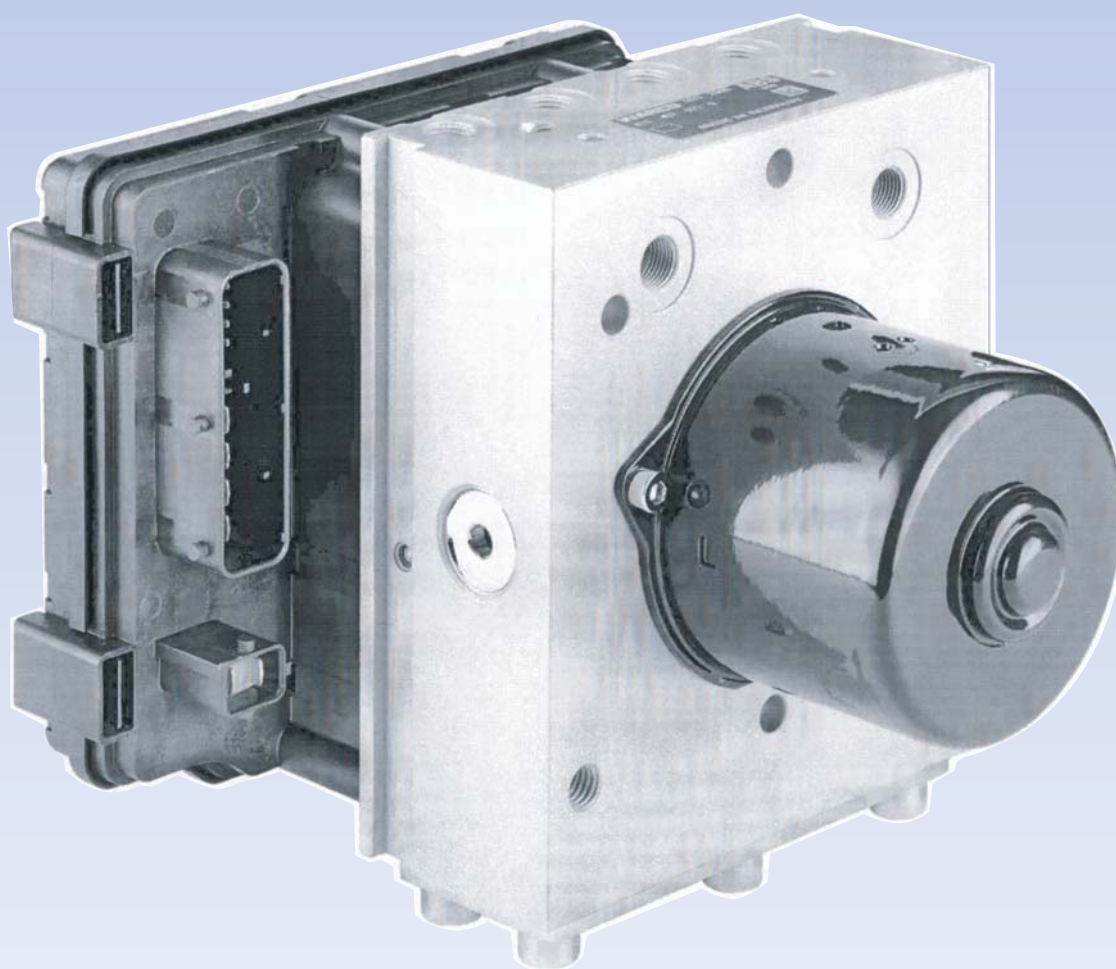


**HYDRAULIC ANTI-LOCK BRAKING SYSTEMS
(HABS) FOR MEDIUM-DUTY TRUCKS, BUSES
AND MOTOR HOME CHASSIS:
FOR E VERSION HYDRAULIC ABS**

MAINTENANCE MANUAL



WABCO

Service Notes

About This Manual

This manual provides instructions for WABCO's E Version hydraulic anti-lock braking system (HABS) for medium-duty trucks, buses and motor home chassis.

Before You Begin

1. Read and understand all instructions and procedures before you begin to service components.
2. Read and observe all Warning and Caution hazard alert messages in this publication. They provide information that can help prevent serious personal injury, damage to components, or both.
3. Follow your company's maintenance and service, installation, and diagnostics guidelines.
4. Use special tools when required to help avoid serious personal injury and damage to components.

Hazard Alert Messages and Torque Symbols

WARNING

A Warning alerts you to an instruction or procedure that you must follow exactly to avoid serious personal injury and damage to components.

CAUTION

A Caution alerts you to an instruction or procedure that you must follow exactly to avoid damage to components.

 This symbol alerts you to tighten fasteners to a specified torque value.

How to Obtain Additional Maintenance, Service and Product Information

Contact WABCO North America Customer Care at 855-228-3203 (United States and Canada); 001-800-889-1834 (Mexico); or email OnTrac@meritor.com.

If Tools and Supplies are Specified in This Manual

Call Meritor's Commercial Vehicle Aftermarket at 888-725-9355 to obtain Meritor tools and supplies.

Information contained in this publication was in effect at the time the publication was approved for printing and is subject to change without notice or liability. WABCO reserves the right to revise the information presented or to discontinue the production of parts described at any time.

pg. i	Asbestos and Non-Asbestos Fibers
1	Section 1: Introduction
	Maintenance
	Manual Information
	Overview
	How Hydraulic ABS Works
2	System Layout
	System Components
	Electronic Control Unit (ECU)
3	Modulator Assembly
	Sensors
4	ABS Warning Lamp
	TOOLBOX™ Software
5	Section 2: Troubleshooting and Testing
	Maintenance
	General Information
	Wiring Diagrams
	System Wiring Information
6	System Diagnostics
	WABCO TOOLBOX™ Software
8	Blink Code Diagnostics
9	Using Blink Code Diagnostics — Optional Feature
20	SPN, SID, FMI Diagnostic Trouble Code List
30	Testing the System
	WABCO TOOLBOX™ Software
	E Version Hydraulic ABS Menus and Toolbars
34	Standard Testing
	System Requirements and Component Tests
35	Standard Component Testing
37	Section 3: Component Replacement
	Component Removal and Installation
	Sensors
	Wheel Speed Sensor Replacement — Front Axle
	Wheel Speed Sensor Replacement — Rear Axle
38	Electronic Control Unit (ECU)
39	Modulator Assembly
40	Modulator Motor
42	Brake Bleeding Procedures
43	Pressure Fill and Bleed
45	Leak Check Procedure for WABCO HABS

Notes

Asbestos and Non-Asbestos Fibers

ASBESTOS FIBERS WARNING

The following procedures for servicing brakes are recommended to reduce exposure to asbestos fiber dust, a cancer and lung disease hazard. Material Safety Data Sheets are available from WABCO.

Hazard Summary

Because some brake linings contain asbestos, workers who service brakes must understand the potential hazards of asbestos and precautions for reducing risks. Exposure to airborne asbestos dust can cause serious and possibly fatal diseases, including asbestosis (a chronic lung disease) and cancer, principally lung cancer and mesothelioma (a cancer of the lining of the chest or abdominal cavities). Some studies show that the risk of lung cancer among persons who smoke and who are exposed to asbestos is much greater than the risk for non-smokers. Symptoms of these diseases may not become apparent for 15, 20 or more years after the first exposure to asbestos.

Accordingly, workers must use caution to avoid creating and breathing dust when servicing brakes. Specific recommended work practices for reducing exposure to asbestos dust follow. Consult your employer for more details.

Recommended Work Practices

1. **Separate Work Areas.** Whenever feasible, service brakes in a separate area away from other operations to reduce risks to unprotected persons. OSHA has set a maximum allowable level of exposure for asbestos of 0.1 f/cc as an 8-hour time-weighted average and 1.0 f/cc averaged over a 30-minute period. Scientists disagree, however, to what extent adherence to the maximum allowable exposure levels will eliminate the risk of disease that can result from inhaling asbestos dust. OSHA requires that the following sign be posted at the entrance to areas where exposures exceed either of the maximum allowable levels:

**DANGER: ASBESTOS
CANCER AND LUNG DISEASE HAZARD
AUTHORIZED PERSONNEL ONLY
RESPIRATORS AND PROTECTIVE CLOTHING
ARE REQUIRED IN THIS AREA.**

2. **Respiratory Protection.** Wear a respirator equipped with a high-efficiency (HEPA) filter approved by NIOSH or MSHA for use with asbestos at all times when servicing brakes, beginning with the removal of the wheels.
3. **Procedures for Servicing Brakes.**
 - a. Enclose the brake assembly within a negative pressure enclosure. The enclosure should be equipped with a HEPA vacuum and worker arm sleeves. With the enclosure in place, use the HEPA vacuum to loosen and vacuum residue from the brake parts.
 - b. As an alternative procedure, use a catch basin with water and a biodegradable, non-phosphate, water-based detergent to wash the brake drum or rotor and other brake parts. The solution should be applied with low pressure to prevent dust from becoming airborne. Allow the solution to flow between the brake drum and the brake support or the brake rotor and caliper. The wheel hub and brake assembly components should be thoroughly wetted to suppress dust before the brake shoes or brake pads are removed. Wipe the brake parts clean with a cloth.
 - c. If an enclosed vacuum system or brake washing equipment is not available, employers may adopt their own written procedures for servicing brakes, provided that the exposure levels associated with the employer's procedures do not exceed the levels associated with the enclosed vacuum system or brake washing equipment. Consult OSHA regulations for more details.
 - d. Wear a respirator equipped with a HEPA filter approved by NIOSH or MSHA for use with asbestos when grinding or machining brake linings. In addition, do such work in an area with a local exhaust ventilation system equipped with a HEPA filter.
 - e. **NEVER** use compressed air by itself, dry brushing, or a vacuum not equipped with a HEPA filter when cleaning brake parts or assemblies. **NEVER** use carcinogenic solvents, flammable solvents, or solvents that can damage brake components as wetting agents.
4. **Cleaning Work Areas.** Clean work areas with a vacuum equipped with a HEPA filter or by wet wiping. **NEVER** use compressed air or dry sweeping to clean work areas. When you empty vacuum cleaners and handle used rags, wear a respirator equipped with a HEPA filter approved by NIOSH or MSHA for use with asbestos. When you replace a HEPA filter, wet the filter with a fine mist of water and dispose of the used filter with care.
5. **Worker Clean-Up.** After servicing brakes, wash your hands before you eat, drink or smoke. Shower after work. Do not wear work clothes home. Use a vacuum equipped with a HEPA filter to vacuum work clothes after they are worn. Launder them separately. Do not shake or use compressed air to remove dust from work clothes.
6. **Waste Disposal.** Dispose of discarded linings, used rags, cloths and HEPA filters with care, such as in sealed plastic bags. Consult applicable EPA, state and local regulations on waste disposal.

Regulatory Guidance

References to OSHA, NIOSH, MSHA, and EPA, which are regulatory agencies in the United States, are made to provide further guidance to employers and workers employed within the United States. Employers and workers employed outside of the United States should consult the regulations that apply to them for further guidance.

NON-ASBESTOS FIBERS WARNING

The following procedures for servicing brakes are recommended to reduce exposure to non-asbestos fiber dust, a cancer and lung disease hazard. Material Safety Data Sheets are available from WABCO.

Hazard Summary

Most recently manufactured brake linings do not contain asbestos fibers. These brake linings may contain one or more of a variety of ingredients, including glass fibers, mineral wool, aramid fibers, ceramic fibers and silica that can present health risks if inhaled. Scientists disagree on the extent of the risks from exposure to these substances. Nonetheless, exposure to silica dust can cause silicosis, a non-cancerous lung disease. Silicosis gradually reduces lung capacity and efficiency and can result in serious breathing difficulty. Some scientists believe other types of non-asbestos fibers, when inhaled, can cause similar diseases of the lung. In addition, silica dust and ceramic fiber dust are known to the State of California to cause lung cancer. U.S. and international agencies have also determined that dust from mineral wool, ceramic fibers and silica are potential causes of cancer.

Accordingly, workers must use caution to avoid creating and breathing dust when servicing brakes. Specific recommended work practices for reducing exposure to non-asbestos dust follow. Consult your employer for more details.

Recommended Work Practices

1. **Separate Work Areas.** Whenever feasible, service brakes in a separate area away from other operations to reduce risks to unprotected persons.
2. **Respiratory Protection.** OSHA has set a maximum allowable level of exposure for silica of 0.1 mg/m³ as an 8-hour time-weighted average. Some manufacturers of non-asbestos brake linings recommend that exposures to other ingredients found in non-asbestos brake linings be kept below 1.0 f/cc as an 8-hour time-weighted average. Scientists disagree, however, to what extent adherence to these maximum allowable exposure levels will eliminate the risk of disease that can result from inhaling non-asbestos dust.

Therefore, wear respiratory protection at all times during brake servicing, beginning with the removal of the wheels. Wear a respirator equipped with a high-efficiency (HEPA) filter approved by NIOSH or MSHA, if the exposure levels may exceed OSHA or manufacturers' recommended maximum levels. Even when exposures are expected to be within the maximum allowable levels, wearing such a respirator at all times during brake servicing will help minimize exposure.

3. **Procedures for Servicing Brakes.**
 - a. Enclose the brake assembly within a negative pressure enclosure. The enclosure should be equipped with a HEPA vacuum and worker arm sleeves. With the enclosure in place, use the HEPA vacuum to loosen and vacuum residue from the brake parts.
 - b. As an alternative procedure, use a catch basin with water and a biodegradable, non-phosphate, water-based detergent to wash the brake drum or rotor and other brake parts. The solution should be applied with low pressure to prevent dust from becoming airborne. Allow the solution to flow between the brake drum and the brake support or the brake rotor and caliper. The wheel hub and brake assembly components should be thoroughly wetted to suppress dust before the brake shoes or brake pads are removed. Wipe the brake parts clean with a cloth.
 - c. If an enclosed vacuum system or brake washing equipment is not available, carefully clean the brake parts in the open air. Wet the parts with a solution applied with a pump-spray bottle that creates a fine mist. Use a solution containing water, and, if available, a biodegradable, non-phosphate, water-based detergent. The wheel hub and brake assembly components should be thoroughly wetted to suppress dust before the brake shoes or brake pads are removed. Wipe the brake parts clean with a cloth.
 - d. Wear a respirator equipped with a HEPA filter approved by NIOSH or MSHA when grinding or machining brake linings. In addition, do such work in an area with a local exhaust ventilation system equipped with a HEPA filter.
 - e. **NEVER** use compressed air by itself, dry brushing, or a vacuum not equipped with a HEPA filter when cleaning brake parts or assemblies. **NEVER** use carcinogenic solvents, flammable solvents, or solvents that can damage brake components as wetting agents.
4. **Cleaning Work Areas.** Clean work areas with a vacuum equipped with a HEPA filter or by wet wiping. **NEVER** use compressed air or dry sweeping to clean work areas. When you empty vacuum cleaners and handle used rags, wear a respirator equipped with a HEPA filter approved by NIOSH or MSHA, to minimize exposure. When you replace a HEPA filter, wet the filter with a fine mist of water and dispose of the used filter with care.
5. **Worker Clean-Up.** After servicing brakes, wash your hands before you eat, drink or smoke. Shower after work. Do not wear work clothes home. Use a vacuum equipped with a HEPA filter to vacuum work clothes after they are worn. Launder them separately. Do not shake or use compressed air to remove dust from work clothes.
6. **Waste Disposal.** Dispose of discarded linings, used rags, cloths and HEPA filters with care, such as in sealed plastic bags. Consult applicable EPA, state and local regulations on waste disposal.

Regulatory Guidance

References to OSHA, NIOSH, MSHA, and EPA, which are regulatory agencies in the United States, are made to provide further guidance to employers and workers employed within the United States. Employers and workers employed outside of the United States should consult the regulations that apply to them for further guidance.

Maintenance

Manual Information

This manual contains service information for the WABCO **E Version** hydraulic ABS. For earlier versions of WABCO HABS, refer to:

- MM38 **C Version** HABS
- MM39 **D Version** HABS

Copies of these manuals are posted on our website:

wabco-na.com.

Overview

WABCO Hydraulic Anti-lock Braking System (HABS) is an electronic wheel speed monitoring and control system used on medium-duty trucks, buses and motor home chassis equipped with a hydraulic brake system.

E Version HABS consists of an electronic control unit (ECU) mounted directly on a modulator valve. Typically, the modulator valve is mounted on the frame rail of the vehicle. Figure 1.1.

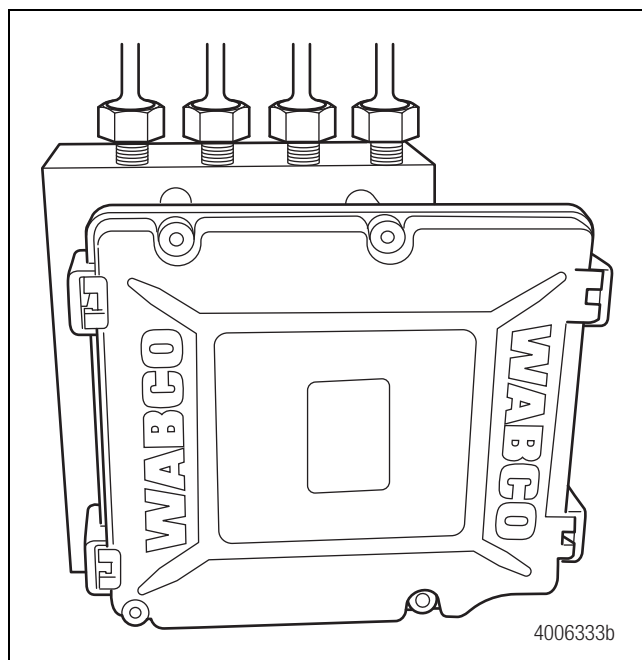


Figure 1.1

How Hydraulic ABS Works

ABS wheel sensors detect wheel speeds. The sensors generate signals that are transmitted to an ECU. If the wheels start to lock, the ECU signals the modulator assembly to regulate the brake pressure of each locking wheel.

During an ABS stop, a solenoid valve in the modulator assembly is rapidly pulsed; that is, it opens and closes several times per second to control the brake pressure. When this occurs, drivers may notice a pulsation of the brake pedal.

An ABS warning lamp on the vehicle instrument panel alerts the driver to a possible system fault and provides blink code information to diagnose the system.

If the ABS warning lamp comes on during normal vehicle operation, drivers may complete their trip, but are instructed to have their vehicle serviced as soon as possible.

In the unlikely event of an ABS system malfunction, the ABS in the affected wheel will be disabled and will return to normal braking. The other sensed wheels may retain their ABS function. Do not rely on the ABS functioning for any of the sensed wheels. Have the vehicle serviced as soon as possible.

1 Introduction

System Layout

A typical WABCO E Version HABS installation is illustrated in Figure 1.2.

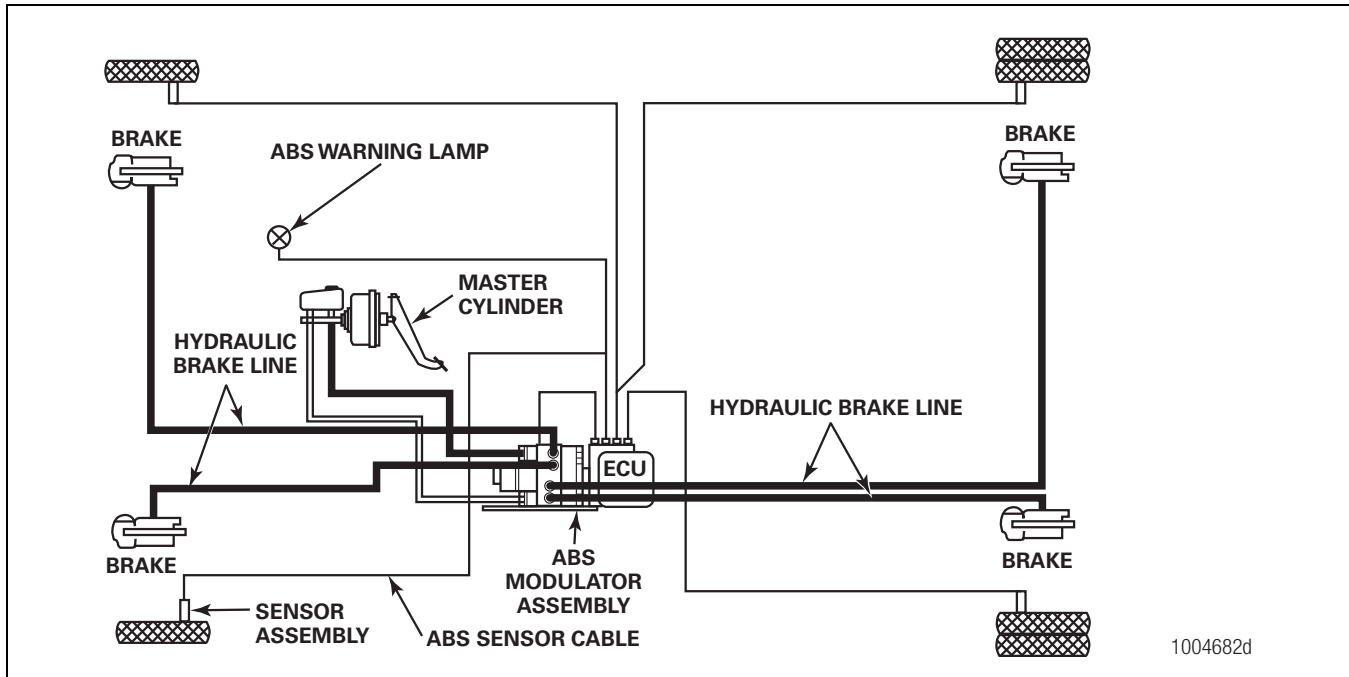


Figure 1.2

The ABS modulator assembly must be mounted **below** the master cylinder and **above** the wheel cylinders.

WABCO recommends that the motor axis makes an angle between $+5^\circ$ and $+30^\circ$ with the horizontal plane, with the motor end pointing up. Contact the OEM or WABCO for additional information regarding modulator orientation.

System Components

The following components make up WABCO E Version HABS.

Electronic Control Unit (ECU)

The electronic control unit (ECU) processes sensor signals and generates solenoid valve commands to reduce, maintain or reapply brake pressure. Figure 1.3.

