, serious injuries, and/or death.

Electrical or Internal Damage

If a DTC triggers a warning indicator lamp on the vehicle, the technician must first read the DTC using the appropriate diagnostic tool. If the DTC indicates that the GSBC Central ECU component must be replaced, *refer the Replacement section on page 22 for more information.*

GSBC CENTRAL ECU WARRANTY INFORMATION

⚠ IMPORTANT

Review the Bendix Warranty Policy before performing any intrusive maintenance procedures. A warranty may be voided if intrusive maintenance is performed during the warranty period. No two vehicles operate under identical conditions; as a result, maintenance intervals may vary. Experience is a valuable guide in determining the best maintenance interval for air brake system components. At a minimum, the Central ECU should be visually inspected for damage and proper mounting every 6 months or 1500 operating hours, whichever comes first.

⚠ IMPORTANT

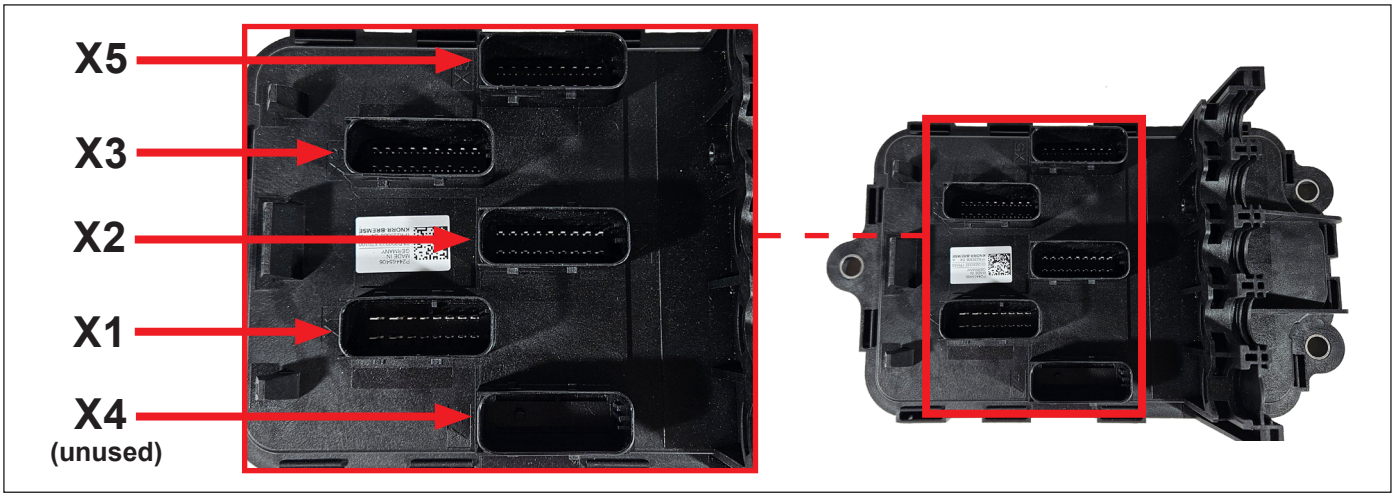
The Central ECU is designed not to require maintenance, and there are no user-serviceable components located inside the ECU housing. Disassembly of the device will void the component warranty and Bendix will not provide technical support or replacement components for components internal to the ECU.

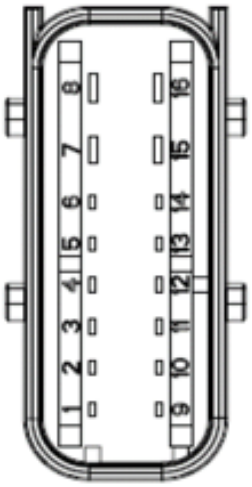
ELECTRICAL INTERFACES

Electrical Connectors

For an electrical schematic of the entire system, *refer to the GSBC System Schematics* section of this document.

NOTE: All connectors described in this section are located on the GSBC Central ECU.

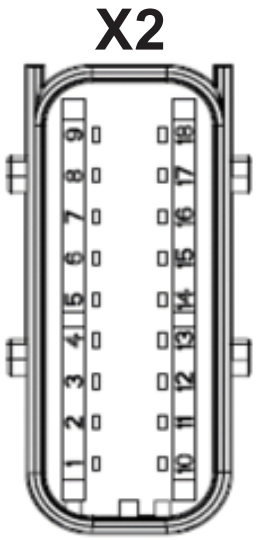




X1 CONNECTOR ON CENTRAL ECU			
PIN NO.	DESCRIPTION	PIN NO.	DESCRIPTION
1	Front Left Modulator Common/Ground	9	Not used
2	Front Left Modulator Exhaust/Outlet	10	Not used
3	Front Left Modulator Hold/Inlet	11	Trailer modulator - 2nd pressure sensor signal
4	Front Right Modulator Common/Ground	12	Not used
5	Front Right Modulator Exhaust/Outlet	13	Not used
6	Front Right Modulator Hold/Inlet	14	Power Line Communication
7	GSBC System ground	15	GSBC System Power supply
8	GSBC System ground	16	GSBC System Power supply

Table 9 – X1 Connector Pin Descriptions

Figure 14 – Central ECU X1 Connector Pinout



X2 CONNECTOR ON CENTRAL ECU			
PIN NO.	DESCRIPTION	PIN NO.	DESCRIPTION
1	EPM2 voltage supply	10	EPM3 Brake CAN High
2	EPM2 ground	11	EPM3 Brake CAN Low
3	EPM3 voltage supply	12	EPM3 Brake CAN High
4	EPM3 ground	13	EPM3 Brake CAN Low
5	Not used	14	eTPCM pressure sensor signal
6	eTPCM valve supply	15	eTPCM pressure sensor supply
7	eTPCM valve backup	16	eTPCM pressure sensor GND
8	eTPCM valve input	17	Not used
9	eTPCM valve output	18	Not used

Table 10 – X2 Connector Pin Descriptions

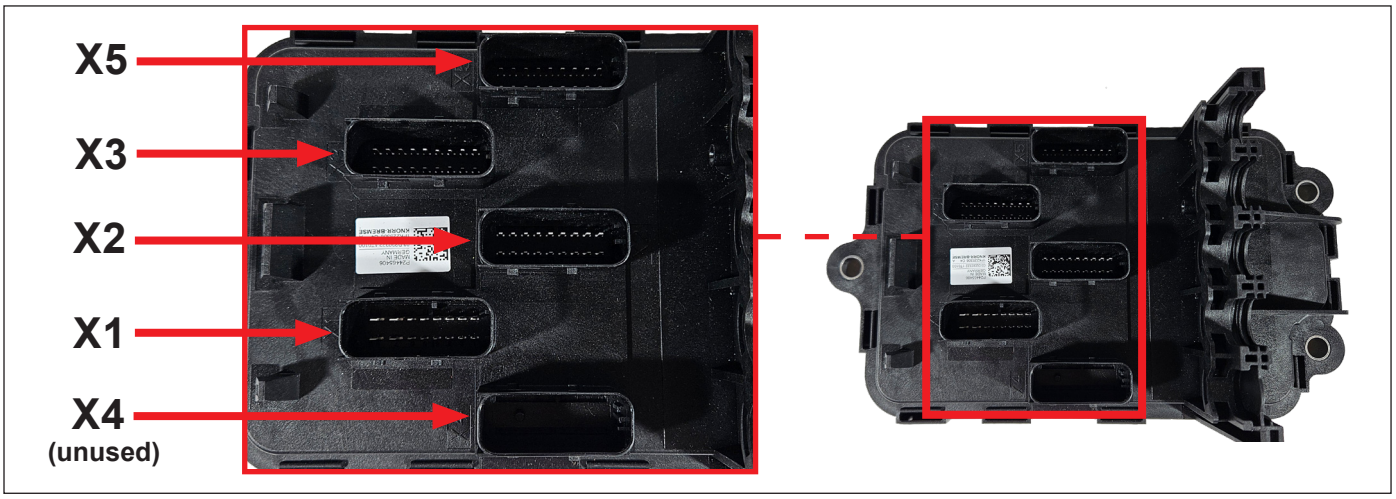
Figure 15 – Central ECU X2 Connector Pinout

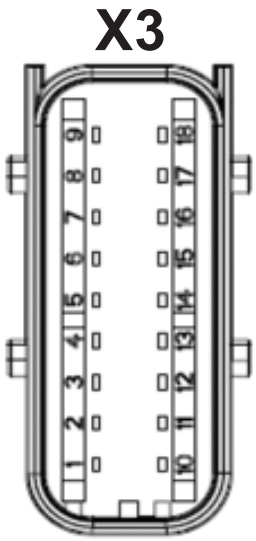
ELECTRICAL INTERFACES (CONT.)

Electrical Connectors (cont.)

For an electrical schematic of the entire system, *refer to the GSBC System Schematics* section of this document.

NOTE: All connectors described in this section are located on the GSBC Central ECU.

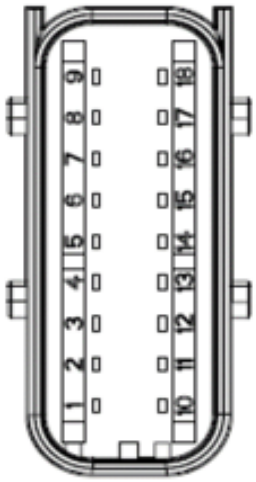




X3 CONNECTOR ON CENTRAL ECU			
PIN NO.	DESCRIPTION	PIN NO.	DESCRIPTION
1	EPM0 ground	10	EPM0 Brake CAN High
2	EPM0 supply	11	EPM0 Brake CAN Low
3	EPM1 supply	12	EPM1 Brake CAN High
4	EPM1 ground	13	EPM1 Brake CAN Low
5	Chassis subnet CAN_High	14	Backbone_1_CAN_H
6	Chassis subnet CAN_Low	15	Backbone_1_CAN_L
7	Not used	16	Not used
8	Brake pedal sensor GND	17	Brake pedal sensor signal 1
9	Brake pedal sensor Supply	18	Brake pedal sensor signal 2

Table 11 – X3 Connector Pin Descriptions

Figure 16 – Central ECU X3 Connector Pinout



X5 CONNECTOR ON CENTRAL ECU			
PIN NO.	DESCRIPTION	PIN NO.	DESCRIPTION
1	Not used	10	Not used
2	Not used	11	Not used
3	Not used	12	Not used
4	Not used	13	Not used
5	Not used	14	Not used
6	SENS_SPL	15	Not used
7	SENS_GND	16	Not used
8	SENS_CAN_H	17	Not used
9	SENS_CAN_L	18	Not used

Table 12 – X5 Connector Pin Descriptions

Figure 17 – Central ECU X5 Connector Pinout

REPLACEMENT

DESCRIPTION	BENDIX P/N
Central ECU Mud Cover	K151610

Table 13 – Central ECU Replacement Parts

If the Central ECU requires replacement, follow these steps:

1. Record the vehicle model, VIN, year, and date of manufacture.
2. Record the part number of the Central ECU (EBS-90).
3. Contact your local dealership or OEM representative for more information on ordering and replacing a Central ECU. You will need to provide the above information so that they can order a new Central ECU.
4. Once the new part arrives, the authorized OEM service department or the OEM representative will program the new Central ECU with same parameter set that was loaded into the original Central ECU component at the vehicle OEM assembly facility.
5. Follow the *GSBC Central ECU Removal and Installation* sections of this document.

⚠ WARNING

Each Central ECU (EBS-90) has VIN-specific programming. DO NOT move a Central ECU from vehicle to vehicle, regardless of how similar the vehicles are to each other. If you modify a vehicle and do not update the Central ECU, the *GSBC* system may fail to function as intended. Serious vehicle braking and performance issues could result, including unnecessary ESP system interventions, exceeding regulated stopping distance, and/or system faults leading to loss of electronic functions. These types of failures can lead to a loss-of-control of the vehicle, potential collisions, property damage, serious injuries, and/or death.

MOUNTING INFORMATION

The Central ECU is rigidly mounted to the vehicle, typically on the frame underneath or immediately behind the cab of the vehicle. It is critical that this component is mounted securely to a rigid part of the vehicle due to the ESP yaw rate sensor being located within the Central ECU. This sensor helps inform the operation of ESP, and loose mounting bolts, or a mounting location that is not rigid, can negatively impact system performance.

Before removal, replacement, or installation of the Central ECU, ensure that the vehicle is safe for maintenance. *Refer to the General Safety Guidelines on page 2* before performing any work on the vehicle.

MOUNTING BOLTS	
Thread Standard & Value	M8 x 1.5 Thread (3x)
Torque Specs	24 N•m ± 4.8 N•m (17.7 ft-lbs ± 1.35 ft-lbs)

Table 14 – Central ECU Mounting and Torque Information

REMOVAL

To remove a Central ECU from a vehicle, complete the following steps:

1. Before removal, replacement, or installation of the Central ECU, ensure that the vehicle is safe for maintenance. *Refer to the General Safety Guidelines on page 2* before performing any work on the vehicle.
2. Turn the vehicle ignition off.
3. Remove battery power from the vehicle per OEM instructions.
4. Remove as much contamination as possible from the Central ECU and Mud Cover prior to disconnecting electrical connections.
5. If the Central ECU and Mud Cover removal requires cutting any wire-ties, make note of location for reassembly.
6. Remove the Mud Cover from the body of the Central ECU.
7. Inspect the wiring harness and wire loom for pinching or chaffed wires.
8. Label each electrical connector prior to removing it from the Central ECU.
9. Disconnect the electrical connectors from the Central ECU.
10. Inspect the electrical connectors on both the Central ECU and mating harness for debris, damage, or corrosion.
11. Note the Central ECU's assembly mounting position and orientation on the vehicle.
12. Remove and retain the mounting bolts that secure the Central ECU.
13. Remove the Central ECU from the vehicle.

INSTALLATION

⚠ WARNING

When replacing the Central ECU (EBS-90), verify with the OEM service department that the unit you are installing has the the correct VIN-specific programming applied. If you modify a vehicle and do not update the Central ECU, the *GSBC* system may fail to function as intended. Serious vehicle braking and performance issues could result, including unnecessary ESP system interventions, exceeding regulated stopping distance, and/or system faults leading to loss of electronic functions. These types of failures can lead to a loss-of-control of the vehicle, potential collisions, property damage, serious injuries, and/or death.

To install a Central ECU to a vehicle, complete the following steps:

1. Before removal, replacement, or installation of the Central ECU, ensure that the vehicle is safe for maintenance. *Refer to the General Safety Guidelines on page 2* before performing any work on the vehicle.
2. Position and secure the Central ECU in the original mounting orientation as noted in *Step 11 of the Removal process* using the mounting bolts retained during removal or new OEM-specified hardware. *See Figure 18*.

⚠ WARNING

The Central ECU (EBS-90) should only be mounted in the factory location and orientation and cannot be moved from that orientation. Failure to do so could result in serious vehicle braking and performance issues, including unnecessary ESP system interventions, exceeding regulated stopping distance, and/or system faults leading to loss of electronic functions. These types of failures can lead to a loss-of-control of the vehicle, potential collisions, property damage, serious injuries, and/or death.

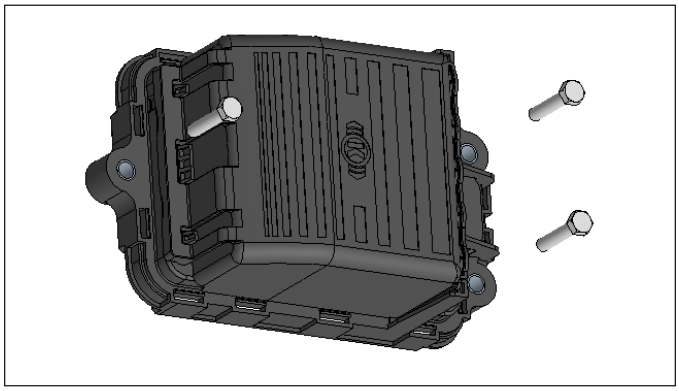


Figure 18 – Central ECU Mounting Bolt Orientation

3. Torque each of the bolts using the torque specifications in *Table 14 in the Mounting Information section on page 22.*

⚠ CAUTION

Do not over tighten! Over-tightening the mounting hardware can cause damage to the Central ECU (EBS-90). Damage to the housing from over-torqued fasteners may not be obvious, and malfunction may occur some time in the future.

4. Reconnect the electrical connectors to the Central ECU.

   NOTE: The use of dielectric grease is not recommend by the connector manufacturer.

5. Ensure that wire harness bundles are routed between the lugs of the ECU housing and Mud Cover so that it the wires are not loose or pinched. *See Figure 19.*

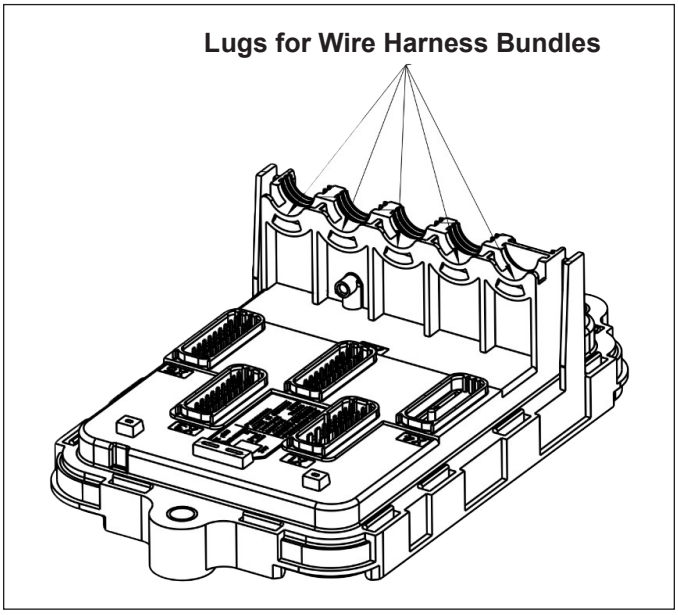


Figure 19 – Central ECU Lug Location

6. Replace the Mud Cover being sure that it clicks into place securely.
7. If applicable, re-secure the wiring harness using the same location and method that was noted in *Step 5 of the Removal process*.
8. Apply power and monitor the vehicle power-up sequence to verify the proper system operation.
9. Use the appropriate diagnostic software tool to ensure that there are no DTCs after power-up.

CENTRAL ECU TROUBLESHOOTING

NOTE: Prior to performing component troubleshooting tests, confirm the vehicle harness is intact and functioning properly. For more information regarding troubleshooting of the vehicle harness, contact the vehicle OEM.

Power Supply Tests

If the DTC indicates a problem with the power supply to the Central ECU, first check the connectors and harness per the following procedure before replacing the ECU.

NOTE: Electrical system troubleshooting tests should only be performed when the vehicle is not running. If the vehicle is running, system voltage will vary and could be as high as 28V. If the vehicle is not running, the battery voltage should be ~24V.

Required tools:

- Multimeter
- 24V Test load (for example, a 1662 or 7511 bulb rated for 18V-32V supply voltage)

NOTE: 1157 bulbs, commonly used as a test load, are only rated to 12V and should **not** be used with a 24V system. Use only test loads rated for 18V-32V supply voltage ranges.

Procedure:

1. Measure resistance and/or continuity between the pins (*see Table 15*).
2. Take all measurements at the Central ECU harness connector.
3. Place the test load across the battery and ground connection and measure the battery voltage with the load attached. Battery to Ground should measure between 18.5V and 32V.

BATTERY	GROUND	MEASUREMENT
X1-15	X1-7	18.5V to 32V
X1-15	X1-8	
X1-16	X1-7	
X1-16	X1-8	

Table 15 – Power Supply Pin Voltages

4. Check for damaged wiring and damaged or corroded connectors and connections.
5. Check the condition of the vehicle battery and associated components, verifying that the power and ground connection are intact, undamaged, and free of corrosion.
6. Check the vehicle's electrical charging system output for proper functionality per the manufacturer's instructions.
7. Plug the ECU back in after performing the above checks on the power system, clear all DTCs, and see if the fault returns.

