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.

TABLE OF CONTENTS

INTRODUCTION & DESCRIPTION 1
GENERAL SAFETY GUIDELINES 2
GSBC SYSTEM OVERVIEW 3
GSBC SYSTEM COMPARISON 6
GSBC SYSTEM COMPONENTS 8
GSBC SYSTEM SCHEMATICS 12
GSBC CENTRAL ECU (EBS-90) 18
Description 18
Maintenance 19
Electrical Interfaces 20
Replacement 22
Central ECU Troubleshooting 24
GSBC SYSTEM TROUBLESHOOTING 25

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 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.

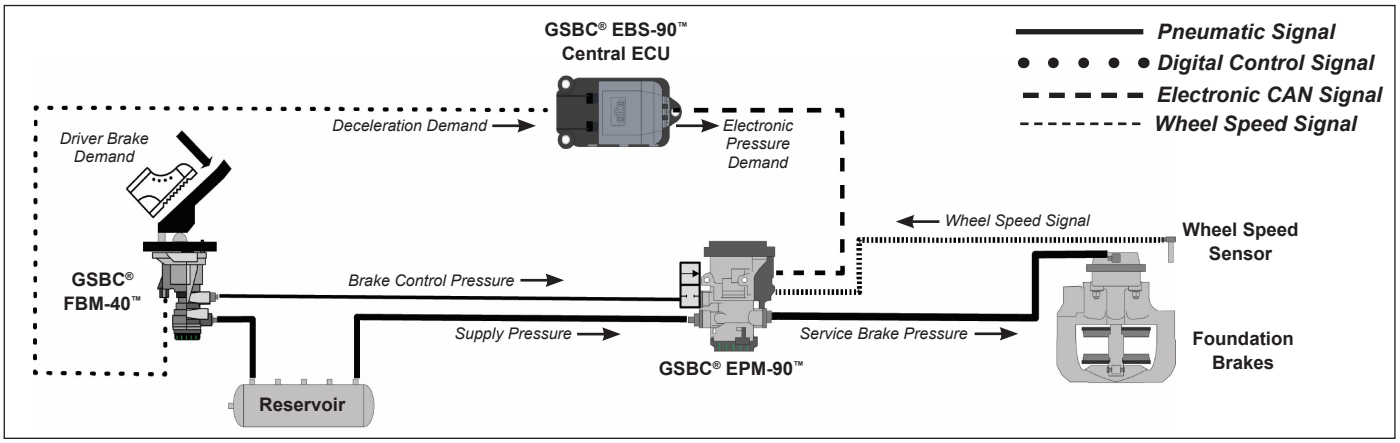


Figure 1 – GSBC System Electronic Primary Mode Example

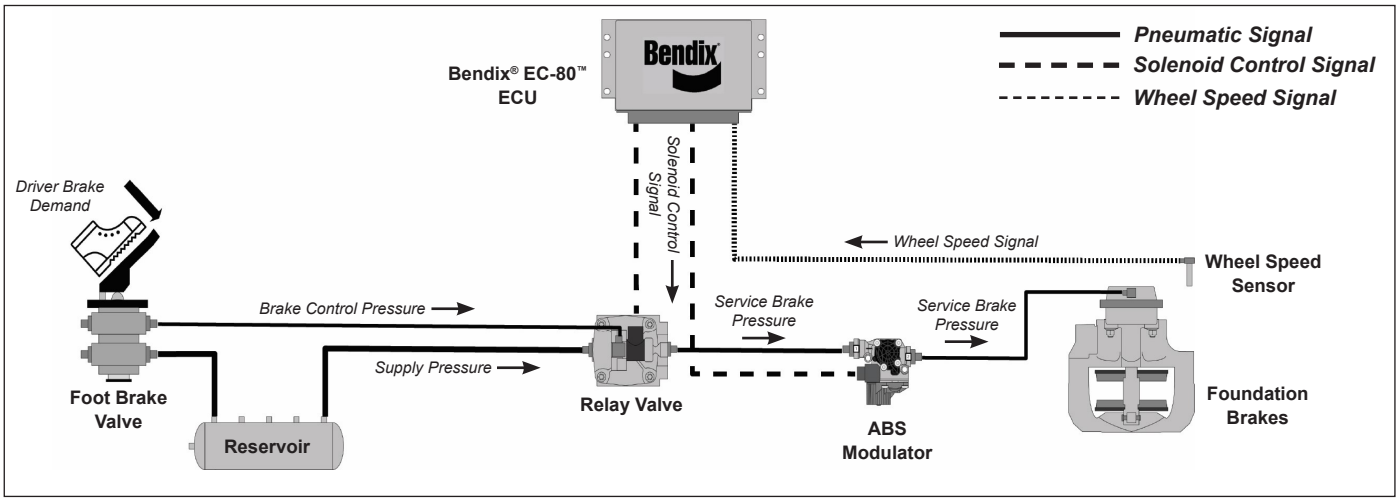


Figure 2 – ABS Normal Operation Example

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.