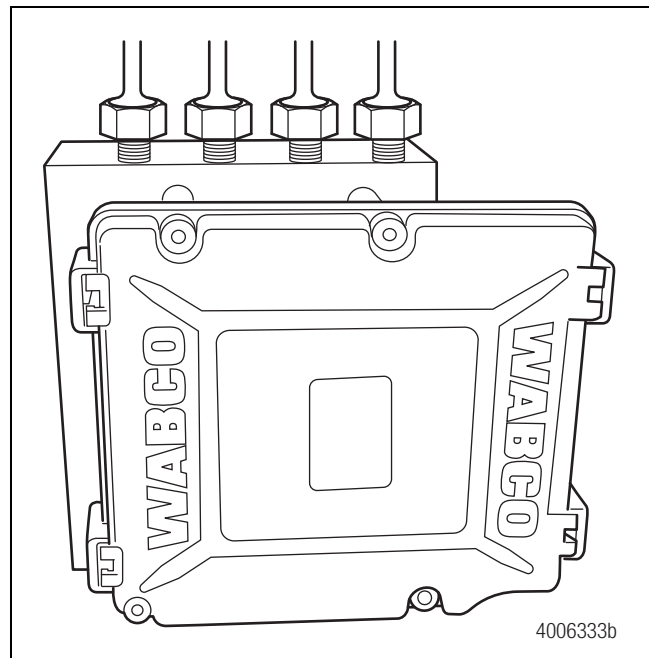


Figure 1.3

Modulator Assembly

⚠ CAUTION

The modulator assembly contains brake fluid. Handle the modulator assembly with appropriate care. Do not expose the modulator assembly to impact loads or excessive vibrations. Do not blow compressed air into the hydraulic ports. Mishandling the modulator assembly may lead to component damage and system failure.

The modulator assembly houses the HABS solenoid control valves, one inlet valve and one outlet valve per wheel, a pump motor and two low pressure accumulators. Figure 1.4.

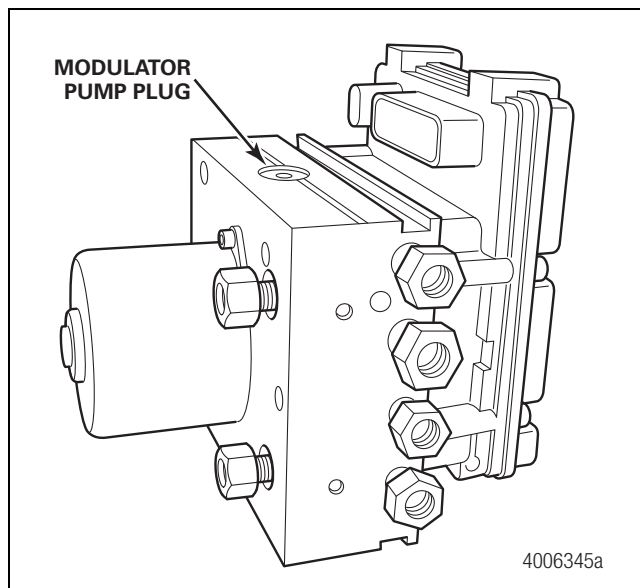


Figure 1.4

Sensors

Sensor with Molded Socket

- Used to measure the speed of a tooth wheel rotating with the vehicle wheel.
- Produces an output voltage proportional to wheel speed. Figure 1.5.

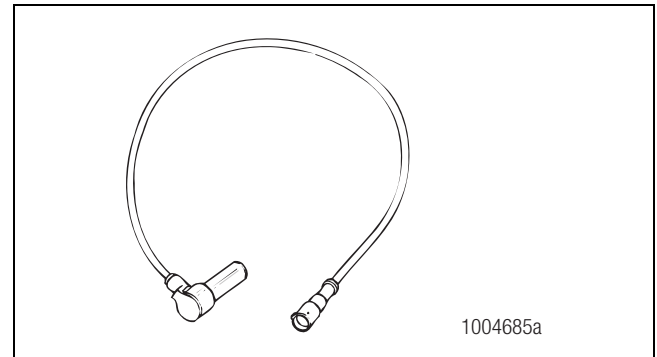


Figure 1.5

Sensor Spring Clip

- Holds the wheel speed sensor in close proximity to the tooth wheel. Figure 1.6.

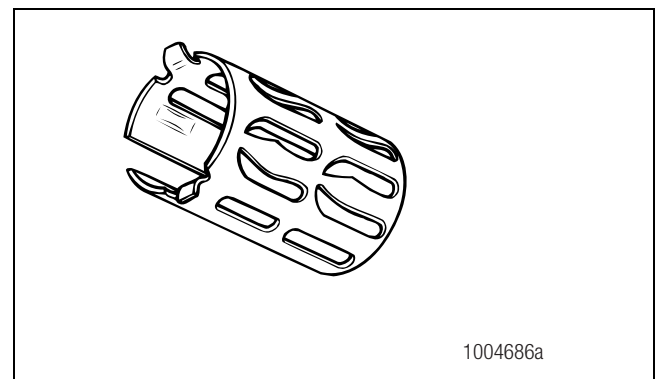


Figure 1.6

Tooth Wheel

- A machined or stamped ring mounted to a machined surface on the hub of each ABS-monitored wheel. Figure 1.7.

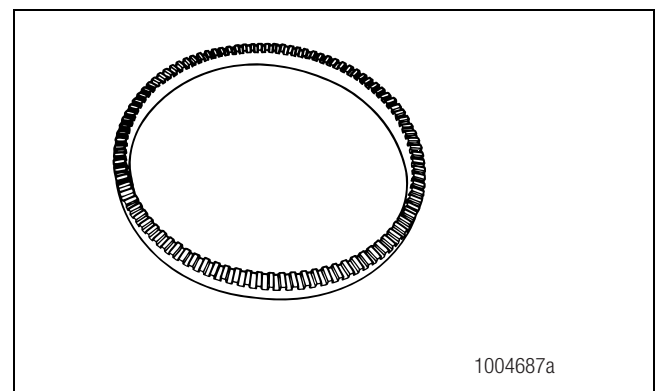


Figure 1.7

1 Introduction

Sensor Extension Cables

- Two-wire cable with molded-on connector. Figure 1.8.
- Connects the wheel speed sensor to the ECU.

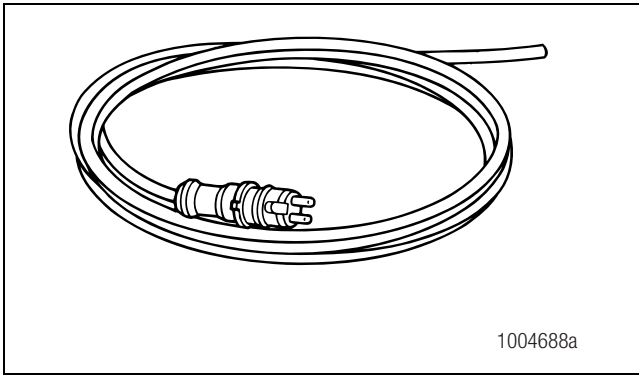


Figure 1.8

ABS Warning Lamp

- Located on vehicle instrument panel. Figure 1.9.
- Alerts drivers to a possible system fault.
- Used by service personnel to display blink codes (optional feature).
- ABS warning lamp is not provided by WABCO.

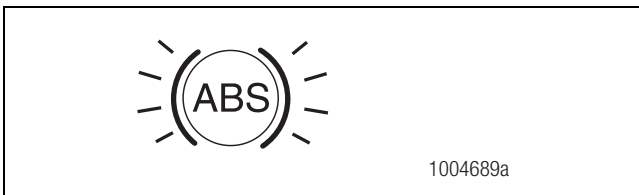


Figure 1.9

TOOLBOX™ Software

- A PC-based diagnostics program.
- Displays system faults and wheel speed data, tests individual components, verifies installation wiring and more.
- Runs in Windows® ME, XP, 2000, Vista, 7 and 8. Figure 1.10.



Figure 1.10

NOTE: An RS232 to J1708 converter box is required.

TOOLBOX™ Software may be obtained at www.wabco-na.com.

Maintenance

General Information

There is no regularly scheduled maintenance required for WABCO E Version Hydraulic ABS. However, ABS does not change current vehicle maintenance requirements. For example, it is important that the vehicle brake fluid level be correctly maintained.

Wiring Diagrams

System Wiring Information

Pin identification is shown in Figure 2.1. Wiring may vary according to the vehicle. Refer to the vehicle specifications for specific wiring diagrams. A typical WABCO Hydraulic ABS wiring diagram appears in Figure 2.2.

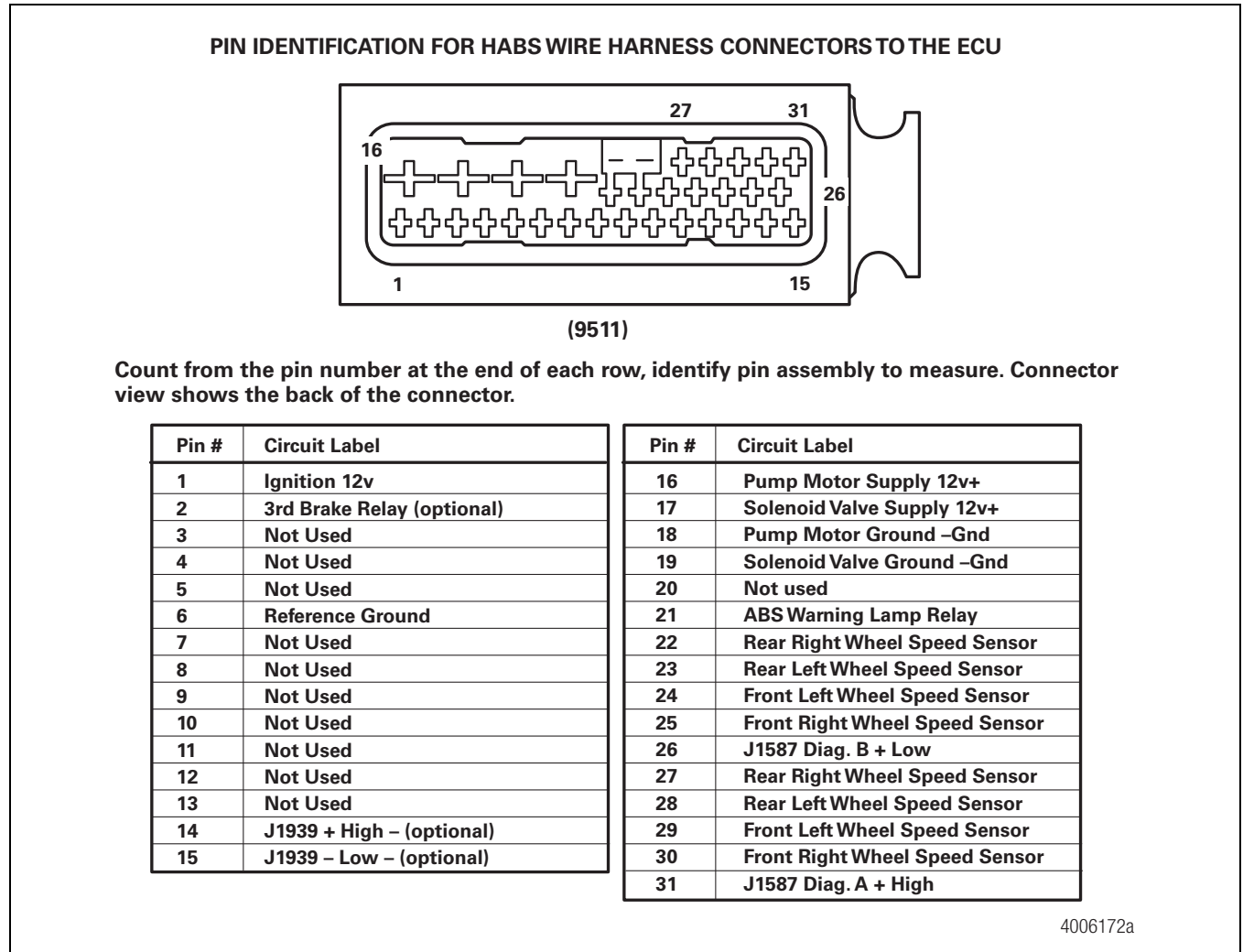


Figure 2.1

2 Troubleshooting and Testing

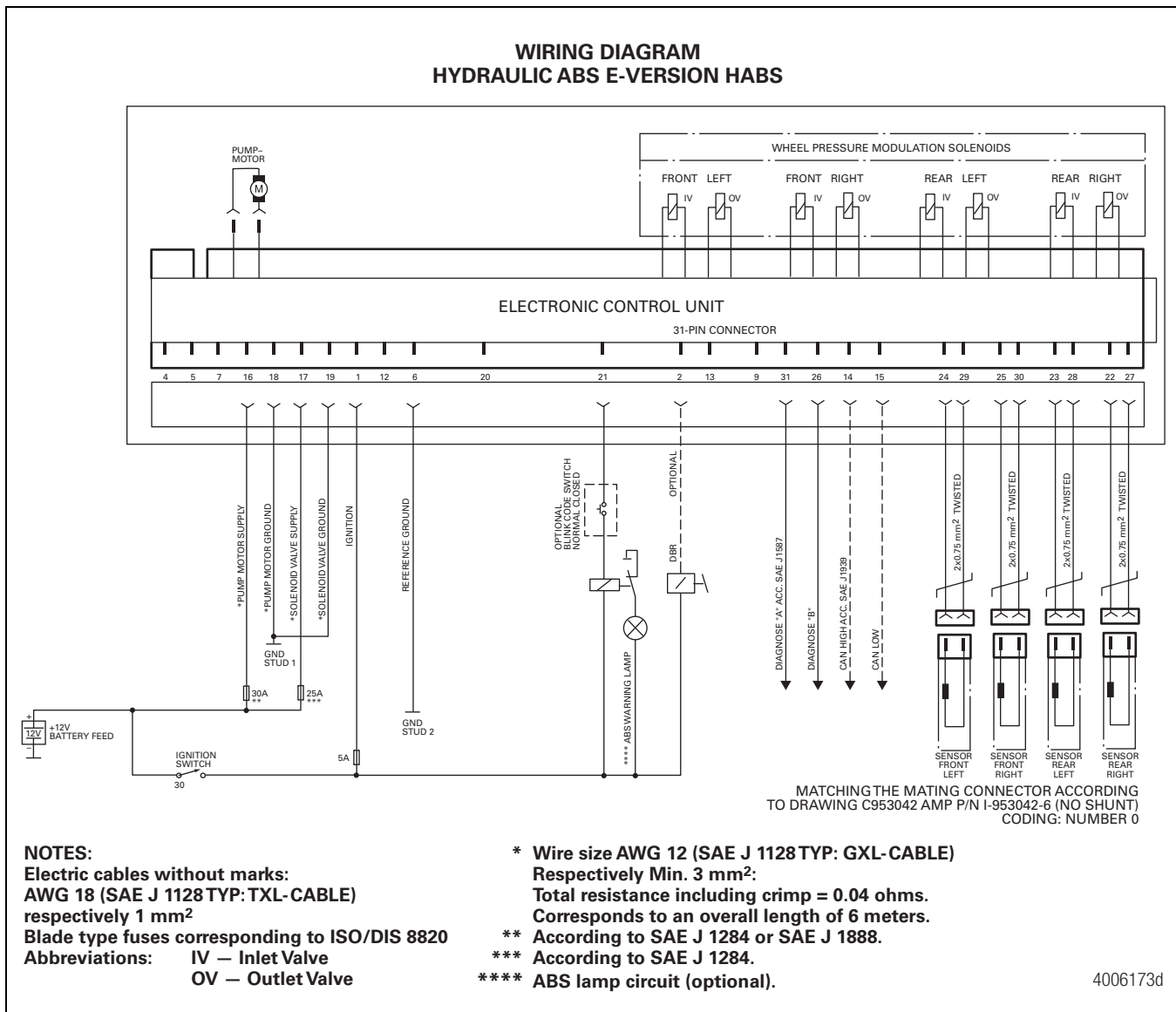


Figure 2.2

System Diagnostics

Use WABCO's PC-based diagnostic program, TOOLBOX™ Software, or standard blink codes to diagnose hydraulic ABS faults. Information for using standard blink codes appears in Table B in this section.

WABCO TOOLBOX™ Software

NOTE: TOOLBOX™ Software may be obtained at www.wabco-na.com.

NOTE: You must have TOOLBOX™ 7.2.2 or newer to communicate with HABS E version.

NOTE: When connecting to TOOLBOX™ Software, verify the communication device settings are correct and J1708 is selected as the Protocol in "Adapter Selection" under the "Utilities" menu. Figure 2.3.

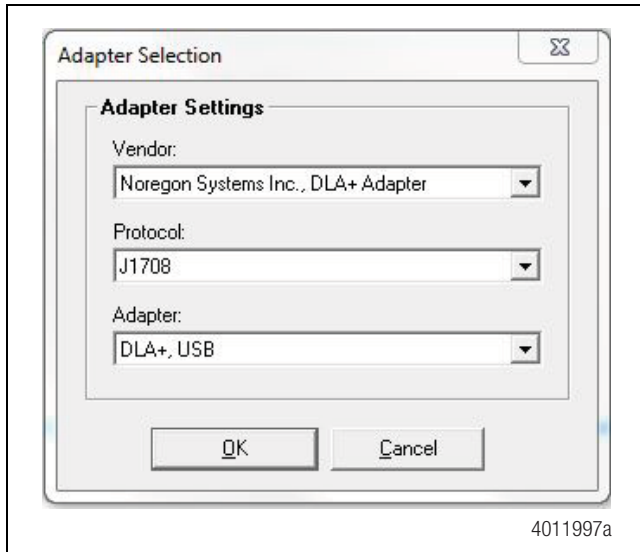


Figure 2.3

If you have TOOLBOX™ Software installed on your computer, use it to identify system faults. Then, follow the on-screen repair information to make the necessary repairs or replacements.

To display Hydraulic ABS faults, use the pull-down menu or the HABS icon, Figure 2.4, to select HABS (Hydraulic ABS) from the **Main Menu**. The **Hydraulic ABS Main Menu** will appear. Figure 2.5.

Select the View ECU Faults icon or select Display Faults to use the pull-down menu. Figure 2.6. This will display the **Fault Information** screen. Figure 2.7.

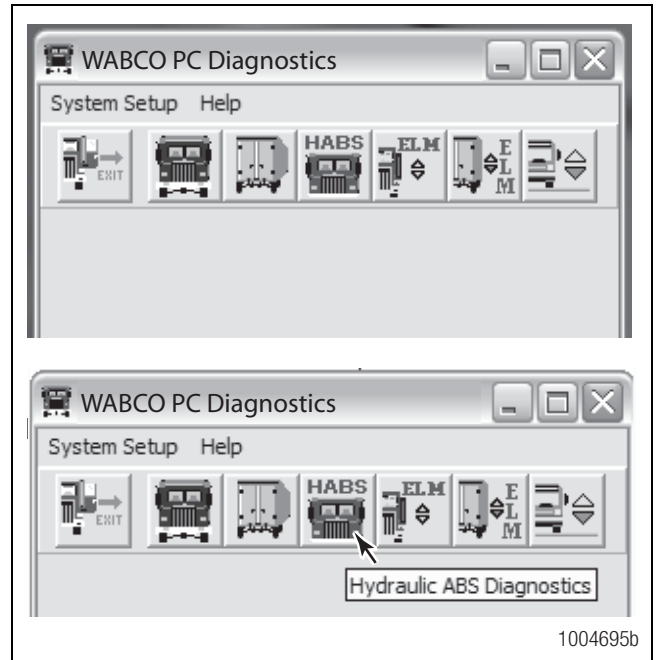


Figure 2.4

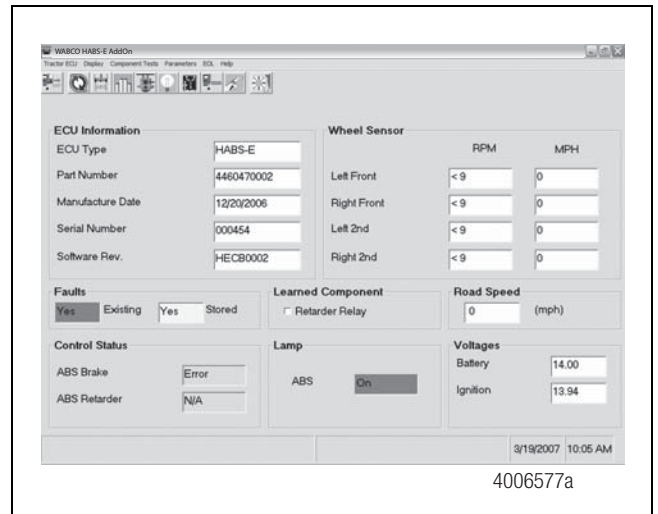


Figure 2.5

2 Troubleshooting and Testing

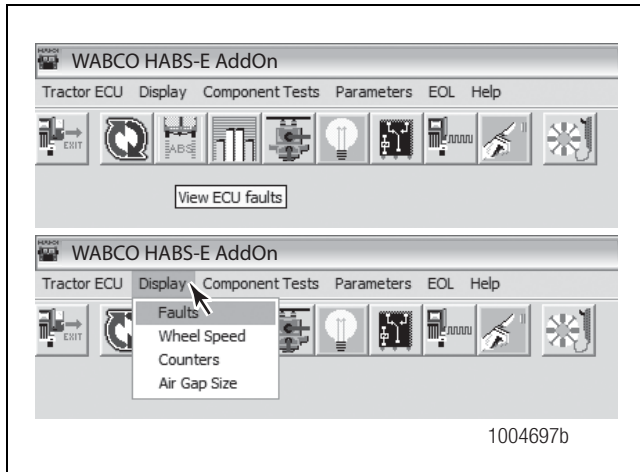


Figure 2.6

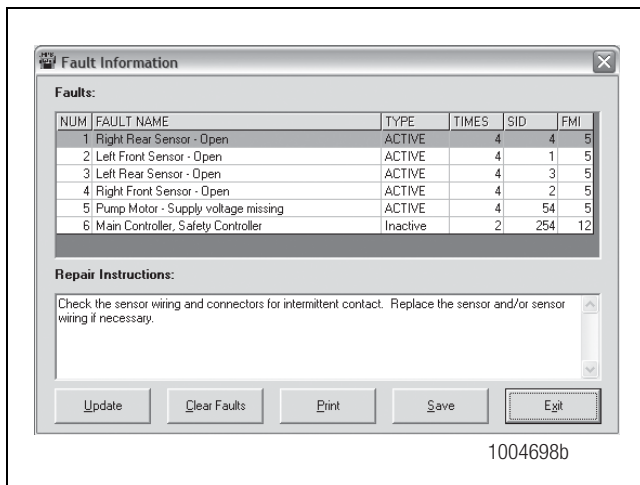


Figure 2.7

The **Fault Information** screen contains a description of the fault. Repair instructions for each fault appear at the bottom of the screen.

