



Service Data

SD-13-4860

Bendix® WS-24™ Antilock Wheel Speed Sensor

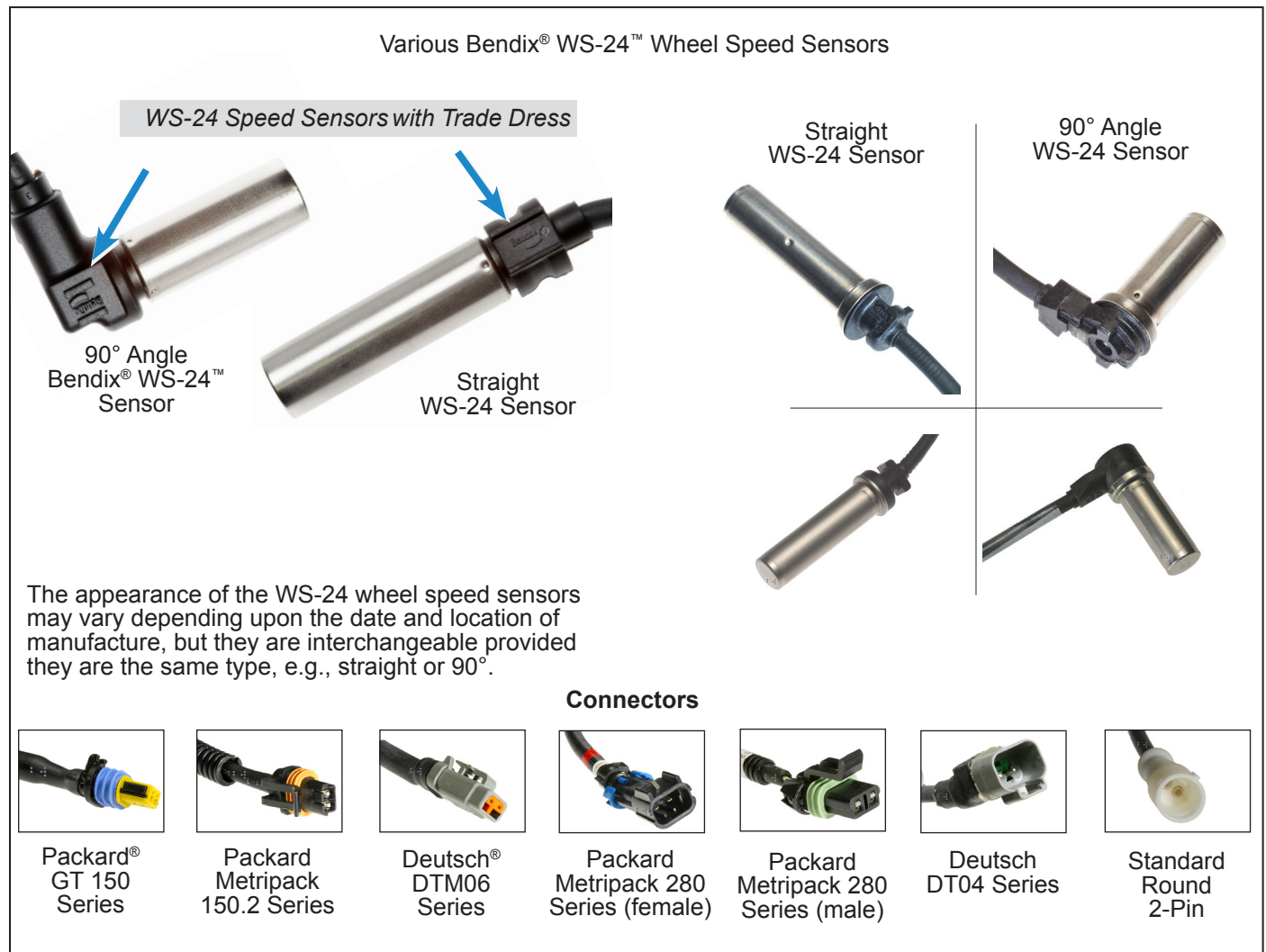


Figure 1 – Wheel Speed Sensors and Connectors

DESCRIPTION

The Bendix® WS-24™ wheel speed sensor is an electromagnetic device used to obtain vehicle speed information for an antilock controller. When the wheel rotates, the sensor and an exciter ring (sometimes called a “rotor” or “tone” wheel) generate a simple AC signal. This signal is sent to the controller, which analyzes the data and commands the antilock system accordingly.