If the harness shows that power is being delivered to the Central ECU properly, there are no signs of damage or corrosion to the harness or connectors, and the fault is still present, contact the vehicle OEM for assistance in obtaining a replacement ECU.

CAN Troubleshooting Tests

If a DTC indicates a problem with CAN communications link, first check the connectors and harness according to the following procedure before replacing the ECU.

Required tools:

- Multimeter

Procedure:

1. Measure resistance and/or continuity between the pins (*see Table 16*).
2. Take all measurements at the Central ECU harness connector pins in order to check wire harness and CAN lines. Probe the connector carefully so that the terminals are not damaged.
3. The pin-to-pin resistances should read as follows:

TEST PINS	TEST PINS	MEASUREMENT
X3-5	X3-6	60 Ohms
X3-14	X3-15	60 Ohms
X3-5	X1-7	Open Circuit
X3-5	X1-15	
X3-6	X1-7	
X3-6	X1-15	
X3-14	X1-7	
X3-14	X1-15	
X3-15	X1-7	
X3-15	X1-15	

Table 16 – CAN Troubleshooting Pin Resistances

If the DTC indicates a problem with a component (other than the GSBC Central ECU), see the appropriate Service Data sheet for the component-specific troubleshooting. *Refer to the GSBC Technical Documentation Reference section of this document.*

If the harness shows that the proper resistance is present, there are no signs of damage or corrosion to the harness or connectors, and the fault is still present, contact the vehicle OEM for assistance in obtaining a replacement ECU.

GSBC SYSTEM TROUBLESHOOTING

GENERAL

Troubleshooting a *GSBC* system is similar to troubleshooting previous generations of brake control systems.

If a warning message or warning indicator lamp related to the brake control system is displayed on the dashboard, *refer to BW8207, Bendix GSBC Operator's Manual, on B2Bendix.com*, or the vehicle owner's manual from the manufacturer for more information about the proper response.

⚠ WARNING

Depending on the severity of the detected fault, it may be safe to continue the trip and schedule maintenance, or it may be necessary to pull over safely and tow the vehicle to a service facility. It is always the operator's responsibility to ensure that the vehicle is safe and legal to drive, and operators must be aware of the laws and regulations within the regions they are operating.

When a vehicle equipped with *GSBC* arrives for service – with or without a warning indicator lamp active – follow this procedure to diagnose any active faults with the *GSBC* system:

1. Connect the vehicle with the appropriate diagnostic tool capable of reading fault codes from the GSBC Central ECU.
2. Save a diagnostic report to document the state of the vehicle as it arrived.
3. If a specific DTC (or a list of DTCs) are listed as "active" faults in the brake controller, use the listed code in either the diangostic tool, or the related Bendix Service Data Sheet documentation, to identify the correct steps for troubleshooting and repairing the fault. *See Table 17 for a list of related GSBC and GSAT Service Data Sheets.*

   NOTE: If a DTC is listed as "inactive," it is not currently causing the system to fault. While it may be indicative of an intermittent problem, it is extremely difficult to troubleshoot and diagnose faults that are not active. The technician should focus their efforts on identifying and correcting active faults before troubleshooting inactive faults.
4. If the active DTC(s) requires replacement of a specific component, refer to the *Diagnostic Trouble Code (DTC) and Service Information* section of this document for more information.

TOOLS REQUIRED

The troubleshooting tools that are commonly required to diagnose and troubleshoot issues with GSBC:

- A compatible vehicle communication interface adaptor that works with the vehicle and the appropriate diagnostic software.
- The latest version of Bendix® ACom® Diagnostic Software available from B2Bendix.com or the appropriate diagnostic software from the vehicle manfacturer.
- A multimeter
- 24V Test load (for example, a 1662 or 7511 bulb rated for 18V-32V supply voltage)

NOTE: 1157 bulbs, commonly used as a test load, are only rated to 12V and should **not** be used with a 24V system. Use only test loads rated for 18V-32V supply voltage ranges.

⚠ IMPORTANT

Most GSBC components utilize Metric Straight Thread with o-ring fittings per ISO 4039-2. These fittings are NOT COMPATIBLE with NPT (National Pipe Taper) threaded fittings. Additionally, there are other metric straight thread with o-ring thread design standards. Be sure to only use fittings that adhere to ISO 4039-2, as other metric threaded fittings are not cross-compatible.

Use of NPT fittings, or the improper metric fittings, could result in excessive leakage, damage to threaded components, improper operation, or even mandatory replacement of components due to thread damage or failure.

RELATED GSBC AND GSAT SERVICE DATA SHEETS

The following documents are available on B2Bendix.com.

COMPONENT/SYSTEM	DOCUMENT NUMBER
GSBC System	*This Document*
ECU (EBS-90)	*This Document*
FBM-40	*SD-27-5028*
EPM-90	*SD-27-5031*
eTPCM-90	*SD-27-5036*
M-50QR	*SD-27-5170*
SAS-80	*SD-27-4709*
WS-24	*SD-13-4860*
GSAT System	*SD-24-250V*

Table 17 – Related Service Data Sheets

DIAGNOSTIC TROUBLE CODE (DTC) AND SERVICE INFORMATION

The *GSBC* system and Bendix ACom Diagnostic Software retain a record of all DTCs. This record is commonly referred to as “event history.” When a DTC self-heals or is manually cleared, the DTC remains in event history as an inactive DTC.

The *GSBC* system is supported by Bendix ACom Diagnostic Software. *Visit B2Bendix.com for additional information or to purchase ACom Diagnostic Software.*

GSBC DTC AND SERVICE ACTIONS TABLE OF CONTENTS

GSBC SYSTEM/ECU (EBS-90) DTCS

IMPORTANT

For all repair steps, first complete the following:

1. **Generate an ACom Diagnostic Software report.**
2. **Clear DTCs.**
3. **Continue with repair information for each active DTC that will not clear.**

NOTE: After completing all repairs, drive the vehicle to ensure the repairs were sufficient.

4. **Once repairs have been made, clear the DTC again.**

GSBC SYSTEM & ECU DTCS					
DTC#	SPN	FMI	DTC NAME	DTC DESCRIPTION	ACTION
0x405122	16465	34	Steering Wheel Position Sensor: Signal Amplitude Greater Than Maximum	Steering angle signal invalid outside of model base limits or improper rate of change.	A
0x405127	16465	39	Steering Wheel Position Sensor: Signal Rate of Change Above Threshold	Steering angle signal invalid outside of model base limits or improper rate of change.	A
0x405128	16465	40	Steering Wheel Position Sensor: Signal Bias Level Out of Range/ Zero Adjustment Failure	Steering angle signal invalid outside of model base limits or improper rate of change.	A
0x405146	16465	70	Steering Wheel Position Sensor: Calibration/Parameter Memory Failure	Steering Angle Sensor End of Line calibration is not finished.	B
0x405149	16465	73	Steering Wheel Position Sensor: Internal Electronic Failure	The Steering Angle Sensor has a feature which monitors the operation of the sensor and indicates its status. The GSBC ECU monitors the sensor status, the range of the sensor values, message counter and checksum.	C
0x405154	16465	84	Steering Wheel Position Sensor: Missing Calibration	Steering Angle Sensor End of Line calibration is not finished.	B
0x405155	16465	85	Steering Wheel Position Sensor: Not Configured	Steering Angle Sensor is installed and configured by EOL Parameter but ESP is not enabled.	D
0x405162	16465	98	Steering Wheel Position Sensor: Signal Compare Failure	The fault is reported if Steering Angle Sensor signal is implausible compared to the YAS signal and reference yaw rate.	E
0x405176	16465	118	Steering Wheel Position Sensor: Wrong Mounting Position	The fault is reported, if the sign of the Steering Angle Sensor signal is incorrect.	F
0x405178	16465	120	Steering Wheel Position Sensor: Alignment or Adjustment Incorrect	Steering Angle Sensor End of Line calibration is not finished.	B
0x405188	16465	136	Steering Wheel Position Sensor: Bus Off	Check for a short circuit between Sensor CAN lines on the Steering Angle Sensor.	G
0x405193	16465	147	Steering Wheel Position Sensor: No Operation	Steering angle signal invalid outside of model base limits or improper rate of change.	A
0x406122	16481	34	Lateral Acceleration Sensor: Signal Amplitude Greater Than Maximum	The fault is reported, if the sensor signal is out of range.	H
0x406128	16481	40	Lateral Acceleration Sensor: Signal Bias Level Out of Range/ Zero Adjustment Failure	The fault is reported, if the sensor signal is out of range.	H
0x406154	16481	84	Lateral Acceleration Sensor: Missing Calibration	This fault is reported, if the End of Line calibration of the lateral acceleration sensor is not finished.	J
0x406162	16481	98	Lateral Acceleration Sensor: Signal Compare Failure	The lateral acceleration signal is checked for plausibility with the signals of the other ESP sensors.The fault is indicated if the difference between the lateral acceleration signal and the reference signals is too high.	K

Table 18 - GSBC System/ECU Diagnostic Trouble Codes (DTCs)

GSBC SYSTEM & ECU DTCS					
DTC#	**SPN**	**FMI**	**DTC NAME**	**DTC DESCRIPTION**	**ACTION**
0x406164	16481	100	Lateral Acceleration Sensor: Signal Plausibility Failure	The fault is reported if lateral acceleration sensor signal is implausible or incorrect compared to the other ESP sensor signals and the reference yaw rate.	**L**
0x406222	16482	34	Longitudinal Acceleration Sensor: Signal Amplitude Greater Than Maximum	Longitudinal sensor signal exceeds the maximum possible range of the longitudinal acceleration.	**M**
0x406228	16482	40	Longitudinal Acceleration Sensor: Signal Bias Level Out of Range/Zero Adjustment Failure	Long term calibration of longitudinal acceleration sensor offset value is too high.	**N**
0x406264	16482	100	Longitudinal Acceleration Sensor: Signal Plausibility Failure	Longitudinal acceleration sensor signal implausible in reference to WSS signals.	**P**
0x406322	16483	34	Yaw Rate Sensor: Signal Amplitude Greater Than Maximum	The fault is reported if the sensor signal is implausible or out of range.	**Q**
0x406327	16483	39	Yaw Rate Sensor: Signal Rate of Change Above Threshold	The fault is reported if the sensor signal is implausible or out of range.	**Q**
0x40632F	16483	47	Yaw Rate Sensor: Signal Erratic	The fault is reported if the sensor signal is implausible or out of range.	**Q**
0x406349	16483	73	Yaw Rate Sensor: Internal Electronic Failure	The YAS has a feature which monitors the operation of the sensor and indicates its status. The GSBC ECU monitors the sensor status flags and the range of the sensor values.	**R**
0x406355	16483	85	Yaw Rate Sensor: Not Configured	YAS is installed and configured by EOL Parameter but ESP is not enabled.	**S**
0x406364	16483	100	Yaw Rate Sensor: Signal Plausibility Failure	The fault is reported if YAS signal is implausible compared to the steering angel sensor and/or reference yaw rate.	**T**
0x406376	16483	118	Yaw Rate Sensor: Wrong Mounting Position	The fault is reported if lateral acceleration sensor signal is implausible or incorrect compared to the other ESP sensor signals and the reference yaw rate.	**L**
0x406392	16483	146	Yaw Rate Sensor: Performance or Incorrect Operation	The yaw rate signal is checked for plausibility with the signals of the other ESP sensors. The fault is indicated if the difference between the yaw rate signal and the reference signals is too high.	**U**
0x406396	16483	150	Yaw Rate Sensor: Component Internal Failure	The fault is reported if the sensor signal is implausible or out of range.	**Q**
0x500C01	20492	1	EBS ESP Sensor Supply: General Electrical Failure	SAS: damage of the Steering Angle Sensor wiring harness, damage of the Steering Angle Sensor sensor, or damage of the central ECU. The fault is set if there is parasitic voltage greater then 4.5V before switching ON sensor supply.	**V**

Table 18 - GSBC System/ECU Diagnostic Trouble Codes (DTCs)

GSBC SYSTEM & ECU DTCS					
DTC#	**SPN**	**FMI**	**DTC NAME**	**DTC DESCRIPTION**	**ACTION**
0x500C16	20492	22	EBS ESP Sensor Supply: Circuit Voltage Below Threshold	Fault is set if supply voltage of the Steering Angle Sensor (measured between pins X5/6 and X5/7) is out of range for ESP (supply voltage is lower than 10V) at least for 40 ms.	**W**
0x500C17	20492	23	EBS ESP Sensor Supply: Circuit Voltage Above Threshold	Fault is set if supply voltage of the central ECU (measured between pins X1/15 and X1/7) is out of range for ESP (supply voltage is higher than 60.5V) at least for 380 ms.	**X**
0x500D31	20493	49	Wheel Speed Sensor 1: No Signal	Fault is set if WSS changes or drops at implausible rates (signal is frequently jumping between 0 and more than 7 mph).	**Y**
0x500D38	20493	56	Wheel Speed Sensor 1: Signal Frequency Incorrect	Noisy WSS signal WSS faulty.	**Z**
0x500D3A	20493	58	Wheel Speed Sensor 1: Signal Has Too Many Pulses	Noisy WSS signal WSS faulty.	**Z**
0x500D54	20493	84	Wheel Speed Sensor 1: Missing Calibration	The deviation between the learned wheel circumferences and the EOL programmed values are too large (deviation > 25%).	**AA**
0x500D95	20493	149	Wheel Speed Sensor 1: Incorrect Assembly	Shortcut between sensor wiring connected to the same EPM (shorted channels) Test pulse is provided for the WSS, and status of all other wheel speed signals are monitored.	**BB**
0x500E31	20494	49	Wheel Speed Sensor 2: No Signal	Fault is set if WSS changes or drops at implausible rates (signal is frequently jumping between 0 and more than 7 mph).	**Y**
0x500E38	20494	56	Wheel Speed Sensor 2: Signal Frequency Incorrect	Noisy WSS signal WSS faulty.	**Z**
0x500E3A	20494	58	Wheel Speed Sensor 2: Signal Has Too Many Pulses	Noisy WSS signal WSS faulty.	**Z**
0x500E54	20494	84	Wheel Speed Sensor 2: Missing Calibration	The deviation between the learned wheel circumferences and the EOL programmed values are too large (deviation > 25%).	**AA**
0x500E95	20494	149	Wheel Speed Sensor 2: Incorrect Assembly	Shortcut between sensor wiring connected to the same EPM (shorted channels) Test pulse is provided for the WSS, and status of all other wheel speed signals are monitored.	**BB**
0x500F31	20495	49	Wheel Speed Sensor 3: No Signal	Fault is set if WSS changes or drops at implausible rates (signal is frequently jumping between 0 and more than 7 mph).	**Y**
0x500F38	20495	56	Wheel Speed Sensor 3: Signal Frequency Incorrect	Noisy WSS signal WSS faulty.	**Z**
0x500F3A	20495	58	Wheel Speed Sensor 3: Signal Has Too Many Pulses	Noisy WSS signal WSS faulty	**Z**
0x500F54	20495	84	Wheel Speed Sensor 3: Missing Calibration	The deviation between the learned wheel circumferences and the EOL programmed values are too large (deviation > 25%).	**AA**

Table 18 - GSBC System/ECU Diagnostic Trouble Codes (DTCs)

GSBC SYSTEM & ECU DTCS					
DTC#	**SPN**	**FMI**	**DTC NAME**	**DTC DESCRIPTION**	**ACTION**
0x500F95	20495	149	Wheel Speed Sensor 3: Incorrect Assembly	Shortcut between sensor wiring connected to the same EPM (shorted channels) Test pulse is provided for the WSS, and status of all other wheel speed signals are monitored.	**BB**
0x501031	20496	49	Wheel Speed Sensor 4: No Signal	Fault is set if WSS changes or drops at implausible rates (signal is frequently jumping between 0 and more than 7 mph).	**Y**
0x501038	20496	56	Wheel Speed Sensor 4: Signal Frequency Incorrect	Noisy WSS signal WSS faulty.	**Z**
0x50103A	20496	58	Wheel Speed Sensor 4: Signal Has Too Many Pulses	Noisy WSS signal WSS faulty.	**Z**
0x501054	20496	84	Wheel Speed Sensor 4: Missing Calibration	The deviation between the learned wheel circumferences and the EOL programmed values are too large (deviation > 25%).	**AA**
0x501095	20496	149	Wheel Speed Sensor 4: Incorrect Assembly	Shortcut between sensor wiring connected to the same EPM (shorted channels) Test pulse is provided for the WSS, and status of all other wheel speed signals are monitored.	**BB**
0x501131	20497	49	Wheel Speed Sensor 5: No Signal	Fault is set if WSS changes or drops at implausible rates (signal is frequently jumping between 0 and more than 7 mph).	**Y**
0x501138	20497	56	Wheel Speed Sensor 5: Signal Frequency Incorrect	Noisy WSS signal WSS faulty.	**Z**
0x50113A	20497	58	Wheel Speed Sensor 5: Signal Has Too Many Pulses	Noisy WSS signal WSS faulty.	**Z**
0x501154	20497	84	Wheel Speed Sensor 5: Missing Calibration	The deviation between the learned wheel circumferences and the EOL programmed values are too large (deviation > 25%).	**AA**
0x501195	20497	149	Wheel Speed Sensor 5: Incorrect Assembly	Shortcut between sensor wiring connected to the same EPM (shorted channels) Test pulse is provided for the WSS, and status of all other wheel speed signals are monitored.	**BB**
0x501231	20498	49	Wheel Speed Sensor 6: No Signal	Fault is set if WSS changes or drops at implausible rates (signal is frequently jumping between 0 and more than 7 mph).	**Y**
0x501238	20498	56	Wheel Speed Sensor 6: Signal Frequency Incorrect	Noisy WSS signal WSS faulty.	**Z**
0x50123A	20498	58	Wheel Speed Sensor 6: Signal Has Too Many Pulses	Noisy WSS signal WSS faulty.	**Z**
0x501254	20498	84	Wheel Speed Sensor 6: Missing Calibration	The deviation between the learned wheel circumferences and the EOL programmed values are too large (deviation > 25%).	**AA**
0x501295	20498	149	Wheel Speed Sensor 6: Incorrect Assembly	Shortcut between sensor wiring connected to the same EPM (shorted channels) Test pulse is provided for the WSS, and status of all other wheel speed signals are monitored.	**BB**

Table 18 - GSBC System/ECU Diagnostic Trouble Codes (DTCs)

GSBC SYSTEM & ECU DTCS					
DTC#	**SPN**	**FMI**	**DTC NAME**	**DTC DESCRIPTION**	**ACTION**
0x501331	20499	49	Wheel Speed Sensor 7: No Signal	Fault is set if WSS changes or drops at implausible rates (signal is frequently jumping between 0 and more than 7 mph).	**Y**
0x501338	20499	56	Wheel Speed Sensor 7: Signal Frequency Incorrect	Noisy WSS signal WSS faulty.	**Z**
0x50133A	20499	58	Wheel Speed Sensor 7: Signal Has Too Many Pulses	Noisy WSS signal WSS faulty.	**Z**
0x501354	20499	84	Wheel Speed Sensor 7: Missing Calibration	The deviation between the learned wheel circumferences and the EOL programmed values are too large (deviation > 25%).	**AA**
0x501395	20499	149	Wheel Speed Sensor 7: Incorrect Assembly	Shortcut between sensor wiring connected to the same EPM (shorted channels) Test pulse is provided for the WSS, and status of all other wheel speed signals are monitored.	**BB**
0x501431	20500	49	Wheel Speed Sensor 8: No Signal	Fault is set if WSS changes or drops at implausible rates (signal is frequently jumping between 0 and more than 7 mph).	**Y**
0x501438	20500	56	Wheel Speed Sensor 8: Signal Frequency Incorrect	Noisy WSS signal WSS faulty.	**Z**
0x50143A	20500	58	Wheel Speed Sensor 8: Signal Has Too Many Pulses	Noisy WSS signal WSS faulty.	**Z**
0x501454	20500	84	Wheel Speed Sensor 8: Missing Calibration	The deviation between the learned wheel circumferences and the EOL programmed values are too large (deviation > 25%).	**AA**
0x501495	20500	149	Wheel Speed Sensor 8: Incorrect Assembly	Shortcut between sensor wiring connected to the same EPM (shorted channels) Test pulse is provided for the WSS, and status of all other wheel speed signals are monitored.	**BB**
0x501531	20501	49	Wheel Speed Sensor 9: No Signal	Fault is set if WSS changes or drops at implausible rates (signal is frequently jumping between 0 and more than 7 mph).	**Y**
0x501538	20501	56	Wheel Speed Sensor 9: Signal Frequency Incorrect	Noisy WSS signal WSS faulty.	**Z**
0x50153A	20501	58	Wheel Speed Sensor 9: Signal Has Too Many Pulses	Noisy WSS signal WSS faulty.	**Z**
0x501554	20501	84	Wheel Speed Sensor 9: Missing Calibration	The deviation between the learned wheel circumferences and the EOL programmed values are too large (deviation > 25%).	**AA**
0x501595	20501	149	Wheel Speed Sensor 9: Incorrect Assembly	Shortcut between sensor wiring connected to the same EPM (shorted channels) Test pulse is provided for the WSS, and status of all other wheel speed signals are monitored.	**BB**
0x501631	20502	49	Wheel Speed Sensor 10: No Signal	Fault is set if WSS changes or drops at implausible rates (signal is frequently jumping between 0 and more than 7 mph).	**Y**