Faults that occur after the screen is displayed will not appear until a screen update is requested. Use the **Update** button to refresh the fault information table.

After making the necessary repairs, use the **Clear Faults** button to clear the fault. Use the **Update** button to refresh the fault information table and display the new list of faults.

Most faults require an ignition cycle and/or test drive above 5 mph to verify fault resolution. Also check the ABS warning lamp to ensure the system functions correctly.

Blink Code Diagnostics

NOTE: If the vehicle does not have a blink code switch, WABCO TOOLBOX™ Software is required to communicate with the ECU to obtain DTCs to diagnose the system.

Definitions

ABS Warning Lamp: This lamp, located on the vehicle instrument panel, serves two purposes:

1. Alerts drivers or service personnel to a possible fault in the hydraulic ABS, as follows:

IF the ABS warning lamp comes on briefly then goes OFF when the ignition is turned ON there are no active faults in the hydraulic ABS

IF the ABS warning lamp comes on and **stays on** AFTER the ignition is turned ON **and**

The vehicle is driven in excess of four mph (6 km/h) . . . **There may be an active fault in the hydraulic ABS**

IF the ABS warning lamp comes on and stays on **and**

Goes OFF after the vehicle is driven in excess of four mph (6 km/h) or illuminates intermittently during driving . . . **There may be a stored fault in the hydraulic ABS**

2. Displays diagnostic blink codes for easy servicing.

Blink Code: A series of blinks or flashes that describe a particular ABS system condition. Refer to Table B and Table C in this section for blink code identification.

Blink Code Diagnostics: The ability of the WABCO ECU to sense faults in the ABS and to define these faults via blink codes.

Blink Code Switch: A momentary switch that activates blink code diagnostic capabilities. Usually, it is mounted under the instrument panel or on the steering column. Refer to the vehicle specifications for type and location.

Clearing Fault Codes: The process of erasing faults from the ECU memory bank. Refer to Table B in this section.

Fault Code: An ABS condition (fault) detected and stored in memory by the WABCO ECU and displayed by blink code. System faults may be **Active** or **Stored**.

Active Fault: A condition that currently exists in the ABS system; for example, a sensor circuit malfunction on the left front steering axle. An active fault **must be repaired before you can display additional faults**. Once an active fault has been repaired, it becomes a stored fault.

Stored Fault: A condition that caused the system to register a fault, but **is not currently active**. For example, a loose wire that corrected itself. A stored fault can also be an active fault that has been corrected. Refer to Active Fault.

Table B, in this section, describes the method of distinguishing between active and stored faults and explains how to clear them.

System Code: Displaying identifier for supply voltage (12V) during system mode. Figure 2.8.

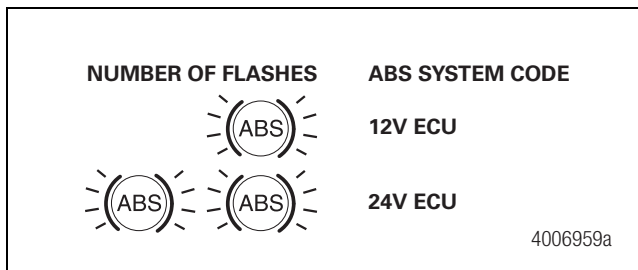


Figure 2.8

Using Blink Code Diagnostics — Optional Feature

Follow the steps listed in Table B to use blink code diagnostics. Refer to Figure 2.16 and Figure 2.17 in this section for blink code illustrations.

1. Wiring Diagram (Figure 2.9)

2 Troubleshooting and Testing

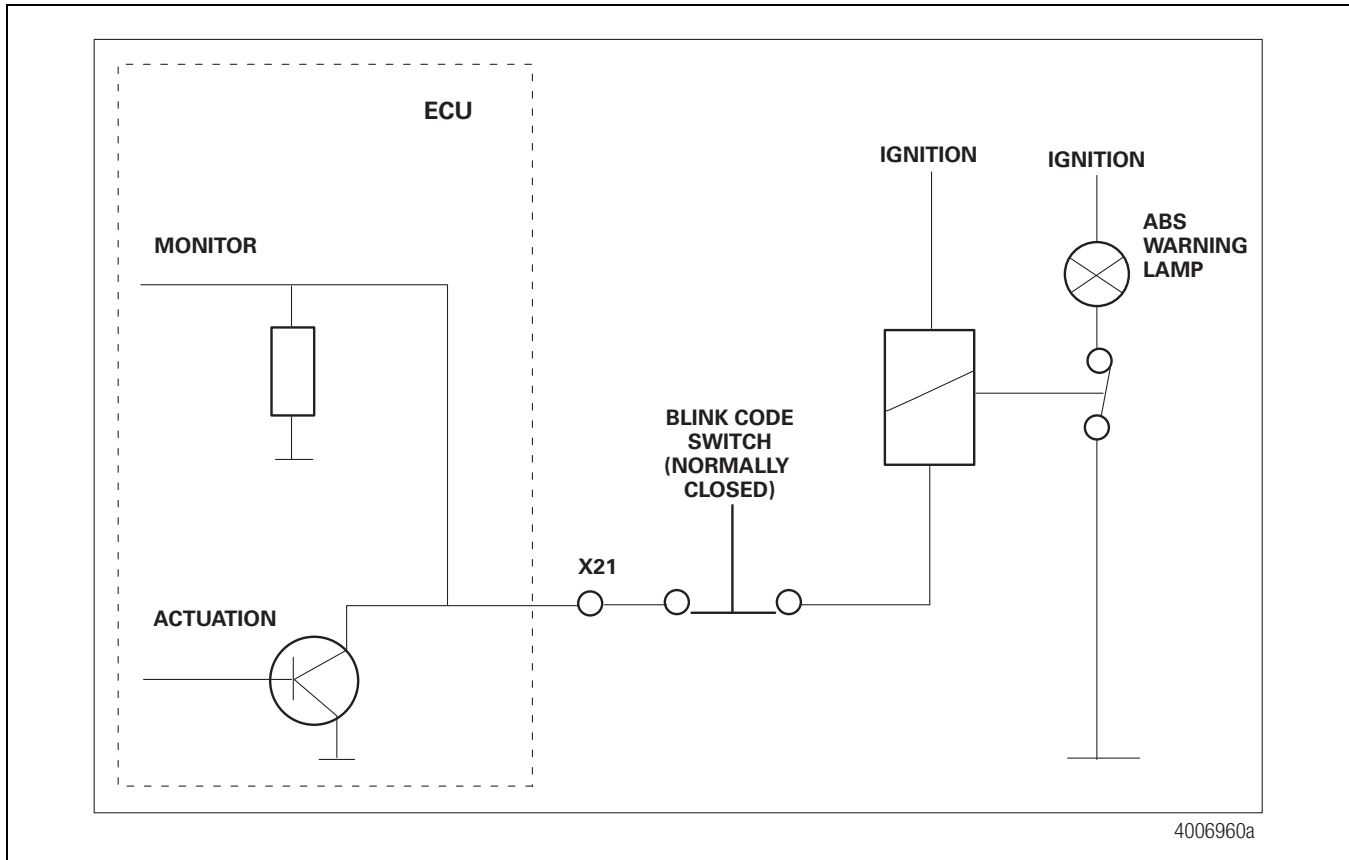


Figure 2.9

2. Activation of Blink Code Function — Optional Feature

For activation, the blink code switch needs to be actuated for a variable length of time. The duration of the actuation determines the blink code mode. After the switch has been released again, the ABS warning lamp remains illuminated for 0.5 second to indicate the reception of a new blink code command from the user.

3. Termination of Blink Code Function — Optional Feature

If either a system fault is detected or the blink code switch is depressed for more than 6.3 seconds, the current blink code command will be terminated immediately.

If the diagnostic mode (output of fault codes via blinking the lamp) has been requested via blink code switch, and if there are no active faults stored inside the ECU (inactive faults only or no faults at all), the blink code is terminated as well after the fault codes have been blinked out once.

Blink code is terminated if ignition is switched off and if the vehicle starts moving (vehicle speed greater than 2.5 mph or 4 km/h).

If the blink code switch is held for 15 seconds or longer, an ABS warning lamp fault will be generated which also terminates the blink code.

4. Blink Code Frequency (Figure 2.10)

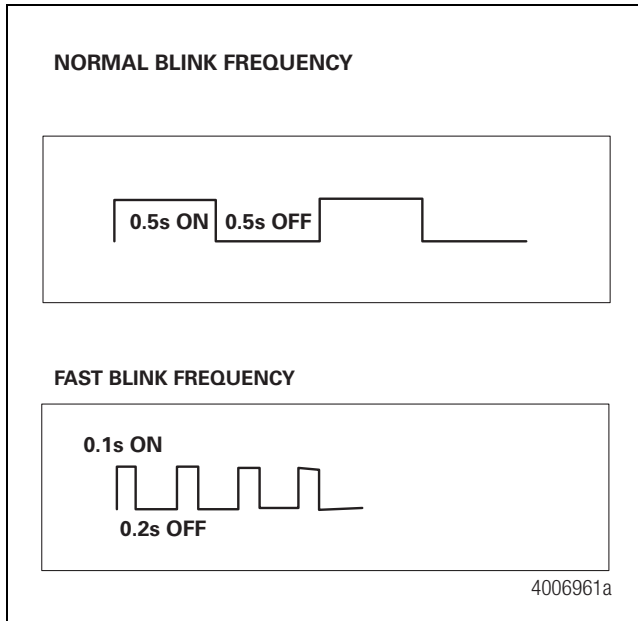


Figure 2.10

5. Diagnostic Mode

To activate the diagnostic mode, press the blink code switch for more than 0.5 second but less than 3.0 seconds.

Figure 2.11.

With active faults:

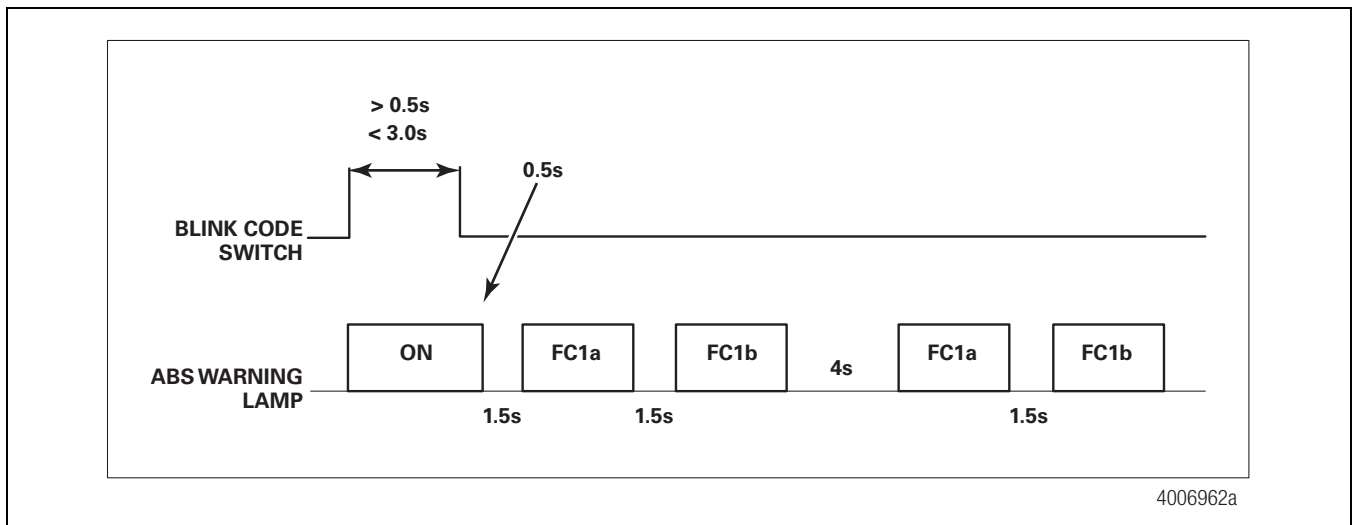


Figure 2.11

2 Troubleshooting and Testing

FC1 is the fault code for the first active fault. **a** indicates the first part of the code. **b** indicates the second part. Table C.

If a fault was detected during the current ignition switch cycle (an active fault), the corresponding fault code (FC1a and FC1b) is repeated continuously.

If there are several active fault codes, only the most recent is displayed.

The diagnostic mode is terminated if:

- The ignition switch is cycled.
- The vehicle starts moving and its speed exceeds 2.5 mph (4 km/h).
- The blink code switch is actuated for more than 6.3 seconds.

With inactive faults: Figure 2.12.

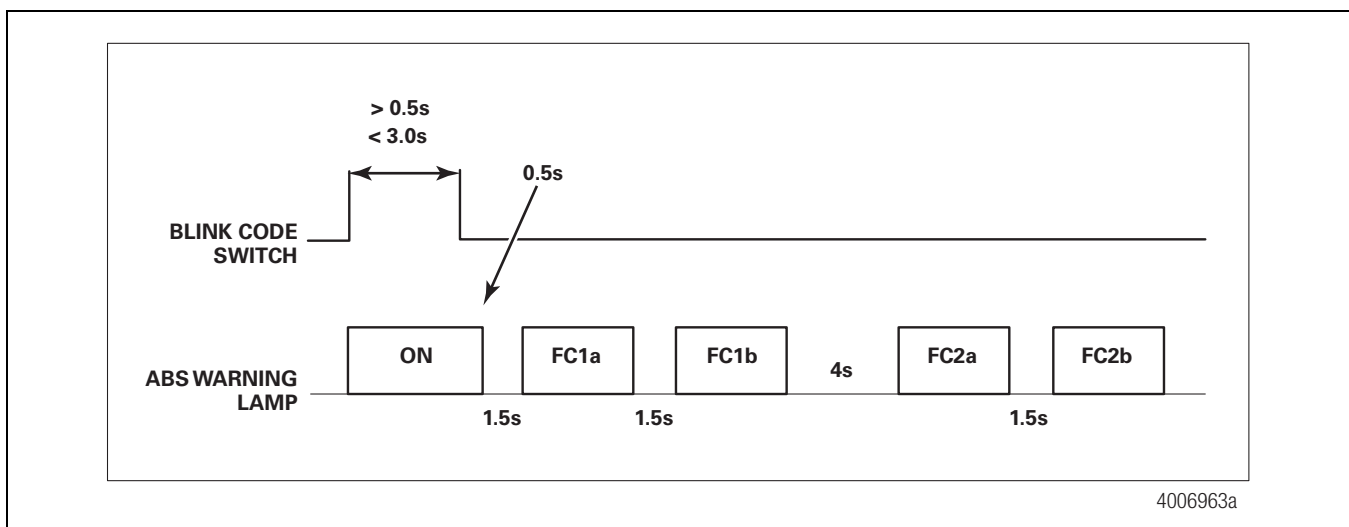


Figure 2.12

FCn is the fault code for an inactive fault. **a** indicates the first part of the code. **b** indicates the second part. Table C.

If there are no active faults, inactive fault codes will be displayed beginning with the most recent. When all inactive fault codes have been displayed, the diagnostic mode is terminated.

6. Clearing Faults (System) Mode

This mode will be activated if the blink code switch is held for more than 3.0 seconds but less than 6.3 seconds. Within this mode, the faults stored in the ECU will be cleared. After clearing all faults, the ABS warning lamp blinks rapidly eight times. Figure 2.13.

Faults will be cleared only if:

- There is no fault currently active. The system code will be displayed.

2 Troubleshooting and Testing

- There are air gap faults or pole wheel faults stored in the ECU with an occurrence count of less than 50. If the occurrence count for both air gap and pole wheel faults is more than 50, the ECU is running in **Sensitive mode** which prevents fault code clearance. The system code will be displayed.

NOTE: In **Sensitive Mode**, modified thresholds increase the speed with which faults are detected.

- The maximum on time of the ABS inlet valves switches is not exceeded. The maximum on time is 1/3. The system code will be displayed continuously.

When the faults are cleared, the system code is displayed continuously. Table A.

Table A: System Code

1x	12V ECU AddOn E
2x	24V ECU AddOn E

Two seconds after activating the system mode, endurance brake (retarder) reconfiguration can be requested by pressing the blink code switch three times for at least 0.5 second each at intervals of less than 3.0 seconds.

Completion of reconfiguration will cause the ABS warning lamp to blink rapidly four times.

The system mode will terminate if:

- The ignition switch is cycled.
- The vehicle starts moving and its speed exceeds 2.5 mph (4 km/h).
- The blink code switch is pressed for longer than 6.3 seconds.

All faults will be cleared in system mode only if:

- There are no active faults.
- There are no sensor counts of 50 or greater.
- The maximum inlet valve actuation time was not exceeded.

After clearing all faults, the ABS warning lamp blinks rapidly eight times followed by continuous repetition of the system code. Figure 2.13.

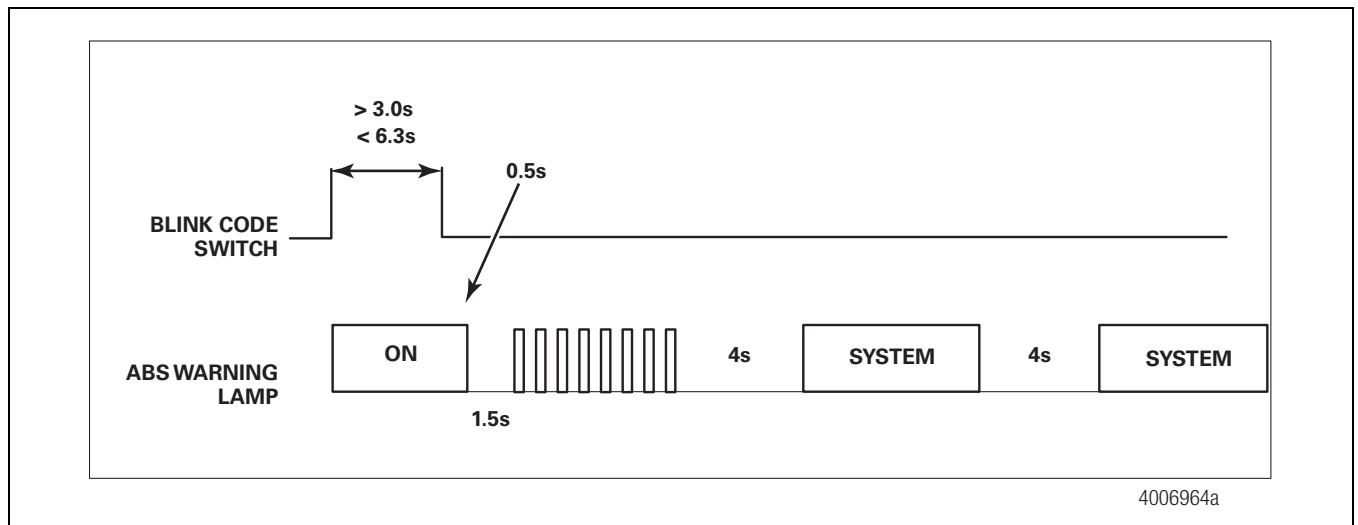


Figure 2.13

Faults will not clear if:

- Active faults are detected.
- Stored faults have an occurrence count of 50 or more.
- Maximum inlet valve actuation time is exceeded.

The system code will display continuously. Figure 2.14.

2 Troubleshooting and Testing

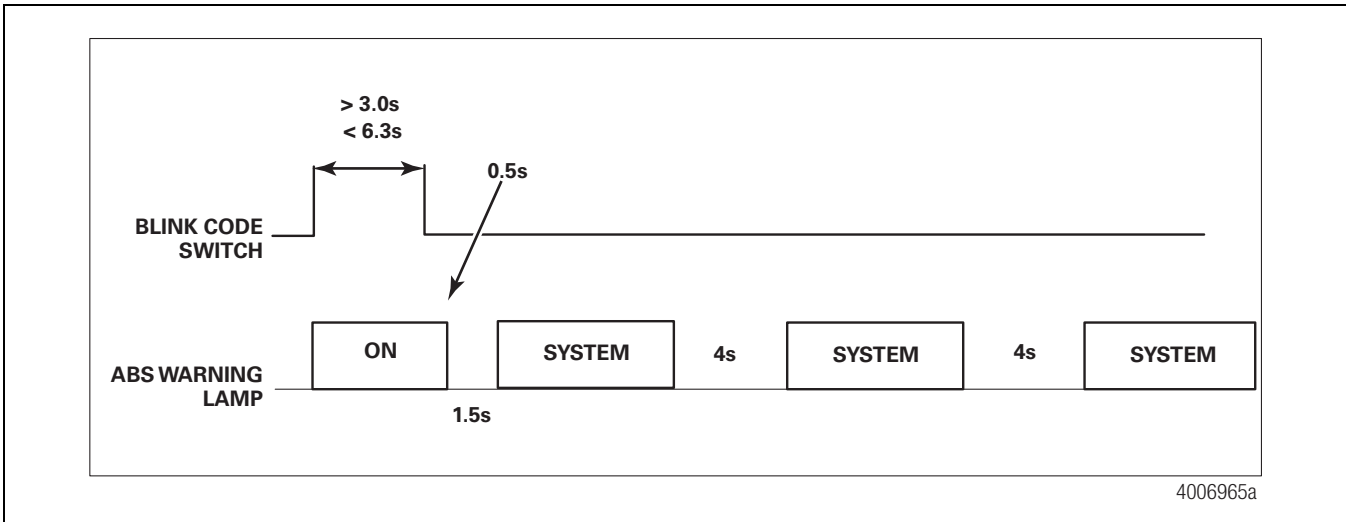


Figure 2.14

7. Retarder Reconfiguration

Within system mode (after 2.0 seconds), request retarder reconfiguration by pressing the blink code switch three times for at least 0.5 second at intervals of less than 3.0 seconds. Figure 2.15.

Reconfiguration occurs only if there are no active faults.

The ABS warning lamp blinks four times to confirm that the retarder has been reconfigured. Then, the system code displays continuously. Figure 2.15.