Specifically, the speed sensor consists of a coil, pole piece, and a magnet. The exciter is a steel ring or gear-like device

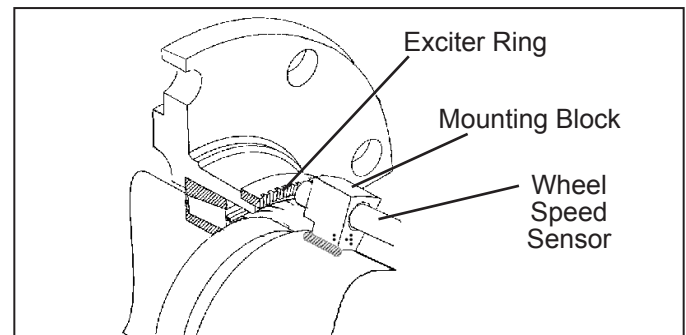


Figure 2 – Wheel End ABS Components



GENERAL SAFETY GUIDELINES

WARNING! PLEASE READ AND FOLLOW THESE INSTRUCTIONS

TO AVOID PERSONAL INJURY OR DEATH:

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

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



WARNING: Not all wheels and valve stems are compatible with Bendix® Air Disc Brakes. Use only wheels and valve stems approved by the vehicle manufacturer to avoid the risk of valve stem shear and other compatibility issues.



WARNING: AVOID CREATING DUST. POSSIBLE CANCER AND LUNG DISEASE HAZARD.

While Bendix Spicer Foundation Brake LLC does not offer asbestos brake linings, the long-term affects of some non-asbestos fibers have not been determined. Current Occupational Safety and Health Administration (OSHA) Regulations cover exposure levels to some components of non-asbestos linings, but not all. The following precautions must be used when handling these materials.

Avoid creating dust. Compressed air or dry brushing must never be used for cleaning brake assemblies or the work area.

- ▲ Bendix recommends that workers doing brake work must take steps to minimize exposure to airborne brake lining particles. Proper procedures to reduce exposure include working in a well-ventilated area, segregation of areas where brake work is done, use of local filtered ventilation systems or use of enclosed cells with filtered vacuums. Respirators approved by the Mine Safety and Health Administration (MSHA) or National Institute for Occupational Safety and Health (NIOSH) should be worn at all times during brake servicing.
- ▲ Workers must wash before eating, drinking, or smoking; shower after working, and should not wear work clothes home. Work clothes should be vacuumed and laundered separately without shaking.
- ▲ OSHA & EPA Regulations regarding testing, disposal of waste, and methods of reducing exposure for asbestos are set forth in 29 & 40 Code of Federal Regulations §1910.1001 & 61.150, respectively. These Regulations provide valuable information which can be utilized to reduce exposure to airborne particles.
- ▲ Safety Data Sheets on this product, as required by OSHA, are available from Bendix. Call 1-800-247-2725 and speak to the Tech Team or e-mail techteam@bendix.com.

that has regularly spaced high and low spots called "teeth." The sensor is mounted in a fixed position, while the exciter is installed on a rotating member so that its "teeth" move, in close proximity, past the tip of the sensor.

The Bendix® WS-24™ sensor is available in both straight and 90° versions, to accommodate axle/wheel space limitations. (See Figure 1.)

OPERATION

The sensor's magnet and pole piece form a magnetic field. As the exciter ring passes by the sensor, the magnetic field is altered, which generates AC voltage in the sensor coil. Each time an exciter tooth and its adjacent space move past the tip of the sensor, an AC voltage "cycle" is generated.

The number of AC cycles per revolution of the vehicle's wheel depends on the number of teeth in the exciter ring, which is programmed into the antilock controller. Using the programmed data, the controller can calculate "vehicle speed" by analyzing the frequency of AC cycles sent by the speed sensor. (The frequency of AC cycles is directly proportional to wheel speed.) *See Figure 4.*

AC voltage is also proportional to speed, but voltage is not used to determine speed. It is only an indication of AC signal strength. The amount of AC voltage generated by a specific speed sensor depends on the distance, or "gap" between the tip of the sensor and the surface of the exciter. Voltage increases as the sensor gap decreases.

Typically, the Bendix® WS-24™ wheel speed sensor is installed in mounting blocks that are welded to the axle housing. (See *Figure 2.*) The WS-24 wheel speed sensors are protected by a stainless steel sheath. The sensors are designed to be used with beryllium copper or stainless steel clamping sleeves (sometimes referred to as a "retainer bushing", "friction sleeve" or "clip") (See *Figure 3*). The clamping sleeve provides a friction fit between the mounting block bore and the WS-24 wheel speed sensor.