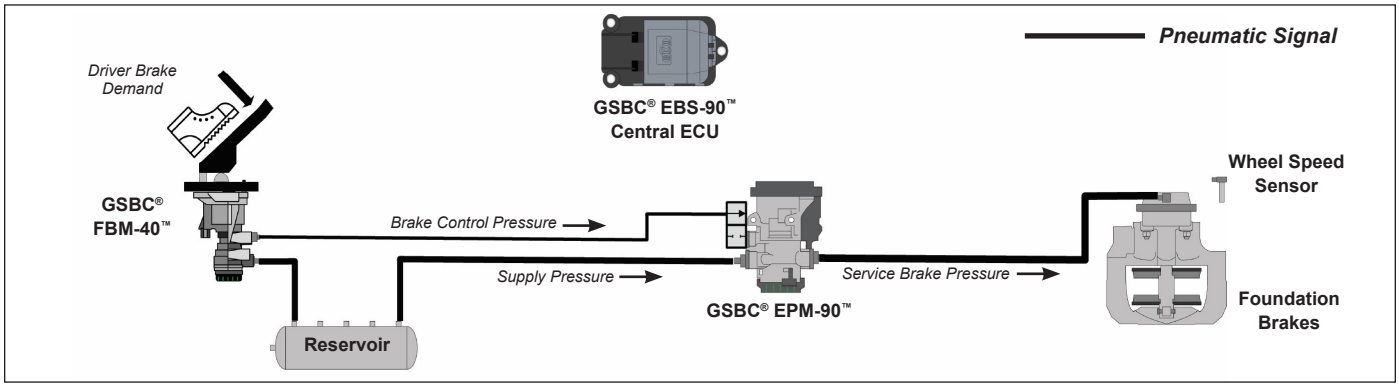


Figure 3 – GSBC System Pneumatic Backup Mode Example

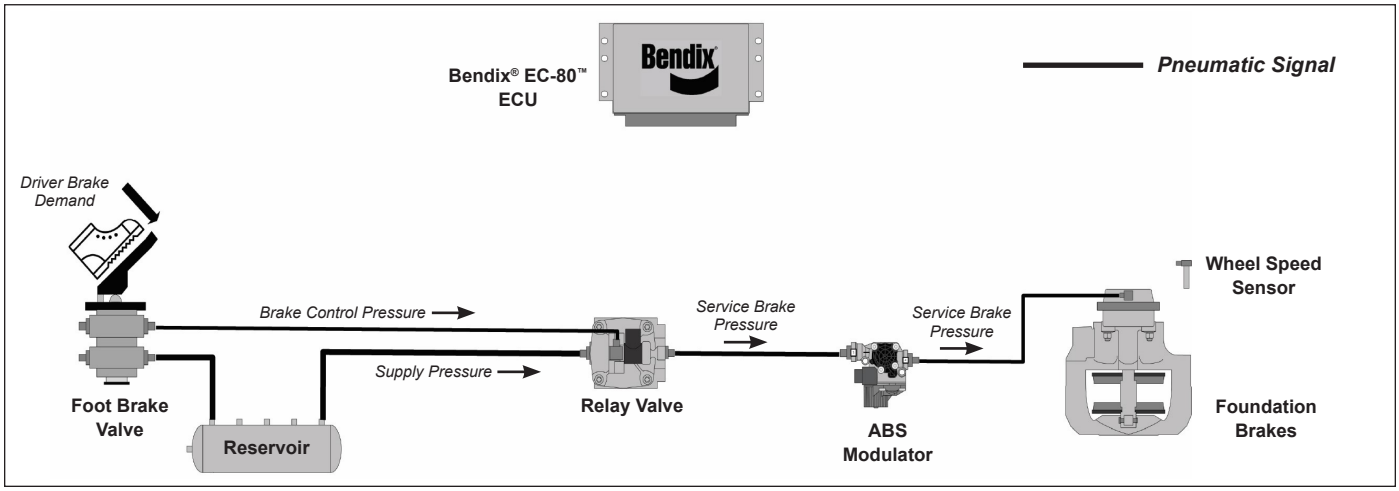


Figure 4 – ABS Faulted Operation Example

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 (YRS) 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 with 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.*

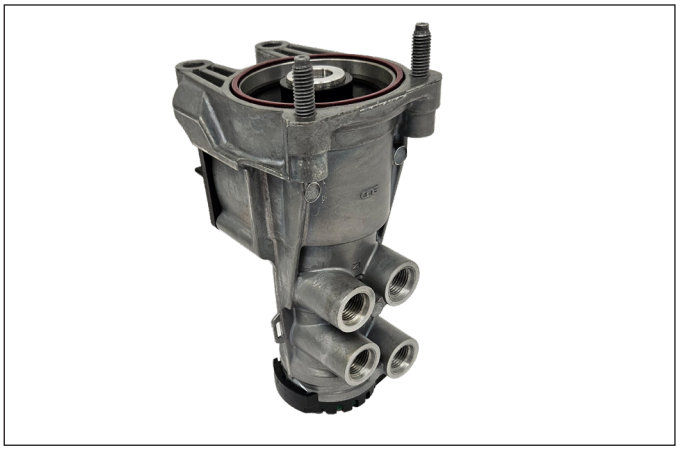


Figure 5 – GSBC FBM-40

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.*

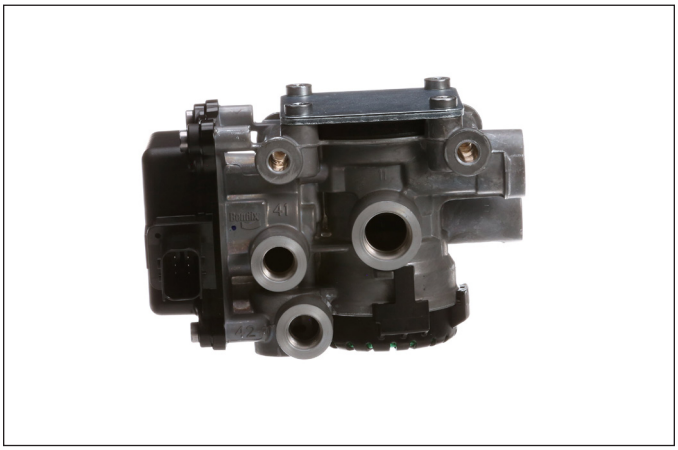


Figure 7 – GSBC eTPCM-90

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 an 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 YRS 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)