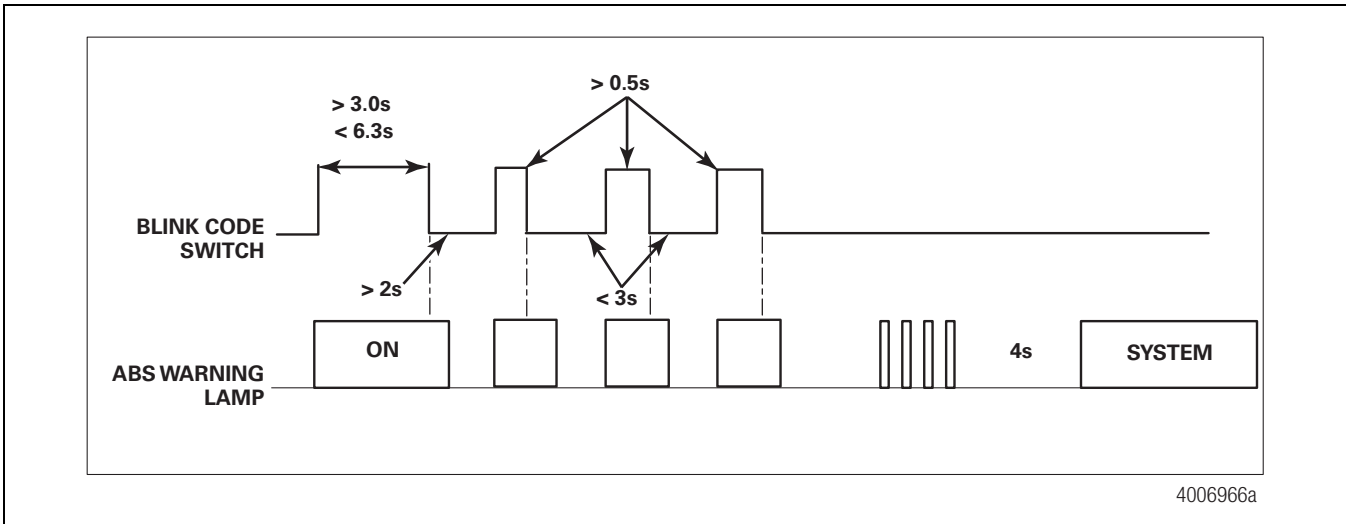


Figure 2.15

Table B: Identifying E Version Hydraulic ABS Blink Codes

Troubleshooting with Blink Code Diagnostics — Optional Feature			
Mode	Procedure	System Response	Action
Diagnostics	Step I. Turn ignition ON.	Possible responses:	
		1. ABS warning lamp comes on momentarily then goes out, indicating System O.K.	No recognizable active faults in the ABS. No action required.
		2. ABS warning lamp does not light, indicating possible wiring fault or burned-out bulb.	Inspect wiring. Inspect bulb. Make the necessary repairs.
		3. ABS warning lamp stays on, indicating:	
		• Fault, or faults, in the system	Continue with blink code diagnostics. Go to Step II.
		• Sensor fault during last operation	Continue with blink code diagnostics. Go to Step II.
		• Faults cleared from ECU, but vehicle not driven.	Drive vehicle — lamp will go out when vehicle reaches four mph (6 km/h).
	• ECU disconnected.	Connect ECU.	
	Step II. Press and hold Blink Code Switch for one second, then release.	ABS warning lamp begins flashing two-digit blink code(s).	Determine if fault is active or stored: Active Fault: Lamp will repeatedly display one code. Stored Fault: Lamp will display code for each stored fault then stop blinking. Faults will be displayed one time only .
	Step III. Count the flashes to determine the blink code.	First Digit: 1-14 flashes, Pause (1-1/2 seconds). Second Digit: 1-11 flashes, Pause (4 seconds).	Find definition for blink code on blink code chart.
Step IV. Turn ignition OFF. Repair and record faults	Active Fault.	Make the necessary repairs.	
	Stored Faults.	Record for future reference.	
Clear	Step V. Turn ignition ON. Clear faults from memory: Press and hold blink code switch for 3.0 to 6.0 seconds, then release.	ABS warning lamp flashes eight times.	All stored faults successfully cleared. Turn ignition OFF. Turn ignition ON. The warning lamp will stay on. This is because the ECU is looking for wheel speed. Drive the vehicle at a speed of four mph (6 km/h). Once the ECU senses wheel speed, the lamp will go off.
		Eight flashes not received.	Active faults still exist, repeat Step I through Step V.

2 Troubleshooting and Testing

Blink Codes Illustrated

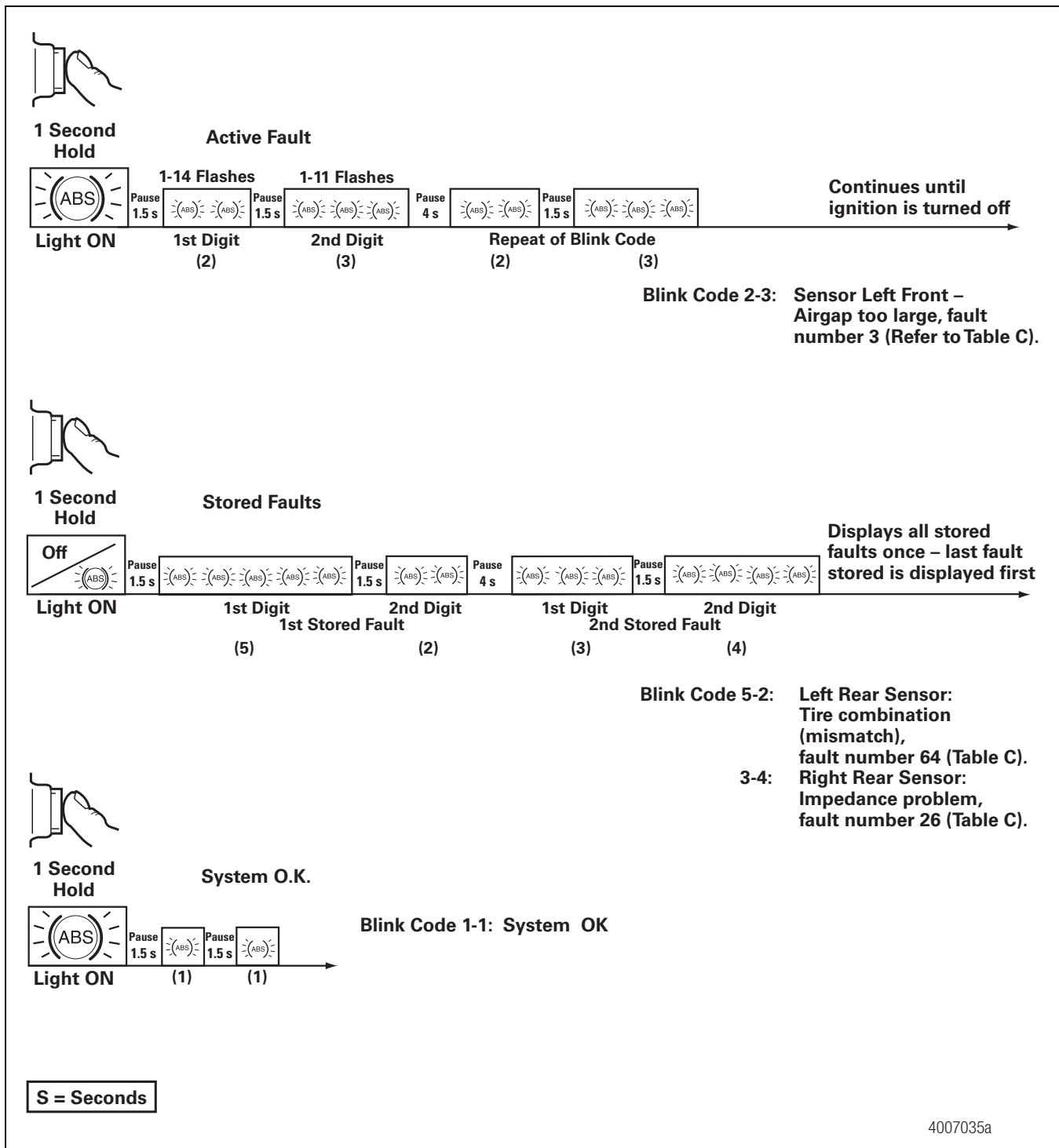


Figure 2.16

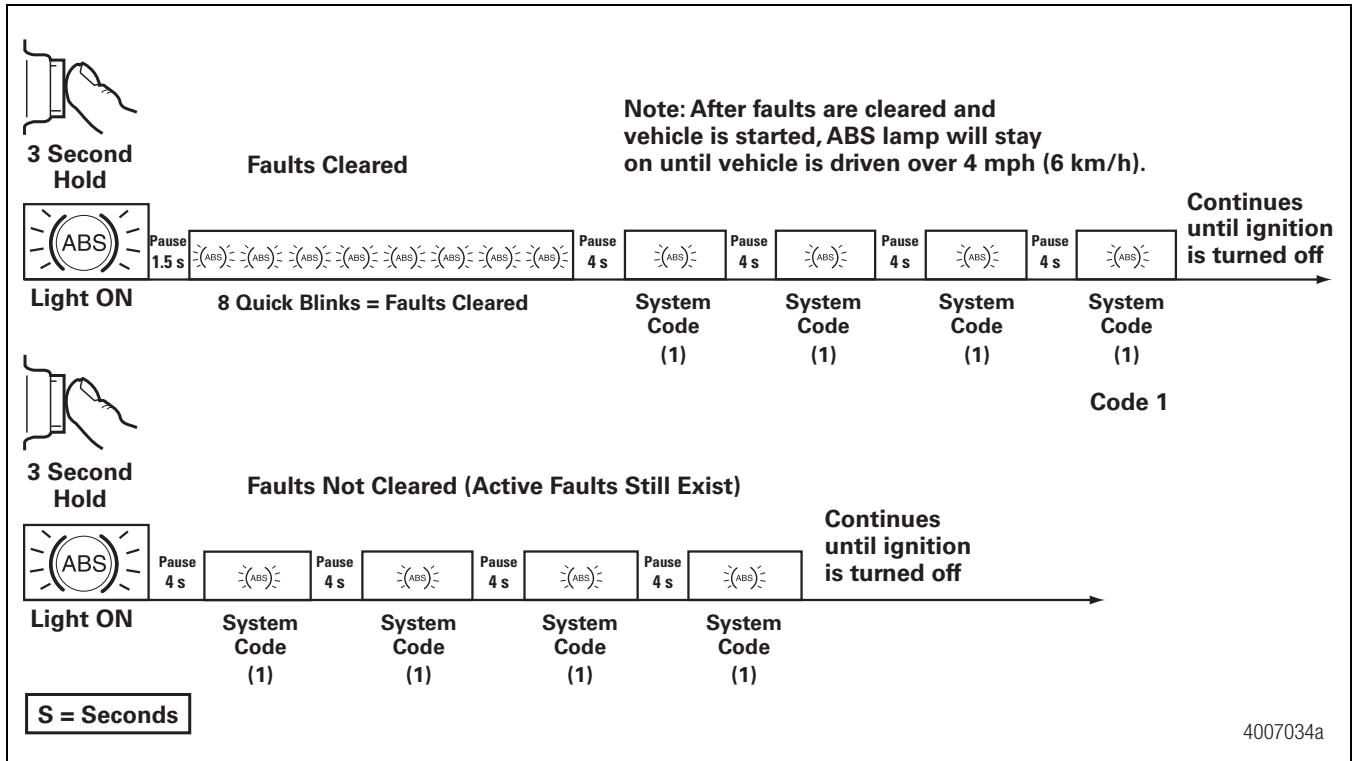


Figure 2.17

E Version Hydraulic ABS Blink Codes

Use the information in Table C to identify a fault and its fault number.

The blink code appears in two parts. The first part identifies the faulty component. The second part identifies the location or the description of the fault.

1. Identify and record the blink code. Blink codes are identified in Columns **1** and **2**.
2. Find the fault number in Column **3**.

Table C: E Version Blink Codes

First Part	Second Part	Fault Number
1 No Failure	1 No Failure	—
2 Sensor: Air gap	1 Right Front	1
2 Sensor: Air gap	2 Left Rear	2
2 Sensor: Air gap	3 Left Front	3
2 Sensor: Air gap	4 Right Rear	4
3 Sensor: Impedance	1 Right Front	23
3 Sensor: Impedance	2 Left Rear	24
3 Sensor: Impedance	3 Left Front	25
3 Sensor: Impedance	4 Right Rear	26
4 Sensor: No trigger at all	1 Right Front	73

2 Troubleshooting and Testing

First Part	Second Part	Fault Number
4 Sensor: No trigger at all	2 Left Rear	74
4 Sensor: No trigger at all	3 Left Front	75
4 Sensor: No trigger at all	4 Right Rear	76
5 Sensor: Tire Combination	1 Right Front	63
5 Sensor: Tire Combination	2 Left Rear	64
5 Sensor: Tire Combination	3 Left Front	65
5 Sensor: Tire Combination	4 Right Rear	66
6 Power Amplifier: Short to Ubat/Uvent	1 Right Front Inlet Valve	9
6 Power Amplifier: Short to Ubat/Uvent	2 Right Front Outlet Valve	10
6 Power Amplifier: Short to Ubat/Uvent	3 Left Front Inlet Valve	11
6 Power Amplifier: Short to Ubat/Uvent	4 Left Front Outlet Valve	12
6 Power Amplifier: Short to Ubat/Uvent	5 Right Rear Inlet Valve	13
6 Power Amplifier: Short to Ubat/Uvent	6 Right Rear Outlet Valve	14
6 Power Amplifier: Short to Ubat/Uvent	7 Left Rear Inlet Valve	15
6 Power Amplifier: Short to Ubat/Uvent	8 Left Rear Outlet Valve	16
6 Power Amplifier: Short to Ubat/Uvent	9 Engine Brake Relay	17
6 Power Amplifier: Short to Ubat/Uvent	10 Brake Light Relay	18
7 Power Amplifier: Open Circuit	1 Right Front Inlet Valve	27
7 Power Amplifier: Open Circuit	2 Right Front Outlet Valve	28
7 Power Amplifier: Open Circuit	3 Left Front Inlet Valve	29
7 Power Amplifier: Open Circuit	4 Left Front Outlet Valve	30
7 Power Amplifier: Open Circuit	5 Right Rear Inlet Valve	31
7 Power Amplifier: Open Circuit	6 Right Rear Outlet Valve	32
7 Power Amplifier: Open Circuit	7 Left Rear Inlet Valve	33
7 Power Amplifier: Open Circuit	8 Left Rear Outlet Valve	34
7 Power Amplifier: Open Circuit	9 Engine Brake Relay	35
7 Power Amplifier: Open Circuit	10 Brake Light Relay	36
8 Power Amplifier: Short to Ground	1 Right Front Inlet Valve	41
8 Power Amplifier: Short to Ground	2 Right Front Outlet Valve	42
8 Power Amplifier: Short to Ground	3 Left Front Inlet Valve	43
8 Power Amplifier: Short to Ground	4 Left Front Outlet Valve	44
8 Power Amplifier: Short to Ground	5 Right Rear Inlet Valve	45
8 Power Amplifier: Short to Ground	6 Right Rear Outlet Valve	46
8 Power Amplifier: Short to Ground	7 Left Rear Inlet Valve	47
8 Power Amplifier: Short to Ground	8 Left Rear Outlet Valve	48

2 Troubleshooting and Testing

First Part	Second Part	Fault Number
8 Power Amplifier: Short to Ground	9 Engine Brake Relay	49
8 Power Amplifier: Short to Ground	10 Brake Light Relay	50
9 Inlet Valve Actuation Time	1 Right Front	80
9 Inlet Valve Actuation Time	2 Left Rear	81
9 Inlet Valve Actuation Time	3 Left Front	82
9 Inlet Valve Actuation Time	4 Right Rear	83
10 Pump Motor	1 pm monitor voltage unexp. high	67
10 Pump Motor	2 pm monitor voltage unexp. low	68
10 Pump Motor	3 motor does not turn	69
10 Pump Motor	4 no pm supply voltage	70
10 Pump Motor	5 pm relay does not switch on	71
10 Pump Motor	6 pm relay does not switch off	72
11 J1939	1 Internal	77
11 J1939	2 bus failure	78
11 J1939	3 message failure	79
12 Pole Wheel	1 Right Front	84
12 Pole Wheel	2 Left Rear	85
12 Pole Wheel	3 Left Front	86
12 Pole Wheel	4 Right Rear	87
13 Brake Chatter	1 Right Front	90
13 Brake Chatter	2 Left Rear	91
13 Brake Chatter	3 Left Front	92
13 Brake Chatter	4 Right Rear	93
14 System	1 valve relay can't switch off	55
14 System	2 valve relay can't switch on	56
14 System	3 reference ground connection	57
14 System	4 tire parameter not correct	58
14 System	5 ABS warning light bulb	59
14 System	6 brake warning light bulb	60
14 System	7 High Voltage	61
14 System	8 Low Voltage	62
14 System	9 Clamp	88
14 System	10 Pull Up Down	89
14 System	11 Internal Error	0

2 Troubleshooting and Testing

SPN, SID, FMI Diagnostic Trouble Code List

SPN	SID	FMI	Blink Code	Description	Warning Light	System Reaction	Cause	Action
Main Controller, Safety Controller								
254	254	12	14 + 9	Clamp	Brake & ABS WL	ABS & EBD Disabled	Multiple possibilities.	<ul style="list-style-type: none"> Reset ECU by cycling the ignition or by using the reset option in TOOLBOX™ Software. If fault persists, check ABS ECU powers, grounds and load test. After checking powers, grounds and load testing, if fault still persists, may indicate the ECU has failed.
254	254	12	14 + 10	Pull Up Down	Brake & ABS WL	ABS & EBD Disabled	Multiple possibilities.	<ul style="list-style-type: none"> Reset ECU by cycling the ignition or by using the reset option in TOOLBOX™ Software. If fault persists, check ABS ECU powers, grounds and load test. After checking powers, grounds and load testing, if fault still persists, may indicate the ECU has failed.
254	254	12	14 + 11	Internal Error	Brake & ABS WL	ABS & EBD Disabled	Multiple possibilities.	<ul style="list-style-type: none"> Reset ECU by cycling the ignition or by using the reset option in TOOLBOX™ Software. If fault persists, check ABS ECU powers, grounds and load test. After checking powers, grounds and load testing, if fault still persists, may indicate the ECU has failed.
Left Front Wheel Speed Sensor								
1	1	1	2 + 3	Air Gap	ABS WL	ABS Wheel Disabled	Sensor air gap is too large, sensor output voltage is too low.	<ul style="list-style-type: none"> Check air gap. The gap should not be greater than 0.040-inch (1.02 mm). Check bearing play and tone ring run out. Eliminate root cause for air gap extension and push sensor back in afterwards. Check tone ring for damage (missing teeth, corrosion).
1	1	5	3 + 3	Impedance	ABS WL	ABS Wheel Disabled	An open circuit has been detected, i.e. ECU detects a disconnected wheel speed sensor.	<ul style="list-style-type: none"> Check sensor impedance and sensor wiring and connectors for intermittent contact. Check harness and/or sensor for open circuit or short to ground. Sensor resistance should measure between 900-2000 ohms.
1	1	7	12 + 3	Tone Ring	ABS WL	ABS Wheel Disabled	Wheel speed signal drops out periodically at speeds higher than 10 kph.	<ul style="list-style-type: none"> Check tone ring for damage/missing teeth/corrosion. Check bearing play and tone ring run out.
1	1	8	4 + 3	No Trigger Detected	ABS WL	ABS Wheel Disabled	Wheel speed sensor signal not detected.	<ul style="list-style-type: none"> Check air gap. The gap should not be greater than 0.040-inch (1.02 mm). Check bearing play and tone ring run out. Eliminate root cause for air gap extension and push sensor back in afterwards. Check tone ring for damage (missing teeth, corrosion). Check sensor impedance and sensor wiring and connectors for intermittent contact. Check sensor installation. Check air gap and push sensor back in afterwards.
1	1	11	13 + 3	Brake Chatter	ABS WL during cycling	Temporary ABS Wheel Disabled	Brake drags or chatters. Abnormal vibrations detected.	<ul style="list-style-type: none"> Check foundation brakes; condition may occur even without system failure.

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Figure 2.18

SPN	SID	FMI	Blink Code	Description	Warning Light	System Reaction	Cause	Action
Left Front Wheel Speed Sensor								
1	1	13	5 + 3	Tire Combination	ABS WL	ABS Wheel Disabled	Incorrect tire size. Check foundation brakes. Condition may occur without system failure.	<ul style="list-style-type: none"> • Check tire wear, inflation and verify size is within released range and change wrong tire. • Check air gap and push sensor back in afterward. • Check tone ring for correct tooth count. • Check tone ring for damage/missing teeth/corrosion. • Clear fault from memory.
254	254	9	9 + 3	Inlet valve actuation time not plausible (75 % switch on time within 5 minutes)	ABS WL	ABS Wheel Disabled	An ABS modulator was activated for an abnormally long time.	<ul style="list-style-type: none"> • Check air gap. The gap should not be greater than 0.040-inch (1.02 mm). • Check bearing play and tone ring run out. Eliminate root cause for air gap extension and push sensor back in afterwards. • Check tone ring for damage/missing teeth/corrosion. • Check sensor impedance and sensor wiring and connectors for intermittent contact.
Right Front Wheel Speed Sensor								
2	2	1	2 + 1	Air Gap	ABS WL	ABS Wheel Disabled	Sensor gap is too large, sensor output voltage is too low.	<ul style="list-style-type: none"> • Check air gap. The gap should not be greater than 0.040-inch (1.02 mm). • Check bearing play and tone ring run out. Eliminate root cause for air gap extension and push sensor back in afterwards. • Check tone ring for damage (missing teeth, corrosion).
2	2	5	3 + 1	Impedance	ABS WL	ABS Wheel Disabled	An open circuit has been detected, i.e. ECU detects a disconnected wheel speed sensor.	<ul style="list-style-type: none"> • Check sensor impedance and sensor wiring and connectors for intermittent contact. • Check harness and/or sensor for open circuit or short to ground. Sensor resistance should measure between 900-2000 ohms.
2	2	7	12 + 1	Tone Ring	ABS WL	ABS Wheel Disabled	Wheel speed signal drops out periodically at speeds higher than 10 kph.	<ul style="list-style-type: none"> • Check tone ring for damage/missing teeth/corrosion. • Check bearing play and tone ring run out.
2	2	8	4 + 1	No Trigger Detected	ABS WL	ABS Wheel Disabled	Wheel speed sensor signal not detected.	<ul style="list-style-type: none"> • Check air gap. The gap should not be greater than 0.040-inch (1.02 mm). • Check bearing play and tone ring run out. Eliminate root cause for air gap extension and push sensor back in afterwards. • Check tone ring for damage (missing teeth, corrosion). • Check sensor impedance and sensor wiring and connectors for intermittent contact. • Check sensor installation. • Check air gap and push sensor back in afterwards.
2	2	11	13 + 1	Brake Chatter	ABS WL during cycling	Temporary ABS Wheel Disabled	Brake drags or chatters. Abnormal vibrations detected.	<ul style="list-style-type: none"> • Check foundation brakes; condition may occur even without system failure.
2	2	13	5 + 1	Tire Combination	ABS WL	ABS Wheel Disabled	Incorrect tire size. Check foundation brakes. Condition may occur without system failure.	<ul style="list-style-type: none"> • Check tire wear, inflation and verify size is within released range and change wrong tire. • Check air gap and push sensor back in afterward. • Check tone ring for correct tooth count. • Check tone ring for damage/missing teeth/corrosion. • Clear fault from memory.