Note that Bendix® sleeve part number 5006849 can not be used with the WS-24 wheel speed sensors. Always use the correct clamping sleeves to avoid problems associated with reduced retention force, such as unwanted sensor movement and resulting ABS trouble codes.

TECHNICAL INFORMATION

Electrical connector - 2 Pin
Sensor resistance (-40°C - 220°C) 1100 - 3400 ohms
Output voltage - At a minimum of 100 Hz (approximately 7 mph) at a gap of .028 inches should produce a sensor voltage of 0.350 VAC
Sensor body outer diameter - 0.627 inch
Sensor resistance (20°C) 1575 - 2100 ohms
Note: Previous model Bendix® WS-20™ sensor's normal resistance range across pins at room temperature was rated at 2000 - 5000 ohms.

The friction fit allows the WS-24 sensor to "slide" back and forth under force but to retain its position when the force is removed.

When the WS-24 sensor is inserted all the way into the mounting block and the wheel is installed on the axle, the hub exciter contacts the sensor, which pushes the sensor back. Also, normal bearing play will "bump" the sensor away from the exciter. The combination of these two actions will establish a running clearance or air gap between the sensor and the exciter.

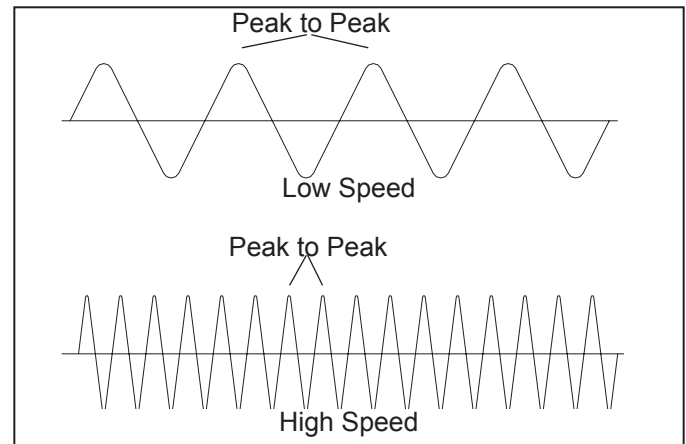


Figure 4 – Speed Sensor Voltage Cycle Output

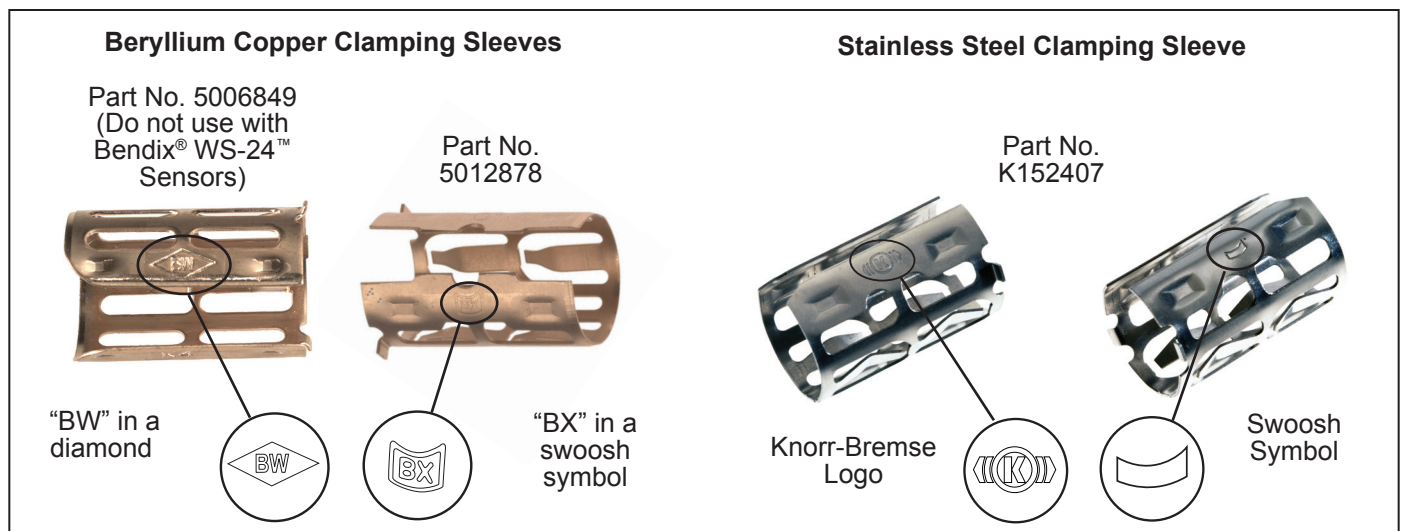


Figure 3 – Clamping Sleeves

PREVENTIVE MAINTENANCE

1. Every 3 months; 25,000 miles; 900 operating hours; or during the vehicle chassis lubrication interval, make the visual inspections noted in "SERVICE CHECKS" below.
2. Every 12 months; 100,000 miles; or 3600 operating hours, perform the OPERATIONAL TEST in this manual.

SERVICE CHECKS

Check all wiring and connectors. Make sure connections are free from visible damage.

Examine the sensor. Make sure the sensor, mounting bracket, and foundation brake components are not damaged. Repair/replace as necessary.

SENSOR IDENTIFICATION