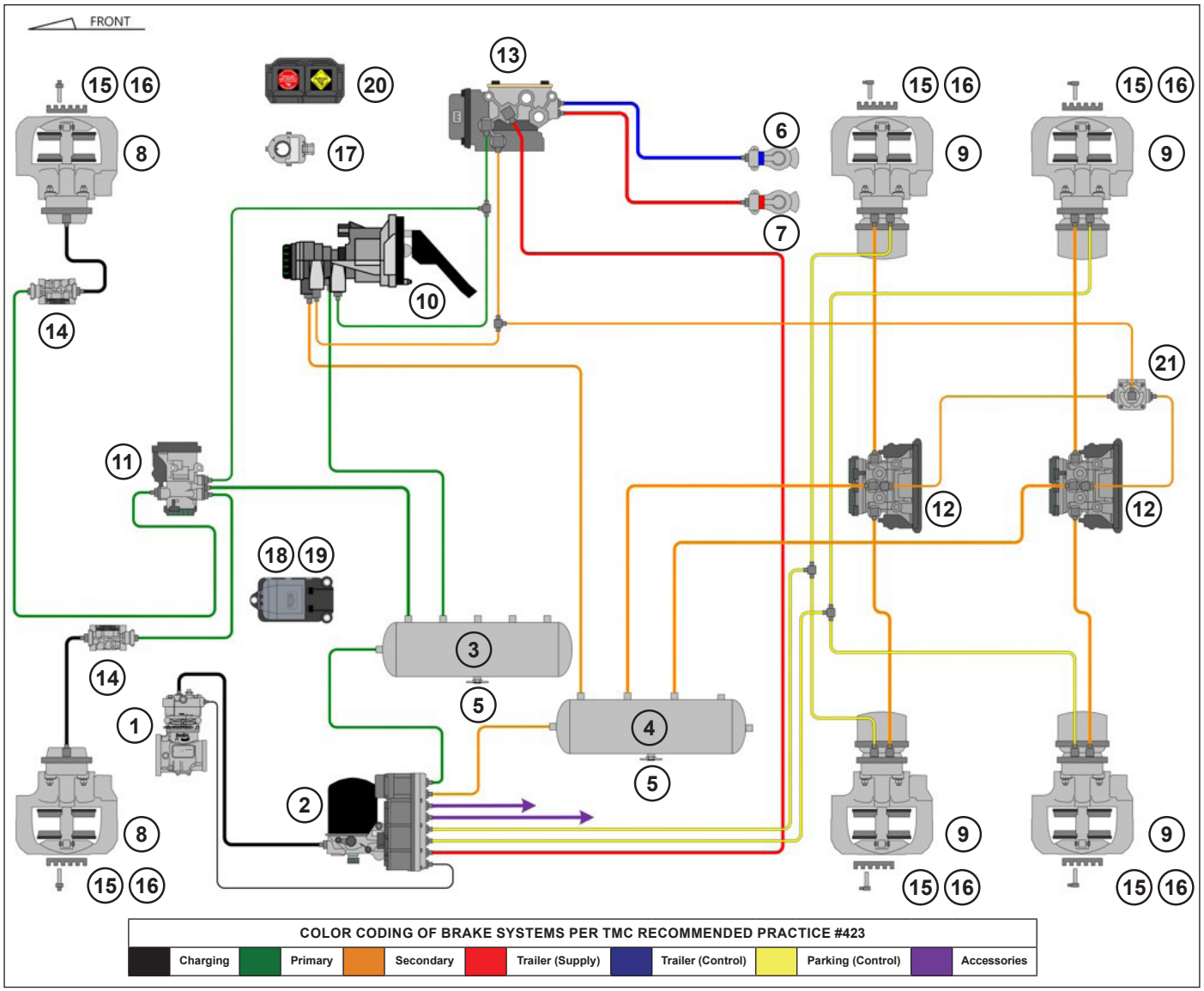


Figure 11 – GSBC System Pneumatic Schematic Example (With GSAT)*

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

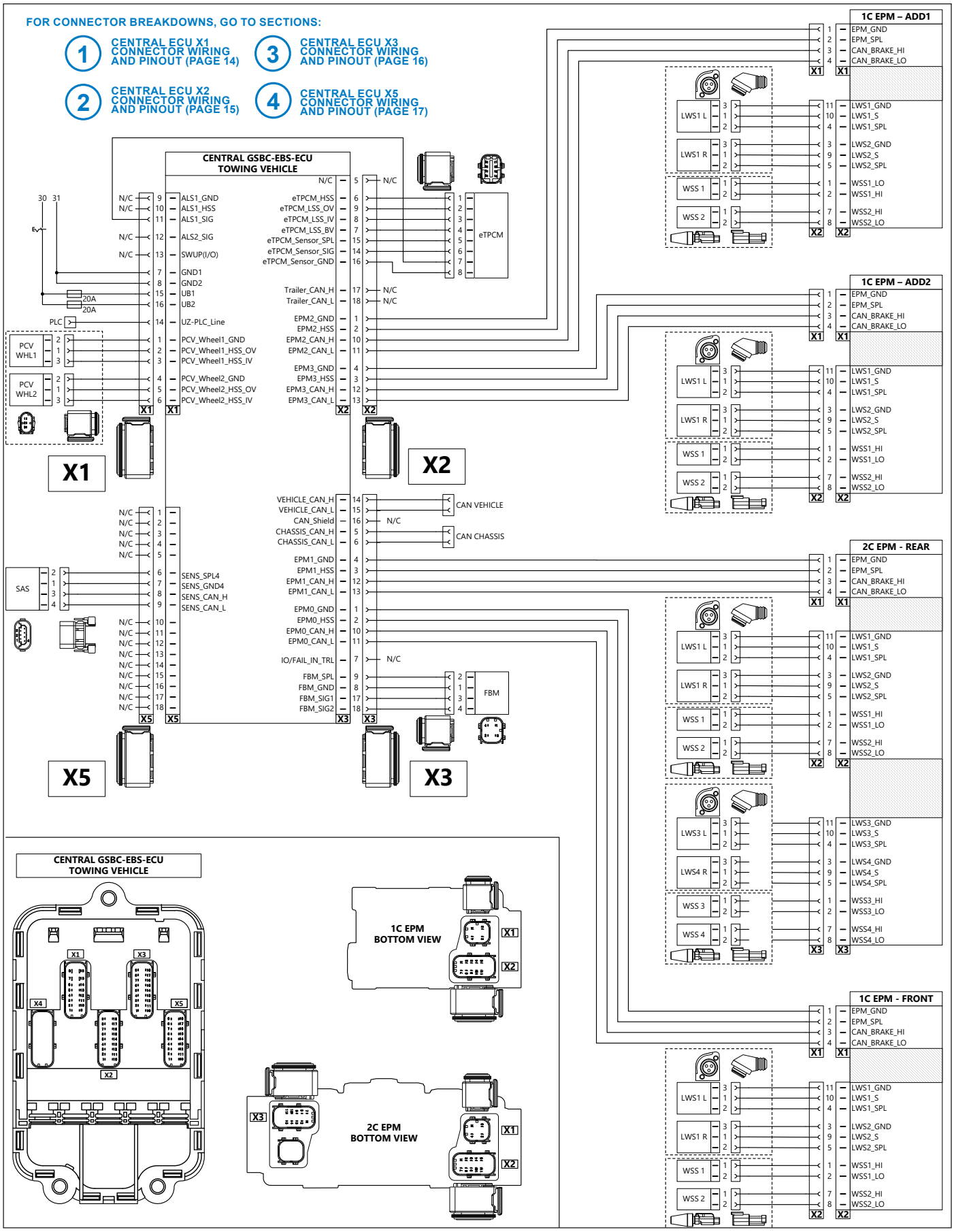


Figure 12 – GSBC System Wiring Schematic Example

GSBC WIRING SCHEMATIC WITH COMPONENT PINOUTS (CONT.)