Table 18 - GSBC System/ECU Diagnostic Trouble Codes (DTCs)

GSBC SYSTEM & ECU DTCS					
DTC#	**SPN**	**FMI**	**DTC NAME**	**DTC DESCRIPTION**	**ACTION**
0x501638	20502	56	Wheel Speed Sensor 10: Signal Frequency Incorrect	Noisy WSS signal WSS faulty.	**Z**
0x50163A	20502	58	Wheel Speed Sensor 10: Signal Has Too Many Pulses	Noisy WSS signal WSS faulty.	**Z**
0x501654	20502	84	Wheel Speed Sensor 10: Missing Calibration	The deviation between the learned wheel circumferences and the EOL programmed values are too large (deviation > 25%).	**AA**
0x501695	20502	149	Wheel Speed Sensor 10: Incorrect Assembly	Shortcut between sensor wiring connected to the same EPM (shorted channels) Test pulse is provided for the WSS, and status of all other wheel speed signals are monitored.	**BB**
0x501721	20503	33	Lining Wear Sensor 1: Signal Amplitude Less Than Minimum	Lining Wear Sensor: Signal Amplitude Fault	**CC**
0x501722	20503	34	Lining Wear Sensor 1: Signal Amplitude Greater Than Maximum	Lining Wear Sensor: Signal Amplitude Fault	**CC**
0x501762	20503	98	Lining Wear Sensor 1: Signal Compare Failure	Lining Wear Sensor: Signal Compare Fault	**DD**
0x501821	20504	33	Lining Wear Sensor 2: Signal Amplitude Less Than Minimum	Lining Wear Sensor: Signal Amplitude Fault	**CC**
0x501822	20504	34	Lining Wear Sensor 2: Signal Amplitude Greater Than Maximum	Lining Wear Sensor: Signal Amplitude Fault	**CC**
0x501862	20504	98	Lining Wear Sensor 2: Signal Compare Failure	Lining Wear Sensor: Signal Compare Fault	**DD**
0x501921	20505	33	Lining Wear Sensor 3: Signal Amplitude Less Than Minimum	Lining Wear Sensor: Signal Amplitude Fault	**CC**
0x501922	20505	34	Lining Wear Sensor 3: Signal Amplitude Greater Than Maximum	Lining Wear Sensor: Signal Amplitude Fault	**CC**
0x501962	20505	98	Lining Wear Sensor 3: Signal Compare Failure	Lining Wear Sensor: Signal Compare Fault	**DD**
0x501A21	20506	33	Lining Wear Sensor 4: Signal Amplitude Less Than Minimum	Lining Wear Sensor: Signal Amplitude Fault	**CC**
0x501A22	20506	34	Lining Wear Sensor 4: Signal Amplitude Greater Than Maximum	Lining Wear Sensor: Signal Amplitude Fault	**CC**
0x501A62	20506	98	Lining Wear Sensor 4: Signal Compare Failure	Lining Wear Sensor: Signal Compare Fault	**DD**
0x501B21	20507	33	Lining Wear Sensor 5: Signal Amplitude Less Than Minimum	Lining Wear Sensor: Signal Amplitude Fault	**CC**
0x501B22	20507	34	Lining Wear Sensor 5: Signal Amplitude Greater Than Maximum	Lining Wear Sensor: Signal Amplitude Fault	**CC**
0x501B62	20507	98	Lining Wear Sensor 5: Signal Compare Failure	Lining Wear Sensor: Signal Compare Fault	**DD**

Table 18 - GSBC System/ECU Diagnostic Trouble Codes (DTCs)

GSBC SYSTEM & ECU DTCS					
DTC#	**SPN**	**FMI**	**DTC NAME**	**DTC DESCRIPTION**	**ACTION**
0x501C21	20508	33	Lining Wear Sensor 6: Signal Amplitude Less Than Minimum	Lining Wear Sensor: Signal Amplitude Fault	**CC**
0x501C22	20508	34	Lining Wear Sensor 6: Signal Amplitude Greater Than Maximum	Lining Wear Sensor: Signal Amplitude Fault	**CC**
0x501C62	20508	98	Lining Wear Sensor 6: Signal Compare Failure	Lining Wear Sensor: Signal Compare Fault	**DD**
0x501D21	20509	33	Lining Wear Sensor 7: Signal Amplitude Less Than Minimum	Lining Wear Sensor: Signal Amplitude Fault	**CC**
0x501D22	20509	34	Lining Wear Sensor 7: Signal Amplitude Greater Than Maximum	Lining Wear Sensor: Signal Amplitude Fault	**CC**
0x501D62	20509	98	Lining Wear Sensor 7: Signal Compare Failure	Lining Wear Sensor: Signal Compare Fault	**DD**
0x501E21	20510	33	Lining Wear Sensor 8: Signal Amplitude Less Than Minimum	Lining Wear Sensor: Signal Amplitude Fault	**CC**
0x501E22	20510	34	Lining Wear Sensor 8: Signal Amplitude Greater Than Maximum	Lining Wear Sensor: Signal Amplitude Fault	**CC**
0x501E62	20510	98	Lining Wear Sensor 8: Signal Compare Failure	Lining Wear Sensor: Signal Compare Fault	**DD**
0x501F21	20511	33	Lining Wear Sensor 9: Signal Amplitude Less Than Minimum	Lining Wear Sensor: Signal Amplitude Fault	**CC**
0x501F22	20511	34	Lining Wear Sensor 9: Signal Amplitude Greater Than Maximum	Lining Wear Sensor: Signal Amplitude Fault	**CC**
0x501F62	20511	98	Lining Wear Sensor 9: Signal Compare Failure	Lining Wear Sensor: Signal Compare Fault	**DD**
0x502021	20512	33	Lining Wear Sensor 10: Signal Amplitude Less Than Minimum	Lining Wear Sensor: Signal Amplitude Fault	**CC**
0x502022	20512	34	Lining Wear Sensor 10: Signal Amplitude Greater Than Maximum	Lining Wear Sensor: Signal Amplitude Fault	**CC**
0x502062	20512	98	Lining Wear Sensor 10: Signal Compare Failure	Lining Wear Sensor: Signal Compare Fault	**DD**
0x504912	20553	18	Wheel 1 Brake Lining Wear Supply Circuit: Circuit Short To Battery	Lining Wear Sensor: Signal Amplitude Fault	**CC**
0x504923	20553	35	Wheel 1 Brake Lining Wear Supply Circuit: Signal Stuck Low	Lining Wear Sensor: Signal Amplitude Fault	**CC**
0x504924	20553	36	Wheel 1 Brake Lining Wear Supply Circuit: Signal Stuck High	Lining Wear Sensor: Signal Amplitude Fault	**CC**
0x504A12	20554	18	Wheel 2 Brake Lining Wear Supply Circuit: Circuit Short To Battery	Lining Wear Sensor: Signal Amplitude Fault	**CC**

Table 18 - GSBC System/ECU Diagnostic Trouble Codes (DTCs)

GSBC SYSTEM & ECU DTCS					
DTC#	**SPN**	**FMI**	**DTC NAME**	**DTC DESCRIPTION**	**ACTION**
0x504A23	20554	35	Wheel 2 Brake Lining Wear Supply Circuit: Signal Stuck Low	Lining Wear Sensor: Signal Amplitude Fault	**CC**
0x504A24	20554	36	Wheel 2 Brake Lining Wear Supply Circuit: Signal Stuck High	Lining Wear Sensor: Signal Amplitude Fault	**CC**
0x504B12	20555	18	Wheel 3 Brake Lining Wear Supply Circuit: Circuit Short To Battery	Lining Wear Sensor: Signal Amplitude Fault	**CC**
0x504B23	20555	35	Wheel 3 Brake Lining Wear Supply Circuit: Signal Stuck Low	Lining Wear Sensor: Signal Amplitude Fault	**CC**
0x504B24	20555	36	Wheel 3 Brake Lining Wear Supply Circuit: Signal Stuck High	Lining Wear Sensor: Signal Amplitude Fault	**CC**
0x504C12	20556	18	Wheel 4 Brake Lining Wear Supply Circuit: Circuit Short To Battery	Lining Wear Sensor: Signal Amplitude Fault	**CC**
0x504C23	20556	35	Wheel 4 Brake Lining Wear Supply Circuit: Signal Stuck Low	Lining Wear Sensor: Signal Amplitude Fault	**CC**
0x504C24	20556	36	Wheel 4 Brake Lining Wear Supply Circuit: Signal Stuck High	Lining Wear Sensor: Signal Amplitude Fault	**CC**
0x504D12	20557	18	Wheel 5 Brake Lining Wear Supply Circuit: Circuit Short To Battery	Lining Wear Sensor: Signal Amplitude Fault	**CC**
0x504D23	20557	35	Wheel 5 Brake Lining Wear Supply Circuit: Signal Stuck Low	Lining Wear Sensor: Signal Amplitude Fault	**CC**
0x504D24	20557	36	Wheel 5 Brake Lining Wear Supply Circuit: Signal Stuck High	Lining Wear Sensor: Signal Amplitude Fault	**CC**
0x504E12	20558	18	Wheel 6 Brake Lining Wear Supply Circuit: Circuit Short To Battery	Lining Wear Sensor: Signal Amplitude Fault	**CC**
0x504E23	20558	35	Wheel 6 Brake Lining Wear Supply Circuit: Signal Stuck Low	Lining Wear Sensor: Signal Amplitude Fault	**CC**
0x504E24	20558	36	Wheel 6 Brake Lining Wear Supply Circuit: Signal Stuck High	Lining Wear Sensor: Signal Amplitude Fault	**CC**
0x504F12	20559	18	Wheel 7 Brake Lining Wear Supply Circuit: Circuit Short To Battery	Lining Wear Sensor: Signal Amplitude Fault	**CC**
0x504F23	20559	35	Wheel 7 Brake Lining Wear Supply Circuit: Signal Stuck Low	Lining Wear Sensor: Signal Amplitude Fault	**CC**
0x504F24	20559	36	Wheel 7 Brake Lining Wear Supply Circuit: Signal Stuck High	Lining Wear Sensor: Signal Amplitude Fault	**CC**
0x505012	20560	18	Wheel 8 Brake Lining Wear Supply Circuit: Circuit Short To Battery	Lining Wear Sensor: Signal Amplitude Fault	**CC**
0x505023	20560	35	Wheel 8 Brake Lining Wear Supply Circuit: Signal Stuck Low	Lining Wear Sensor: Signal Amplitude Fault	**CC**
0x505024	20560	36	Wheel 8 Brake Lining Wear Supply Circuit: Signal Stuck High	Lining Wear Sensor: Signal Amplitude Fault	**CC**

Table 18 - GSBC System/ECU Diagnostic Trouble Codes (DTCs)

GSBC SYSTEM & ECU DTCS					
DTC#	SPN	FMI	DTC NAME	DTC DESCRIPTION	ACTION
0x505112	20561	18	Wheel 9 Brake Lining Wear Supply Circuit: Circuit Short To Battery	Lining Wear Sensor: Signal Amplitude Fault	CC
0x505123	20561	35	Wheel 9 Brake Lining Wear Supply Circuit: Signal Stuck Low	Lining Wear Sensor: Signal Amplitude Fault	CC
0x505124	20561	36	Wheel 9 Brake Lining Wear Supply Circuit: Signal Stuck High	Lining Wear Sensor: Signal Amplitude Fault	CC
0x505212	20562	18	Wheel 10 Brake Lining Wear Supply Circuit: Circuit Short To Battery	Lining Wear Sensor: Signal Amplitude Fault	CC
0x505223	20562	35	Wheel 10 Brake Lining Wear Supply Circuit: Signal Stuck Low	Lining Wear Sensor: Signal Amplitude Fault	CC
0x505224	20562	36	Wheel 10 Brake Lining Wear Supply Circuit: Signal Stuck High	Lining Wear Sensor: Signal Amplitude Fault	CC
0x507E68	20606	104	Brake Lining Wear: Event Information	Lining Wear Sensor: Signal Compare Fault	DD
0x508707	20615	7	Wheel 1 Braking Monitoring: Mechanical Failures	The left and right wheel speeds are compared on every axle to detect the effect of a possible brake damage.	EE
0x508762	20615	98	Wheel 1 Braking Monitoring: Signal Compare Failure	Noisy WSS signal WSS faulty.	Z
0x508C07	20620	7	Wheel 2 Braking Monitoring: Mechanical Failures	The left and right wheel speeds are compared on every axle to detect the effect of a possible brake damage.	EE
0x508C62	20620	98	Wheel 2 Braking Monitoring: Signal Compare Failure	Noisy WSS signal WSS faulty.	Z
0x508D07	20621	7	Wheel 3 Braking Monitoring: Mechanical Failures	The left and right wheel speeds are compared on every axle to detect the effect of a possible brake damage.	EE
0x508D62	20621	98	Wheel 3 Braking Monitoring: Signal Compare Failure	Noisy WSS signal WSS faulty.	Z
0x508E07	20622	7	Wheel 4 Braking Monitoring: Mechanical Failures	The left and right wheel speeds are compared on every axle to detect the effect of a possible brake damage.	EE
0x508E62	20622	98	Wheel 4 Braking Monitoring: Signal Compare Failure	Noisy WSS signal WSS faulty.	Z
0x508F07	20623	7	Wheel 5 Braking Monitoring: Mechanical Failures	The left and right wheel speeds are compared on every axle to detect the effect of a possible brake damage.	EE
0x508F62	20623	98	Wheel 5 Braking Monitoring: Signal Compare Failure	Noisy WSS signal WSS faulty.	Z
0x509007	20624	7	Wheel 6 Braking Monitoring: Mechanical Failures	The left and right wheel speeds are compared on every axle to detect the effect of a possible brake damage.	EE
0x509062	20624	98	Wheel 6 Braking Monitoring: Signal Compare Failure	Noisy WSS signal WSS faulty.	Z

Table 18 - GSBC System/ECU Diagnostic Trouble Codes (DTCs)

GSBC SYSTEM & ECU DTCS					
DTC#	**SPN**	**FMI**	**DTC NAME**	**DTC DESCRIPTION**	**ACTION**
0x509107	20625	7	Wheel 7 Braking Monitoring: Mechanical Failures	The left and right wheel speeds are compared on every axle to detect the effect of a possible brake damage.	**EE**
0x509162	20625	98	Wheel 7 Braking Monitoring: Signal Compare Failure	Noisy WSS signal WSS faulty.	**Z**
0x509207	20626	7	Wheel 8 Braking Monitoring: Mechanical Failures	The left and right wheel speeds are compared on every axle to detect the effect of a possible brake damage.	**EE**
0x509262	20626	98	Wheel 8 Braking Monitoring: Signal Compare Failure	Noisy WSS signal WSS faulty.	**Z**
0x509307	20627	7	Wheel 9 Braking Monitoring: Mechanical Failures	The left and right wheel speeds are compared on every axle to detect the effect of a possible brake damage.	**EE**
0x509362	20627	98	Wheel 9 Braking Monitoring: Signal Compare Failure	Noisy WSS signal WSS faulty.	**Z**
0x509407	20628	7	Wheel 10 Braking Monitoring: Mechanical Failures	The left and right wheel speeds are compared on every axle to detect the effect of a possible brake damage.	**EE**
0x509462	20628	98	Wheel 10 Braking Monitoring: Signal Compare Failure	Noisy WSS signal WSS faulty.	**Z**
0x509695	20630	149	Wheel Speed Sensor Configuration: Incorrect Assembly	The fault is set if the comparison of the wheel speeds on one axle during curve driving is not plausible (during curve driving the inner wheel is slower).	**FF**
0x509768	20631	104	Roller Test Bench Mode: Event Information	Indicator that Dyno Mode is active.	**GG**
0x509E54	20638	84	EBS, Configurable High Side Switch Circuits: Missing Calibration	Unconfigured EPM connected to GSBC ECU.	**HH**
0x50B116	20657	22	Voltage Regulator, Power Supply: Circuit Voltage Below Threshold	Undervoltage detected by EBS Central ECU.	**JJ**
0x50B117	20657	23	Voltage Regulator, Power Supply: Circuit Voltage Above Threshold	Undervoltage detected by EBS Central ECU.	**JJ**
0x50B216	20658	22	Voltage Regulator: Circuit Voltage Below Threshold	Undervoltage detected by EBS Central ECU.	**JJ**
0x50B41C	20660	28	10V Power Supply: Circuit Voltage Out of Range	Internal pre-stabilizer voltage is higher than 13V and 10V supply voltage is either below 8.5V or above 10.5V.	**KK**
0x50B449	20660	73	10V Power Supply: Internal Electronic Failure	Internal pre-stabilizer voltage is higher than 13V and 10V supply voltage is either below 8.5V or above 10.5V.	**KK**
0x50B509	20661	9	Pre-Stabilizer Circuit: Component Failures	Internal pre-stabilizer voltage is higher than 13V and 10V supply voltage is either below 8.5V or above 10.5V.	**KK**

Table 18 - GSBC System/ECU Diagnostic Trouble Codes (DTCs)

GSBC SYSTEM & ECU DTCS					
DTC#	**SPN**	**FMI**	**DTC NAME**	**DTC DESCRIPTION**	**ACTION**
0x50B549	20661	73	Pre-Stabilizer Circuit: Internal Electronic Failure	Internal pre-stabilizer voltage is higher than 13V and 10V supply voltage is either below 8.5V or above 10.5V.	**KK**
0x50E498	20708	152	Brake Pad: Component or System Over Temperature	Brakes have been overused. Possible causes are: excessively long or frequent brake activation with no time for cooling.	**LL**
0x50E592	20709	146	Brake System: Performance or Incorrect Operation	Imbalanced brake performed (left to right) has been detected.	**MM**
0x600063	24576	99	Anti-Lock Brake System: Circuit/ Component Protection Time-Out	The fault is set if the ABS activity is unacceptably long. Detection time depends on driving situations. (Fault setting is based on internal values, which are not measurable from outside).	**NN**
0xC01086	49168	134	CAN Communication Backbone 1 Net : Signal Invalid	Data from vehicle CAN is checked. This fault is set to indicate missing CAN signals for ESP or MASS (e.g. driveline signals).	**PP**
0xC01088	49168	136	CAN Communication Backbone 1 Net : Bus Off	Data from vehicle CAN is checked. This fault is set to indicate missing CAN signals for ESP or MASS (e.g. driveline signals).	**PP**
0xC02888	49192	136	CAN Communication Chassis Net: Bus Off	Missing messages from other components.	**QQ**
0xC10087	49408	135	Lost Communication with EMS: Missing Message	Missing messages from other components.	**QQ**
0xC10187	49409	135	Lost Communication with TECU: Missing Message	Missing messages from other components.	**QQ**
0xC12687	49446	135	Lost Communication With Steering Angle Sensor Module: Missing Message	Missing message from SAS.	**RR**
0xC12787	49447	135	Lost Communication With External Yaw Rate Sensor Module: Missing Message	Missing Message from YAS.	**SS**
0xC14087	49472	135	Lost Communication With VMCU: Missing Message	Missing messages from other components.	**QQ**
0xD00563	53253	99	Lost Communication with Trailer Brake Lever: Circuit/Component Protection Time-Out	Missing messages from other components.	**QQ**
0xD00592	53253	146	Lost Communication with Trailer Brake Lever: Performance or Incorrect Operation	Missing messages from other components.	**QQ**
0xD00687	53254	135	Power Line Carrier Relay: Missing Message	Missing messages from other components.	**QQ**
0xD00696	53254	150	Power Line Carrier Relay: Component Internal Failure	PLC Relay internal fault	**TT**
0xD14087	53568	135	Lost Communication With APM: Missing Message	Missing messages from other components.	**QQ**
0xD14586	53573	134	Vehicle Weight Signal: Signal Invalid	Invalid signal from axle load sensor.	**UU**