Use Bendix® ACom® diagnostic software to identify the suspected sensor. To verify the correct wheel sensor or axle has been identified, the ACom software can be used to view real time wheel speed sensor outputs. To determine which axle has been identified as drive or additional, lift the axle in question and hand spin the wheel at least ½ revolution per second. The wheel speed will be displayed via the ACom software.

INSPECT FOR PHYSICAL DAMAGE

Inspect the sensor cable for cuts, evidence of pinching or wear, or abrasions with wiring exposed. Make sure the block is securely attached to the axle housing. If any of the above conditions are noted, replace the sensor and clamping sleeve, then clear the Diagnostic Trouble Code (DTC) according to the Electronic Control Unit (ECU) Service Data sheet directions. Re-check the system before returning the vehicle to service.

ELECTRICAL TESTING

The vehicle should be at an ambient temperature to achieve a nominal resistance, or AC voltage, value. Be observant of the wheel end temperature when taking measurement readings. At extreme temperature ranges, -40°F to 428°F (-40° to 220°C), the sensor resistance can vary from 1100 to 3400 ohms. To avoid possible connector seal damage it is recommended to first check sensor resistance, or AC voltage output, at the ECU connections. If the resistance or voltage output is not within the stated parameters at this location, perform the test at the next connector, typically the wheel end. Before disconnecting any electrical connections at the wheel end, remove as much contamination from the connector as possible to preserve the sealing integrity of the connection.

1. Inspect the connectors and terminals for corrosion, physical damage (bent) or loose connections. If possible, repair and/or clean the connector and terminals.

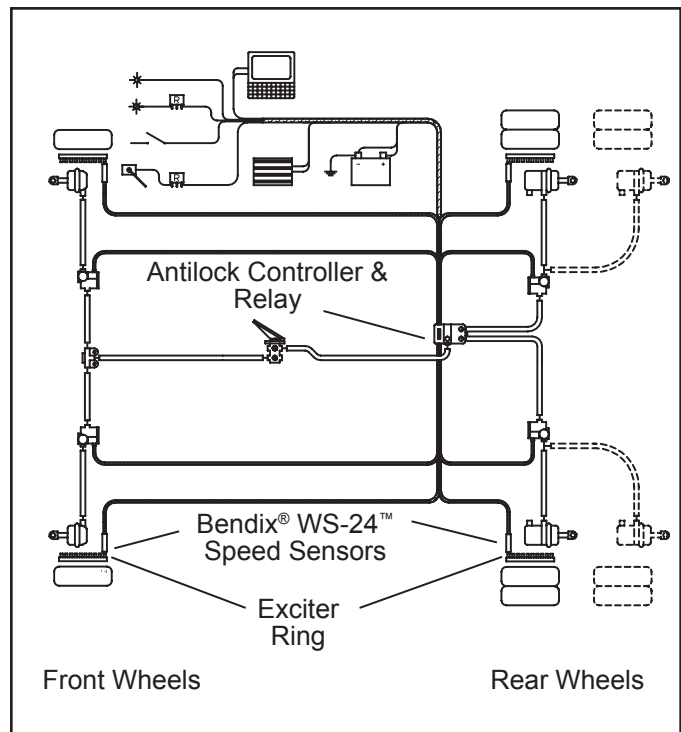


Figure 5 – Typical Antilock System

2. Use a volt-ohm meter to measure the resistance across the connector terminals, at an ambient temperature range of 0°F to 100°F (-18°C to 38°C) sensor resistance range can be 1200 to 2700 ohms. Record your measurements.