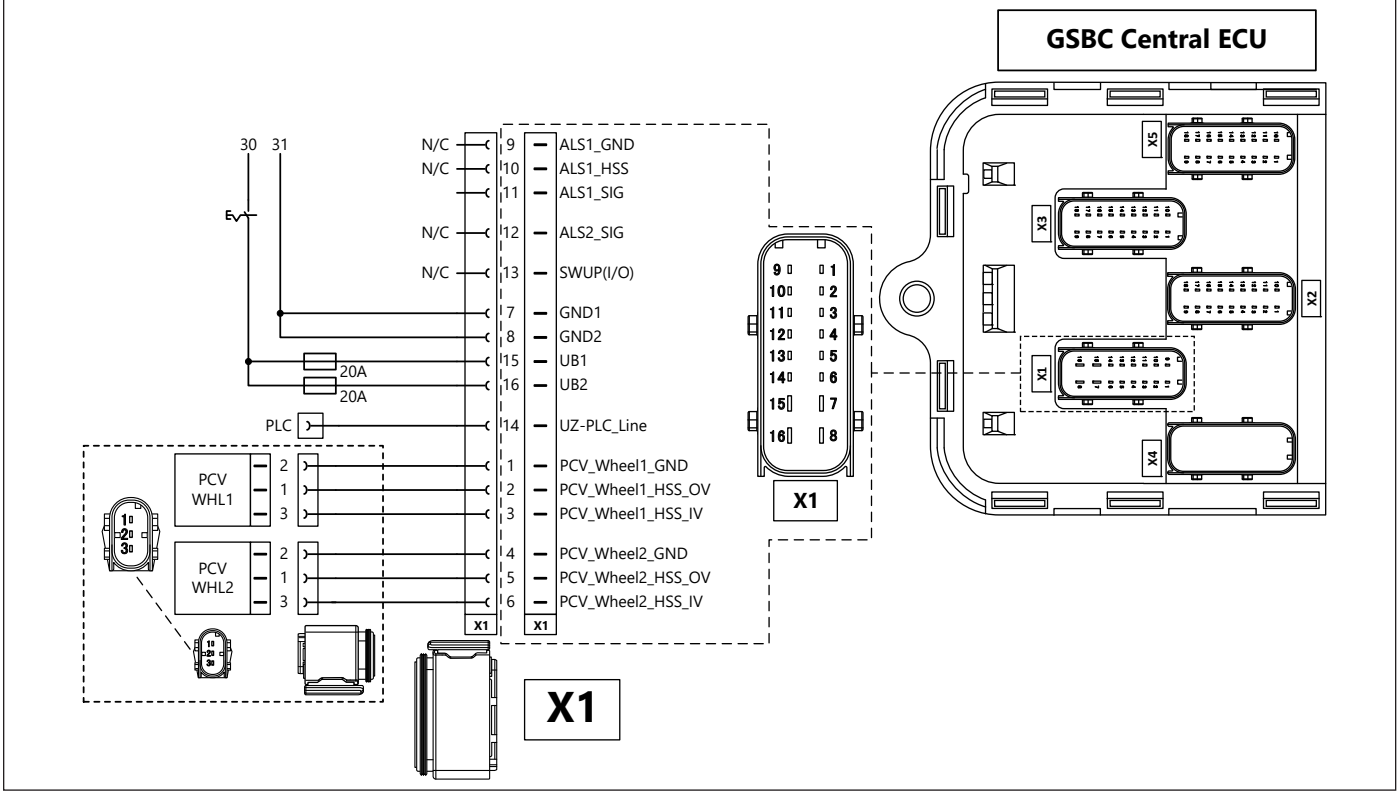
ELECTRICAL INTERFACES

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

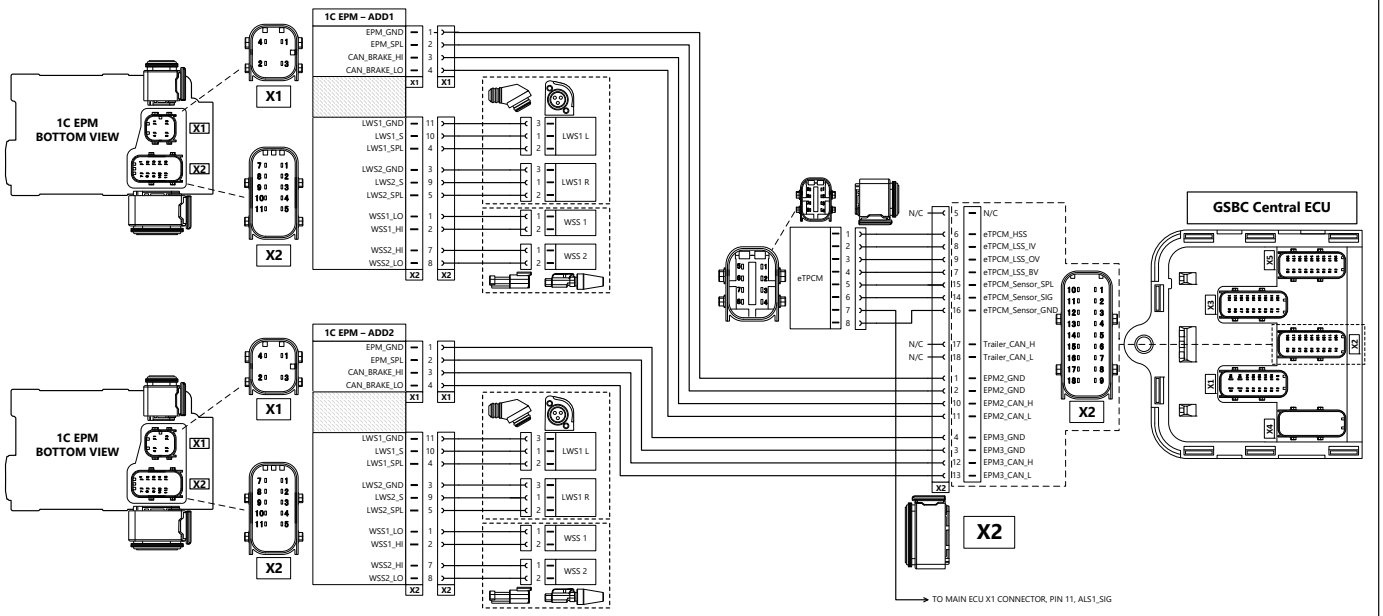
DEVICE KEY	
REFERENCE	**DEVICE**
PCV	GSBC M-50QR