Table 18 - GSBC System/ECU Diagnostic Trouble Codes (DTCs)

GSBC SYSTEM & ECU DTCS					
DTC#	**SPN**	**FMI**	**DTC NAME**	**DTC DESCRIPTION**	**ACTION**
0xD14781	53575	129	Vehicle Speed Electronic Data Link: Invalid Serial Data Received	Implausible vehicle speed calculated.	**VV**
0xD15287	53586	135	Lost Communication With RECU: Missing Message	Missing messages from other components.	**QQ**
0xD15487	53588	135	Lost Communication With BBM: Missing Message	Missing messages from other components.	**QQ**
0xD15587	53589	135	Lost Communication With CIOM: Missing Message	Missing messages from other components.	**QQ**
0xD15687	53590	135	Lost Communication With RCIOM: Missing Message	Missing messages from other components.	**QQ**
0xD15787	53591	135	Lost Communication With CCIOM: Missing Message	Missing messages from other components.	**QQ**
0xD15887	53592	135	Lost Communication With DACU: Missing Message	Missing messages from other components.	**QQ**
0xD16107	53601	7	Vehicle Braking State: Mechanical Failures	Fault is set if the vehicle deceleration does not match to the demaned deceleration within atolerance in normal vehicle condition. The tolerance and the acceptable deceleration depend on EBS status.	**XX**
0xD16192	53601	146	Vehicle Braking State: Performance or Incorrect Operation	Fault is set if the vehicle deceleration does not match to the demaned deceleration within the tolerance in normal vehicle condition. The tolerance and the acceptable deceleration depend on EBS status.	**XX**
0xD16368	53603	104	External Brake Request Message: Event Information	Missing messages from other components.	**QQ**
0xD16968	53609	104	DTC Notification Max Limit Reached: Event Information	Large number of active faults. Check and correct faults to clear this message.	**YY**
0xF00008	61440	8	Electronic Control Unit: Bus Signal/Message Failures	Internal software fault detected.	**ZZ**
0xF00029	61440	41	Electronic Control Unit: Signal invalid	Internal software fault detected.	**AA**
0xF00043	61440	67	Electronic Control Unit: Special Memory Failure	Internal software fault detected.	**AA**
0xF00044	61440	68	Electronic Control Unit: Data Memory Failure	Internal software fault detected.	**AA**
0xF00046	61440	70	Electronic Control Unit: Calibration/Parameter Memory Failure	Internal software fault detected.	**AA**
0xF00047	61440	71	Electronic Control Unit: Watchdog/Safety µC Failure	Internal GSBC ECU electronic fault.	**R**
0xF00048	61440	72	Electronic Control Unit: Supervision Software Failure	Internal software fault detected.	**AAA**
0xF00049	61440	73	Electronic Control Unit: Internal Electronic Failure	Voltage is detected on the ground (GND) pins of the GSBC ECU.	**BBB**

Table 18 - GSBC System/ECU Diagnostic Trouble Codes (DTCs)

GSBC SYSTEM & ECU DTCS					
DTC#	**SPN**	**FMI**	**DTC NAME**	**DTC DESCRIPTION**	**ACTION**
0xF0004B	61440	75	Electronic Control Unit: Over Temperature	GSBC ECU is over maximum temperature.	**CCC**
0xF00056	61440	86	Electronic Control Unit: Invalid/ Incompatible Configuration	Internal software fault detected.	**AA**
0xF00057	61440	87	Electronic Control Unit: Invalid/Incompatible Software Component	Internal software fault detected.	**AA**
0xF00061	61440	97	Electronic Control Unit: Signal Calculation Failure	Internal software fault detected.	**AA**
0xF00062	61440	98	Electronic Control Unit: Signal Compare Failure	Internal software fault detected.	**AA**
0xF00063	61440	99	Electronic Control Unit: Circuit/ Component Protection Time-Out	Internal software fault detected.	**AA**
0xF00064	61440	100	Electronic Control Unit: Signal Plausibility Failure	Internal software fault detected.	**AA**
0xF00066	61440	102	Electronic Control Unit: Signal Has Too Many Transitions/Events	Lifetime cyce limit exceeded for valve(s).	**DDD**
0xF00068	61440	104	Electronic Control Unit: Event Information	Internal software fault detected.	**AA**
0xF00092	61440	146	Electronic Control Unit: Performance or Incorrect Operation	Internal software fault detected.	**AA**
0xF00094	61440	148	Electronic Control Unit: Unexpected Operation	Internal GSBC ECU electronic fault.	**R**
0xF00096	61440	150	Electronic Control Unit: Component Internal Failure	Internal software fault detected.	**EEE**
0xF0009A	61440	154	Electronic Control Unit: Component or System Operating Conditions	Internal software fault detected.	**FFF**
0xF0009D	61440	157	Electronic Control Unit: Component or System Under Temperature	GSBC ECU is under minimum temperature.	**GGG**
0xF00316	61443	22	Battery Power: Circuit Voltage Below Threshold	Battery voltage supplied to GSBC ECU is too high or too low.	**HHH**
0xF00317	61443	23	Battery Power: Circuit Voltage Above Threshold	Battery voltage supplied to GSBC ECU is too high or too low.	**HHH**
0xF0031C	61443	28	Battery Power: Circuit Voltage Out of Range	Battery voltage supplied to GSBC ECU is too high or too low.	**HHH**

Table 18 - GSBC System/ECU Diagnostic Trouble Codes (DTCs)

DIAGNOSTIC CODE (DTC) AND SERVICE INFORMATION (CONT.)

SERVICE ACTION CODE TABLE

NOTE: Prior to servicing a vehicle, refer to the *General Safety Guidelines on page 2*.

SERVICE ACTION CODE	RECOMMENDED SERVICE ACTION
A	Check steering system for damage (drag link, steer arm, pitman arm, i-shaft, steering gear). Check the mounting of the SAS to the steering column. Replace the sensor if it is damaged. Check if SAS is calibrated correctly (0 degree in straight-line position.Calibrate sensor if it is not correctly calibrated. Clear fault. Perform an ECU reset (Turn ignition off, release brake pedal, wait 90 seconds without touching a control, then start vehicle) followed by a short test drive (including driving both in a straight line and turns). If fault returns, replace the SAS.
B	Recalibrate the SAS. If this fault returns, replace the SAS.
C	Check wire harness and connector pins on SAS. Sensor should receive 12Vdc from the harness, and measure for proper resistance between the high and low CAN pins on the harness. Clear fault. If fault returns, replace the SAS.
D	SAS is installed but ESP is not enabled. Check if vehicle and ECU configuration match. If configuraiton is not correct, contact vehicle OEM for assistance.
E	Mismatch between SAS and YAS readings. Check if SAS is calibrated correctly: with engine running, set steered wheels in straight position. Read SAS via diagnostics and check if the value of SAS is 0 ±10 degrees. If value is not OK, recalibrate the sensor. While engine is still running, mark zero position on the steering wheel, and turn it in both directions by one turn (360 degrees). Check the steering angle values via diagnostics are ±360 ±10 degrees (sign should be negative while turning left and positive while turning right). If values are not OK, check the mounting and the steering shaft interface of the SAS matches OEM installation requirements. With engine running turn the steering wheel to its end positions, read the steering angle values via diagnostics and check if the read values are equivalent to each other in each direction. If fault is still present, check steering system for damage (drag link, steer arm, pitman arm, i-shaft, steering gear). If fault is still active, replace the SAS and recalibrate SAS. Check whether wheelbase and wheel track correspond to the vehicle specifications as built. If vehicle has been modified, contact the OEM for assistance in updating the vehicle parameters. Check that the ECU is mounted in its original orientation. Perform an ECU reset, (turn ignition off, release brake pedal, wait 90 seconds without touching a control, then start vehicle) followed by a short test drive (including driving both in a straight line and turns). If fault returns, replace GSBC Central ECU (YAS is an internal non-serviceable component inside the GSBC Central ECU).

Table 19 – GSBC System/ECU Service Action Codes

SERVICE ACTION CODE	RECOMMENDED SERVICE ACTION
F	Check if SAS is calibrated correctly: with engine running, set steered wheels in straight position. Read SAS via diagnostics and check if the value of SAS is 0 ±10 degrees. If value is not OK, recalibrate the sensor. While engine is still running, mark zero position on the steering wheel, and turn it in both directions by one turn (360 degrees). Check the steering angle values via diagnostics are ±360 ±10 degrees (sign should be negative while turning left and positive while turning right). If values are not OK, check the mounting and the steering shaft interface of the SAS matches OEM installation requirements. With engine running turn the steering wheel to its end positions, read the steering angle values via diagnostics, and check if the read values are equivalent to each other in each direction. If fault is still present, check steering system for damage (drag link, steer arm, pitman arm, i-shaft, steering gear). If fault is still active, replace the SAS and recalibrate SAS.
G	Check the SAS connector and wiring harness for a short on CAN High and CAN Low.
H	Ensure vehicle is on level ground. Check that the mounting position of the GSBC Central ECU is in the original position and all mounting bolts are properly torqued. Perform End of Line calibration of Lateral acceleration sensor (LAS). Perform an ECU reset (Turn ignition off, release brake pedal, wait 90 seconds without touching a control, then start vehicle) followed by a short test drive (including driving both in a straight line and turns). If fault returns, replace the GSBC Central ECU.
J	Ensure vehicle is on level ground. Perform End of Line calibration of LAS.
K	Ensure vehicle is on level ground. Check that the mounting position of the GSBC Central ECU is in the original position and all mounting bolts are properly torqued. Check whether wheelbase and wheel track correspond to the vehicle specifications as built. If vehicle has been modified, contact the OEM for assistance in updating the vehicle parameters. Perform End of Line calibration of LAS. Perform an ECU reset, (turn ignition off, release brake pedal, wait 90 seconds without touching a control, then start vehicle) followed by a short test drive (including driving both in a straight line and turns). During road test, confirm that vehicle speedometer is reporting an accurate value and matches brake controller reported speed. If fault does not clear or fault returns, replace the GSBC Central ECU.

Table 19 – GSBC System/ECU Service Action Codes

SERVICE ACTION CODE	RECOMMENDED SERVICE ACTION
L	Ensure vehicle is on level ground. Check that the mounting position of the GSBC Central ECU is in the original position and all mounting bolts are properly torqued. Check whether wheelbase and wheel track correspond to the vehicle specifications as built. If vehicle has been modified, contact the OEM for assistance in updating the vehicle parameters. Perform End of Line calibration of YAS. Check if SAS is calibrated correctly: with engine running, set steered wheels in straight position. Read SAS via diagnostics and check if the value of SAS is 0 ±10 degrees. If value is not OK, recalibrate the sensor. While engine is still running, mark zero position on the steering wheel, and turn it in both directions by one turn (360 degrees). Check the steering angle values via diagnostics are ±360 ±10 degrees (sign should be negative while turning left and positive while turning right). If values are not OK, check the mounting and the steering shaft interface of the SAS matches OEM installation requirements. With engine running turn the steering wheel to its end positions, read the steering angle values via diagnostics and check if the read values are equivalent to each other in each direction. If fault is still present, check steering system for damage (drag link, steer arm, pitman arm, i-shaft, steering gear). If fault is still active, replace the SAS and recalibrate SAS. Perform an ECU reset, (turn ignition off, release brake pedal, wait 90 seconds without touching a control, then start vehicle) followed by a short test drive (including driving both in a straight line and turns). During road test, confirm that vehicle speedometer is reporting an accurate value and matches brake controller reported speed. If fault does not clear or fault returns, replace the GSBC Central ECU (YAS is an internal, non-serviceable part of the GSBC Central ECU).
M	Ensure vehicle is on level ground. Check that the mounting position of the GSBC Central ECU is in the original position and all mounting bolts are properly torqued. Check whether wheelbase and wheel track correspond to the vehicle specifications as built. If vehicle has been modified, contact the OEM for assistance in updating the vehicle parameters. Perform End of Line calibration of LAS. Perform an ECU reset, (turn ignition off, release brake pedal, wait 90 seconds without touching a control, then start vehicle) followed by a short test drive (including driving both in a straight line and turns). During road test, make multiple starts at varying acceleration rates from a stop while travelling in a straight line. If fault does not clear or fault returns, replace the GSBC Central ECU.

Table 19 – GSBC System/ECU Service Action Codes

SERVICE ACTION CODE	RECOMMENDED SERVICE ACTION
N	Ensure vehicle is on level ground. Check that the mounting position of the GSBC Central ECU is in the original position and all mounting bolts are properly torqued. Address any WSS faults that may be active on the vehicle. Verify proper operation and position of WSSs. Clear DTC. Perform an ECU reset, (turn ignition off, release brake pedal, wait 90 seconds without touching a control, then start vehicle) followed by a short test drive (including driving both in a straight line and turns). If fault does not clear or fault returns, replace the GSBC Central ECU.
P	Ensure vehicle is on level ground. Check that the mounting position of the GSBC Central ECU is in the original position and all mounting bolts are properly torqued. Address any WSS faults that may be active on the vehicle. Verify proper operation and position of WSSs. Clear DTC. Perform an ECU reset, (turn ignition off, release brake pedal, wait 90 seconds without touching a control, then start vehicle) followed by a short test drive. During road test, make multiple starts at varying acceleration rates from a stop while travelling in a straight line. If fault does not clear or fault returns, replace the GSBC Central ECU.
Q	Ensure vehicle is on level ground. Check that the mounting position of the GSBC Central ECU is in the original position and all mounting bolts are properly torqued. Clear DTC. Perform an ECU reset, (turn ignition off, release brake pedal, wait 90 seconds without touching a control, then start vehicle) followed by a short test drive (including driving both in a straight line and turns). If fault does not clear or fault returns, replace the GSBC Central ECU.
R	Clear fault. If fault returns, replace the GSBC Central ECU.
S	YAS is installed but ESP is not enabled. Check if vehicle and ECU configuration match. If configuraiton is not correct, contact vehicle OEM for assistance.
T	Check the mounting of the sensor. Check whether wheelbase and wheel track correspond to the vehicle specification in the dataset and download correct dataset. Check mounting of SAS. Perform End of Line calibration of SAS. Perform End of Line calibration of Lateral Acceleration Sensor . If fault is still active after ECU reset (ignition off/on, brake pedal released) and short driving maneuver (straight line and curve), replace the YAS/GSBC Central ECU.
U	Check for other ESP sensor related faults (for example, Steer Angle Sensor, YAS and Wheel Speed Sensor, etc.) and correct as needed. If no other faults are active, replace the GSBC Central ECU.

Table 19 – GSBC System/ECU Service Action Codes

SERVICE ACTION CODE	RECOMMENDED SERVICE ACTION
V	Switch off the GSBC Central ECU. Disconnect the SAS connector (X5) from the GSBC Central ECU and switch on the GSBC Central ECU again. Note: DTCs related to “ESP sensor communication interrupted” will appear additionally during this procedure; ignore them and erase them at the end of the test procedure. If sensor supply error becomes active again with SAS disconnected from the GSBC Central ECU, then the GSBC Central ECU is the source of the problem. Replace the GSBC Central ECU. If sensor supply error does not become active again, then the fault is either in the wiring or in the SAS itself. To check the wiring harness, disconnect the SAS from the vehicle wiring harness. Check the vehicle wiring harness between the GSBC Central ECU and SAS for short circuits between pins. Repair wiring harness if faults are found. If wiring is OK, replace the SAS, (located in the steering column) ensuring that vehicle ECU is powered off. Confirm that fault is fixed by reconnecting the wiring harness, repowering the ECU, and clearing any active DTCs.
W	SAS supply voltage low. Measure supply voltage to GSBC Central ECU. ECU power supply/battery voltage must be greater than 15V. If battery voltage is below 15V, charge or repair vehicle power system before proceeding. Once vehicle battery voltage is above 15V, disconnect SAS wiring from GSBC Central ECU. Measure SAS power supply pin voltage at GSBC Central ECU. If SAS supply voltage is less than 10V with adequate battery voltage at GSBC Central ECU, then the GSBC Central ECU has an internal electronic failure that requires replacement of the GSBC Central ECU. If ECU power supply is adequate and DTC is still present, reconnect SAS wiring at GSBC Central ECU and disconnect SAS from vehicle harness in steering column. Measure supply voltage at vehicle harness pins. If supply voltage is below 10V, repair or replace vehicle harness as necessary. If voltage measured at vehicle harness is above 10V and DTC can not be cleared, replace SAS. If DTC can be cleared but reappears intermittently, check all connections between the GSBC Central ECU and SAS, as well as checking harness for damaged wiring.
X	SAS supply voltage high. Measure supply voltage to GSBC Central ECU. ECU power supply/battery voltage must be less than 60.5V. If Battery voltage is above 60.5V, repair vehicle power system before proceeding. Once vehicle battery voltage is within normal operating range, disconnect SAS wiring from GSBC Central ECU. Measure SAS power supply pin voltage at GSBC Central ECU. If SAS supply voltage is outside the range of 12 ±2V with normal battery voltage at GSBC Central ECU, then the GSBC Central ECU has an internal electronic failure that requires replacement of the GSBC Central ECU. If ECU power supply is adequate and DTC is still present, reconnect SAS wiring at GSBC Central ECU and disconnect SAS from vehicle harness in steering column. Measure supply voltage at vehicle harness pins. If supply voltage is above 14V, repair or replace vehicle harness as necessary. If voltage measured at vehicle harness is within the range of 12V ±2V and DTC can not be cleared, replace SAS. If DTC can be cleared but reappears intermittently, check all connections between the GSBC Central ECU and SAS, as well as checking harness for damaged wiring.