☐ OK - between 1200 and 2700 ohms.

☐ Not OK - less than 1200 or more than 2700 ohms.

Resistance measurement = _____.

If OK, continue to Step 3.

If Not OK, replace the sensor and clamping sleeve.

3. Confirm that wheel chocks are in place on the vehicle. Raise the wheel off the ground to test the suspect wheel speed sensor.
4. Release the parking brakes.
5. By hand, slowly rotate the wheel at a rate of at least ½ revolution per second. Using an AC rms voltage meter, measure the voltage at the ECU across the sensor terminals and record your measurement.

☐ OK - Output voltage is 0.25 Volt AC minimum.

☐ Not OK - Output voltage is less than 0.25 Volt AC.

AC voltage measurement = _____.

6. If voltage is not OK, reposition the sensor by gently pushing it closer toward the wheel until it touches the exciter ring. Repeat the voltage measurement.

AC voltage measurement = _____.

If still not OK, replace the sensor and the clamping sleeve.

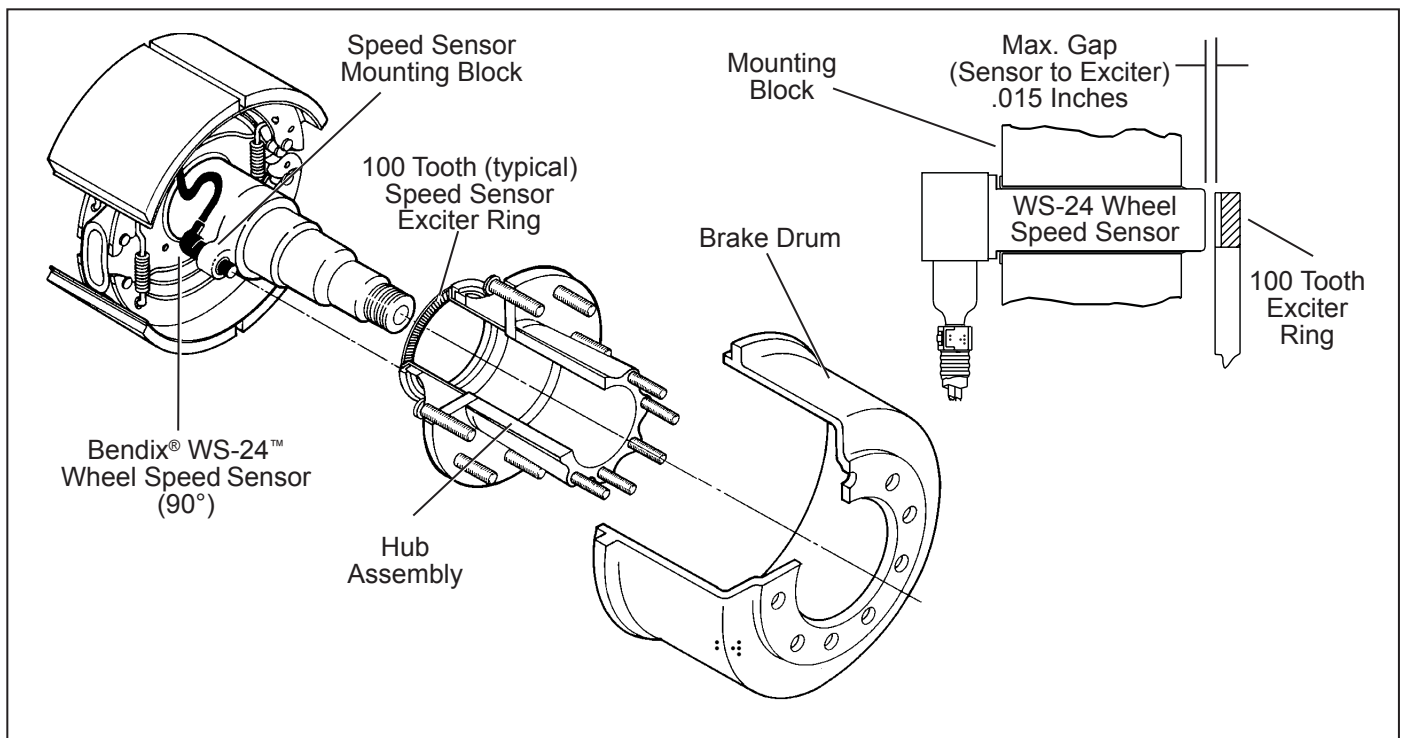


Figure 6 – WS-24 Wheel Speed Sensor Installation

7. If the resistance and voltage readings are OK, the sensor itself is not the cause of the Diagnostic Trouble Code (DTC). Reconnect the sensor and examine the wiring harness and ECU connector for causes of failure, such as pinched wires, loose pins, abrasions, exposed wires, etc.
8. After repair, re-check the system before returning the vehicle to service. If necessary, drive the vehicle to confirm the system is functioning correctly.