eTPCM	GSBC eTPCM-90
EPM0-3	GSBC EPM-90
FBM	GSBC FBM-40
SAS	SAS-80

GSBC WIRING SCHEMATIC WITH COMPONENT PINOUTS (CONT.)

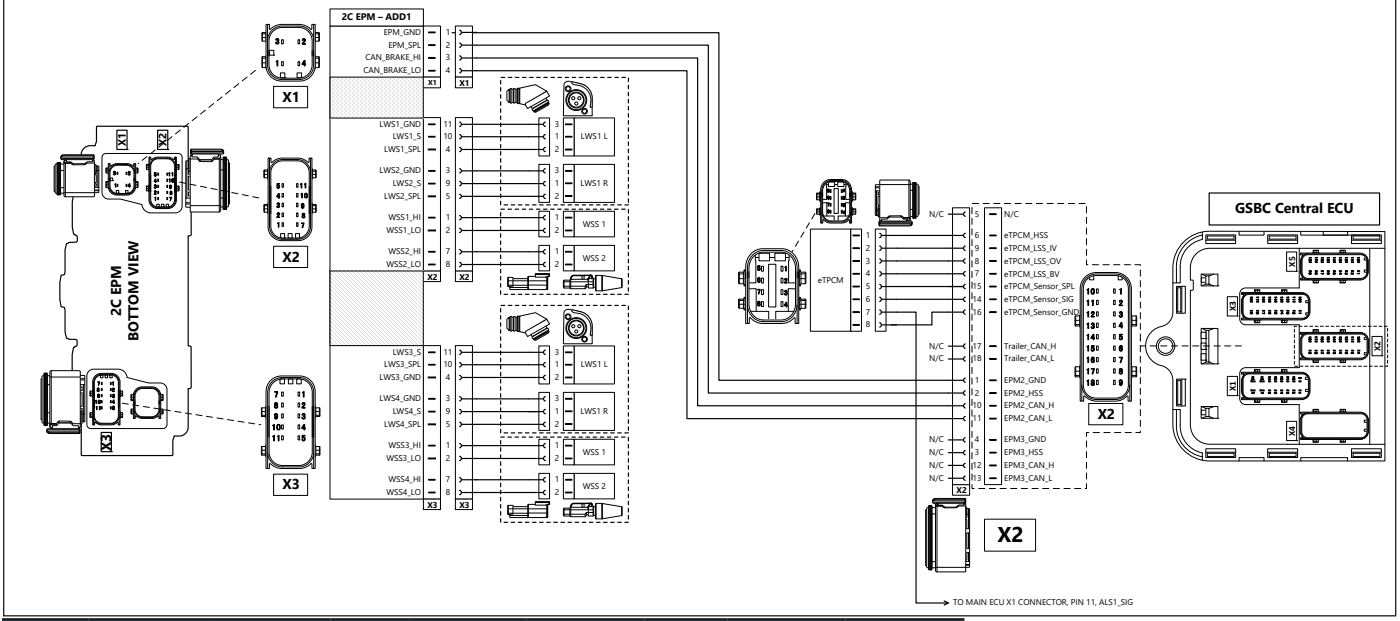
2. CENTRAL ECU X2 CONNECTOR WIRING AND PINOUT