Table 19 – GSBC System/ECU Service Action Codes

SERVICE ACTION CODE	RECOMMENDED SERVICE ACTION
Y	Check WSS for damage. Replace sensor if it is mechanically damaged. Check WSS mounting to ensure that the sensor is rigidly held in place. Correct any mounting errors or damage discovered. Check the tone wheel for dirt and metallic particles, and for the correct number of teeth. Clean tone wheel if necessary, and replace if damage is discovered. Check wheel end for excessive bearing end play, and repair wheel bearing as necessary per OEM guidelines. Check and correct air gap between WSS and tone wheel by measuring the wheel speed signal. WSS signal must be higher than 100mV peak to peak (0.1VAC) at wheel speed of roughly 2 mph. If air gap is incorrect, re-adjust sensor and repeat test. Check the cables and connectors between EPM and wheel-speed sensor for shorted or open circuits. Remove WSS connector from EPM. At WSS wiring harness connector, measure resistance across two pins of wheel speed sensor harness. Resistance must be between 800 and 2000 Ohms. Measure resistance of between sensor pins and vehicle GND. Resistance must be greater than 200 kOhm. If either resistance measurement is outside measured range, disconnect wheel speed sensor from vehicle harness (if applicable) and re-check sensor pins. If test fails, replace sensor. Otherwise, investigate vehicle harness per OEM procedure for short or open circuit. Measure voltage between EPM GND and either WSS pin (with the wheel speed sensor connected to the EPM electrical connector). Voltage must in range 0.5-4.3V. If voltage is not present and harness is known good, proceed to next step. Switch left and right WSS and repeat all tests above. If problem remains on the same side of the vehicle, replace EPM. Otherwise, switch sensors back and replace indicated WSS/harness.
Z	Check WSS for damage. Replace sensor if it is mechanically damaged. Check WSS mounting to ensure that the sensor is rigidly held in place. Correct any mounting errors or damage discovered. Check the tone wheel for dirt and metallic particles, and for the correct number of teeth. Clean tone wheel if necessary, and replace if damage is discovered. Check wheel end for excessive bearing end play, and repair wheel bearing as necessary per OEM guidelines. Check and correct air gap between WSS and tone wheel by measuring the wheel speed signal. WSS signal must be higher than 100mV peak to peak (0.1VAC) at wheel speed of roughly 2 mph. If air gap is incorrect, re-adjust sensor and repeat test. Check the cables and connectors between EPM and wheel-speed sensor for shorted or open circuits. Remove WSS connector from EPM. At WSS wiring harness connector, measure resistance across two pins of wheel speed sensor harness. Resistance must be between 800 and 2000 Ohms. Measure resistance of between sensor pins and vehicle GND. Resistance must be greater than 200 kOhm. If either resistance measurement is outside measured range, disconnect wheel speed sensor from vehicle harness (if applicable) and re-check sensor pins. If test fails, replace sensor. Otherwise, investigate vehicle harness per OEM procedure for short or open circuit. If all checks pass and DTC cannot be cleared, confirm that configuration stored in the GSBC Central ECU corresponds to wheel rolling circumference and tone wheel teeth number. If it does not match, then correct the configuration values or contact the OEM for assistance in downloading the correct dataset.
AA	Check if tire size of all tires matches according vehicle configuration as built, and confirm that the tire size for all tires has been configured in GSBC Central ECU and matches tires installed on vehicle. Check the number of teeth on each tone wheel on all wheel ends, and confirm that they match the configuraiton loaded into the GSBC Central ECU.

Table 19 – GSBC System/ECU Service Action Codes

SERVICE ACTION CODE	RECOMMENDED SERVICE ACTION
BB	Check for shorts between different WSS connected to the same EPM. Check the cables and connectors between EPM and wheel-speed sensor for damage, shorted, or open circuits. Trace the WSS with the fault back to the EPM. Remove all WSSs connected to that EPM. Measure resistance between sensor pins (any pin) of different WSS connectors on harness. Resistance must be greater than 200 kOhm. If resistance is less than 200 kOhm, WSSs are shorted together. Repair or replace WSS and/or vehicle harness as necessary to eliminate short.
CC	Clear DTC. If fault returns, then check for shorts to ground or battery in lining wear harness. If there are no faults found in the harness, check the lining wear sensor for proper operation. Replace the lining wear sensor if it is not functioning properly or if it is damaged. If the fault is still present after these steps, replace the EPM connected to the faulted lining wear sensor.
DD	Check brake actuators and pads. Replace worn parts.
EE	The system has detected brake imbalance between two sides of the same axle. Inspect all foundation brake components on both sides of the axle, looking for signs of uneven brake wear side to side. Correct any mechanical faults with the foundation brakes, and additionally inspect the air lines between the EPM and the foundation brakes, looking for kinked, damaged, or obstructed air lines. Repair or replace as necessary.
FF	The WSS cables are reversed at the EPM connector of an axle (for example, the left side sensor cable is connected to the right side sensor connector, and the right side sensor cable is connected to the left side sensor connector). Inspect EPM and swap specified sensors across the axle. If the sensors are correct or cannot be moved, the dataset will need to be updated to reflect the hardware configuration. Contact the vehicle OEM for assistance in updating the dataset.
GG	No action needed. This is not a fault but an indicator of the active Dyno Mode.
HH	Check vehicle wiring. Check if there is an additional unconfigured EPM connected to the GSBC Central ECU. Compare vehicle configuration to original (factory) configuraiton. If changes have been made to the vehicle after it was built, consult the OEM for assistance in updating vehicle configuration in GSBC Central ECU.
JJ	Check battery voltage. If battery voltage is outside OEM specifications, repair vehicle charging system per OEM instructions. Check wiring from battery to the ECU. Ensure voltage difference between ECU supply and ground pins (X1:7 to X1:15, and X1:8 to X1:16) is within specification. Clear fault. If fault returns, replace the ECU.
KK	Internal 10V power supply is out of range. Check battery voltage. If battery voltage is outside OEM specifications, repair vehicle charging system per OEM instructions. Check wiring from battery to the ECU. Ensure voltage difference between ECU supply and ground pins (X1:7 to X1:15, and X1:8 to X1:16) is within specification. Clear fault. If fault returns replace the ECU
LL	Check and inspect the foundation brakes for signs of overheating. If brakes have overheated, make any repairs necessary and inform the driver. If no signs of overheating are found, check vehicle data bus and parameter file for inaccurate or missing information regarding: time/date, wheel speed, brake pressure, ambient temperature, and threshold pressure. Any incorrect, corrupted, or missing configuration values or changes to the vehicle's physical configuration can cause brake energy (and heat estimated brake temperature) to be calculated incorrectly.
MM	Imbalanced brake performance (left to right) has been detected. Check for uneven brake wear across all axles. Inspect foundation brake components, brake adjustment, brake hoses, and suspension components.

Table 19 – GSBC System/ECU Service Action Codes

SERVICE ACTION CODE	RECOMMENDED SERVICE ACTION
NN	The system has detected an implausibly long ABS event. First, using diagnostic software, graph each wheel speed sensor individually while turning that wheel, and inspect for proper response and consistency between wheel ends. Next, confirm that the system is parameterized properly. Check and confirm that the following parameters are set correctly in the ECU and that the vehicle has not been modified since leaving the factory: • Tire size • Tire Static Loaded Radius (SLR) • Tone wheel tooth count • WSS configuration (ensure that each sensor is located in the correct location) • Axle configuration (ensure that the vehicle is properly parameterized for steer, driven and liftable axles) • Confirm that each EPM delivery is going to the correct wheel end (and that hoses are not switched across an axle) If a parameter does not match the vehicle, correct the configuration values or change the part of the vehicle. For configuration information, contact OEM. Finally, if the GSBC Central ECU parameterization is correct, physically inspect the vehicle for the following: • Check that the pneumatic air lines and components are operating properly and not obstructed • Check that the foundation brakes are in good repair and not damaged or excessively worn • Check the WSSs for damage and appropriate gap from the tone wheel • Check the tone wheels for damage or debris
PP	Clear DTC and reset ECU. Check other ECUs on vehicle for failures or correct function. Inspect J1939 CAN for damage, shorts, opens, or incorrect operation, including chafing damage. If no other faults are found and everything else is operating normally, replace the GSBC Central ECU.
QQ	Missing CAN messages. Clear DTC and reset ECU. Inspect electrical connectors at the GSBC Central ECU and the ECU with missing messages for damage, corrosion, or shorted connectors. If damage is found, repair or replace the damage as necessary. Inspect CAN wiring for damage, shorts, opens, or incorrect operation, including chafing damage. Check other ECU for proper operation; contact OEM for additional assistance.
RR	Clear DTC and reset ECU. Check and eliminate contact failures at the connectors of Steer Angle Sensor (SAS) and GSBC Central ECU. Inspect CAN wiring for damage, shorts, opens, or incorrect operation, including chafing damage. If other CAN devices are working normally, replace SAS.
SS	Clear DTC and reset ECU. Check other ECUs on vehicle for failures or correct function. Inspect CAN wiring for damage, shorts, opens, or incorrect operation, including chafing damage. Check that GSBC Central ECU is getting good power from the vehicle. Confirm that there are no other active CAN faults before proceeding. If wiring is OK and failure is still present, replace the GSBC Central ECU.
TT	Replace PLC Relay.
UU	If vehicle is equipped with an axle load sensor, check sensor operation per OEM guidelines. Check that GSBC Central ECU parameters regarding vehicle weight are correct. Check that vehicle has not been modified since leaving the factory. For help in updating GSBC Central ECU configuration to reflect vehicle changes, contact vehicle OEM.
VV	Check that the configuration of the tire circumference in the GSBC Central ECU parameter settings matches the circumference of the mounted tire. Correct that value if it is incorrect. Reset GSBC self-learned wheel circumferences. Inspect the WSSs and tone rings for damage or wear. Confirm that the tone ring tooth count settings in the GSBC Central ECU is correct and matches the tone rings installed on the vehicle.
XX	Vehicle did not decelerate within expected bounds. Check vehicle for problems leading to reduced braking. Check for sufficient supply pressure, faded brakes or signs of overheated brakes, overloaded vehicle and/or trailer, check pneumatic plumbing for restrictions and other obstructions. Check and inspect foundation brakes for proper maintenance and operation.
YY	Large number of active faults. Check the active faults and correct them.

Table 19 – GSBC System/ECU Service Action Codes

SERVICE ACTION CODE	RECOMMENDED SERVICE ACTION
ZZ	Switch ignition off. Disconnect Vehicle CAN from GSBC Central ECU and wait 15s. Reconnect Vehicle CAN to GSBC Central ECU and switch ignition on. If the fault clears, check for unexpected/ improper CAN communication from other ECUs while ignition is off. If no other ECUs are active while ignition is off, replace GSBC Central ECU.
AAA	Resetting the ECU should clear the DTC. If the DTC comes back, reflash the GSBC Central ECU software. Contact the vehicle OEM for software and assistance.
BBB	Turn off the vehicle. Inspect the GSBC Central ECU connector with the GND1 and GND2 pins. Confirm that the electrical connector and wires are not damaged, corroded, shorted, or open. Confirm that the wires connected to GND1 and GND2 are connected to chassis ground. Repair any problems discovered per OEM recommendations. Turn the vehicle back on. Check that there is ~0V difference between GND1 and GND2 pins. Reset GSBC Central ECU. If the problem is still present, replace GSBC Central ECU.
CCC	The GSBC Central ECU is over temperature (above 248°F [120°C]). Power off the vehicle and wait for the vehicle to cool down. If the vehicle has cooled down and the fault is still active, replace the GSBC Central ECU.
DDD	Replace valves that have exceeded lifetime cycle limit(s) and reset the counter with diagnostic tool.
EEE	Switch ignition off. Disconnect Vehicle CAN from GSBC Central ECU and wait 15s. Reconnect Vehicle CAN to GSBC Central ECU and switch ignition on. If the fault clears, check for unexpected/ improper CAN communication from other ECUs while ignition is off. If no other ECUs are active while ignition is off, replace GSBC Central ECU.
FFF	Replace ECU if DTC still active after multiple ignition on-off cycles.
GGG	The GSBC Central ECU is under temperature (below -35°F [-37°C]). If the vehicle has been warmed above that temperature and the fault is still active, replace the ECU.
HHH	If the state is active continuously, check vehicle's power supply system. Measure voltage between pins X1/15 and X1/7. Voltage is out of range for electronic pressure control if supply voltage is lower than 15V or higher than 36V. Voltage is out of range for keeping the EPMs switched on if supply voltage is lower than 10V for at least 40ms or higher than 36V for 380ms. Voltage is out of range for controlling the eTPCM and modulators if supply voltage is not between 19V-32V. If battery voltage at GSBC Central ECU connectors is correct and within normal range, replace ECU.

Table 19 – GSBC System/ECU Service Action Codes

GSBC EPM-90 DTCS

IMPORTANT

For all repair steps, first complete the following:

1. **Generate an ACom Diagnostic Software report.**
2. **Clear DTCs.**
3. **Continue with repair information for each active DTC that will not clear.**

NOTE: After completing all repairs, drive the vehicle to ensure the repairs were sufficient.

4. **Once repairs have been made, clear the DTC again.**

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GSBC EPM-90 DTCS					
DTC #	**SPN (J1939)**	**FMI (J1939)**	**DTC NAME**	**DTC DESCRIPTION**	**SD SHEET**
0x506712	20583	18	Wheel 1 EPM: Circuit Short To Battery	Internal WSS Analog signals are not in valid range. Short to Battery detected at high side or low side.	SD-27-5031
0x506714	20583	20	Wheel 1 EPM: Circuit Short To Ground or Open	Hardware fault detected inside EPM. Short to Gnd detected at high side or low side.	SD-27-5031
0x506718	20583	24	Wheel 1 EPM: Circuit Current Below Threshold	Hardware fault detected inside EPM. Sensor not connected or High side/Low side open.	SD-27-5031
0x506764	20583	100	Wheel 1 EPM: Signal Plausibility Failure	Sensor frequency is out of the specified ranges.	SD-27-5031
0x506812	20584	18	Wheel 2 EPM: Circuit Short To Battery	Internal WSS Analog signals are not in valid range. Short to Battery detected at high side or low side.	SD-27-5031
0x506814	20584	20	Wheel 2 EPM: Circuit Short To Ground or Open	Hardware fault detected inside EPM. Short to Gnd detected at high side or low side.	SD-27-5031
0x506818	20584	24	Wheel 2 EPM: Circuit Current Below Threshold	Hardware fault detected inside EPM. Sensor not connected or High side/Low side open.	SD-27-5031
0x506864	20584	100	Wheel 2 EPM: Signal Plausibility Failure	Sensor frequency is out of the specified ranges.	SD-27-5031
0x506912	20585	18	Wheel 3 EPM: Circuit Short To Battery	Internal WSS Analog signals are not in valid range. Short to Battery detected at high side or low side.	SD-27-5031
0x506914	20585	20	Wheel 3 EPM: Circuit Short To Ground or Open	Hardware fault detected inside EPM. Short to Gnd detected at high side or low side.	SD-27-5031
0x506918	20585	24	Wheel 3 EPM: Circuit Current Below Threshold	Hardware fault detected inside EPM. Sensor not connected or High side/Low side open.	SD-27-5031
0x506964	20585	100	Wheel 3 EPM: Signal Plausibility Failure	Sensor frequency is out of the specified ranges.	SD-27-5031
0x506A12	20586	18	Wheel 4 EPM: Circuit Short To Battery	Internal WSS Analog signals are not in valid range. Short to Battery detected at high side or low side.	SD-27-5031
0x506A14	20586	20	Wheel 4 EPM: Circuit Short To Ground or Open	Hardware fault detected inside EPM. Short to Gnd detected at high side or low side.	SD-27-5031
0x506A18	20586	24	Wheel 4 EPM: Circuit Current Below Threshold	Hardware fault detected inside EPM. Sensor not connected or High side/Low side open.	SD-27-5031
0x506A64	20586	100	Wheel 4 EPM: Signal Plausibility Failure	Sensor frequency is out of the specified ranges.	SD-27-5031

Table 20 - GSBC EPM-90 Diagnostic Trouble Codes (DTCs)

GSBC EPM-90 DTCS					
DTC #	SPN (J1939)	FMI (J1939)	DTC NAME	DTC DESCRIPTION	SD SHEET
0x506B14	20587	20	Wheel 5 EPM: Circuit Short To Ground or Open	Hardware fault detected inside EPM. Short to Gnd detected at high side or low side.	SD-27-5031
0x506B18	20587	24	Wheel 5 EPM: Circuit Current Below Threshold	Hardware fault detected inside EPM. Sensor not connected or High side/Low side open.	SD-27-5031
0x506B64	20587	100	Wheel 5 EPM: Signal Plausibility Failure	Sensor frequency is out of the specified ranges.	SD-27-5031
0x506C12	20588	18	Wheel 6 EPM: Circuit Short To Battery	Internal WSS Analog signals are not in valid range. Short to Battery detected at high side or low side.	SD-27-5031
0x506C14	20588	20	Wheel 6 EPM: Circuit Short To Ground or Open	Hardware fault detected inside EPM. Short to Gnd detected at high side or low side.	SD-27-5031
0x506C18	20588	24	Wheel 6 EPM: Circuit Current Below Threshold	Hardware fault detected inside EPM. Sensor not connected or High side/Low side open.	SD-27-5031
0x506C64	20588	100	Wheel 6 EPM: Signal Plausibility Failure	Sensor frequency is out of the specified ranges.	SD-27-5031
0x506D12	20589	18	Wheel 7 EPM: Circuit Short To Battery	Internal WSS Analog signals are not in valid range. Short to Battery detected at high side or low side.	SD-27-5031
0x506D14	20589	20	Wheel 7 EPM: Circuit Short To Ground or Open	Hardware fault detected inside EPM. Short to Gnd detected at high side or low side.	SD-27-5031
0x506D18	20589	24	Wheel 7 EPM: Circuit Current Below Threshold	Hardware fault detected inside EPM. Sensor not connected or High side/Low side open.	SD-27-5031
0x506D64	20589	100	Wheel 7 EPM: Signal Plausibility Failure	Sensor frequency is out of the specified ranges.	SD-27-5031
0x506E12	20590	18	Wheel 8 EPM: Circuit Short To Battery	Internal WSS Analog signals are not in valid range. Short to Battery detected at high side or low side.	SD-27-5031
0x506E14	20590	20	Wheel 8 EPM: Circuit Short To Ground or Open	Hardware fault detected inside EPM. Short to Gnd detected at high side or low side.	SD-27-5031
0x506E18	20590	24	Wheel 8 EPM: Circuit Current Below Threshold	Hardware fault detected inside EPM. Sensor not connected or High side/Low side open.	SD-27-5031
0x506E64	20590	100	Wheel 8 EPM: Signal Plausibility Failure	Sensor frequency is out of the specified ranges.	SD-27-5031
0x506F12	20591	18	Wheel 9 EPM: Circuit Short To Battery	Internal WSS Analog signals are not in valid range. Short to Battery detected at high side or low side.	SD-27-5031
0x506F14	20591	20	Wheel 9 EPM: Circuit Short To Ground or Open	Hardware fault detected inside EPM. Short to Gnd detected at high side or low side.	SD-27-5031
0x506F18	20591	24	Wheel 9 EPM: Circuit Current Below Threshold	Hardware fault detected inside EPM. Sensor not connected or High side/Low side open.	SD-27-5031
0x506F64	20591	100	Wheel 9 EPM: Signal Plausibility Failure	Sensor frequency is out of the specified ranges.	SD-27-5031
0x507012	20592	18	Wheel 10 EPM: Circuit Short To Battery	Internal WSS Analog signals are not in valid range. Short to Battery detected at high side or low side.	SD-27-5031
0x507014	20592	20	Wheel 10 EPM: Circuit Short To Ground or Open	Hardware fault detected inside EPM. Short to Gnd detected at high side or low side.	SD-27-5031
0x507018	20592	24	Wheel 10 EPM: Circuit Current Below Threshold	Hardware fault detected inside EPM. Sensor not connected or High side/Low side open.	SD-27-5031
0x507064	20592	100	Wheel 10 EPM: Signal Plausibility Failure	Sensor frequency is out of the specified ranges.	SD-27-5031
0x509556	20629	86	Electro-Pneumatic Module: Invalid/Incompatible Configuration	Error is set if inconsistency is found between EEPROM dataset of the GSBC ECU and EEPROM dataset of the EPMs, or if any of the EPMs has incompatible software version.	SD-27-5031

Table 20 - GSBC EPM-90 Diagnostic Trouble Codes (DTCs)