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Figure 2.19

2 Troubleshooting and Testing

SPN	SID	FMI	Blink Code	Description	Warning Light	System Reaction	Cause	Action
Right Front Wheel Speed Sensor								
254	254	9	9 + 1	Inlet valve actuation time not plausible (75 % switch on time within 5 minutes)	ABS WL	ABS Wheel Disabled	An ABS modulator was activated for an abnormally long time.	<ul style="list-style-type: none"> • Check air gap. The gap should not be greater than 0.040-inch (1.02 mm). • Check bearing play and tone ring run out. Eliminate root cause for air gap extension and push sensor back in afterwards. • Check tone ring for damage/missing teeth/corrosion. • Check sensor impedance and sensor wiring and connectors for intermittent contact.
Left Rear Wheel Speed Sensor								
3	3	1	2 + 2	Air Gap	ABS WL	Speed Signal Taken From Other Rear Wheel	Sensor gap is too large, sensor output voltage is too low.	<ul style="list-style-type: none"> • Check air gap. The gap should not be greater than 0.040-inch (1.02 mm). • Check bearing play and tone ring run out. Eliminate root cause for air gap extension and push sensor back in afterwards. • Check tone ring for damage (missing teeth, corrosion).
3	3	5	3 + 2	Impedance	ABS WL	Speed Signal Taken From Other Rear Wheel	An open circuit has been detected, i.e. ECU detects a disconnected wheel speed sensor.	<ul style="list-style-type: none"> • Check sensor impedance and sensor wiring and connectors for intermittent contact. • Check harness and or sensor for open circuit or short to ground. Sensor resistance should measure between 900-2000 ohms.
3	3	7	12 + 2	Tone Ring	ABS WL	Speed Signal Taken From Other Rear Wheel	Wheel speed signal drops out periodically at speeds higher than 10 kph.	<ul style="list-style-type: none"> • Check tone ring for damage/missing teeth/corrosion. • Check bearing play and tone ring run out.
3	3	8	4 + 2	No Trigger Detected	ABS WL	Speed Signal Taken From Other Rear Wheel	Wheel speed sensor signal not detected.	<ul style="list-style-type: none"> • Check air gap. The gap should not be greater than 0.040-inch (1.02 mm). • Check bearing play and tone ring run out. Eliminate root cause for air gap extension and push sensor back in afterwards. • Check tone ring for damage (missing teeth, corrosion). • Check sensor impedance and sensor wiring and connectors for intermittent contact. • Check sensor installation. • Check air gap and push sensor back in afterwards.
3	3	11	13 + 2	Brake Chatter	ABSWL during cycling	Temporary ABS Wheel Disabled	Brake drags or chatters. Abnormal vibrations detected.	<ul style="list-style-type: none"> • Check foundation brakes; condition may occur even without system failure.
3	3	13	5 + 2	Tire Combination	ABS WL	Speed Signal Taken From Other Rear Wheel	Incorrect tire size. Check foundation brakes. Condition may occur without system failure.	<ul style="list-style-type: none"> • Check tire wear, inflation and verify size is within released range and change wrong tire. • Check air gap and push sensor back in afterward. • Check tone ring for correct tooth count. • Check tone ring for damage/missing teeth/corrosion. • Clear fault from memory.

4011912a

Figure 2.20

SPN	SID	FMI	Blink Code	Description	Warning Light	System Reaction	Cause	Action
Left Rear Wheel Speed Sensor								
254	254	9	9 + 2	Inlet valve actuation time not plausible (75 % switch on time within 5 minutes)	ABS WL	Speed Signal Taken From Other Rear Wheel	An ABS modulator was activated for an abnormally long time.	<ul style="list-style-type: none"> • Check air gap. The gap should not be greater than 0.040-inch (1.02 mm). • Check bearing play and tone ring run out. Eliminate root cause for air gap extension and push sensor back in afterwards. • Check tone ring for damage/missing teeth/corrosion. • Check sensor impedance and sensor wiring and connectors for intermittent contact.
Right Rear Wheel Speed Sensor								
4	4	1	2 + 4	Air Gap	ABS WL	Speed Signal Taken From Other Rear Wheel	Sensor gap is too large, sensor output voltage is too low.	<ul style="list-style-type: none"> • Check air gap. The gap should not be greater than 0.040-inch (1.02 mm). • Check bearing play and tone ring run out. Eliminate root cause for air gap extension and push sensor back in afterwards. • Check tone ring for damage (missing teeth, corrosion).
4	4	5	3 + 4	Impedance	ABS WL	Speed Signal Taken From Other Rear Wheel	An open circuit has been detected, i.e. ECU detects a disconnected wheel speed sensor.	<ul style="list-style-type: none"> • Check sensor impedance and sensor wiring and connectors for intermittent contact. • Check harness and or sensor for open circuit or short to ground. Sensor resistance should measure between 900-2000 ohms.
4	4	7	12 + 4	Tone Ring	ABS WL	Speed Signal Taken From Other Rear Wheel	Wheel speed signal drops out periodically at speeds higher than 10 kph.	<ul style="list-style-type: none"> • Check tone ring for damage/missing teeth/corrosion. • Check bearing play and tone ring run out.
4	4	8	4 + 4	No Trigger Detected	ABS WL	Speed Signal Taken From Other Rear Wheel	A sensor lead from wheel end is broken.	<ul style="list-style-type: none"> • Check air gap. The gap should not be greater than 0.040-inch (1.02 mm). • Check bearing play and tone ring run out. Eliminate root cause for air gap extension and push sensor back in afterwards. • Check tone ring for damage (missing teeth, corrosion). • Check sensor impedance and sensor wiring and connectors for intermittent contact. • Check sensor installation. • Check air gap and push sensor back in afterwards.
4	4	11	13 + 4	Brake Chatter	ABS/WL during cycling	Temporary ABS Wheel Disabled	Brake drags or chatters. Abnormal vibrations detected.	<ul style="list-style-type: none"> • Check foundation brakes; condition may occur even without system failure.
4	4	13	5 + 4	Tire Combination	ABS WL	Speed Signal Taken From Other Rear Wheel	Incorrect tire size. Check foundation brakes. Condition may occur without system failure.	<ul style="list-style-type: none"> • Check tire wear, inflation and verify size is within released range and change wrong tire. • Check air gap and push sensor back in afterward. • Check tone ring for correct tooth count. • Check tone ring for damage/missing teeth/corrosion. • Clear fault from memory.

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Figure 2.21

2 Troubleshooting and Testing

SPN	SID	FMI	Blink Code	Description	Warning Light	System Reaction	Cause	Action
Right Rear Wheel Speed Sensor								
254	254	9	9 + 4	Inlet valve actuation time not plausible (75 % switch on time within 5 minutes)	ABS WL	Speed Signal Taken From Other Rear Wheel	An ABS modulator was activated for an abnormally long time.	<ul style="list-style-type: none"> • Check air gap. The gap should not be greater than 0.040-inch (1.02 mm). • Check bearing play and tone ring run out. Eliminate root cause for air gap extension and push sensor back in afterwards. • Check tone ring for damage/missing teeth/corrosion. • Check sensor impedance and sensor wiring and connectors for intermittent contact.
Power Amp. In Valve Left Front								
42	42	3	6 + 3	Shorted to Battery	ABS WL	ABS Disabled & EBD Disabled	Inlet (IV) short to BATT detected.	<ul style="list-style-type: none"> • Disconnect and inspect connectors for any sign of damage, moisture or corrosion, clean connectors if necessary. • Check all ECU powers and grounds including load test. • If DTC persists, may indicate ECU has failed.
42	42	5	7 + 3	Open Circuit	ABS WL	ABS Wheel Disabled	Inlet (IV) open circuit detected.	<ul style="list-style-type: none"> • Disconnect and inspect connectors for any sign of damage, moisture or corrosion, clean connectors if necessary. • Check all ECU powers and grounds including load test. • If DTC persists, may indicate ECU has failed.
42	42	6	8 + 3	Short to Ground	ABS WL	ABS Wheel Disabled	Inlet (IV) short to ground detected.	<ul style="list-style-type: none"> • Disconnect and inspect connectors for any sign of damage, moisture or corrosion, clean connectors if necessary. • Check all ECU powers and grounds including load test. • If DTC persists, may indicate ECU has failed.
Power Amp. Out Valve Left Front								
48	48	3	6 + 4	Shorted to Battery	ABS WL	ABS Disabled & EBD Disabled	Outlet (OV) short to BATT detected.	<ul style="list-style-type: none"> • Disconnect and inspect connectors for any sign of damage, moisture or corrosion, clean connectors if necessary. • Check all ECU powers and grounds including load test. • If DTC persists, may indicate ECU has failed.
48	48	5	7 + 4	Open Circuit	ABS WL	ABS Wheel Disabled	Outlet (OV) open circuit detected.	<ul style="list-style-type: none"> • Disconnect and inspect connectors for any sign of damage, moisture or corrosion, clean connectors if necessary. • Check all ECU powers and grounds including load test. • If DTC persists, may indicate ECU has failed.
48	48	6	8 + 4	Short to Ground	ABS WL	ABS Wheel Disabled	Outlet (OV) short to ground detected.	<ul style="list-style-type: none"> • Disconnect and inspect connectors for any sign of damage, moisture or corrosion, clean connectors if necessary. • Check all ECU powers and grounds including load test. • If DTC persists, may indicate ECU has failed.
Power Amp. In Valve Right Front								
43	43	3	6 + 1	Shorted to Battery	ABS WL	ABS Disabled & EBD Disabled	Inlet (IV) short to BATT detected.	<ul style="list-style-type: none"> • Disconnect and inspect connectors for any sign of damage, moisture or corrosion, clean connectors if necessary. • Check all ECU powers and grounds including load test. • If DTC persists, may indicate ECU has failed.
43	43	5	7 + 1	Open Circuit	ABS WL	ABS Wheel Disabled	Inlet (IV) open circuit detected.	<ul style="list-style-type: none"> • Disconnect and inspect connectors for any sign of damage, moisture or corrosion, clean connectors if necessary. • Check all ECU powers and grounds including load test. • If DTC persists, may indicate ECU has failed.
43	43	6	8 + 1	Short to Ground	ABS WL	ABS Wheel Disabled	Inlet (IV) short to ground detected.	<ul style="list-style-type: none"> • Disconnect and inspect connectors for any sign of damage, moisture or corrosion, clean connectors if necessary. • Check all ECU powers and grounds including load test. • If DTC persists, may indicate ECU has failed.

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Figure 2.22

SPN	SID	FMI	Blink Code	Description	Warning Light	System Reaction	Cause	Action
Power Amp. In Valve Right Front								
43	43	3	6 + 1	Shorted to Battery	ABS WL	ABS Disabled & EBD Disabled	Inlet (IV) short to BATT detected.	<ul style="list-style-type: none"> Disconnect and inspect connectors for any sign of damage, moisture or corrosion, clean connectors if necessary. Check all ECU powers and grounds including load test. If DTC persists, may indicate ECU has failed.
43	43	5	7 + 1	Open Circuit	ABS WL	ABS Wheel Disabled	Inlet (IV) open circuit detected.	<ul style="list-style-type: none"> Disconnect and inspect connectors for any sign of damage, moisture or corrosion, clean connectors if necessary. Check all ECU powers and grounds including load test. If DTC persists, may indicate ECU has failed.
43	43	6	8 + 1	Short to Ground	ABS WL	ABS Wheel Disabled	Inlet (IV) short to ground detected.	<ul style="list-style-type: none"> Disconnect and inspect connectors for any sign of damage, moisture or corrosion, clean connectors if necessary. Check all ECU powers and grounds including load test. If DTC persists, may indicate ECU has failed.
Power Amp. Out Valve Right Front								
49	49	3	6 + 2	Shorted to Battery	ABS WL	ABS Disabled & EBD Disabled	Outlet (OV) short to BATT detected.	<ul style="list-style-type: none"> Disconnect and inspect connectors for any sign of damage, moisture or corrosion, clean connectors if necessary. Check all ECU powers and grounds including load test. If DTC persists, may indicate ECU has failed.
49	49	5	7 + 2	Open Circuit	ABS WL	ABS Wheel Disabled	Outlet (OV) open circuit detected.	<ul style="list-style-type: none"> Disconnect and inspect connectors for any sign of damage, moisture or corrosion, clean connectors if necessary. Check all ECU powers and grounds including load test. If DTC persists, may indicate ECU has failed.
49	49	6	8 + 2	Short to Ground	ABS WL	ABS Wheel Disabled	Outlet (OV) short to ground detected.	<ul style="list-style-type: none"> Disconnect and inspect connectors for any sign of damage, moisture or corrosion, clean connectors if necessary. Check all ECU powers and grounds including load test. If DTC persists, may indicate ECU has failed.
Power Amp. In Valve Left Rear								
44	44	3	6 + 7	Shorted to Battery	ABS WL	ABS Disabled & EBD Disabled	Inlet (IV) short to BATT detected.	<ul style="list-style-type: none"> Disconnect and inspect connectors for any sign of damage, moisture or corrosion, clean connectors if necessary. Check all ECU powers and grounds including load test. If DTC persists, may indicate ECU has failed.
44	44	5	7 + 7	Open Circuit	ABS WL	ABS Wheel Disabled & EBD Disabled	Inlet (IV) open circuit detected.	<ul style="list-style-type: none"> Disconnect and inspect connectors for any sign of damage, moisture or corrosion, clean connectors if necessary. Check all ECU powers and grounds including load test. If DTC persists, may indicate ECU has failed.
44	44	6	8 + 7	Short to Ground	ABS WL	ABS Wheel Disabled & EBD Disabled	Inlet (IV) short to ground detected.	<ul style="list-style-type: none"> Disconnect and inspect connectors for any sign of damage, moisture or corrosion, clean connectors if necessary. Check all ECU powers and grounds including load test. If DTC persists, may indicate ECU has failed.

4011915a

Figure 2.23

2 Troubleshooting and Testing

SPN	SID	FMI	Blink Code	Description	Warning Light	System Reaction	Cause	Action
Power Amp. Out Valve Left Rear								
50	50	3	6 + 8	Shorted to Battery	ABS WL	ABS Disabled & EBD Disabled	Outlet (OV) short to BATT detected.	<ul style="list-style-type: none"> Disconnect and inspect connectors for any sign of damage, moisture or corrosion, clean connectors if necessary. Check all ECU powers and grounds including load test. If DTC persists, may indicate ECU has failed.
50	50	5	7 + 8	Open Circuit	ABS WL	ABS Wheel Disabled & EBD Disabled	Outlet (OV) open circuit detected.	<ul style="list-style-type: none"> Disconnect and inspect connectors for any sign of damage, moisture or corrosion, clean connectors if necessary. Check all ECU powers and grounds including load test. If DTC persists, may indicate ECU has failed.
50	50	6	8 + 8	Short to Ground	ABS WL	ABS Wheel Disabled & EBD Disabled	Outlet (OV) short to ground detected.	<ul style="list-style-type: none"> Disconnect and inspect connectors for any sign of damage, moisture or corrosion, clean connectors if necessary. Check all ECU powers and grounds including load test. If DTC persists, may indicate ECU has failed.
Power Amp. In Valve Right Rear								
45	45	3	6 + 5	Shorted to Battery	ABS WL	ABS Disabled & EBD Disabled	Inlet (IV) short to BATT detected.	<ul style="list-style-type: none"> Disconnect and inspect connectors for any sign of damage, moisture or corrosion, clean connectors if necessary. Check all ECU powers and grounds including load test. If DTC persists, may indicate ECU has failed.
45	45	5	7 + 5	Open Circuit	ABS WL	ABS Wheel Disabled & EBD Disabled	Inlet (IV) open circuit detected.	<ul style="list-style-type: none"> Disconnect and inspect connectors for any sign of damage, moisture or corrosion, clean connectors if necessary. Check all ECU powers and grounds including load test. If DTC persists, may indicate ECU has failed.
45	45	6	8 + 5	Short to Ground	ABS WL	ABS Wheel Disabled & EBD Disabled	Inlet (IV) short to ground detected.	<ul style="list-style-type: none"> Disconnect and inspect connectors for any sign of damage, moisture or corrosion, clean connectors if necessary. Check all ECU powers and grounds including load test. If DTC persists, may indicate ECU has failed.
Power Amp. Out Valve Right Rear								
51	51	3	6 + 6	Shorted to Battery	ABS WL	ABS Disabled & EBD Disabled	Outlet (OV) short to BATT detected.	<ul style="list-style-type: none"> Disconnect and inspect connectors for any sign of damage, moisture or corrosion, clean connectors if necessary. Check all ECU powers and grounds including load test. If DTC persists, may indicate ECU has failed.
51	51	5	7 + 6	Open Circuit	ABS WL	ABS Wheel Disabled & EBD Disabled	Outlet (OV) open circuit detected.	<ul style="list-style-type: none"> Disconnect and inspect connectors for any sign of damage, moisture or corrosion, clean connectors if necessary. Check all ECU powers and grounds including load test. If DTC persists, may indicate ECU has failed.
51	51	6	8 + 6	Short to Ground	ABS WL	ABS Wheel Disabled & EBD Disabled	Outlet (OV) short to ground detected.	<ul style="list-style-type: none"> Disconnect and inspect connectors for any sign of damage, moisture or corrosion, clean connectors if necessary. Check all ECU powers and grounds including load test. If DTC persists, may indicate ECU has failed.

4011916a

Figure 2.24

SPN	SID	FMI	Blink Code	Description	Warning Light	System Reaction	Cause	Action
Power Amp. Endurance Brake Relay								
13	13	3	6 + 9	Shorted to Battery	ABS WL	EBD Disabled	Endurance brake relay output short to BATT detected.	<ul style="list-style-type: none"> Check wiring and connections from the ECU to the EBR. If DTC persists, may indicate ECU has failed.
13	13	5	7 + 9	Open Circuit	ABS WL	EBD Disabled	Endurance brake relay output open detected.	<ul style="list-style-type: none"> Check wiring and connections from the ECU to the EBR. If DTC persists, may indicate ECU has failed.
13	13	6	8 + 9	Short to Ground	ABS WL	EBD Disabled	Endurance brake relay short to ground detected.	<ul style="list-style-type: none"> Check wiring and connections from the ECU to the EBR. If DTC persists, may indicate ECU has failed.
Internal Valve Relay (provides supply voltage for ABS pressure control valves)								
30	30	3	14 + 1	Cannot switch off	ABS WL	ABS Disabled & EBD Disabled	ABS pressure control valve cannot switch off.	<ul style="list-style-type: none"> Disconnect and inspect connectors for any sign of damage, moisture or corrosion, clean connectors if necessary. Check all ECU powers and grounds including load test, may need to review wiring diagnostics and repair with OEM. If connectors and harness pass all checks, and if DTC persists, may indicate ECU has failed.
30	30	4	14 + 2	Valve supply voltage missing or cannot switch on	Brake & ABS WL	ABS Disabled & EBD Disabled	ABS pressure control valve cannot switch on.	<ul style="list-style-type: none"> Disconnect and inspect connectors for any sign of damage, moisture or corrosion, clean connectors if necessary. Check all ECU powers and grounds including load test, with key ON, the voltage level shall be ~12 volts at pin 17 to ground. May need to review wiring diagnostics and repair with OEM. If connectors and harness pass all checks, and if DTC persists, may indicate ECU has failed.
ABS Warning Light Relay (if available)								
1438	23	5	14 + 5	Open or Grounded	ABS WL	Activation of blink code switch longer than 16 seconds causes fault detection	No load to + or grounded.	<ul style="list-style-type: none"> Check wiring and connections of the brake ABS warning lamp circuit relay pin 20 of 31-pin connector. With ECU disconnected, with key ON, the voltage level shall be ~12 volts at pin 20 to ground. May need to review wiring diagnostics and repair with OEM. If connectors and wiring pass all checks, and if DTC persists, may indicate ECU has failed.
ECU Main Ground or Reference Ground Connection								
98	98	2	14 + 3	ECU Main or Reference Ground	Brake &	Activation of blink code switch longer than 16 seconds causes fault detection	No load to + or grounded.	<ul style="list-style-type: none"> Disconnect and inspect connectors for any sign of damage, moisture or corrosion, clean connectors if necessary. Check all ECU powers and grounds including load test, may need to review wiring diagnostics and repair with OEM. If connectors and wiring pass all checks, and if DTC persists, may indicate ECU has failed.
ECU Main Ground or Reference Ground Connection								
251	251	3	14 + 7	High Voltage	ABS WL	None	ECU supply voltage too high.	<ul style="list-style-type: none"> Check alternator and battery. Disconnect and inspect connectors for any sign of damage, moisture or corrosion, clean connectors if necessary. Check all ECU powers and grounds including load test, may need to review wiring diagnostics and repair with OEM.