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	-	-

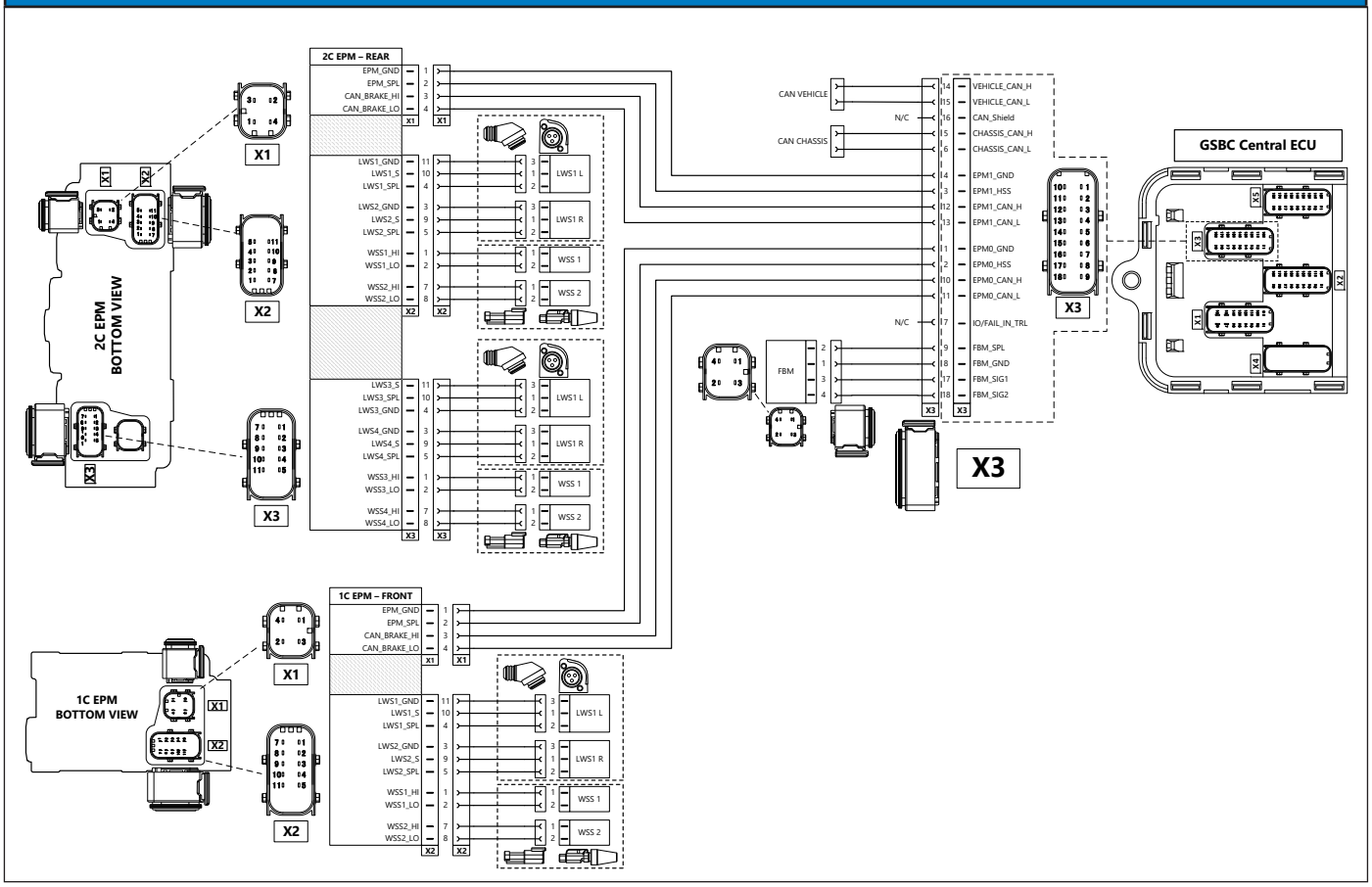
Table 5 – X2 Pin Match

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



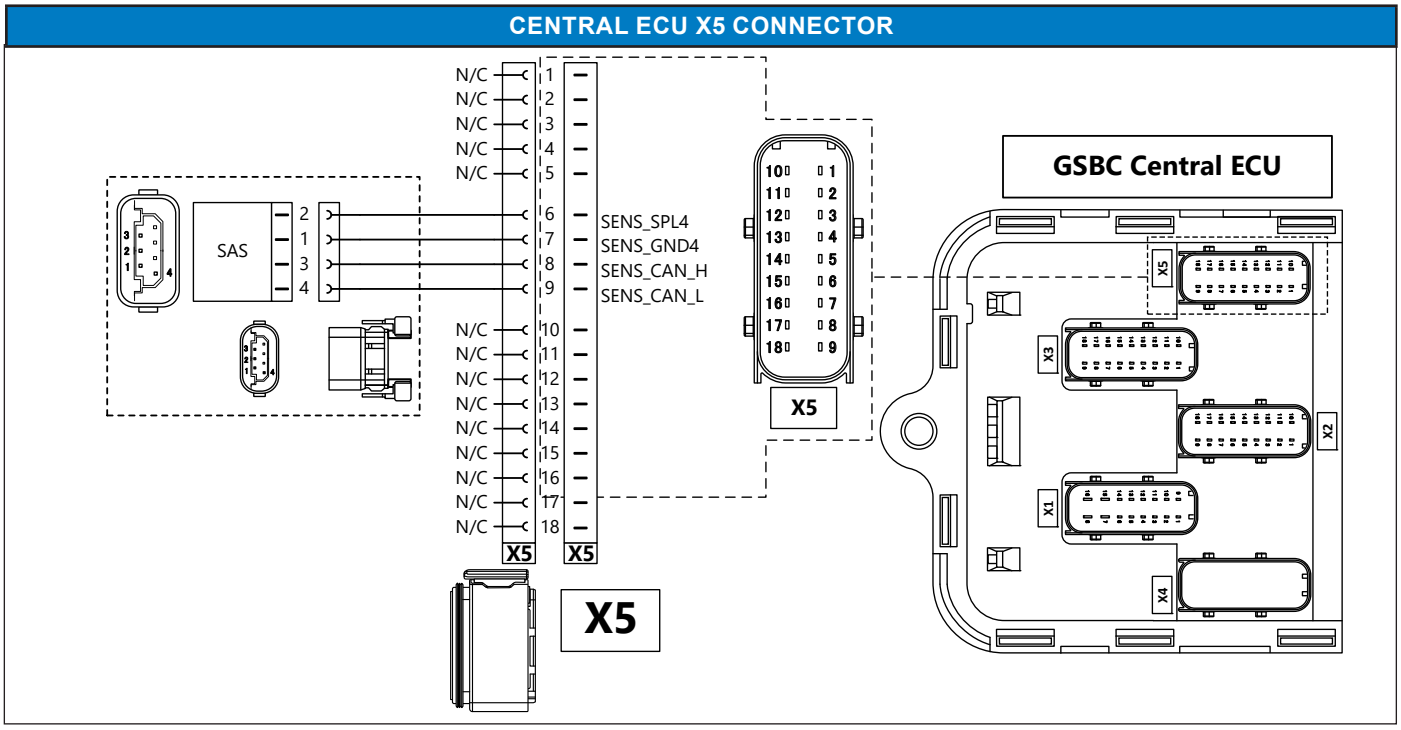
X3 CONNECTOR PIN MATCH								
PIN	DEVICE	PIN MATCH	PIN	DEVICE	PIN MATCH	PIN	DEVICE	PIN MATCH
1	EPM0	X1:1	7	-	-	13	EPM1	X1:4
2	EPM0	X1:2	8	FBM	1	14	-	-
3	EPM1	X1:2	9	FBM	2	15	-	-
4	EPM1	X1:1	10	EPM0	X1:3	16	-	-
5	-	-	11	EPM0	X1:4	17	FBM	3
6	-	-	12	EPM1	X1:3	18	FBM	4