GSBC EPM-90 DTCS					
DTC #	SPN (J1939)	FMI (J1939)	DTC NAME	DTC DESCRIPTION	SD SHEET
0x50B712	20663	18	EPM0, PCL0 Pressure Sensor: Circuit Short To Battery	EPM internal electrical failure.	SD-27-5031
0x50B716	20663	22	EPM0, PCL0 Pressure Sensor: Circuit Voltage Below Threshold	EPM internal electrical failure.	SD-27-5031
0x50B718	20647	43	EPM0, PCL0 Pressure Sensor: Circuit Current Below Threshold	EPM internal electrical failure.	SD-27-5031
0x50B721	20663	33	EPM0, PCL0 Pressure Sensor: Signal Amplitude Less Than Minimum	EPM internal electrical failure.	SD-27-5031
0x50B722	20663	34	EPM0, PCL0 Pressure Sensor: Signal Amplitude Greater Than Maximum	EPM internal electrical failure.	SD-27-5031
0x50B728	20663	40	EPM0, PCL0 Pressure Sensor: Signal Bias Level Out of Range/Zero Adjustment Failure	The error is set if the internal EPM pressure sensor voltage signal is generally too low or too high (outside of valid signal range).	SD-27-5031
0x50B812	20664	18	EPM0, PCL1 Pressure Sensor: Circuit Short To Battery	EPM internal electrical failure.	SD-27-5031
0x50B816	20664	22	EPM0, PCL1 Pressure Sensor: Circuit Voltage Below Threshold	EPM internal electrical failure.	SD-27-5031
0x50B818	20664	24	EPM0, PCL1 Pressure Sensor: Circuit Current Below Threshold	EPM internal electrical failure.	SD-27-5031
0x50B821	20664	33	EPM0, PCL1 Pressure Sensor: Signal Amplitude Less Than Minimum	EPM internal electrical failure.	SD-27-5031
0x50B822	20664	34	EPM0, PCL1 Pressure Sensor: Signal Amplitude Greater Than Maximum	EPM internal electrical failure.	SD-27-5031
0x50B828	20664	40	EPM0, PCL1 Pressure Sensor: Signal Bias Level Out of Range/Zero Adjustment Failure	The error is set if the monitoring function detects too high pressure sensor offset while not braking.	SD-27-5031
0x50B912	20665	18	EPM1, PCL0 Pressure Sensor: Circuit Short To Battery	EPM internal electrical failure.	SD-27-5031
0x50B916	20665	22	EPM1, PCL0 Pressure Sensor: Circuit Voltage Below Threshold	EPM internal electrical failure.	SD-27-5031
0x50B918	20665	24	EPM1, PCL0 Pressure Sensor: Circuit Current Below Threshold	EPM internal electrical failure.	SD-27-5031
0x50B921	20665	33	EPM1, PCL0 Pressure Sensor: Signal Amplitude Less Than Minimum	EPM internal electrical failure.	SD-27-5031
0x50B922	20665	34	EPM1, PCL0 Pressure Sensor: Signal Amplitude Greater Than Maximum	EPM internal electrical failure.	SD-27-5031
0x50B928	20665	40	EPM1, PCL0 Pressure Sensor: Signal Bias Level Out of Range/Zero Adjustment Failure	The error is set if the internal EPM pressure sensor voltage signal is generally too low or too high (outside of valid signal range).	SD-27-5031
0x50BA12	20666	18	EPM1, PCL1 Pressure Sensor: Circuit Short To Battery	EPM internal electrical failure.	SD-27-5031
0x50BA16	20666	22	EPM1, PCL1 Pressure Sensor: Circuit Voltage Below Threshold	EPM internal electrical failure.	SD-27-5031

Table 20 - GSBC EPM-90 Diagnostic Trouble Codes (DTCs)

GSBC EPM-90 DTCS					
DTC #	**SPN (J1939)**	**FMI (J1939)**	**DTC NAME**	**DTC DESCRIPTION**	**SD SHEET**
0x50BA18	20666	24	EPM1, PCL1 Pressure Sensor: Circuit Current Below Threshold	EPM internal electrical failure.	SD-27-5031
0x50BA21	20666	33	EPM1, PCL1 Pressure Sensor: Signal Amplitude Less Than Minimum	EPM internal electrical failure.	SD-27-5031
0x50BA22	20666	34	EPM1, PCL1 Pressure Sensor: Signal Amplitude Greater Than Maximum	EPM internal electrical failure.	SD-27-5031
0x50BA28	20666	40	EPM1, PCL1 Pressure Sensor: Signal Bias Level Out of Range/Zero Adjustment Failure	The error is set if the monitoring function detects too high pressure sensor offset while not braking.	SD-27-5031
0x50BB12	20667	18	EPM2, PCL0 Pressure Sensor: Circuit Short To Battery	EPM internal electrical failure.	SD-27-5031
0x50BB16	20667	22	EPM2, PCL0 Pressure Sensor: Circuit Voltage Below Threshold	EPM internal electrical failure.	SD-27-5031
0x50BB18	20667	24	EPM2, PCL0 Pressure Sensor: Circuit Current Below Threshold	EPM internal electrical failure.	SD-27-5031
0x50BB21	20667	33	EPM2, PCL0 Pressure Sensor: Signal Amplitude Less Than Minimum	EPM internal electrical failure.	SD-27-5031
0x50BB22	20667	34	EPM2, PCL0 Pressure Sensor: Signal Amplitude Greater Than Maximum	EPM internal electrical failure.	SD-27-5031
0x50BB28	20667	40	EPM2, PCL0 Pressure Sensor: Signal Bias Level Out of Range/Zero Adjustment Failure	The error is set if the internal EPM pressure sensor voltage signal is generally too low or too high (outside of valid signal range).	SD-27-5031
0x50BC12	20668	18	EPM2, PCL1 Pressure Sensor: Circuit Short To Battery	EPM internal electrical failure.	SD-27-5031
0x50BC16	20668	22	EPM2, PCL1 Pressure Sensor: Circuit Voltage Below Threshold	EPM internal electrical failure.	SD-27-5031
0x50BC18	20668	24	EPM2, PCL1 Pressure Sensor: Circuit Current Below Threshold	EPM internal electrical failure.	SD-27-5031
0x50BC21	20668	33	EPM2, PCL1 Pressure Sensor: Signal Amplitude Less Than Minimum	EPM internal electrical failure.	SD-27-5031
0x50BC22	20668	34	EPM2, PCL1 Pressure Sensor: Signal Amplitude Greater Than Maximum	EPM internal electrical failure.	SD-27-5031
0x50BC28	20668	40	EPM2, PCL1 Pressure Sensor: Signal Bias Level Out of Range/Zero Adjustment Failure	The error is set if the monitoring function detects too high pressure sensor offset while not braking.	SD-27-5031
0x50BD12	20669	18	EPM3, PCL0 Pressure Sensor: Circuit Short To Battery	EPM internal electrical failure.	SD-27-5031

Table 20 - GSBC EPM-90 Diagnostic Trouble Codes (DTCs)

GSBC EPM-90 DTCS					
DTC #	SPN (J1939)	FMI (J1939)	DTC NAME	DTC DESCRIPTION	SD SHEET
0x50BD18	20669	24	EPM3, PCL0 Pressure Sensor: Circuit Current Below Threshold	EPM internal electrical failure.	SD-27-5031
0x50BD21	20669	33	EPM3, PCL0 Pressure Sensor: Signal Amplitude Less Than Minimum	EPM internal electrical failure.	SD-27-5031
0x50BD22	20669	34	EPM3, PCL0 Pressure Sensor: Signal Amplitude Greater Than Maximum	EPM internal electrical failure.	SD-27-5031
0x50BD28	20669	40	EPM3, PCL0 Pressure Sensor: Signal Bias Level Out of Range/Zero Adjustment Failure	The error is set if the internal EPM pressure sensor voltage signal is generally too low or too high (outside of valid signal range).	SD-27-5031
0x50BE12	20670	18	EPM3, PCL1 Pressure Sensor: Circuit Short To Battery	EPM internal electrical failure.	SD-27-5031
0x50BE16	20670	22	EPM3, PCL1 Pressure Sensor: Circuit Voltage Below Threshold	EPM internal electrical failure.	SD-27-5031
0x50BE18	20670	24	EPM3, PCL1 Pressure Sensor: Circuit Current Below Threshold	EPM internal electrical failure.	SD-27-5031
0x50BE21	20670	33	EPM3, PCL1 Pressure Sensor: Signal Amplitude Less Than Minimum	EPM internal electrical failure.	SD-27-5031
0x50BE22	20670	34	EPM3, PCL1 Pressure Sensor: Signal Amplitude Greater Than Maximum	EPM internal electrical failure.	SD-27-5031
0x50BE28	20670	40	EPM3, PCL1 Pressure Sensor: Signal Bias Level Out of Range/Zero Adjustment Failure	The error is set if the monitoring function detects too high pressure sensor offset while not braking.	SD-27-5031
0x50BF01	20671	1	Electro-Pneumatic Modulator 0: General Electrical Failure	This error is set if the supply voltage of a switched-off EPM is higher than 4V, while the EPM is switched off and another is switched on.	SD-27-5031
0x50BF02	20671	2	Electro-Pneumatic Modulator 0: General Signal Failure	The error is set if an EPM hardware fault is detected, or a special inactive DTC message is sent with wrong content, or if the reference voltage is out of range, or if the pressure demand value sent back by the EPM does not match any of the last 6 pressure demand values from the GSBC ECU.	SD-27-5031
0x50BF04	20671	4	Electro-Pneumatic Modulator 0: System Internal Failures	The failure is reported for a variety of EPM related internal faults.	SD-27-5031
0x50BF07	20671	7	Electro-Pneumatic Modulator 0: Mechanical Failures	The error is set if an EPM hardware fault is detected.	SD-27-5031
0x50BF09	20671	9	Electro-Pneumatic Modulator 0: Component Failures	EPM internal electrical failure.	SD-27-5031
0x50BF11	20671	17	Electro-Pneumatic Modulator 0: Circuit Short To Ground	The error is set if supply voltage of EPM becomes less than 4V or if EPM consumes more than 8A with supply of EPM switched on.	SD-27-5031
0x50BF12	20671	18	Electro-Pneumatic Modulator 0: Circuit Short To Battery	The error is set if supply voltage of EPM becomes higher than 4V with supply of EPM switched off.	SD-27-5031
0x50BF19	20671	25	Electro-Pneumatic Modulator 0: Circuit Current Above Threshold	The error is set if supply voltage of EPM becomes less than 4V or if EPM consumes more than 8A with supply of EPM switched on.	SD-27-5031
0x50BF25	20671	37	Electro-Pneumatic Modulator 0: Signal Shape/Waveform Failure	The error is set if implausible voltage drop, during valve activation, is detected.	SD-27-5031

Table 20 - GSBC EPM-90 Diagnostic Trouble Codes (DTCs)

GSBC EPM-90 DTCS					
DTC #	SPN (J1939)	FMI (J1939)	DTC NAME	DTC DESCRIPTION	SD SHEET
0x50BF29	20671	41	Electro-Pneumatic Modulator 0: Signal invalid	EPM internal electrical failure.	SD-27-5031
0x50BF56	20671	86	Electro-Pneumatic Modulator 0: Invalid/Incompatible Configuration	The error is set if implausible voltage drop, during valve activation, is detected.	SD-27-5031
0x50BF96	20671	150	Electro-Pneumatic Modulator 0: Component Internal Failure	The error is set if test routines detect an internal hardware error of the EPM.	SD-27-5031
0x50BF98	20671	152	Electro-Pneumatic Modulator 0: Component or System Over Temperature	EPM PCB temperature exceeds the upper threshold temperature (248°F/120°C).	SD-27-5031
0x50BF9D	20671	157	Electro-Pneumatic Modulator 0: Component or System Under Temperature	EPM PCB temperature exceeds the lower threshold temperature (-40 degrees F/C).	SD-27-5031
0x50C001	20672	1	Electro-Pneumatic Modulator 1: General Electrical Failure	This error is set if the supply voltage of a switched-off EPM is higher than 4V, while the EPM is switched off and another is switched on.	SD-27-5031
0x50C002	20672	2	Electro-Pneumatic Modulator 1: General Signal Failure	The error is set if an EPM hardware fault is detected, or a special inactive DTC message is sent with wrong content, or if the reference voltage is out of range, or if the pressure demand value sent back by the EPM does not match any of the last 6 pressure demand values from the GSBC ECU.	SD-27-5031
0x50C004	20672	4	Electro-Pneumatic Modulator 1: System Internal Failures	The failure is reported for a variety of EPM related internal faults.	SD-27-5031
0x50C007	20672	7	Electro-Pneumatic Modulator 1: Mechanical Failures	The error is set if an EPM hardware fault is detected.	SD-27-5031
0x50C009	20672	9	Electro-Pneumatic Modulator 1: Component Failures	EPM internal electrical failure.	SD-27-5031
0x50C011	20672	17	Electro-Pneumatic Modulator 1: Circuit Short To Ground	The error is set if supply voltage of EPM becomes less than 4V or if EPM consumes more than 8A with supply of EPM switched on.	SD-27-5031
0x50C012	20672	18	Electro-Pneumatic Modulator 1: Circuit Short To Battery	The error is set if supply voltage of EPM becomes higher than 4V with supply of EPM switched off.	SD-27-5031
0x50C019	20672	25	Electro-Pneumatic Modulator 1: Circuit Current Above Threshold	The error is set if supply voltage of EPM becomes less than 4V or if EPM consumes more than 8A with supply of EPM switched on.	SD-27-5031
0x50C025	20672	37	Electro-Pneumatic Modulator 1: Signal Shape/Waveform Failure	The error is set if implausible voltage drop, during valve activation, is detected.	SD-27-5031
0x50C029	20672	41	Electro-Pneumatic Modulator 1: Signal Invalid	EPM internal electrical failure.	SD-27-5031
0x50C056	20672	86	Electro-Pneumatic Modulator 1: Invalid/Incompatible Configuration	The error is set if implausible voltage drop, during valve activation, is detected.	SD-27-5031
0x50C096	20672	150	Electro-Pneumatic Modulator 1: Component Internal Failure	The error is set if test routines detect an internal hardware error of the EPM.	SD-27-5031
0x50C098	20672	152	Electro-Pneumatic Modulator 1: Component or System Over Temperature	EPM PCB temperature exceeds the upper threshold temperature (248°F/120°C).	SD-27-5031
0x50C09D	20672	157	Electro-Pneumatic Modulator 1: Component or System Under Temperature	EPM PCB temperature exceeds the lower threshold temperature (-40 degrees F/C).	SD-27-5031

Table 20 - GSBC EPM-90 Diagnostic Trouble Codes (DTCs)

GSBC EPM-90 DTCS					
DTC #	SPN (J1939)	FMI (J1939)	DTC NAME	DTC DESCRIPTION	SD SHEET
0x50C102	20673	2	Electro-Pneumatic Modulator 2: General Signal Failure	The error is set if an EPM hardware fault is detected, or a special inactive DTC message is sent with wrong content, or if the reference voltage is out of range, or if the pressure demand value sent back by the EPM does not match any of the last 6 pressure demand values from the GSBC ECU.	SD-27-5031
0x50C104	20673	4	Electro-Pneumatic Modulator 2: System Internal Failures	The failure is reported for a variety of EPM related internal faults.	SD-27-5031
0x50C107	20673	7	Electro-Pneumatic Modulator 2: Mechanical Failures	The error is set if an EPM hardware fault is detected.	SD-27-5031
0x50C109	20673	9	Electro-Pneumatic Modulator 2: Component Failures	EPM internal electrical failure.	SD-27-5031
0x50C111	20673	17	Electro-Pneumatic Modulator 2: Circuit Short To Ground	The error is set if supply voltage of EPM becomes less than 4V or if EPM consumes more than 8A with supply of EPM switched on.	SD-27-5031
0x50C112	20673	18	Electro-Pneumatic Modulator 2: Circuit Short To Battery	The error is set if supply voltage of EPM becomes higher than 4V with supply of EPM switched off.	SD-27-5031
0x50C119	20673	25	Electro-Pneumatic Modulator 2: Circuit Current Above Threshold	The error is set if supply voltage of EPM becomes less than 4V or if EPM consumes more than 8A with supply of EPM switched on.	SD-27-5031
0x50C125	20673	37	Electro-Pneumatic Modulator 2: Signal Shape/Waveform Failure	The error is set if implausible voltage drop, during valve activation, is detected.	SD-27-5031
0x50C129	20673	41	Electro-Pneumatic Modulator 2: Signal Invalid	EPM internal electrical failure.	SD-27-5031
0x50C156	20673	86	Electro-Pneumatic Modulator 2: Invalid/Incompatible Configuration	The error is set if implausible voltage drop, during valve activation, is detected.	SD-27-5031
0x50C196	20673	150	Electro-Pneumatic Modulator 2: Component Internal Failure	The error is set if test routines detect an internal hardware error of the EPM.	SD-27-5031
0x50C198	20673	152	Electro-Pneumatic Modulator 2: Component or System Over Temperature	EPM PCB temperature exceeds the upper threshold temperature (248°F/120°C).	SD-27-5031
0x50C19D	20673	157	Electro-Pneumatic Modulator 2: Component or System Under Temperature	EPM PCB temperature exceeds the lower threshold temperature (-40 degrees°F/°C).	SD-27-5031
0x50C201	20674	1	Electro-Pneumatic Modulator 3: General Electrical Failure	This error is set if the supply voltage of a switched-off EPM is higher than 4V, while the EPM is switched off and another is switched on.	SD-27-5031
0x50C202	20674	2	Electro-Pneumatic Modulator 3: General Signal Failure	The error is set if an EPM hardware fault is detected, or a special inactive DTC message is sent with wrong content, or if the reference voltage is out of range, or if the pressure demand value sent back by the EPM does not match any of the last 6 pressure demand values from the GSBC ECU.	SD-27-5031
0x50C204	20674	4	Electro-Pneumatic Modulator 3: System Internal Failures	The failure is reported for a variety of EPM related internal faults.	SD-27-5031
0x50C207	20674	7	Electro-Pneumatic Modulator 3: Mechanical Failures	The error is set if an EPM hardware fault is detected.	SD-27-5031
0x50C209	20674	9	Electro-Pneumatic Modulator 3: Component Failures	EPM internal electrical failure.	SD-27-5031
0x50C211	20674	17	Electro-Pneumatic Modulator 3: Circuit Short To Ground	The error is set if supply voltage of EPM becomes less than 4V or if EPM consumes more than 8A with supply of EPM switched on.	SD-27-5031

Table 20 - GSBC EPM-90 Diagnostic Trouble Codes (DTCs)

GSBC EPM-90 DTCS					
DTC #	**SPN (J1939)**	**FMI (J1939)**	**DTC NAME**	**DTC DESCRIPTION**	**SD SHEET**
0x50C212	20674	18	Electro-Pneumatic Modulator 3: Circuit Short To Battery	The error is set if supply voltage of EPM becomes higher than 4V with supply of EPM switched off.	SD-27-5031
0x50C219	20674	25	Electro-Pneumatic Modulator 3: Circuit Current Above Threshold	The error is set if supply voltage of EPM becomes less than 4V or if EPM consumes more than 8A with supply of EPM switched on.	SD-27-5031
0x50C225	20674	37	Electro-Pneumatic Modulator 3: Signal Shape/Waveform Failure	The error is set if implausible voltage drop, during valve activation, is detected.	SD-27-5031
0x50C229	20674	41	Electro-Pneumatic Modulator 3: Signal Invalid	EPM internal electrical failure.	SD-27-5031
0x50C256	20674	86	Electro-Pneumatic Modulator 3: Invalid/Incompatible Configuration	The error is set if implausible voltage drop, during valve activation, is detected.	SD-27-5031
0x50C296	20674	150	Electro-Pneumatic Modulator 3: Component Internal Failure	The error is set if test routines detect an internal hardware error of the EPM.	SD-27-5031
0x50C298	20674	152	Electro-Pneumatic Modulator 3: Component or System Over Temperature	EPM PCB temperature exceeds the upper threshold temperature (248°F/120°C).	SD-27-5031
0x50C29D	20674	157	Electro-Pneumatic Modulator 3: Component or System Under Temperature	EPM PCB temperature exceeds the lower threshold temperature (-40 degrees °F/°C).	SD-27-5031
0x50C322	20675	34	EPM0, Pressure Control Loop0: Signal Amplitude Greater Than Maximum	This fault detects trapped pressure in the FBM and/or the EPM.	SD-27-5031
0x50C371	20675	113	EPM0, Pressure Control Loop0: Actuator Stuck	This error is set if the EPM detects trapped pressure.	SD-27-5031
0x50C377	20675	119	EPM0, Pressure Control Loop0: Commanded Position Not Reachable	This error is set if an EPM does not pass an automatic performance test, which could indicate trapped pressure.	SD-27-5031
0x50C37E	20675	126	EPM0, Pressure Control Loop0: Actuator Stuck On	This fault detects trapped pressure in the FBM and/or the EPM.	SD-27-5031
0x50C422	20676	34	EPM0, Pressure Control Loop1: Signal Amplitude Greater Than Maximum	This fault detects trapped pressure in the FBM and/or the EPM.	SD-27-5031
0x50C471	20676	113	EPM0, Pressure Control Loop1: Actuator Stuck	This error is set if the EPM detects trapped pressure.	SD-27-5031
0x50C477	20676	119	EPM0, Pressure Control Loop1: Commanded Position Not Reachable	This error is set if an EPM does not pass an automatic performance test, which could indicate trapped pressure.	SD-27-5031
0x50C47E	20676	126	EPM0, Pressure Control Loop1: Actuator Stuck On	This fault detects trapped pressure in the FBM and/or the EPM.	SD-27-5031
0x50C522	20677	34	EPM1, Pressure Control Loop0: Signal Amplitude Greater Than Maximum	This fault detects trapped pressure in the FBM and/or the EPM.	SD-27-5031
0x50C571	20677	113	EPM1, Pressure Control Loop0: Actuator Stuck	This error is set if the EPM detects trapped pressure.	SD-27-5031
0x50C577	20677	119	EPM1, Pressure Control Loop0: Commanded Position Not Reachable	This error is set if an EPM does not pass an automatic performance test, which could indicate trapped pressure.	SD-27-5031
0x50C57E	20677	126	EPM1, Pressure Control Loop0: Actuator Stuck On	This fault detects trapped pressure in the FBM and/or the EPM.	SD-27-5031