4011917a

Figure 2.25

2 Troubleshooting and Testing

Pump Motor								
SPN	SID	FMI	Blink Code	Description	Warning Light	System Reaction	Cause	Action
2581	54	3	10 + 1	Pump motor operates when not expected	ABS WL	ABS Disabled	Motor fault detected.	<ul style="list-style-type: none"> Disconnect and inspect the ECU 31-pin connector for any sign of damage, moisture or corrosion, verify all lock tabs are in good condition and clean connectors if necessary. Check all ECU powers and grounds including load test, may need to review wiring diagnostics and repair with OEM. If connectors and wiring pass all checks, and if DTC persists, may indicate ECU/Modulator has failed.
2581	54	4	10 + 2	Pump motor does not switch on	ABS WL	ABS Disabled	Pump motor internal monitoring.	<ul style="list-style-type: none"> Disconnect and inspect the ECU 31-pin connector for any sign of damage, moisture or corrosion, verify all lock tabs are in good condition and clean connectors if necessary. Check all ECU powers and grounds including load test, may need to review wiring diagnostics and repair with OEM. If connectors and wiring pass all checks, and if DTC persists, may indicate ECU/Modulator has failed.
2581	54	5	10 + 4	Supply voltage for pump motor missing	ABS WL	ABS Disabled	No supply voltage to the pump.	<ul style="list-style-type: none"> Disconnect and inspect the ECU 31-pin connector for any sign of damage, moisture or corrosion, verify all lock tabs are in good condition and clean connectors if necessary. Check all ECU powers and grounds including load test, may need to review wiring diagnostics and repair with OEM. If connectors and wiring pass all checks, and if DTC persists, may indicate ECU/Modulator has failed.
2581	54	7	10 + 3	Pump motor does not turn	ABS WL	ABS Disabled	Pump motor.	<ul style="list-style-type: none"> Disconnect and inspect the ECU 31-pin connector for any sign of damage, moisture or corrosion, verify all lock tabs are in good condition and clean connectors if necessary. Check all ECU powers and grounds including load test, may need to review wiring diagnostics and repair with OEM. If connectors and wiring pass all checks, and if DTC persists, may indicate ECU/Modulator has failed.
2581	54	12	10 + 5	Relay voltage missing	ABS WL	ABS Disabled	Pump motor relay voltage.	<ul style="list-style-type: none"> Disconnect and inspect the ECU 31-pin connector for any sign of damage, moisture or corrosion, verify all lock tabs are in good condition and clean connectors if necessary. Check all ECU powers and grounds including load test, may need to review wiring diagnostics and repair with OEM. If connectors and wiring pass all checks, and if DTC persists, may indicate ECU/Modulator has failed.

4011918a

Figure 2.26

SPN	SID	FMI	Blink Code	Description	Warning Light	System Reaction	Cause	Action
J1939 Communication								
231	231	5	11 + 2	J1939 Data Bus Error	ABS WL	J1939 Data Errors or J1939 Time Out	J1939 High(+) or Low (-) open or shorted.	<ul style="list-style-type: none"> Check electrical system of J1939 bus (connections, wiring). Disconnect and inspect the 31-pin connector for any sign of damage, moisture or corrosion, clean connectors if necessary. At the 31-pin harness connector, check resistance across pins 14, 15 with the key off (should be 60 ohms). At the 31-pin harness connector pin 14, check voltage to ground key on (should be 2.5 to 5 volts). At the 31-pin harness connector pin 15, check voltage to ground key on (should be 2.5 volts or less). The readings for pins 14 and 15 may fluctuate within the range but they should never be the same and the total voltage of pins 14 and 15 should equal approximately 5 volts. May need to review J1939 circuit diagnostics and repair with the OEM. If all J1939 checks pass, may indicate a failed ECU.
231	231	12	11 + 1	J1939 Internal Error	ABS WL	None	Internal fault.	<ul style="list-style-type: none"> Disconnect and inspect the 31-pin connector for any sign of damage, moisture or corrosion, clean connectors if necessary. At the 31-pin harness connector, check resistance across pins 14, 15 with the key off (should be 60 ohms). At the 31-pin harness connector pin 14, check voltage to ground key on (should be 2.5 to 5 volts). At the 31-pin harness connector pin 15, check voltage to ground key on (should be 2.5 volts or less). The readings for pins 14 and 15 may fluctuate within the range but they should never be the same and the total voltage of pins 14 and 15 should equal approximately 5 volts. May need to review J1939 circuit diagnostics and repair with the OEM. If all J1939 checks pass, may indicate a failed ECU.
231	231	9	11 + 3	J1939 Message Time Out	ABS WL	None	Incorrect message received or Time Out detected fault.	<ul style="list-style-type: none"> Check J1939 devices (retarder, engine ECU). Check electrical system of J1939 bus (connections, wiring). Disconnect and inspect the 31-pin connector for any sign of damage, moisture or corrosion, clean connectors if necessary. At the 31-pin harness connector, check resistance across pins 14, 15 with the key off (should be 60 ohms). At the 31-pin harness connector pin 14, check voltage to ground key on (should be 2.5 to 5 volts). At the 31-pin harness connector pin 15, check voltage to ground key on (should be 2.5 volts or less). The readings for pins 14 and 15 may fluctuate within the range but they should never be the same and the total voltage of pins 14 and 15 should equal approximately 5 volts. May need to review J1939 circuit diagnostics and repair with the OEM. May have unusual or erratic sensor readings for 2 or more sensors, check sensor adjustment, wheel end play and tone rings for issues. If all J1939 checks pass, may indicate a failed ECU.

4011919a

Figure 2.27

2 Troubleshooting and Testing

Testing the System

This section of the manual contains information for testing the hydraulic ABS with TOOLBOX™ Software, as well as procedures for conducting standard air and electrical tests.

⚠ WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Exhaust gas contains poison. When testing a vehicle with the engine running, test in a well-ventilated area or route the exhaust hose outside.

To avoid serious personal injury, keep away, and keep test equipment away, from all moving or hot engine parts.

Refer to, and follow, the vehicle manufacturer's Warnings, Cautions and Service Procedures.

When testing, set the parking brake and place the gear selector in NEUTRAL (manual transmission) or PARK (automatic transmission) unless otherwise directed.

WABCO TOOLBOX™ Software

To obtain TOOLBOX™ Software, go to www.wabco-na.com.

Use TOOLBOX™ Software to verify the activation of various system components:

- Turn valves, pump and retarder relay on and off (Valve Activation Menu).
- Turn ABS warning lamp on and off (Miscellaneous Output Activation Menu).

NOTE: TOOLBOX™ Software must be connected to the vehicle and the vehicle ignition must be ON in order to display information.

E Version Hydraulic ABS Menus and Toolbars

Select Hydraulic ABS from the TOOLBOX™ *Main Menu*.

TOOLBOX™ senses the type of ECU being used and displays the *HABS Main Screen*.

Main Screen

This screen provides icons and pull-down menu task selections. It also provides information about the current status of WABCO HABS. Figure 2.28.

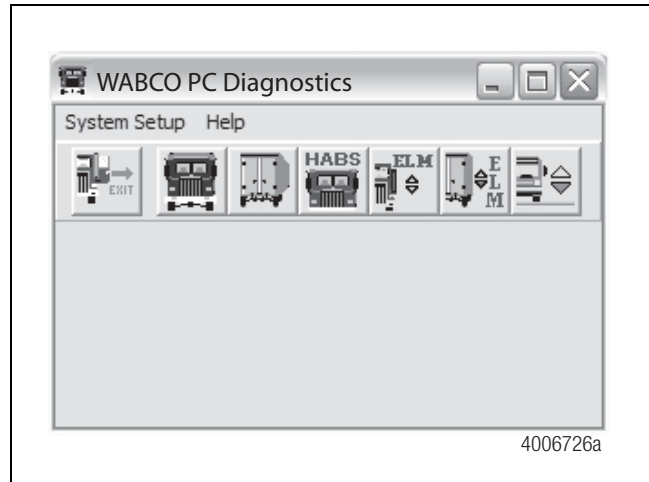


Figure 2.28

ECU information is read once from the ECU and does not change. All other information (e.g., wheel sensors, voltages and fault information) is read and updated continuously.

Display

Select *Display* from the HABS *Main Screen*. A pull-down menu will appear. Figure 2.29.

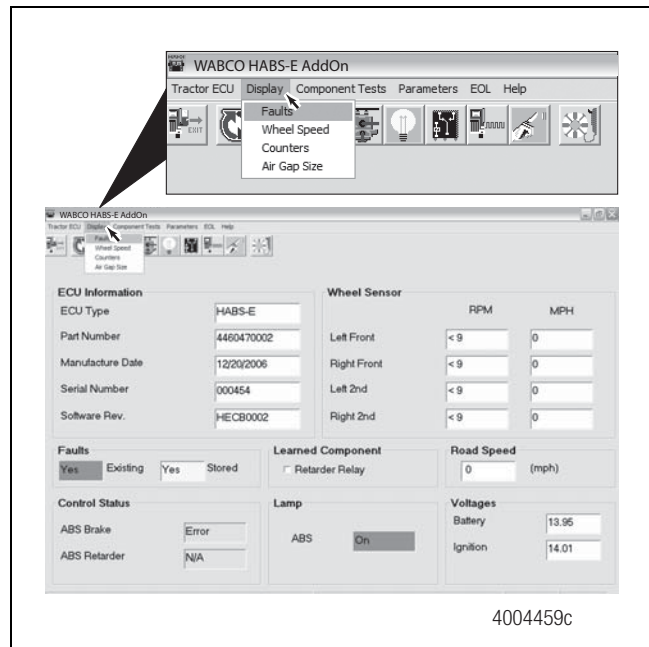


Figure 2.29

Faults

Select **Faults** to display the **Fault Information** screen. Figure 2.30.

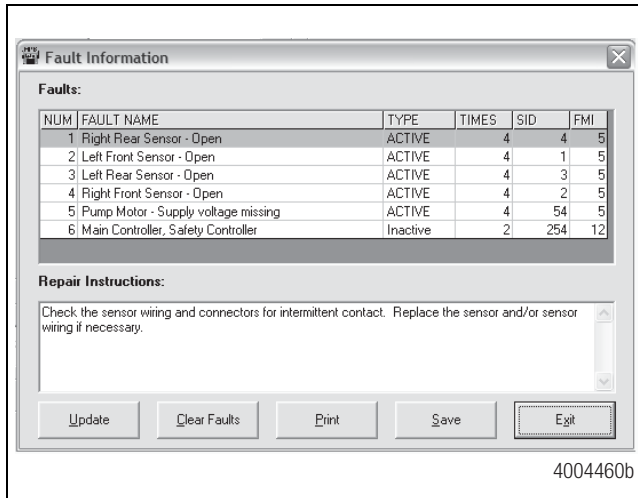


Figure 2.30

The **Fault Information** screen contains a description of each fault, including the type of fault (Active or Stored), number of occurrences, SID and FMI number. Repair instructions for the fault appear at the bottom of the screen.

Faults that occur after the screen is displayed will not appear until a screen update is requested. Use the **Update** button at the bottom of the screen to refresh the fault information table and display a new list of faults.

After making any required repairs, use the **Clear Faults** button to clear the fault. Clear each fault as it is repaired. Cycle the ignition after clearing the faults.

Use the **Save** or **Print** button to save or print the fault information data. Select **Exit** to close this section.

Wheel Speed

Select **Wheel Speed** to display the **Wheel Speed** screen. Figure 2.31.

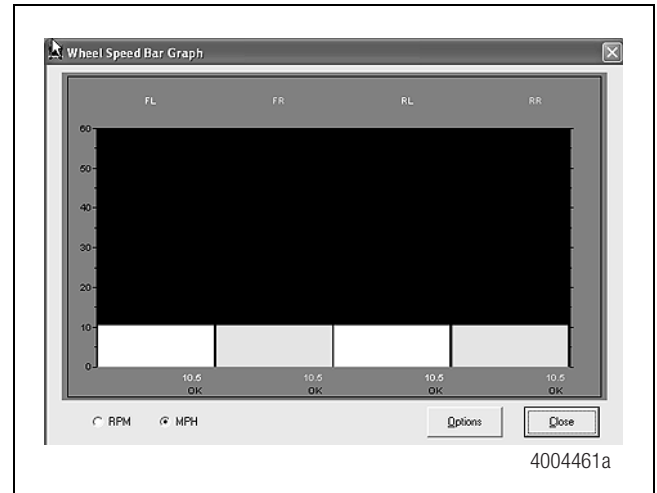


Figure 2.31

Use the **Wheel Speed** screen to verify that sensors are connected at each wheel. Speed at a sensed wheel (FL, FR, RL, RR) indicates sensors are installed, but does not verify correct sensor installation.

Counters

Select **Counters** to display the **Counters** screen. Figure 2.32.

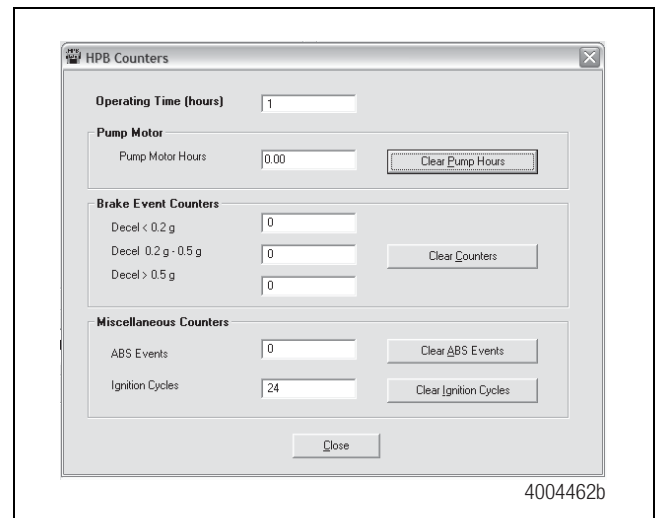


Figure 2.32

The **Counters** screen provides an overview of HABS component performance (pump hours, brake events, etc.) as well as general vehicle activity such as ignition cycles. Occurrences displayed on this screen accumulate until the **Clear** button is selected.

2 Troubleshooting and Testing

Component Tests

Select **Component Tests** from the HABS **Main Screen**. A pull-down menu will appear. Figure 2.33.

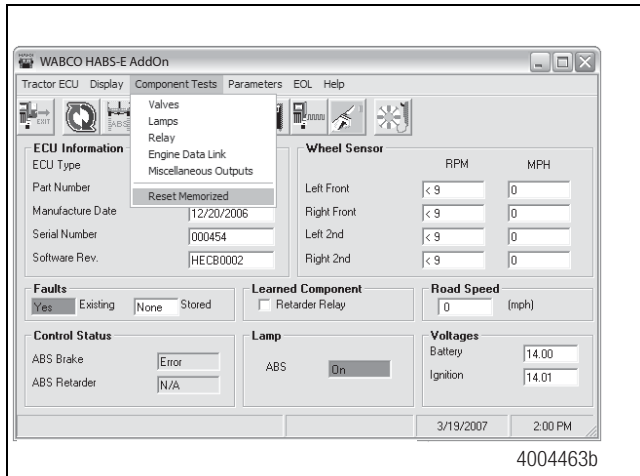


Figure 2.33

Miscellaneous Outputs

Select **Miscellaneous Outputs** to display the **Actuate Miscellaneous Outputs** test screen. Figure 2.34.

NOTE: Use TOOLBOX™ Software to test the following components: Retarder Relay, Brake Light Relay, Supply Valve, Cut-Off Valve, ABS Lamp, Traction Lamp, Brake Warning, Pump Front, Pump Rear, Buzzer.

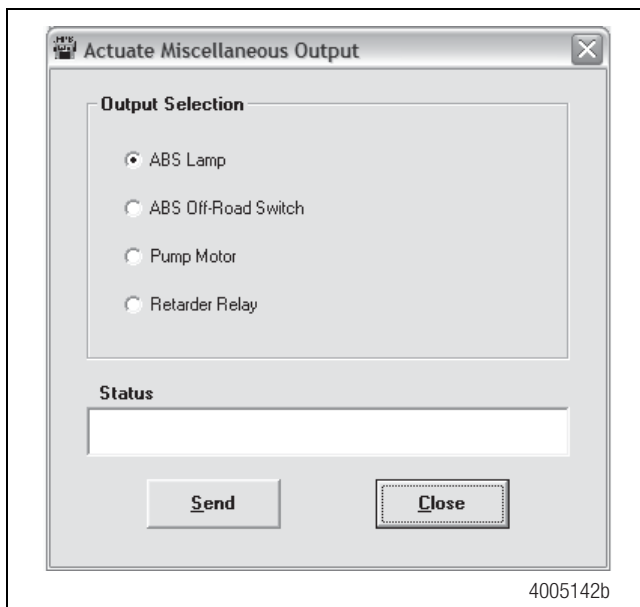


Figure 2.34

This screen provides a check of several HABS components, as well as a way to check either inlet or outlet activity of the valves, pump or retarder relay.

Highlight the component you wish to test, then select the **Send** button to actuate the component. Component activation status appears in the **Status Box** field. Select **Close** to exit this screen.

Valves

Select **Valves** to display the **Valve Activation** test screen. Figure 2.35.

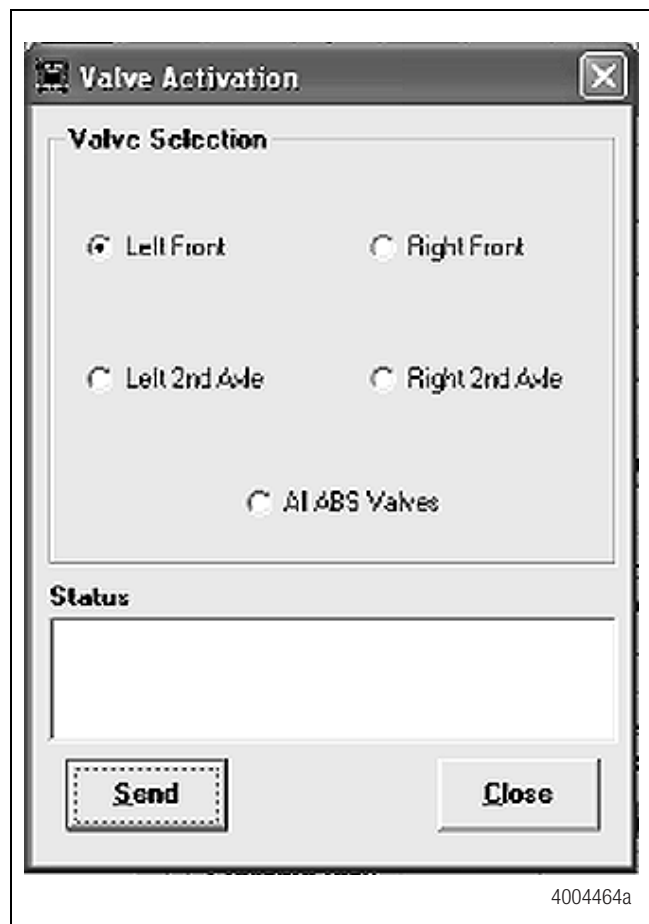


Figure 2.35

The **Valve Activation** test screen lets you activate the HABS valves to check for correct activation and to verify correct brake line installation.

Click on the valve you wish to test, then click the **Send** button to actuate the component. Component activation status appears in the **Status** box field. Select **Close** to exit this screen.

Lamps

Select **Lamps** to display the **Lamp Test** screen. Figure 2.36.

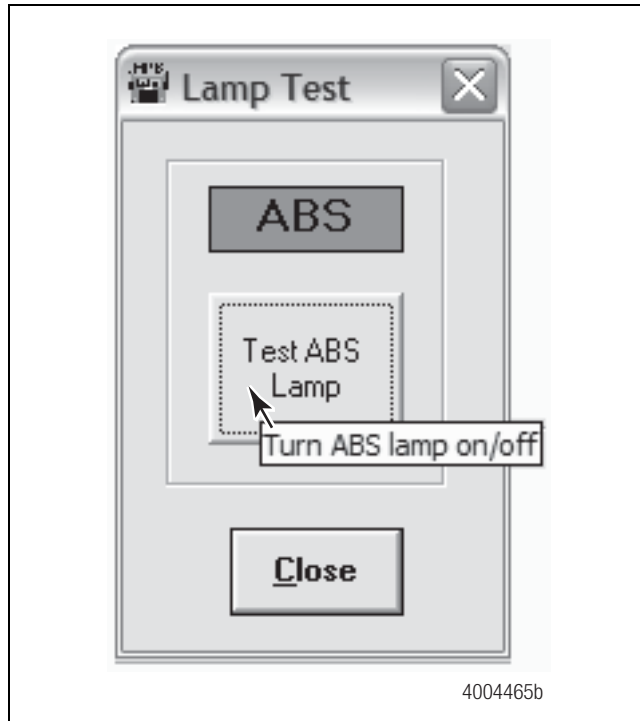


Figure 2.36

As each lamp is tested, check the actual lamp to verify correct operation. Select **Close** to exit this screen.

Relay

Select **Relay** to display the **Activate Relay** test screen. Figure 2.37.

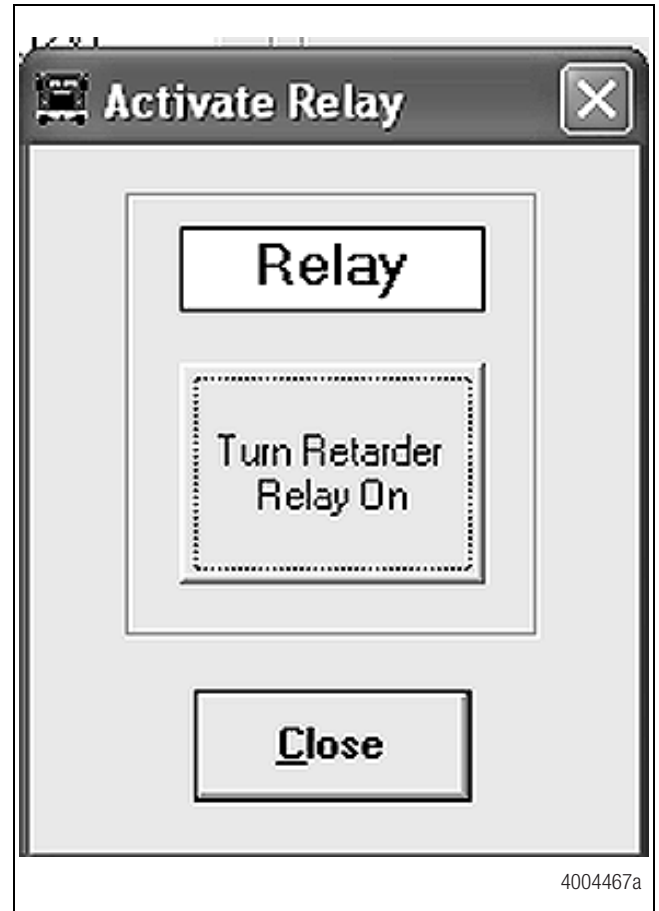


Figure 2.37

This screen allows you to turn the retarder relay on or off. This is helpful in verifying correct operation, installation and wiring of the unit under test. Select **Close** to exit this screen.