SENSOR REMOVAL

Before disconnecting any electrical connections at the wheel end, remove as much contamination from the connector as possible to preserve the sealing integrity of the connection.

1. Unplug the cable assembly connector from its lead. Lift the lock tab and pull on the connector until it disengages.
2. Gently pry the sensor and clamping sleeve from the mounting block.

SENSOR INSTALLATION

1. When using clamping sleeve—Bendix® part number 5012878—it is recommend a high-temperature rated silicon- or lithium-based grease be applied to the interior of the mounting block for better corrosion protection.
2. When using stainless steel clamping sleeve—Bendix® part number K152407—it is required to apply a high-temperature rated silicon- or lithium-based grease to the sensor body. This lubrication will keep the movement between the sensor and the clamping sleeve independent from one another.

3. Install the new clamping sleeve fully into the block, with the retaining tabs toward the inside of the vehicle.
4. Gently push (DO NOT STRIKE) the sensor into the mounting block hole until it bottoms out on the face of the tone ring. Secure the cable lead wire to the knuckle/ axle housing 3-6 inches from the sensor.
5. Apply a moderate amount of dielectric non-conductive grease to both the sensor connector and the harness connector.
6. Engage the connectors, and push together until the lock tab snaps into place.

NOTE: It is important for the wheel bearings to be adjusted per the manufacturer's recommendations. Excessive wheel end play can result in excessive air gap where the sensor is pushed too far away from the tone ring leading to loss of ABS or Stability Control systems.

OPERATIONAL TESTING

There are multiple ways to verify the wheel speed sensor has been installed properly.

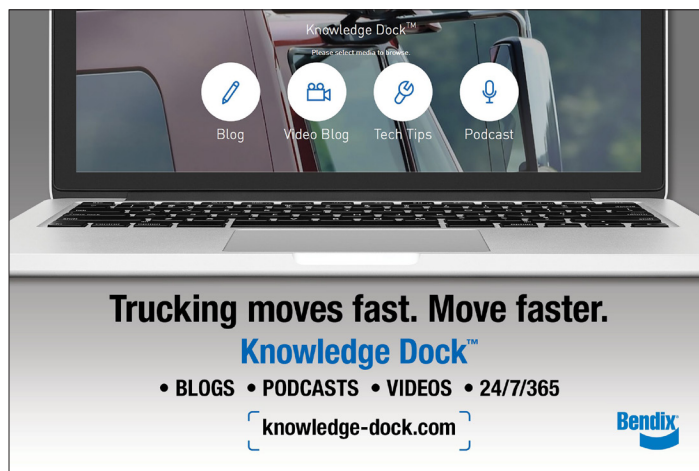
Prior to connecting the sensor to its mating connector, raise the vehicle wheel so it rotates easily. Connect a volt-ohm meter to the sensor leads, set the meter to AC volts, spin the wheel (approximately 0.5 revolutions per second). The output voltage should read greater than 0.250 V.

Test Drive: it is recommended to test drive the vehicle to verify the repair in a dynamic state. Test drive the vehicle in a safe area to a minimum speed of 15 mph. Be sure to make multiple right and left hand turns while driving, start and stop the vehicle with the brakes several times. Observe the following:

1. ABS dash lamp should not be illuminated after the test drive.

2. The Light Emitting Diode (LED) display on the Bendix controller, if so equipped, should only have the green LED illuminated.
3. If Bendix® ACom® diagnostic software is available: During the drive, wheel sensor output can be monitored and recorded in the ACom diagnostic wheel speed window. All sensors should record speeds.

If the sensor fails to operate as described, check the wiring from the controller to the sensor. Make sure all connectors are properly, and tightly, installed. Check for frayed or damaged wires. For additional troubleshooting information reference *Bendix® Wheel Speed Sensor Checklist* (BW2453 available for download on bendix.com), or see the troubleshooting procedure for the specific ABS system in use.



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