Table 20 - GSBC EPM-90 Diagnostic Trouble Codes (DTCs)

GSBC EPM-90 DTCS					
DTC #	SPN (J1939)	FMI (J1939)	DTC NAME	DTC DESCRIPTION	SD SHEET
0x50C671	20678	113	EPM1, Pressure Control Loop1: Actuator Stuck	This error is set if the EPM detects trapped pressure.	SD-27-5031
0x50C677	20678	119	EPM1, Pressure Control Loop1: Commanded Position Not Reachable	This error is set if an EPM does not pass an automatic performance test, which could indicate trapped pressure.	SD-27-5031
0x50C67E	20678	126	EPM1, Pressure Control Loop1: Actuator Stuck On	This fault detects trapped pressure in the FBM and/or the EPM.	SD-27-5031
0x50C722	20679	34	EPM2, Pressure Control Loop0: Signal Amplitude Greater Than Maximum	This fault detects trapped pressure in the FBM and/or the EPM.	SD-27-5031
0x50C771	20679	113	EPM2, Pressure Control Loop0: Actuator Stuck	This error is set if the EPM detects trapped pressure.	SD-27-5031
0x50C777	20679	119	EPM2, Pressure Control Loop0: Commanded Position Not Reachable	This error is set if an EPM does not pass an automatic performance test, which could indicate trapped pressure.	SD-27-5031
0x50C77E	20679	126	EPM2, Pressure Control Loop0: Actuator Stuck On	This fault detects trapped pressure in the FBM and/or the EPM.	SD-27-5031
0x50C822	20680	34	EPM2, Pressure Control Loop1: Signal Amplitude Greater Than Maximum	This fault detects trapped pressure in the FBM and/or the EPM.	SD-27-5031
0x50C871	20680	113	EPM2, Pressure Control Loop1: Actuator Stuck	This error is set if the EPM detects trapped pressure.	SD-27-5031
0x50C877	20680	119	EPM2, Pressure Control Loop1: Commanded Position Not Reachable	This error is set if an EPM does not pass an automatic performance test, which could indicate trapped pressure.	SD-27-5031
0x50C87E	20680	126	EPM2, Pressure Control Loop1: Actuator Stuck On	This fault detects trapped pressure in the FBM and/or the EPM.	SD-27-5031
0x50C922	20681	34	EPM3, Pressure Control Loop0: Signal Amplitude Greater Than Maximum	This fault detects trapped pressure in the FBM and/or the EPM.	SD-27-5031
0x50C971	20681	113	EPM3, Pressure Control Loop0: Actuator Stuck	This error is set if the EPM detects trapped pressure.	SD-27-5031
0x50C977	20681	119	EPM3, Pressure Control Loop0: Commanded Position Not Reachable	This error is set if an EPM does not pass an automatic performance test, which could indicate trapped pressure.	SD-27-5031
0x50C97E	20681	126	EPM3, Pressure Control Loop0: Actuator Stuck On	This fault detects trapped pressure in the FBM and/or the EPM.	SD-27-5031
0x50CA22	20682	34	EPM3, Pressure Control Loop1: Signal Amplitude Greater Than Maximum	This fault detects trapped pressure in the FBM and/or the EPM.	SD-27-5031
0x50CA71	20682	113	EPM3, Pressure Control Loop1: Actuator Stuck	This error is set if the EPM detects trapped pressure.	SD-27-5031
0x50CA77	20682	119	EPM3, Pressure Control Loop1: Commanded Position Not Reachable	This error is set if an EPM does not pass an automatic performance test, which could indicate trapped pressure.	SD-27-5031
0x50CA7E	20682	126	EPM3, Pressure Control Loop1: Actuator Stuck On	This fault detects trapped pressure in the FBM and/or the EPM.	SD-27-5031
0x50CB11	20683	17	EPM0, PCL0, Inlet Solenoid Valve: Circuit Short To Ground	EPM internal electrical failure.	SD-27-5031
0x50CB12	20683	18	EPM0, PCL0, Inlet Solenoid Valve: Circuit Short To Battery	EPM internal electrical failure.	SD-27-5031
0x50CB18	20683	24	EPM0, PCL0, Inlet Solenoid Valve: Circuit Current Below Threshold	EPM internal electrical failure.	SD-27-5031
0x50CB2B	20683	43	EPM0, PCL0, Inlet Solenoid Valve: Signal Cross Coupled	EPM internal electrical failure.	SD-27-5031

Table 20 - GSBC EPM-90 Diagnostic Trouble Codes (DTCs)

GSBC EPM-90 DTCS					
DTC #	SPN (J1939)	FMI (J1939)	DTC NAME	DTC DESCRIPTION	SD SHEET
0x50CB71	20683	113	EPM0, PCL0, Inlet Solenoid Valve: Actuator Stuck	Measured EPM pressure response not sufficient given the system reported reservoir pressure.	SD-27-5031
0x50CC11	1292	17	EPM0, PCL1, Inlet Solenoid Valve: Circuit Short To Ground	EPM internal electrical failure.	SD-27-5031
0x50CC12	20684	18	EPM0, PCL1, Inlet Solenoid Valve: Circuit Short To Battery	EPM internal electrical failure.	SD-27-5031
0x50CC18	20684	24	EPM0, PCL1, Inlet Solenoid Valve: Circuit Current Below Threshold	EPM internal electrical failure.	SD-27-5031
0x50CC2B	20684	43	EPM0, PCL1, Inlet Solenoid Valve: Signal Cross Coupled	EPM internal electrical failure.	SD-27-5031
0x50CC71	20684	113	EPM0, PCL1, Inlet Solenoid Valve: Actuator Stuck	Measured EPM pressure response not sufficient given the system reported reservoir pressure.	SD-27-5031
0x50CD11	20685	17	EPM1, PCL0, Inlet Solenoid Valve: Circuit Short To Ground	EPM internal electrical failure.	SD-27-5031
0x50CD12	20685	18	EPM1, PCL0, Inlet Solenoid Valve: Circuit Short To Battery	EPM internal electrical failure.	SD-27-5031
0x50CD18	20685	24	EPM1, PCL0, Inlet Solenoid Valve: Circuit Current Below Threshold	EPM internal electrical failure.	SD-27-5031
0x50CD2B	20685	43	EPM1, PCL0, Inlet Solenoid Valve: Signal Cross Coupled	EPM internal electrical failure.	SD-27-5031
0x50CD71	20685	113	EPM1, PCL0, Inlet Solenoid Valve: Actuator Stuck	Measured EPM pressure response not sufficient given the system reported reservoir pressure.	SD-27-5031
0x50CE11	20686	17	EPM1, PCL1, Inlet Solenoid Valve: Circuit Short To Ground	EPM internal electrical failure.	SD-27-5031
0x50CE12	20686	18	EPM1, PCL1, Inlet Solenoid Valve: Circuit Short To Battery	EPM internal electrical failure.	SD-27-5031
0x50CE18	20686	24	EPM1, PCL1, Inlet Solenoid Valve: Circuit Current Below Threshold	EPM internal electrical failure.	SD-27-5031
0x50CE2B	20686	43	EPM1, PCL1, Inlet Solenoid Valve: Signal Cross Coupled	EPM internal electrical failure.	SD-27-5031
0x50CE71	20686	113	EPM1, PCL1, Inlet Solenoid Valve: Actuator Stuck	Measured EPM pressure response not sufficient given the system reported reservoir pressure.	SD-27-5031
0x50CF11	20687	17	EPM2, PCL0, Inlet Solenoid Valve: Circuit Short To Ground	EPM internal electrical failure.	SD-27-5031
0x50CF12	20687	18	EPM2, PCL0, Inlet Solenoid Valve: Circuit Short To Battery	EPM internal electrical failure.	SD-27-5031
0x50CF18	20687	24	EPM2, PCL0, Inlet Solenoid Valve: Circuit Current Below Threshold	EPM internal electrical failure.	SD-27-5031
0x50CF2B	20687	43	EPM2, PCL0, Inlet Solenoid Valve: Signal Cross Coupled	EPM internal electrical failure.	SD-27-5031

Table 20 - GSBC EPM-90 Diagnostic Trouble Codes (DTCs)

GSBC EPM-90 DTCS					
DTC #	SPN (J1939)	FMI (J1939)	DTC NAME	DTC DESCRIPTION	SD SHEET
0x50D011	20688	17	EPM2, PCL1, Inlet Solenoid Valve: Circuit Short To Ground	EPM internal electrical failure.	SD-27-5031
0x50D012	20688	18	EPM2, PCL1, Inlet Solenoid Valve: Circuit Short To Battery	EPM internal electrical failure.	SD-27-5031
0x50D018	20688	24	EPM2, PCL1, Inlet Solenoid Valve: Circuit Current Below Threshold	EPM internal electrical failure.	SD-27-5031
0x50D02B	20688	43	EPM2, PCL1, Inlet Solenoid Valve: Signal Cross Coupled	EPM internal electrical failure.	SD-27-5031
0x50D071	20688	113	EPM2, PCL1, Inlet Solenoid Valve: Actuator Stuck	Measured EPM pressure response not sufficient given the system reported reservoir pressure.	SD-27-5031
0x50D111	20689	17	EPM3, PCL0, Inlet Solenoid Valve: Circuit Short To Ground	EPM internal electrical failure.	SD-27-5031
0x50D112	20689	18	EPM3, PCL0, Inlet Solenoid Valve: Circuit Short To Battery	EPM internal electrical failure.	SD-27-5031
0x50D118	20689	24	EPM3, PCL0, Inlet Solenoid Valve: Circuit Current Below Threshold	EPM internal electrical failure.	SD-27-5031
0x50D12B	20689	43	EPM3, PCL0, Inlet Solenoid Valve: Signal Cross Coupled	EPM internal electrical failure.	SD-27-5031
0x50D171	20689	113	EPM3, PCL0, Inlet Solenoid Valve: Actuator Stuck	Measured EPM pressure response not sufficient given the system reported reservoir pressure.	SD-27-5031
0x50D211	20690	17	EPM3, PCL1, Inlet Solenoid Valve: Circuit Short To Ground	EPM internal electrical failure.	SD-27-5031
0x50D212	20690	18	EPM3, PCL1, Inlet Solenoid Valve: Circuit Short To Battery	EPM internal electrical failure.	SD-27-5031
0x50D218	20690	24	EPM3, PCL1, Inlet Solenoid Valve: Circuit Current Below Threshold	EPM internal electrical failure.	SD-27-5031
0x50D22B	20690	43	EPM3, PCL1, Inlet Solenoid Valve: Signal Cross Coupled	EPM internal electrical failure.	SD-27-5031
0x50D271	20690	113	EPM3, PCL1, Inlet Solenoid Valve: Actuator Stuck	Measured EPM pressure response not sufficient given the system reported reservoir pressure.	SD-27-5031
0x50D311	20691	17	EPM0, PCL0, Outlet Solenoid Valve: Circuit Short To Ground	EPM internal electrical failure.	SD-27-5031
0x50D312	20691	18	EPM0, PCL0, Outlet Solenoid Valve: Circuit Short To Battery	EPM internal electrical failure.	SD-27-5031
0x50D318	20691	24	EPM0, PCL0, Outlet Solenoid Valve: Circuit Current Below Threshold	EPM internal electrical failure.	SD-27-5031
0x50D32B	20691	43	EPM0, PCL0, Outlet Solenoid Valve: Signal Cross Coupled	EPM internal electrical failure.	SD-27-5031
0x50D371	20691	113	EPM0, PCL0, Outlet Solenoid Valve: Actuator Stuck	Fault set if EPM detects trapped pressure. Fault could be in FBM, EPM, or related plumbing.	SD-27-5031

Table 20 - GSBC EPM-90 Diagnostic Trouble Codes (DTCs)

GSBC EPM-90 DTCS					
DTC #	**SPN (J1939)**	**FMI (J1939)**	**DTC NAME**	**DTC DESCRIPTION**	**SD SHEET**
0x50D411	20692	17	EPM0, PCL1, Outlet Solenoid Valve: Circuit Short To Ground	EPM internal electrical failure.	SD-27-5031
0x50D412	20692	18	EPM0, PCL1, Outlet Solenoid Valve: Circuit Short To Battery	EPM internal electrical failure.	SD-27-5031
0x50D418	20692	24	EPM0, PCL1, Outlet Solenoid Valve: Circuit Current Below Threshold	EPM internal electrical failure.	SD-27-5031
0x50D42B	20692	43	EPM0, PCL1, Outlet Solenoid Valve: Signal Cross Coupled	EPM internal electrical failure.	SD-27-5031
0x50D471	20692	113	EPM0, PCL1, Outlet Solenoid Valve: Actuator Stuck	Fault set if EPM detects trapped pressure. Fault could be in FBM, EPM, or related plumbing.	SD-27-5031
0x50D511	20693	17	EPM1, PCL0, Outlet Solenoid Valve: Circuit Short To Ground	EPM internal electrical failure.	SD-27-5031
0x50D512	20693	18	EPM1, PCL0, Outlet Solenoid Valve: Circuit Short To Battery	EPM internal electrical failure.	SD-27-5031
0x50D518	20693	24	EPM1, PCL0, Outlet Solenoid Valve: Circuit Current Below Threshold	EPM internal electrical failure.	SD-27-5031
0x50D52B	20693	43	EPM1, PCL0, Outlet Solenoid Valve: Signal Cross Coupled	EPM internal electrical failure.	SD-27-5031
0x50D571	20693	113	EPM1, PCL0, Outlet Solenoid Valve: Actuator Stuck	Fault set if EPM detects trapped pressure. Fault could be in FBM, EPM, or related plumbing.	SD-27-5031
0x50D611	20694	17	EPM1, PCL1, Outlet Solenoid Valve: Circuit Short To Ground	EPM internal electrical failure.	SD-27-5031
0x50D612	20694	18	EPM1, PCL1, Outlet Solenoid Valve: Circuit Short To Battery	EPM internal electrical failure.	SD-27-5031
0x50D618	20694	24	EPM1, PCL1, Outlet Solenoid Valve: Circuit Current Below Threshold	EPM internal electrical failure.	SD-27-5031
0x50D62B	20694	43	EPM1, PCL1, Outlet Solenoid Valve: Signal Cross Coupled	EPM internal electrical failure.	SD-27-5031
0x50D671	20694	113	EPM1, PCL1, Outlet Solenoid Valve: Actuator Stuck	Fault set if EPM detects trapped pressure. Fault could be in FBM, EPM, or related plumbing.	SD-27-5031
0x50D711	20695	17	EPM2, PCL0, Outlet Solenoid Valve: Circuit Short To Ground	EPM internal electrical failure.	SD-27-5031
0x50D712	20695	18	EPM2, PCL0, Outlet Solenoid Valve: Circuit Short To Battery	EPM internal electrical failure.	SD-27-5031
0x50D718	20695	24	EPM2, PCL0, Outlet Solenoid Valve: Circuit Current Below Threshold	EPM internal electrical failure.	SD-27-5031
0x50D72B	20695	43	EPM2, PCL0, Outlet Solenoid Valve: Signal Cross Coupled	EPM internal electrical failure.	SD-27-5031

Table 20 - GSBC EPM-90 Diagnostic Trouble Codes (DTCs)

GSBC EPM-90 DTCS					
DTC #	SPN (J1939)	FMI (J1939)	DTC NAME	DTC DESCRIPTION	SD SHEET
0x50D811	20696	17	EPM2, PCL1, Outlet Solenoid Valve: Circuit Short To Ground	EPM internal electrical failure.	SD-27-5031
0x50D812	20696	18	EPM2, PCL1, Outlet Solenoid Valve: Circuit Short To Battery	EPM internal electrical failure.	SD-27-5031
0x50D818	20696	24	EPM2, PCL1, Outlet Solenoid Valve: Circuit Current Below Threshold	EPM internal electrical failure.	SD-27-5031
0x50D82B	20696	43	EPM2, PCL1, Outlet Solenoid Valve: Signal Cross Coupled	EPM internal electrical failure.	SD-27-5031
0x50D871	20696	113	EPM2, PCL1, Outlet Solenoid Valve: Actuator Stuck	Fault set if EPM detects trapped pressure. Fault could be in FBM, EPM, or related plumbing.	SD-27-5031
0x50D911	20697	17	EPM3, PCL0, Outlet Solenoid Valve: Circuit Short To Ground	EPM internal electrical failure.	SD-27-5031
0x50D912	20697	18	EPM3, PCL0, Outlet Solenoid Valve: Circuit Short To Battery	EPM internal electrical failure.	SD-27-5031
0x50D918	20697	24	EPM3, PCL0, Outlet Solenoid Valve: Circuit Current Below Threshold	EPM internal electrical failure.	SD-27-5031
0x50D92B	20697	43	EPM3, PCL0, Outlet Solenoid Valve: Signal Cross Coupled	EPM internal electrical failure.	SD-27-5031
0x50D971	20697	113	EPM3, PCL0, Outlet Solenoid Valve: Actuator Stuck	Fault set if EPM detects trapped pressure. Fault could be in FBM, EPM, or related plumbing.	SD-27-5031
0x50DA11	20698	17	EPM3, PCL1, Outlet Solenoid Valve: Circuit Short To Ground	EPM internal electrical failure.	SD-27-5031
0x50DA12	20698	18	EPM3, PCL1, Outlet Solenoid Valve: Circuit Short To Battery	EPM internal electrical failure.	SD-27-5031
0x50DA18	20698	24	EPM3, PCL1, Outlet Solenoid Valve: Circuit Current Below Threshold	EPM internal electrical failure.	SD-27-5031
0x50DA2B	20698	43	EPM3, PCL1, Outlet Solenoid Valve: Signal Cross Coupled	EPM internal electrical failure.	SD-27-5031
0x50DA71	20698	113	EPM3, PCL1, Outlet Solenoid Valve: Actuator Stuck	Fault set if EPM detects trapped pressure. Fault could be in FBM, EPM, or related plumbing.	SD-27-5031
0x50DB11	20699	17	EPM0, PCL0, Backup Solenoid Valve: Circuit Short To Ground	EPM internal electrical failure.	SD-27-5031
0x50DB12	20699	18	EPM0, PCL0, Backup Solenoid Valve: Circuit Short To Battery	EPM internal electrical failure.	SD-27-5031
0x50DB18	20699	24	EPM0, PCL0, Backup Solenoid Valve: Circuit Current Below Threshold	EPM internal electrical failure.	SD-27-5031
0x50DB2B	20699	43	EPM0, PCL0, Backup Solenoid Valve: Signal Cross Coupled	EPM internal electrical failure.	SD-27-5031
0x50DC11	20700	17	EPM0, PCL1, Backup Solenoid Valve: Circuit Short To Ground	EPM internal electrical failure.	SD-27-5031