2 Troubleshooting and Testing

Engine Data Link

Select **Engine Data Link** to display the **Data Link** test screen. Figure 2.38.

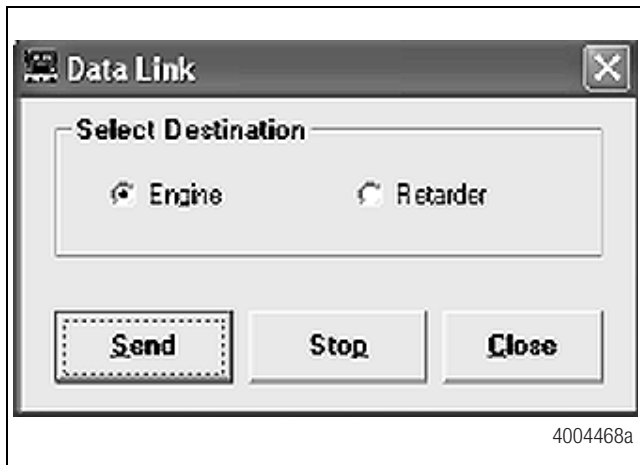


Figure 2.38

This screen allows you to send a “limit engine torque” command to the engine or a “disable retarder” command to the retarder.

Select the data link destination (engine or retarder), then select **Send** to test. Use the **Stop** button to end testing. Select **Close** to exit this screen.

Reset Memorized

This is an automatic default and cannot be de-selected. It indicates the ECU has memorized the installed retarder relay. Once the ECU has seen a retarder, it expects to see it every time the vehicle is powered up. Figure 2.39.

Because there are times when an ECU is moved to another vehicle — or during diagnostic testing — you may want the ECU to disregard this learned component. Use the **Reset Memorized** command for this purpose.

Select **Component Tests** from the Hydraulic ABS **Main Menu**. Then, select **Reset Memorized** from the pull-down menu to reset the **Learned Component** screen. Figure 2.40.

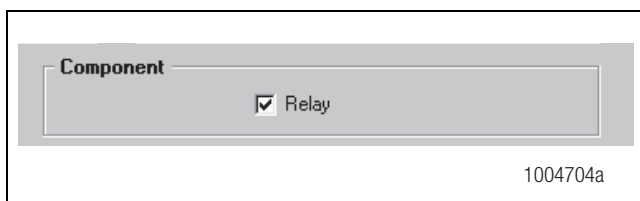


Figure 2.39

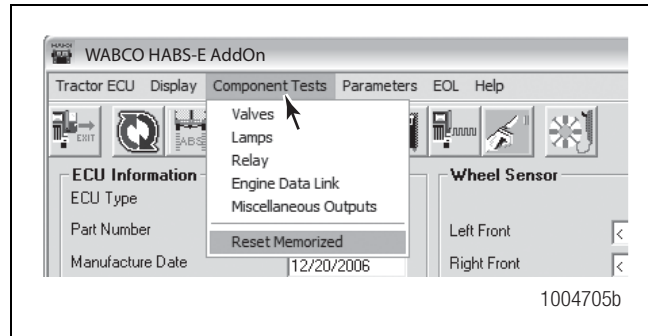


Figure 2.40

Standard Testing

Test Equipment: Volt-Ohm Meter (VOM)

Use of a VOM with automatic polarity sensing is recommended. This eliminates the concern of the polarity of the meter leads during voltage measurements.

System Requirements and Component Tests

Tire Size Range

For correct hydraulic ABS operation, front and rear tire sizes must be within 16% of each other.

Calculate the tire size with the following equation:

$$\% \text{ Difference} = (\text{RPM Steer}/\text{RPM Drive}) - 1 \times 100$$

RPM = tire revolutions per mile

⚠ CAUTION

When troubleshooting or testing the ABS system, do not damage the connector terminals. Damaged connector terminals may cause system malfunction.

Wiring Check

Voltage must be between 9.5 and 14 volts for the 12-volt hydraulic ABS to function correctly.

Disconnect the 31-pin connector and verify all the lock tabs are there and good, check for any signs of damage, moisture or corrosion.

Ground Checks

Check all the ground wire circuits, with the key off, disconnect the 31-pin harness connector and check resistance to ground pins 6, 18, 19. All readings should be less than 1 ohm, if the readings are not in spec, may need to review wiring diagnostics and repair with the OEM.

Voltage Checks

Check all the power wire circuits, with the key off, disconnect 31-pin harness connector and check voltage to ground pins 1, 16, 17. All readings should be approximately 9.5 to 14 volts, except pin 17 there should be no voltage key off. With the key on, recheck voltage at pins 1, 16, 17 of the 31-pin connector. All readings should be approximately 9.5 to 14 volts, if the readings are not in spec, may need to review wiring diagnostics and repair with the OEM.

Load Test

A compromised wire or circuit may still be able to provide resistance and voltage readings that would be within specification for a Digital Volt Ohm Meter or test light but might not be capable of handling enough current to allow the system to function properly. To make sure of the integrity of the wire or circuit, a load test is necessary. With the key on, load test across pins 1-6, 16-18, 17-19 of the 31-pin harness connector with a device that will draw about 5 amps (such as a Sealed Beam headlight) for approximately 10 seconds. The headlamp should be bright. If the lamp does not light, is dim or flickers, it would indicate an issue with the wiring, may need to review wiring diagnostics and repair with the OEM.

Standard Component Testing

ABS Warning Lamp

If the ABS warning lamp does not come on after the ignition is turned on, or it comes on but does not go out after three seconds, check all ABS fuses or circuit breakers and replace if necessary. Check the wiring to the ABS diagnostic switch and the warning lamp and repair or replace the wiring as required. When checking the warning lamp, follow these steps:

1. Check voltage potential at the lamp socket.
2. Check continuity of the wires to the socket.
3. Replace the bulb.

NOTE: A complete wiring diagram for 4S/4M D Version hydraulic ABS appears in Figure 2.2 in this section.

ABS Blink Code Switch

When testing the ABS diagnostic switch, perform the following.

1. Check the resistance between the terminals while cycling the switch. A lack of continuity is an indication of a faulty switch.
2. Check the continuity of the wires to the switch:
Pins 21 and 6 on the 31-pin harness

Sensor Adjustment

On steering axles, the sensor is typically accessible on the in-board side of the steering knuckle.

On drive axles, the sensor is typically accessible on the in-board side of the rear axle spindle.

To adjust the sensor, push the sensor in until it contacts the tooth wheel.

- Do not pry or push sensors with sharp objects.
- Sensors will self-adjust during wheel rotation.

NOTE: No gap is allowable at installation. During normal operation, the gap should not exceed 0.04-inch.

Sensor Output Voltage Test

Sensor output voltage must be at least 0.2 volt AC at 30 rpm. Test the sensor output voltage as follows:

1. Turn ignition OFF.
2. Disconnect the ECU to measure voltage at the pins on the ECU connector. Refer to Table D.

WARNING

Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip and fall over. Serious personal injury and damage to components can result.

3. Place blocks under the front and rear tires to stop the vehicle from moving.
4. Raise the vehicle off the ground. Place safety stands under the axle.
5. Rotate the wheel by hand at 30 rpm (1/2 revolution per second).

2 Troubleshooting and Testing

6. Measure the voltage at the pins indicated in Table D. Voltage tolerance is ≥ 0.2 volts alternating current (VAC).

Table D: Sensor Check Pins

Sensor	HABS E Version ECU
	31-Pin Harness
Left Front	24 and 29
Right Front	25 and 30
Left Rear	23 and 28
Right Rear	22 and 27

Sensor Resistance

The sensor circuit resistance must be between 900 and 2000 ohms. Measure resistance at the sensor connector, or at the pins on the ECU connector, as follows.

1. Turn ignition OFF.
2. To measure resistance at the pins on ECU connector, disconnect the ECU connector from the ECU.
3. To measure resistance at the sensor connector, disconnect the sensor from the sensor extension cable.
4. The sensor resistance should be 900-2000 ohms at the sensor and through the circuit to the ECU. The readings at the ECU and the sensor should be within 1 ohm of each other.
 - **If the sensor reading is not between 900-2000 ohms:**
Replace the sensor.

Component Removal and Installation

Sensors

Sensor Lube Specification

WABCO specifications call for a sensor lubricant with the following characteristics.

Lube must be mineral oil-based and contain molydisulfide. It should have excellent anti-corrosion and adhesion characteristics and be capable of continuous function in a temperature range of -40° to 300°F (-40° to 150°C).

WABCO provides sensor lube in a packet with each sensor service part.

Wheel Speed Sensor Replacement — Front Axle

Removal

WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

Park the vehicle on a level surface. Block the wheels to prevent the vehicle from moving. Support the vehicle with safety stands. Do not work under a vehicle supported only by jacks. Jacks can slip and fall over. Serious personal injury and damage to components can result.

CAUTION

To avoid damage to the electrical system or HABS components, when welding on a HABS-equipped vehicle disconnect the power connector from the ECU.

1. Park the vehicle on a level surface. Apply the parking brakes. Block the rear tires to prevent the vehicle from moving.
If necessary, raise the front tires off the ground. Place safety stands under the axle.
2. Disconnect the fasteners that hold the sensor cable to other components.
3. Disconnect the sensor cable from the chassis harness.
4. Remove the sensor from the sensor holder. Twist and pull the sensor to remove it from the sensor bracket. **Do not pull on the cable. Figure 3.1.**

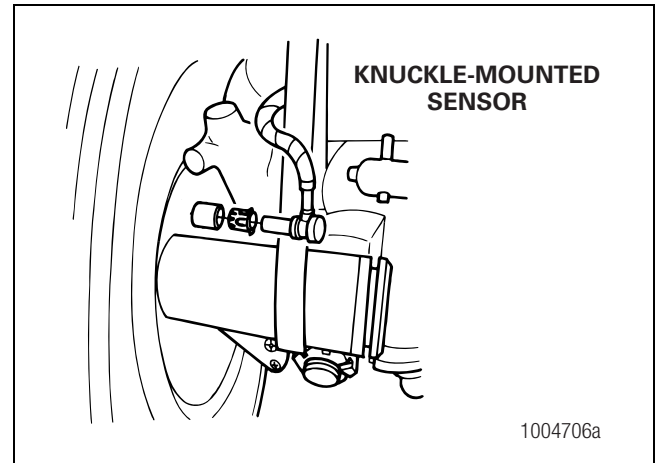


Figure 3.1

Installation

1. Connect the sensor cable to the chassis harness.
2. Install the fasteners used to hold the sensor cable in place.
3. Apply a WABCO-recommended lubricant to the sensor spring clip and sensor.
4. Install the sensor spring clip. Verify that the spring clip tabs are on the inboard side of the vehicle.
5. With the tabs on the inboard side, push the sensor spring clip into the bushing in the steering knuckle until the clip stops.
6. Push the sensor completely into the sensor spring clip until it contacts the tooth wheel.
7. Fasten the sensor cable every 12 inches. Correctly bundle and store any excess cable in the sub-frame. Figure 3.1.
8. Remove the blocks and safety stands.
9. Perform a voltage output check to ensure correct installation. Refer to Section 2.

Wheel Speed Sensor Replacement — Rear Axle

Removal

1. Apply the parking brake. Block the front tires to prevent vehicle movement.
2. Raise the rear tires off the ground. Place safety stands under the axle.
3. If the rear tire must be removed to gain access to the sensor, release the parking brake to release the brake shoe.
Remove the wheel and tire assembly from the axle.

3 Component Replacement

4. Remove the sensor from the mounting block. Use a twisting motion if necessary. **Do not pull on the cable.**
5. Disconnect the sensor cable from the chassis harness.
6. Remove the sensor cable from any cable clamps or clips.
7. Remove the sensor spring clip from the sensor bracket.

Installation

1. Connect the new sensor cable to the chassis harness.
2. Press the sensor spring clip into the sensor bracket, located on the rear axle, until it stops. Verify that the tabs are on the inboard side.
3. Apply a WABCO-recommended lubricant to the sensor.
4. Push the sensor completely into the spring clip until it contacts the tooth wheel.
5. Reattach the sensor cable to the cable clamps or clips.
6. Fasten the sensor cable every 12 inches. Correctly bundle and store excess cable in the sub-frame. Figure 3.2.

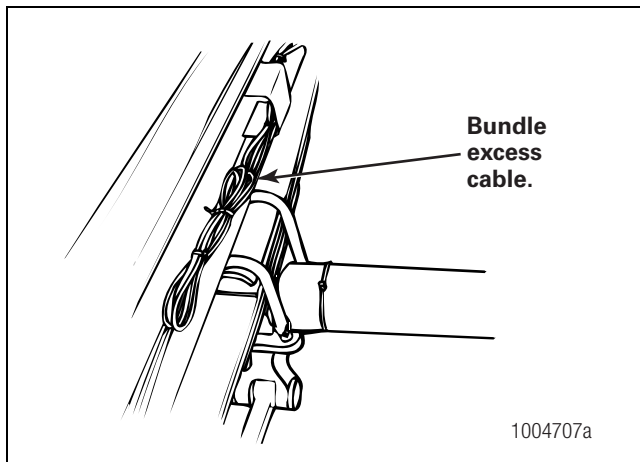


Figure 3.2

7. Replace the tire and remove the safety stands. Lower the vehicle and remove the blocks from the front tires.
8. Perform a voltage output check to ensure correct installation. Refer to Section 2.

Electronic Control Unit (ECU)

Removal

⚠ WARNING

To prevent serious eye injury, always wear safe eye protection when you perform vehicle maintenance or service.

⚠ CAUTION

Hydraulic brake fluid is a caustic substance. Contact with the hydraulic brake fluid can cause skin irritation. Do not let hydraulic brake fluid touch any painted surfaces, as it will remove the paint. Hydraulic brake fluid may also damage certain non-metal surfaces. Do not let fluid contact brake pads, shoes, rotors or discs.

NOTE: Do not open the ECU. Opening the ECU to gain access to the internal components will void the warranty.



NOTE: The following general guidelines are provided to facilitate the safe removal of the ECU module from the modulator assembly.

- It is not necessary to remove the entire modulator to replace the Electronic Control Unit (ECU).
 - When only the ECU is replaced, bleeding the system is not necessary.
1. Park the vehicle on a level surface. For vehicles with manual parking brakes, apply the parking brakes.
 2. Block the front and rear tires to prevent vehicle movement.
 3. Disconnect the battery.
 4. Use a clean rag to carefully wipe the surface of the modulator and the surrounding area.
 5. Open the latches on the 31-pin harness attached to the ECU. After the latch is released, remove the connectors from the ECU.
 6. Use a 4 mm Allen wrench to loosen and remove the four mounting screws that attach the ECU module to the modulator valve.
 7. Carefully remove the ECU by lifting straight out. To avoid damage, do not twist the ECU during removal. Determine the warranty status of the ECU. If the ECU is under warranty, return it to WABCO. If it is not under warranty, discard the used ECU.
 8. Use a clean rag to carefully clean the area around the valves formerly covered by the ECU.

Installation

CAUTION

Excessive force in positioning the ECU onto the modulator will damage the ECU housing. Do not force the ECU into position. Use a gentle, even pressure when positioning the ECU.

1. Position the ECU onto the modulator valve. Apply gentle pressure to seat the ECU. Motor connectors must achieve full depth into the housing. The gap between the modulator and ECU must not exceed 0.08-inch (2 mm).
2. Use a 4 mm Allen wrench to tighten the four mounting screws that attach the ECU to the modulator. Tighten to 14 in-lb (1.5 N•m). Do not exceed this torque. The metal sleeves on the ECU housing must rest flat on the body of the modulator. 
3. When the ECU is correctly installed with the metal sleeves flat on the modulator, tighten the bolts to 21-30 in-lb (2.5-3.5 N•m). 

WARNING

Electrical connectors must be correctly installed with the latch pushed in to lock the connector. Failure to do so may allow the connectors to come loose or disconnect resulting in loss of ABS function.

4. Attach the 31-pin harness connector to the ECU.
5. Connect the battery.

Modulator Assembly

Removal

CAUTION

The modulator assembly contains hydraulic brake fluid, a caustic substance. Remove the valve carefully so that fluid does not leak and cause skin irritation or damage to components.

NOTE: If there is interference, the entire bracket and valve assembly can be removed.

1. Apply the parking brakes. Block the front and rear tires to prevent vehicle movement.
2. Place a container under the modulator assembly to catch leaking brake fluid.


3. Disconnect the electrical harness connectors from the modulator assembly.
4. Mark the six brake lines for ease of installation. Disconnect the lines from the modulator assembly.
5. Remove the three mounting capscrews and washers that attach the modulator assembly to the bracket.

NOTE: Whenever any hydraulic system fitting is loosened or disconnected, the entire system must be bled to remove any air that may have entered. Refer to "Brake Bleeding Procedures" in this section.

6. Remove the modulator assembly.

Installation

NOTE: WABCO recommends that the motor axis makes an angle between +5° and +30° with the horizontal plane, with the motor end pointing up. Contact the OEM or WABCO for additional information regarding modulator orientation.

1. Position the modulator assembly in place on the vehicle. Figure 3.3.
2. Tighten the three mounting nuts to 16 ft-lb (22 N•m). 
3. Connect the electrical harnesses to the modulator assembly.
4. Connect and tighten the brake line connections.
5. Bleed the brake system per the Brake Bleeding Procedures in this section.

3 Component Replacement

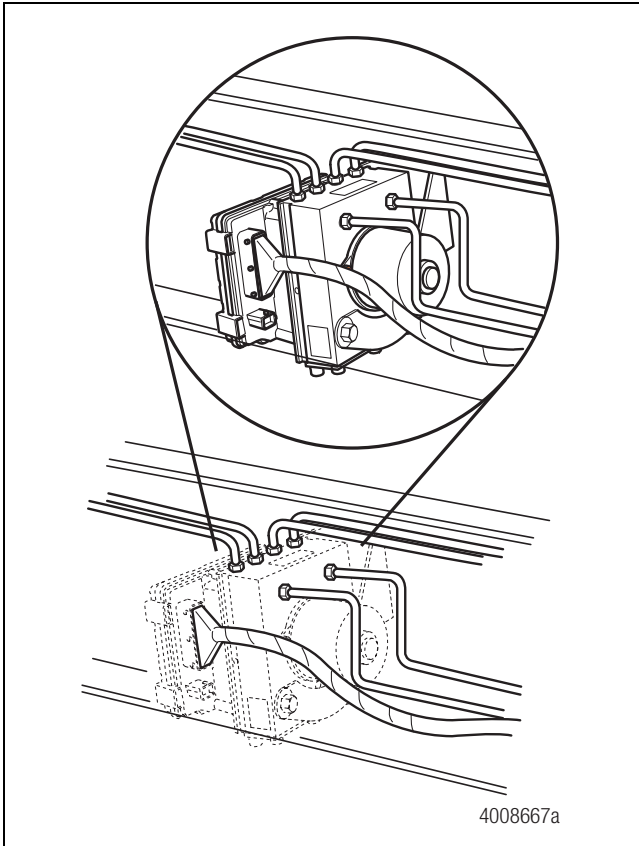


Figure 3.3

Modulator Motor

Removal

1. Remove the modulator assembly from the vehicle. Refer to "Modulator Assembly, Removal" in this section.
2. Remove the two motor mounting screws. Figure 3.4.

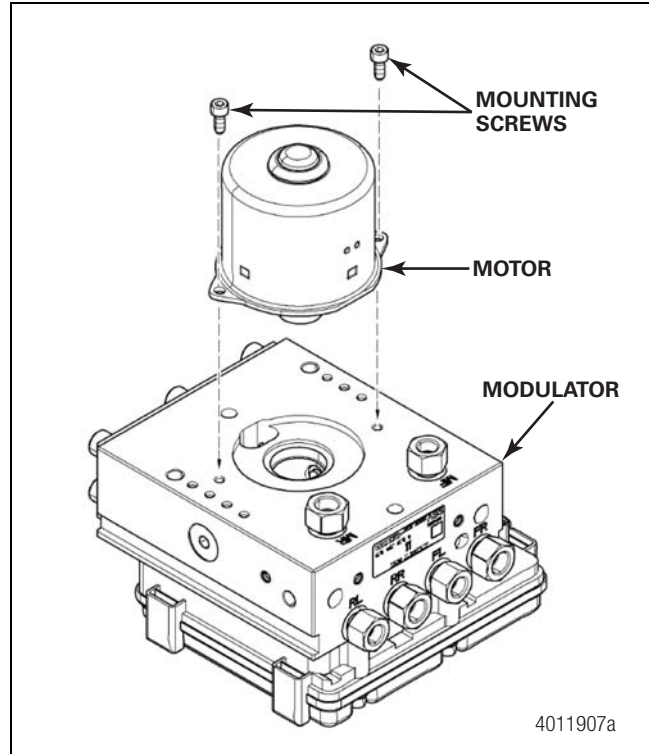


Figure 3.4

3. Carefully pull the motor straight off of the modulator. Do not twist or bend.

Installation

It will also be necessary to remove the ECU and the pump before installing the motor.

1. Remove the ECU as follows.
 - A. Use a 4 mm Allen wrench to loosen and remove the four mounting screws that attach the ECU to the modulator valve.
 - B. Carefully remove the ECU by lifting straight out. To avoid damage, do not twist the ECU during removal.
2. Remove the pumps as follows.
 - A. Remove the pump plugs from the sides of the modulator. Figure 3.5.
 - B. Back the pumps out until the pump plungers are no longer visible in the motor bore.

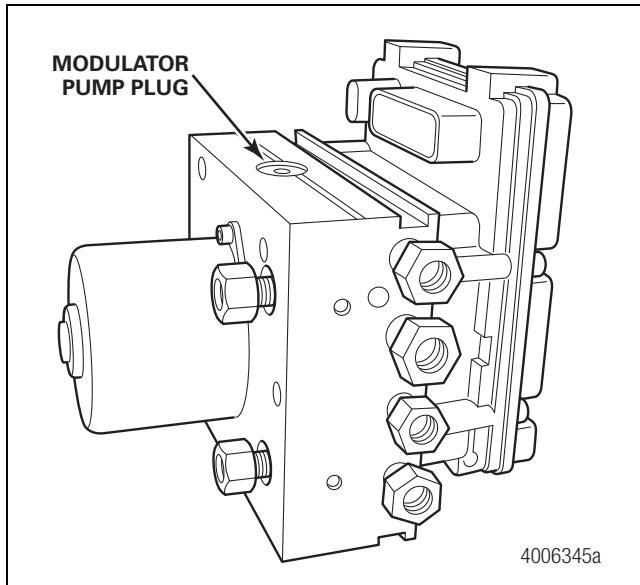




Figure 3.5

NOTE: Prior to installing the new motor, make sure the motor mounting surfaces, holes and threads are clean and free of any debris or contamination. Debris could affect the new motor seal against the aluminum block.