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



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 to 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

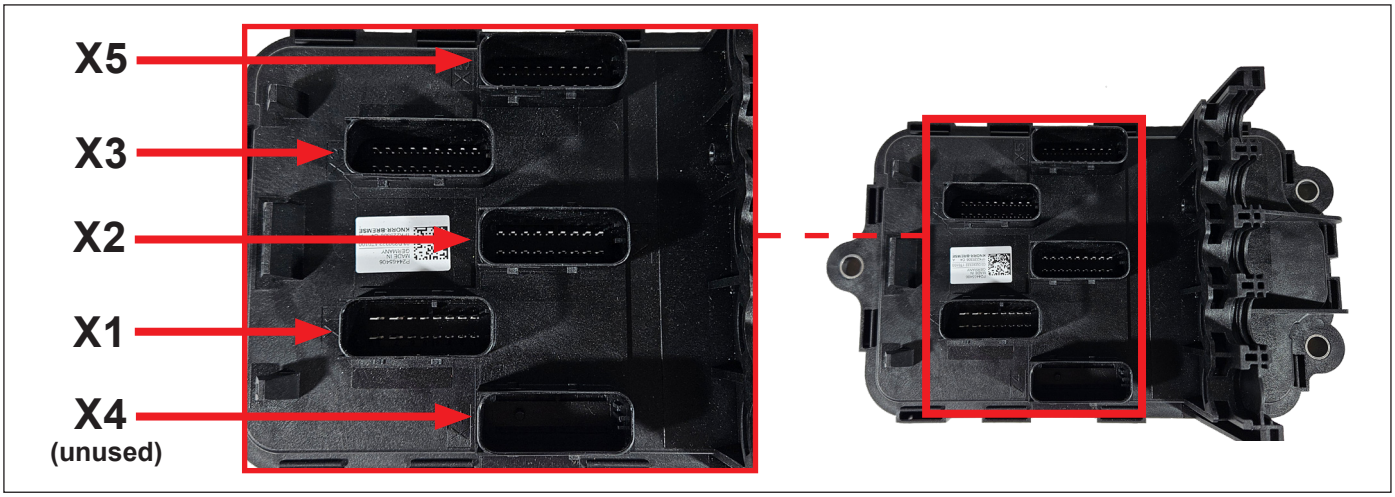
The Central ECU is designed not to require maintenance, and there are no user-serviceable components located inside the ECU housing. Disassembly of the device will void the component warranty and Bendix will not provide technical support or replacement components for components internal to the ECU.

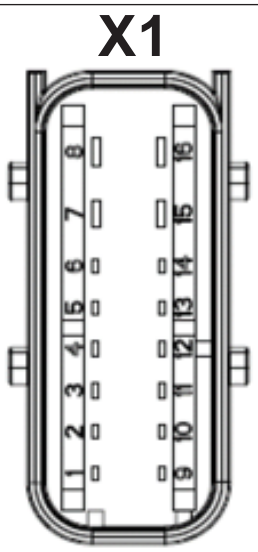
ELECTRICAL INTERFACES

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.

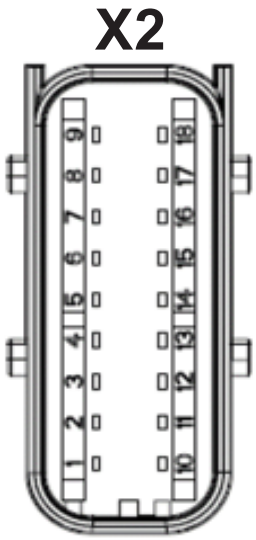




X1 CONNECTOR ON CENTRAL ECU			
PIN NO.	DESCRIPTION	PIN NO.	DESCRIPTION
1	Front Left Modulator Common/Ground	9	Not used
2	Front Left Modulator Exhaust/Outlet	10	Not used
3	Front Left Modulator Hold/Inlet	11	Trailer modulator - 2nd pressure sensor signal
4	Front Right Modulator Common/Ground	12	Not used
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

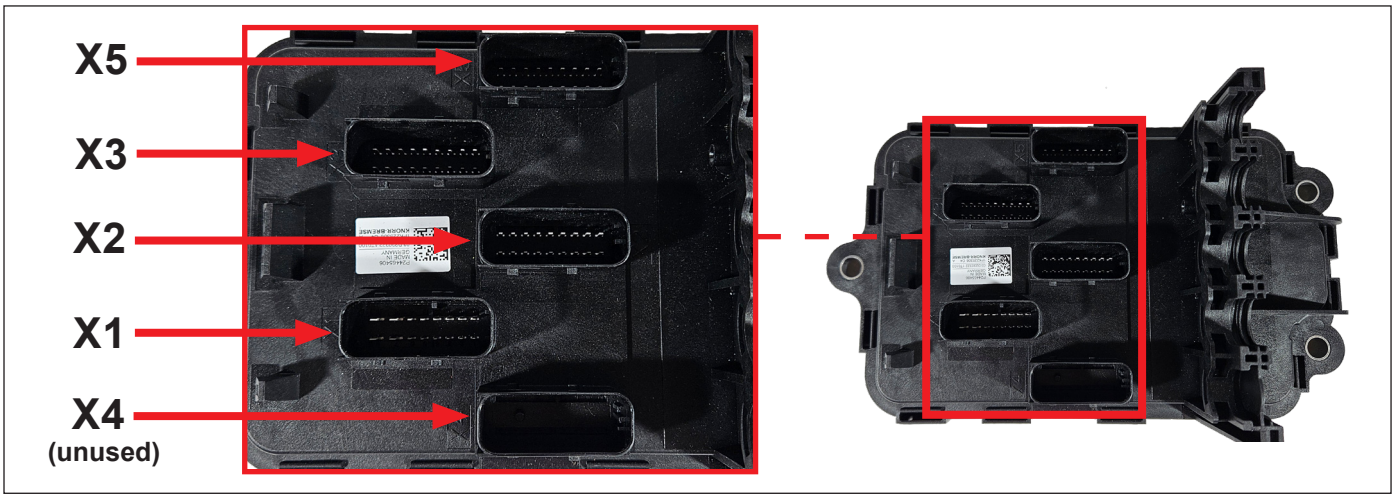
Figure 15 – Central ECU X2 Connector Pinout