Table 20 - GSBC EPM-90 Diagnostic Trouble Codes (DTCs)

GSBC EPM-90 DTCS					
DTC #	**SPN (J1939)**	**FMI (J1939)**	**DTC NAME**	**DTC DESCRIPTION**	**SD SHEET**
0x50DC12	20700	18	EPM0, PCL1, Backup Solenoid Valve: Circuit Short To Battery	EPM internal electrical failure.	SD-27-5031
0x50DC18	20700	24	EPM0, PCL1, Backup Solenoid Valve: Circuit Current Below Threshold	EPM internal electrical failure.	SD-27-5031
0x50DC2B	20700	43	EPM0, PCL1, Backup Solenoid Valve: Signal Cross Coupled	EPM internal electrical failure.	SD-27-5031
0x50DD11	20701	17	EPM1, PCL0, Backup Solenoid Valve: Circuit Short To Ground	EPM internal electrical failure.	SD-27-5031
0x50DD12	20701	18	EPM1, PCL0, Backup Solenoid Valve: Circuit Short To Battery	EPM internal electrical failure.	SD-27-5031
0x50DD18	20701	24	EPM1, PCL0, Backup Solenoid Valve: Circuit Current Below Threshold	EPM internal electrical failure.	SD-27-5031
0x50DD2B	20701	43	EPM1, PCL0, Backup Solenoid Valve: Signal Cross Coupled	EPM internal electrical failure.	SD-27-5031
0x50DE11	20702	17	EPM1, PCL1, Backup Solenoid Valve: Circuit Short To Ground	EPM internal electrical failure.	SD-27-5031
0x50DE12	20702	18	EPM1, PCL1, Backup Solenoid Valve: Circuit Short To Battery	EPM internal electrical failure.	SD-27-5031
0x50DE18	20702	24	EPM1, PCL1, Backup Solenoid Valve: Circuit Current Below Threshold	EPM internal electrical failure.	SD-27-5031
0x50DE2B	20702	43	EPM1, PCL1, Backup Solenoid Valve: Signal Cross Coupled	EPM internal electrical failure.	SD-27-5031
0x50DF11	20703	17	EPM2, PCL0, Backup Solenoid Valve: Circuit Short To Ground	EPM internal electrical failure.	SD-27-5031
0x50DF12	20703	18	EPM2, PCL0, Backup Solenoid Valve: Circuit Short To Battery	EPM internal electrical failure.	SD-27-5031
0x50DF18	20703	24	EPM2, PCL0, Backup Solenoid Valve: Circuit Current Below Threshold	EPM internal electrical failure.	SD-27-5031
0x50DF2B	20703	43	EPM2, PCL0, Backup Solenoid Valve: Signal Cross Coupled	EPM internal electrical failure.	SD-27-5031
0x50E011	20704	17	EPM2, PCL1, Backup Solenoid Valve: Circuit Short To Ground	EPM internal electrical failure.	SD-27-5031
0x50E012	20704	18	EPM2, PCL1, Backup Solenoid Valve: Circuit Short To Battery	EPM internal electrical failure.	SD-27-5031
0x50E018	20704	24	EPM2, PCL1, Backup Solenoid Valve: Circuit Current Below Threshold	EPM internal electrical failure.	SD-27-5031
0x50E02B	20704	43	EPM2, PCL1, Backup Solenoid Valve: Signal Cross Coupled	EPM internal electrical failure.	SD-27-5031

Table 20 - GSBC EPM-90 Diagnostic Trouble Codes (DTCs)

GSBC EPM-90 DTCS					
DTC #	SPN (J1939)	FMI (J1939)	DTC NAME	DTC DESCRIPTION	SD SHEET
0x50E112	20705	18	EPM3, PCL0, Backup Solenoid Valve: Circuit Short To Battery	EPM internal electrical failure.	SD-27-5031
0x50E118	20705	24	EPM3, PCL0, Backup Solenoid Valve: Circuit Current Below Threshold	EPM internal electrical failure.	SD-27-5031
0x50E12B	20705	43	EPM3, PCL0, Backup Solenoid Valve: Signal Cross Coupled	EPM internal electrical failure.	SD-27-5031
0x50E211	20706	17	EPM3, PCL1, Backup Solenoid Valve: Circuit Short To Ground	EPM internal electrical failure.	SD-27-5031
0x50E212	20706	18	EPM3, PCL1, Backup Solenoid Valve: Circuit Short To Battery	EPM internal electrical failure.	SD-27-5031
0x50E218	20706	24	EPM3, PCL1, Backup Solenoid Valve: Circuit Current Below Threshold	EPM internal electrical failure.	SD-27-5031
0x50E22B	20706	43	EPM3, PCL1, Backup Solenoid Valve: Signal Cross Coupled	EPM internal electrical failure.	SD-27-5031
0x50E367	20707	103	EPM, Pneumatic Backup Circuit: Signal Incorrect After Event	Temporary Brake Test Failure: EPM reports insufficient pressure delivered by FBM.	SD-27-5031
0xD0011F	49153	31	Lost Communication With EPM0: Circuit Intermittent	EPM internal electrical failure.	SD-27-5031
0xD0018F	53249	143	Lost Communication With EPM0: Erratic	Inconsistent communications between EPM and GSBC ECU.	SD-27-5031
0xD0021F	53250	31	Lost Communication With EPM1: Circuit Intermittent	EPM internal electrical failure.	SD-27-5031
0xD0028F	53250	143	Lost Communication With EPM1: Erratic	Inconsistent communications between EPM and GSBC ECU.	SD-27-5031
0xD0031F	53251	31	Lost Communication With EPM2: Circuit Intermittent	EPM internal electrical failure.	SD-27-5031
0xD0038F	53251	143	Lost Communication With EPM2: Erratic	Inconsistent communications between EPM and GSBC ECU.	SD-27-5031
0xD0041F	53252	31	Lost Communication With EPM3: Circuit Intermittent	EPM internal electrical failure.	SD-27-5031
0xD0048F	53252	143	Lost Communication With EPM3: Erratic	Inconsistent communications between EPM and GSBC ECU.	SD-27-5031

Table 20 - GSBC EPM-90 Diagnostic Trouble Codes (DTCs)

GSBC E-TPCM-90 DTCS

IMPORTANT

For all repair steps, first complete the following:

1. **Generate an ACom Diagnostic Software report.**
2. **Clear DTCs.**
3. **Continue with repair information for each active DTC that will not clear.**

NOTE: After completing all repairs, drive the vehicle to ensure the repairs were sufficient.

4. **Once repairs have been made, clear the DTC again.**

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GSBC ETPCM-90 DTCS					
DTC #	**SPN (J1939)**	**FMI (J1939)**	**DTC NAME**	**DTC DESCRIPTION**	**SD SHEET**
0x500022	20480	34	Signal amplitude greater than maximum	eTPCM sensor signal voltage is higher than 4.5V	SD-27-5036
0x500028	20480	40	Signal bias level out of range/ zero adjustment failure	Measured voltage never comes into the offset range (0.5-0.85V)	SD-27-5036
0x50002A	20480	42	Signal stuck in range	Sensor supply is too high or too low; electrical failure in the central ECU	SD-27-5036
0x500112	20481	18	Circuit short to battery	Damage in the wiring (low resistance to UB) and/or connectors between eTPCM and *GSBC* ECU, damaged eTPCM, or *GSBC* ECU	SD-27-5036
0x500114	20481	20	Circuit short to ground or open	Damage in the wiring (low insulation resistance to vehicle ground or interruption) and/or connectors between eTPCM and *GSBC* ECU, damaged eTPCM, or *GSBC* ECU	SD-27-5036
0x500149	20481	73	Internal electronic failure	Valve low side shorted to other eTPCM valve's low side	SD-27-5036
0x500212	20482	18	Circuit short to battery	Damage in the wiring (low resistance to UB) and/or connectors between eTPCM and *GSBC* ECU, damaged eTPCM, or *GSBC* ECU	SD-27-5036
0x500214	20482	20	Circuit short to ground or open	Damage in the wiring (low insulation resistance to vehicle ground or interruption) and/or connectors between eTPCM and *GSBC* ECU, damaged eTPCM, or *GSBC* ECU	SD-27-5036
0x500249	20482	73	Internal electronic failure	Short circuit between eTPCM OV and other eTPCM valve	SD-27-5036
0x500312	20483	18	Circuit short to battery	Damage in the wiring (low resistance to UB) and/or connectors between eTPCM and *GSBC* ECU, damaged eTPCM, or *GSBC* ECU	SD-27-5036

Table 21 – GSBC e-TPCM-90 Diagnostic Trouble Codes (DTCs)

GSBC ETPCM-90 DTCS					
DTC #	**SPN (J1939)**	**FMI (J1939)**	**DTC NAME**	**DTC DESCRIPTION**	**SD SHEET**
0x500314	20483	20	Circuit short to ground or open	Damage in the wiring (low insulation resistance to vehicle ground or interruption) and/or connectors between eTPCM and *GSBC* ECU, damaged eTPCM, or *GSBC* ECU	SD-27-5036
0x500349	20483	73	Internal electronic failure	Short circuit between eTPCM backup solenoid (BV) and other eTPCM valve	SD-27-5036
0x500616	20486	22	Circuit voltage below threshold	Damaged wiring (interruption or low resistance towards ground) or connectors or damage of the eTPCM or damage of the *GSBC* ECU	SD-27-5036
0x500617	20486	23	Circuit voltage above threshold	Damaged wiring (low resistance towards other wires) or connectors or damage of the eTPCM or damage of the *GSBC* ECU	SD-27-5036
0x500711	20487	17	Circuit short to ground	eTPCM common high side shorted to ground or short circuit	SD-27-5036
0x500712	20487	18	Circuit short to battery	eTPCM common high side shorted to battery	SD-27-5036
0x500713	20487	19	Circuit open	eTPCM common high side open circuit or broken wire	SD-27-5036
0x508866	20616	102	Signal has too many transitions/events	eTPCM solenoid activation count exceeds lifetime limit	SD-27-5036
0x508872	20616	114	Actuator stuck open	Residual pressure trapped in the eTPCM valve's control volume (pressure threshold exceeded)	SD-27-5036
0x508873	20616	115	Actuator stuck closed	Difference between the eTPCM demand and measured pressure exceeds limit (1.5 bar in static situation or an implausible inlet valve actuation is detected)	SD-27-5036
0x508899	20616	153	Exceeded learning limit	The actuation count of the eTPCM solenoids are compared with a pre-configured limit; if actuation count reaches the 95% of the limit, this fault is set	SD-27-5036
0x50B677	20662	119	Commanded position not reachable	eTPCM delivery pressure not detected during temporary backup mode test	SD-27-5036
0x50B678	20662	120	Alignment or adjustment incorrect	eTPCM delivery pressure not detected during temporary brake test	SD-27-5036

Table 21 – GSBC e-TPCM-90 Diagnostic Trouble Codes (DTCs)

GSBC FBM-40 DTCS

IMPORTANT

For all repair steps, first complete the following:

1. **Generate an ACom Diagnostic Software report.**
2. **Clear DTCs.**
3. **Continue with repair information for each active DTC that will not clear.**

NOTE: After completing all repairs, drive the vehicle to ensure the repairs were sufficient.

4. **Once repairs have been made, clear the DTC again.**

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GSBC FBM-40 DTCS					
DTC #	**SPN (J1939)**	**FMI (J1939)**	**DTC NAME**	**DTC DESCRIPTION**	**SD SHEET**
0x507141	20593	65	General Checksum Failure	Fault is reported if the bootloader software of the FBM detects a checksum error in the application software of the A or B controller.	SD-27-5028
0x507142	20593	66	General Memory Failure	Fault is reported if the data integrity check inside the FBM failed (checksum error, stack overflow, program flow error, general integrity of volatile data).	SD-27-5028
0x507149	20593	73	Internal Electronic Failure	Failure is reported if the monitoring functions detect an internal HW fault of the electronic control unit of the FBM.	SD-27-5028
0x50714A	20593	74	Incorrect Component Installed	Fault is reported if incompatibility is detected between the FBM and ECU.	SD-27-5028
0x50714B	20593	75	Over Temperature	Fault is reported if one of the two DFBM temperature sensors delivers a high value.	SD-27-5028
0x507192	20593	146	Performance or Incorrect Operation	Learned FBM offset is higher than the threshold value of the FBM signal that pressure demand should be sent to the EPMs above. (Threshold value is set according to the mechanical charateristic of the FBM).	SD-27-5028
0x507194	20593	148	Unexpected Operation	Fault is reported if the FBM detects an incompatibility between its boot and drive software or detects ICC problem.	SD-27-5028
0x507211	20594	17	Circuit Short To Ground	Fault is reported if FBM supply voltage is below vehicle battery voltage by a difference of more than 6V.	SD-27-5028
0x507212	20594	18	Circuit Short To Battery	Fault is reported if the communication from the ECU to the FBM is disturbed, or if the FBM does not power down properly.	SD-27-5028
0x507282	20594	130	Alive/Sequence Counter Incorrect/ Not Updated	Fault is reported if the message counter sent by the FBM is inconsistent with the timestamp of reception (short term observation window < 40 ms).	SD-27-5028
0x507287	20594	135	Missing Message	Fault is reported if the communication between the FBM and the EBS ECU is disturbed.	SD-27-5028
0x507294	20594	148	Unexpected Operation	Fault is reported if the sensor outputs of the FBM do not match but they are in tolerable range.	SD-27-5028

Table 22 – GSBC FBM-40 Diagnostic Trouble Codes (DTCs)

GSBC M-50QR DTCS

IMPORTANT

For all repair steps, first complete the following:

1. **Generate an ACom Diagnostic Software report.**
2. **Clear DTCs.**
3. **Continue with repair information for each active DTC that will not clear.**

NOTE: After completing all repairs, drive the vehicle to ensure the repairs were sufficient.

4. **Once repairs have been made, clear the DTC again.**

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GSBC M-50QR DTCS					
DTC #	**SPN (J1939)**	**FMI (J1939)**	**DTC NAME**	**DTC DESCRIPTION**	**SD SHEET**
0x500511	20485	17	Pressure Control Valve: Circuit Short To Ground	Modulator common low side shorted to ground or short circuit.	SD-27-5170
0x500512	20485	18	Pressure Control Valve: Circuit Short To Battery	Modulator common low side shorted to battery.	SD-27-5170
0x500513	20485	19	Pressure Control Valve: Circuit Open	Modulator common low side open circuit or broken wire.	SD-27-5170
0x500549	20485	73	Pressure Control Valve: Internal Electronic Failure	Power to HW component (Modulator) can not be switched off.	SD-27-5170
0x50054B	20485	75	Pressure Control Valve: Over Temperature	Modulator activated for extended amount of time.	SD-27-5170
0x500595	20485	149	Pressure Control Valve: Incorrect Assembly	Modulator common low side shorted to other valve or hardware defect.	SD-27-5170
0x509F35	20639	53	Axle 1, Left Wheel, Pressure Control Valve: Signal High Time Greater Than Maximum	The error is set if modulator activation duration exceeds a pre-set limit.	SD-27-5170
0x50A035	20640	53	Axle 1, Right Wheel, Pressure Control Valve: Signal High Time Greater Than Maximum	The error is set if modulator activation duration exceeds a pre-set limit.	SD-27-5170
0x50A511	20645	17	Axle 1, Left Wheel, Pressure Control Valve, Inlet Valve: Circuit Short To Ground	Short from modulator inlet valve pin to ground.	SD-27-5170
0x50A512	20645	18	Axle 1, Left Wheel, Pressure Control Valve, Inlet Valve: Circuit Short To Battery	Short from modulator inlet valve pin to battery voltage.	SD-27-5170
0x50A518	20645	24	Axle 1, Left Wheel, Pressure Control Valve, Inlet Valve: Circuit Current Below Threshold	Open circuit or broken wire on modulator inlet valve pin.	SD-27-5170
0x50A52B	20645	43	Axle 1, Left Wheel, Pressure Control Valve, Inlet Valve: Signal Cross Coupled	Modulators on opposite sides of vehicle are shorted together.	SD-27-5170
0x50A611	20646	17	Axle 1, Right Wheel, Pressure Control Valve, Inlet Valve: Circuit Short To Ground	Short from modulator inlet valve pin to ground.	SD-27-5170
0x50A612	20646	18	Axle 1, Right Wheel, Pressure Control Valve, Inlet Valve: Circuit Short To Battery	Short from modulator inlet valve pin to battery voltage.	SD-27-5170

Table 23 – GSBC M-50QR Diagnostic Trouble Codes (DTCs)

GSBC M-50QR DTCS					
DTC #	**SPN (J1939)**	**FMI (J1939)**	**DTC NAME**	**DTC DESCRIPTION**	**SD SHEET**
0x50A618	20646	24	Axle 1, Right Wheel, Pressure Control Valve, Inlet Valve: Circuit Current Below Threshold	Open circuit or broken wire on modulator inlet valve pin.	SD-27-5170
0x50A62B	20646	43	Axle 1, Right Wheel, Pressure Control Valve, Inlet Valve: Signal Cross Coupled	Modulators on opposite sides of vehicle are shorted together.	SD-27-5170
0x50A711	20647	17	Axle 1, Left Wheel, Pressure Control Valve, Outlet Valve: Circuit Short To Ground	Short from modulator outlet valve pin to ground.	SD-27-5170
0x50A712	20647	18	Axle 1, Left Wheel, Pressure Control Valve, Outlet Valve: Circuit Short To Battery	Short from modulator outlet valve pin to battery voltage.	SD-27-5170
0x50A718	20647	24	Axle 1, Left Wheel, Pressure Control Valve, Outlet Valve: Circuit Current Below Threshold	Open circuit or broken wire on modulator outlet valve pin.	SD-27-5170
0x50A72B	20647	43	Axle 1, Left Wheel, Pressure Control Valve, Outlet Valve: Signal Cross Coupled	Modulators on opposite sides of vehicle are shorted together.	SD-27-5170
0x50A811	20648	17	Axle 1, Right Wheel, Pressure Control Valve, Outlet Valve: Circuit Short To Ground	Short from modulator outlet valve pin to ground.	SD-27-5170
0x50A812	20648	18	Axle 1, Right Wheel, Pressure Control Valve, Outlet Valve: Circuit Short To Battery	Short from modulator outlet valve pin to battery voltage.	SD-27-5170
0x50A818	20648	24	Axle 1, Right Wheel, Pressure Control Valve, Outlet Valve: Circuit Current Below Threshold	Open circuit or broken wire on modulator outlet valve pin.	SD-27-5170
0x50A82B	20648	43	Axle 1, Right Wheel, Pressure Control Valve, Outlet Valve: Signal Cross Coupled	Modulators on opposite sides of vehicle are shorted together.	SD-27-5170
0xF00009	61440	9	Electronic Control Unit: Component Failures	Internal SW fault detected.	SD-27-5170

Table 23 – GSBC M-50QR Diagnostic Trouble Codes (DTCs)

RELATED TECHNICAL DOCUMENTATION REFERENCE

Go to B2Bendix.com to download the latest version of related technical documentation.

DOCUMENT #	DOCUMENT TITLE
BW8207	*GSBC Operator's Manual*
SD-27-5028	*GSBC FBM-40 Service Data Sheet*
SD-27-5031	*GSBC EPM-90 Service Data Sheet*
SD-27-5036	*GSBC eTPCM-90 Service Data Sheet*
SD-27-5170	*GSBC M-50QR Service Data Sheet*
SD-13-4860	*Bendix WS-24 Antilock WSS Service Data Sheet*
SD-27-4709	*Bendix SAS Service Data Sheet*
SD-24-250V	*GSAT System Service Data Sheet*

BENDIX TECHNICAL SUPPORT

The Bendix Tech Team is available via email at techteam@bendix.com and by phone at 1-800-AIR-BRAKE (1-800-247-2725), option 2, Monday through Thursday, 8:00 a.m. to 6:00 p.m. and Friday, 8:00 a.m. to 5:00 p.m. ET. Follow the instructions in the recorded message.