3. Once the pumps have been backed off, install the motor and tighten the two mounting screws to 53 + 8.8 lb-in (6 + 1 N•m). 
4. Reinstall the pumps.
5. Reinstall the pump plugs and tighten to 177 + 35 lb-in (20 + 4 N•m). 
6. Reinstall the ECU. Refer to “Electronic Control Unit, Installation” in this section.
7. Reinstall the E version modulator assembly on the vehicle. Refer to “Modulator Assembly, Installation” in this section.

Resetting Counters after a New Modulator Motor is Installed

As described in the E Version Hydraulic ABS Menus and Toolbars section, the Counters screen displays the existing ABS motor performance. When a new E Version modulator motor is installed as a replacement, the Pump Motor Hours counter and Ignition Cycles counter must be cleared within the ECU using the TOOLBOX™ Software. This will allow the ECU to start counting new motor run time and ignition cycles.

NOTE: When connecting to TOOLBOX™ Software, verify the communication device settings are correct and J1708 is selected as the Protocol in “Adapter Selection” under the “Utilities” menu.

1. Connect to the vehicle using the J1708 protocol and adapter that can be used as the vehicle interface.
2. Open the TOOLBOX™ Software.
3. Select the J1708/PLC TOOLBOX™ menu for the HABS-E unit information. Figure 3.6.

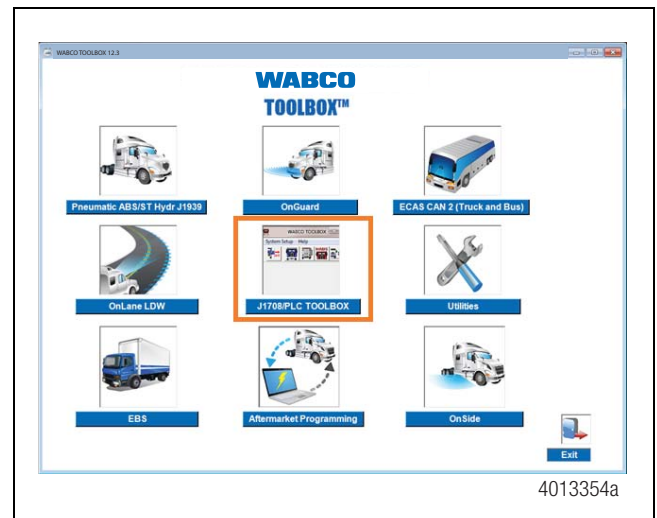


Figure 3.6

4. Select **HABS** on the next window. Figure 3.7.

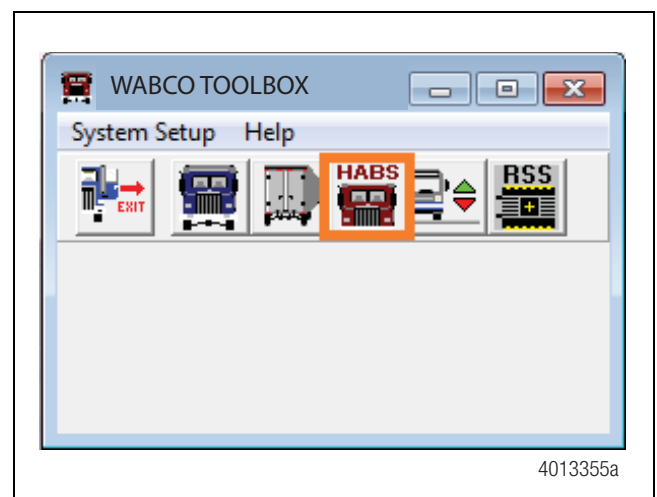


Figure 3.7

3 Component Replacement

- In the HABS-E window, click on **Display** on the top menu. Figure 3.8.

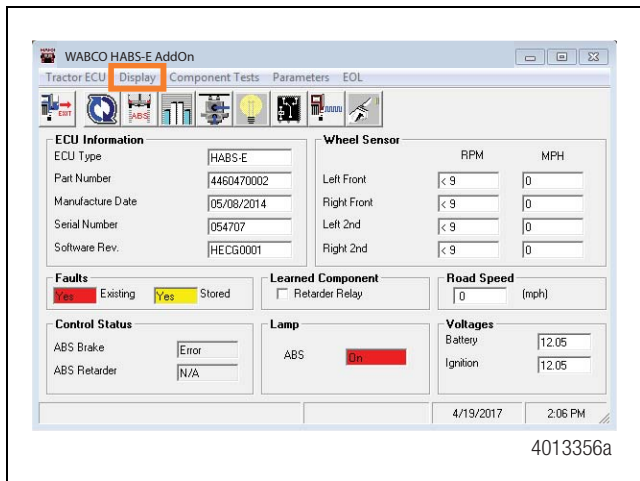


Figure 3.8

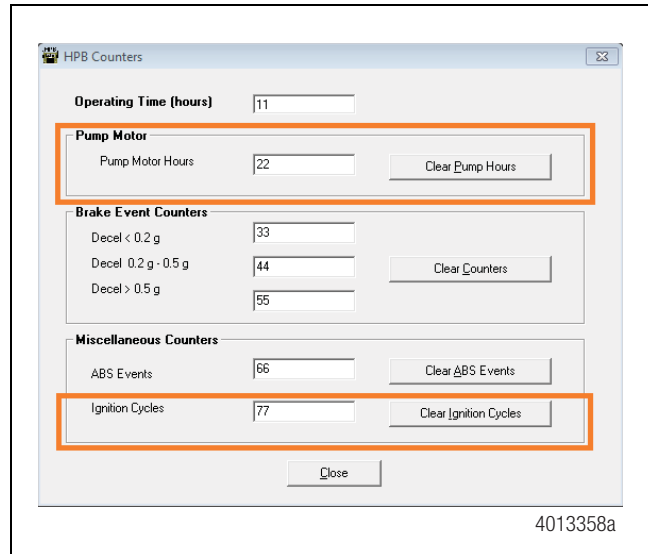


Figure 3.10

- Select **Counters** in the **Display Menu** to show the Pump Motor Hours and the Ignition Cycles window. Figure 3.9.

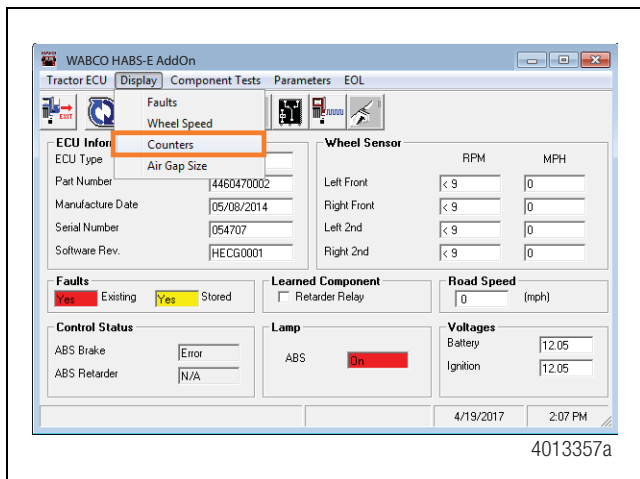


Figure 3.9

- When both the Pump Motor Hours and Ignition Cycles counters are set back to ZERO, select **Close**. Figure 3.11.

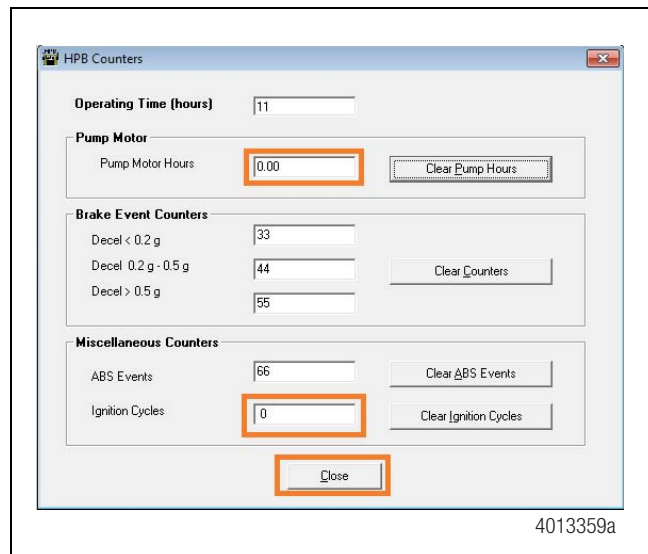


Figure 3.11

- In the Counters window, click on the **Clear Pump Hours** and **Clear Ignition Cycles** buttons ONLY. Do NOT clear any other counters. Figure 3.10.

Brake Bleeding Procedures

General

The following brake bleeding methods explain how to bleed the hydraulic ABS modulator assembly during installation, or in the event of air in the brake system. There are instructions for both pressure and manual bleeding procedures.

These instructions include the procedure for bleeding both the master cylinder and the brake system. In some cases, for example, if you are replacing only the modulator assembly, it may not be necessary to bleed the master cylinder. If you have any questions, please contact WABCO North America Customer Care at 855-228-3203.

⚠ WARNING

Failure to bleed the system whenever any hydraulic system fitting is loosened or disconnected will allow air to remain in the system. This will prevent the hydraulic pressure in the brake system from rising enough to apply the brakes correctly. This will cause the stopping distance to increase and can result in serious personal injury.

Correctly discard hydraulic brake fluid that is removed from the brake system. Hydraulic brake fluid that is removed can be contaminated and can cause damage, loss of braking and serious personal injury.

Use only the type of hydraulic brake fluid specified by the equipment manufacturer. Do not use or mix different types of hydraulic brake fluid. The wrong hydraulic brake fluid will damage the rubber parts of the brake caliper and can cause damage, loss of braking and serious personal injury.

⚠ CAUTION

Hydraulic brake fluid is a caustic substance. Contact with hydraulic brake fluid can cause skin irritation. Do not let hydraulic brake fluid touch any painted surfaces, as it will remove the paint. Hydraulic brake fluid may also damage certain non-metal surfaces. Do not let fluid get on brake pads, shoes, rotors or discs.

NOTE: Use DOT 3 or DOT 4 hydraulic brake fluid. Refer to the vehicle specifications to determine which fluid to use.

NOTE: The modulator assembly must be handled with appropriate care and should not be exposed to excessive impact or compressed air at the hydraulic ports prior to assembly.

Pressure Fill and Bleed

Pressure fill and bleed is the preferred method for bleeding the service brake system. It requires the use of a special pressure bleeder kit, consisting of a tank, pressure pump and valve, gauge, tubing and adapter. These kits are available from a number of manufacturers and include instructions for use. Figure 3.12.

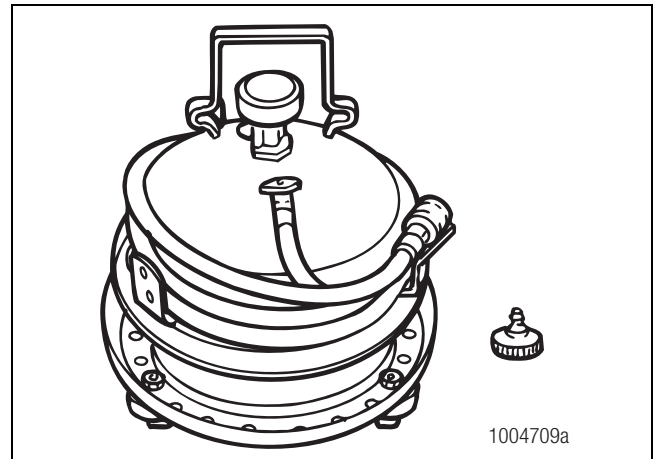


Figure 3.12

Pressure Fill and Bleed Procedure

⚠ CAUTION

Turn the ignition OFF for the entire bleed procedure. Do not energize the unit during the bleed procedure. Improper bleeding may result in system malfunction due to the presence of air in the closed hydraulic system.

1. Apply the parking brake and block the tires. Turn the ignition OFF and disconnect the battery terminals.
2. Fill the pressure bleeder with new DOT 3 or DOT 4 hydraulic brake fluid. Refer to the vehicle specifications to determine which fluid to use.
3. Follow the manufacturer's instructions to connect the pressure bleeder to the brake master cylinder reservoir.
4. Set the filling pressure to 20 to 30 psi (1.5 to 2.0 bar).
5. Turn on the bleed equipment until the fluid level in the reservoir reaches approximately 0.875-inches (20 mm).
6. Release pressure for three to five seconds. Apply pressure for five to 10 seconds.
7. Repeat Step 5 and Step 6 approximately 10 times. After releasing the pressure, air bubbles should rise up into the reservoir.

3 Component Replacement

⚠ WARNING

Do not let the brake master cylinder fluid get below the minimum level during the bleeding operation. Keep the master cylinder reservoir filled with new DOT-approved brake fluid, as specified by the original equipment manufacturer. Failure to keep the brake reservoir level above minimum could result in more air entering the system, making it impossible to effectively bleed the system resulting in increased stopping distance.

8. Bleed the brake system:
 - Set the filling pressure to 20 to 30 psi (1.5 to 2.0 bar).
 - Place a wrench on the brake actuator bleeder fitting. Start with the farthest from the modulator, typically the right rear, then attach a length of clear plastic tubing to the bleeder fitting. Verify that the tube fits snugly.

NOTE: Both the tubing and container must be able to withstand the effects of hydraulic brake fluid. Tools used for bleeding the system should be brake fluid-safe.

9. Submerge the tubing in a container of clean hydraulic brake fluid. Figure 3.13.

Loosen the bleeder fitting until the fluid begins to flow (about 3/4 turn). Let the hydraulic fluid flow out of the fitting until it is free of air bubbles.

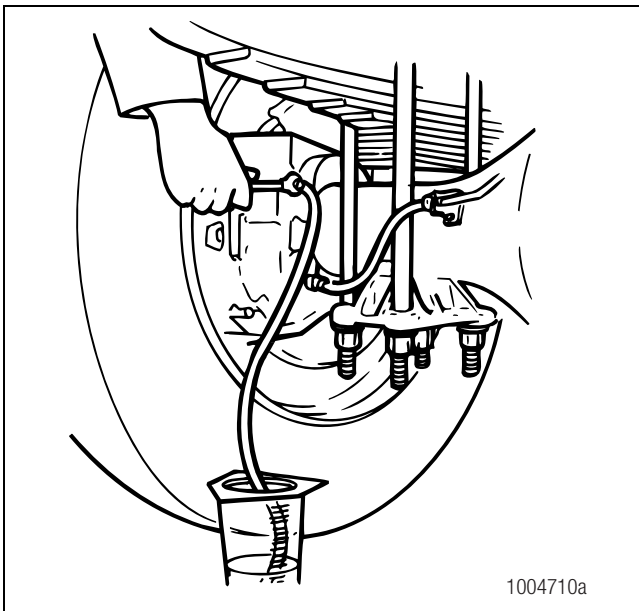


Figure 3.13

10. Tighten firmly to secure the fitting.
11. Repeat Step 5 through Step 8 to bleed the remaining three brake actuators. Bleed in sequence of the longest to shortest circuit from the modulator assembly.
12. Turn off bleed equipment and remove pressure. Remove the bleed device and check the fluid level in the reservoir. Fill if required. Replace the reservoir cap and dispose of used brake fluid.
13. Remove the wheel blocks.

Manual Bleed Procedure

NOTE: The ignition must remain off for the entire bleed procedure; energizing the unit during bleeding must be impossible. Two people are required to perform this procedure.

1. Apply the parking brake and block the tires. Turn the ignition OFF and disconnect the battery terminals.
2. Fill the reservoir with DOT 3 or DOT 4 hydraulic brake fluid. Refer to the vehicle specifications to determine which fluid to use.
3. Depress the brake pedal five times using the stroke between 1/3 travel and maximum travel in five seconds.
4. Release the pedal for five to 10 seconds. Air bubbles will rise into the reservoir while depressing and releasing the pedal.
5. Repeat Step 3 and Step 4 another three times, or until sufficient pedal resistance is felt.

⚠ WARNING

Do not let the brake master cylinder fluid get below the minimum level during the bleeding operation. Keep the master cylinder reservoir filled with new DOT-approved brake fluid as specified by the original equipment manufacturer. Failure to keep the brake reservoir level above minimum could result in more air entering the system, making it impossible to effectively bleed the system resulting in increased stopping distance.

6. Bleed the brake system. Place a wrench on the brake actuator bleeder fitting. Start with the farthest from the modulator, (typically the right rear), then attach a length of clear plastic tubing to the bleeder fitting. Verify that the tube fits snugly.

NOTE: Both the tubing and container must be able to withstand the effects of brake fluid. Tools used for bleeding the system should be brake fluid-safe.

7. Submerge the tubing in a container of clean brake fluid. Figure 3.13.
8. Depress the brake pedal 10 to 15 times, using the maximum available stroke.
9. Loosen the bleeder fitting until the fluid begins to flow (about 3/4 turn), while depressing the brake pedal through its maximum available stroke.
10. Tighten the fitting firmly prior to releasing the brake pedal.
11. Repeat Step 6 through Step 8 several times until the discharged fluid is free of air bubbles.
12. Repeat Step 3 through Step 9 to bleed the remaining three brake actuators. Bleed in sequence of the longest to the shortest circuit from the modulator.
13. Check the travel of the brake pedal. If a firm resistance is felt, the manual bleeding procedure is complete.
14. Check the fluid level in the reservoir and fill if required. Replace the reservoir cap and dispose of used brake fluid.
15. Remove the wheel blocks.

Brake Fluid Replacement Requirement

For the correct functioning of the ABS, seals and components, WABCO recommends replacing brake fluid every two (2) years on all vehicles equipped with WABCO HPB system. This is done to minimize exposure to contaminated brake fluid. To replace the brake fluid, please follow the instructions indicated by the OEM.

NOTE: While changing the brake fluid according to instructions provided by the OEM, please read and observe all Warning and Caution hazard alert messages including those listed below.

WARNING

Never reuse hydraulic brake fluid that has been removed from a vehicle. Hydraulic brake fluid that has been removed can be contaminated and can cause damage, loss of braking and serious personal injury. Always discard hydraulic brake fluid in accordance with applicable environmental requirements. Use DOT 3 or DOT 4 hydraulic brake fluid. Refer to the vehicle specification sheet to determine which fluid to use. Do not use or mix different types of hydraulic brake fluid. The incorrect hydraulic brake fluid will damage the rubber parts of the brake caliper and can cause damage, loss of braking and serious personal injury.

Leak Check Procedure for WABCO HABS

Check the HABS for Brake Fluid Leaks

With Pressure Removed:

WARNING

Block the wheels to keep the vehicle from moving. Unwanted vehicle movement can result in serious personal injury.

1. Park the vehicle on a level surface. For vehicles with manual parking brakes, apply the parking brake. Block the wheels to keep the vehicle from moving.
2. Inspect the entire hydraulic brake system including brake lines and line fitting connections for the presence of brake fluid damage or other evidence of a leak.
 - **If a leak is identified:** Perform the following.
 - A. Clean and dry the entire area.
 - B. Determine the source of the leak.
 - C. Make the necessary repairs.
3. If the hydraulic system is compromised by exposure to air, it is necessary to bleed the affected circuit. Refer to the appropriate section in this manual.

With Pressure Applied:

If there was no evidence of a leak when the system was checked with the pressure removed, apply pressure to the system and recheck for leaks. Two people are required to perform this check.

1. With the vehicle parked on a level surface, depress the brake pedal and hold to deliver brake pressure to the calipers.
2. Inspect the entire hydraulic brake system including brake lines and line fitting connections for the presence of brake fluid damage or other evidence of a leak.
 - **If a leak is identified:** Perform the following.
 - A. Clean and dry the entire area.
 - B. Determine the source of the leak.
 - C. Deplete system pressure. Refer to the appropriate section in this manual for instructions.
 - D. Make the necessary repairs.
3. If the hydraulic system is compromised by exposure to air, it is necessary to bleed the affected circuit. Refer to the appropriate section in this manual.

3 Component Replacement

System Test

After all necessary repairs have been made and the system has been bled, verify the hydraulic circuits are connected correctly. Two people are required to perform this test.

1. Park the vehicle on a level surface.

WARNING

Block the wheels to keep the vehicle from moving. Unwanted vehicle movement can result in serious personal injury.

2. Block the wheels to keep the vehicle from moving.
3. Raise the rear wheels. Place supports under the rear axle.
4. Depress the brake pedal. Attempt to turn the rear wheels one at a time. They should not move with the brakes applied.
5. Connect the vehicle to a PC with TOOLBOX™ Software installed. Use TOOLBOX™ Software to activate the solenoid valves for the left rear wheel. You should be able to turn this wheel by hand when the solenoids activate. Repeat this check for the right rear wheel. Go to Step 6.
6. Remove the axle stands from under the rear axle to lower the vehicle.
7. Remove the blocks from the front tires and place them in front of the rear tires.
8. Raise the front tires. Place supports under the front axle.
9. Repeat Steps 4 and 5.
10. Remove the axle stands from under the front axle to lower the vehicle.
11. Make any necessary repairs. If any plumbing changes were made, bleed the system again.

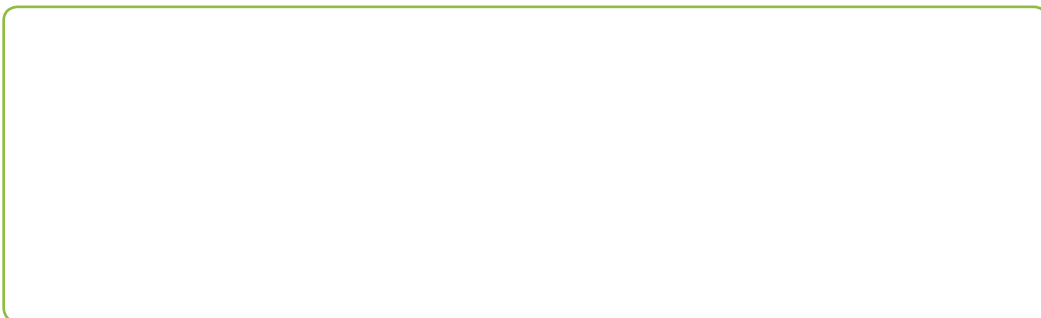


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