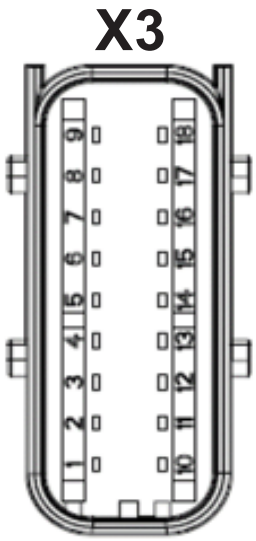
ELECTRICAL INTERFACES (CONT.)

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.

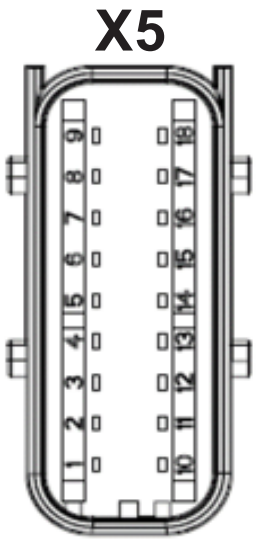




X3 CONNECTOR ON CENTRAL ECU			
PIN NO.	DESCRIPTION	PIN NO.	DESCRIPTION
1	EPM0 ground	10	EPM0 Brake CAN High
2	EPM0 supply	11	EPM0 Brake CAN Low
3	EPM1 supply	12	EPM1 Brake CAN High
4	EPM1 ground	13	EPM1 Brake CAN Low
5	Chassis subnet CAN_High	14	Backbone_1_CAN_H
6	Chassis subnet CAN_Low	15	Backbone_1_CAN_L
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.

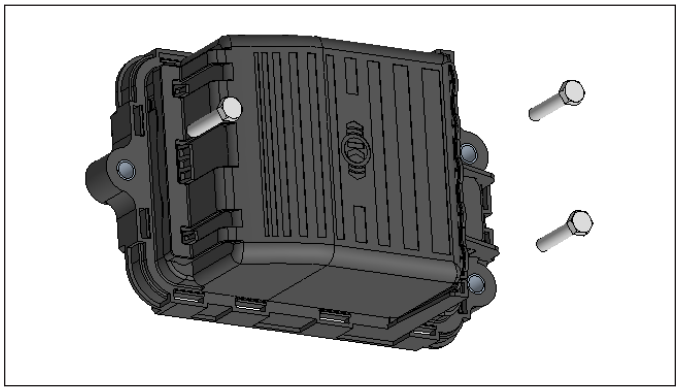


Figure 18 – Central ECU Mounting Bolt Orientation

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 recommended by the connector manufacturer.

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

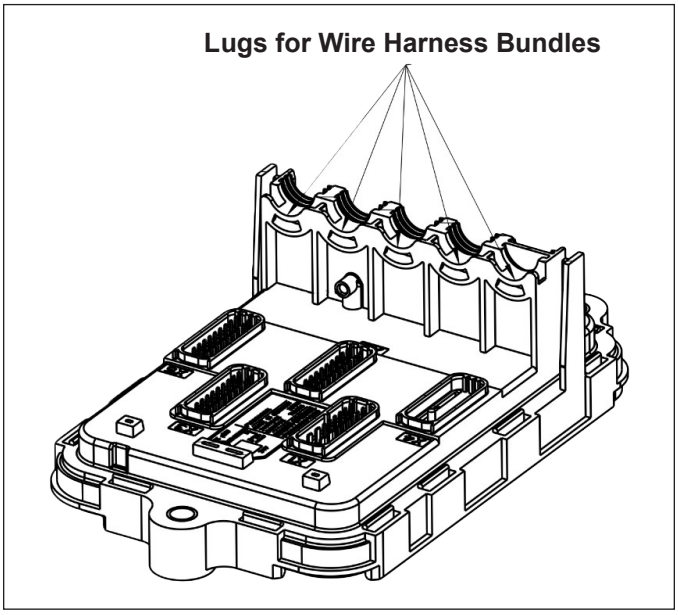


Figure 19 – Central ECU Lug Location

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 voltage between the pins (*refer to 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 (*refer to 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 ± 5 Ohms
X3-14	X3-15	60 ± 5 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 diagnostic 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 on B2Bendix.com or the appropriate diagnostic software from the vehicle manufacturer
- 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.*

Bendix ACom Diagnostic Software supports all DTCs for Bendix products. For additional troubleshooting support, *go to B2Bendix.com > Services & Support > Diagnostic Trouble Code Search.*

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.

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*

B2BENDIX.COM
24/7/365 ACCESS
FULL SERVICE AT YOUR FINGERTIPS

TECHNICAL SUPPORT
1-800-AIR-BRAKE (1-800-247-2725)
TECHTEAM@BENDIX.COM

BRAKE-SCHOOL.COM
WEB-BASED TRAINING
LOG ON AND LEARN FROM THE BEST

Bendix®

Any references in this document to VOLVO are solely for identification and cross reference purposes.
The trademarks are the property of their respective companies.

Unless otherwise indicated, the trademarks used in this document, including Bendix, are United States trademarks owned by, or licensed to, Bendix Commercial Vehicle Systems LLC.