



Wheel Speed Sensor Technical Specification

1 Introduction

Note: Nothing in this standard supercedes applicable laws and regulations.

Note: In the event of conflict between the English and domestic language, the English language shall take precedence.

1.1 Purpose. This standard in conjunction with the Program Specific Technical Specification and the outline drawing establishes the requirements for active Wheel Speed Sensor (WSS) assemblies, the associated target wheels, and their interfaces in a vehicle.

1.2 Applicability. Individual platform suspension, knuckle, axle, driveline, and bearing configuration define the WSS assembly, target wheel, and cable routing requirements. The requirements for the sensor cable specified in this document are not applicable for cordless Sensors.

1.3 Remarks. The WSS assembly in conjunction with the target wheel is designed to transmit a signal proportional to the wheel rotation to the electronic control unit.

The WSS system shall produce 48 pulses per wheel revolution and the sensing technology shall be of active, non-directional type unless otherwise specified.

2 References

Note: Only the latest approved standards are applicable unless otherwise specified.

2.1 External Standards/Specifications.

ISO 11469	ISO 14572	SAE J1128	SAE/USCAR-44
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2.2 GM Standards/Specifications.

GMW3059	GMW3172	GMW15105	GMW15841
GMW3091	GMW3191	GMW15392	GMW15862
GMW3097	GMW14089	GMW15626	
GMW3103	GMW14573	GMW15826	

2.3 Additional References.

- GM Best Practice BRAKES-236
- GM Best Practice BRAKES-145
- GM CEMENT database <https://gmweb.gm.com/sites/CCP/Pages/Home-Page.aspx>
- Failure Mode and Effects Analysis (FMEA) Reference Manual, AIAG
- Fundamental Statistical Process Control Reference Manual, Automotive Industry Action Group, (AIAG) 1991
- Production Part Approval Process, AIAG, 1993
- Yazaki drawing 7287-0973-30 GA

3 Requirements

3.1 System/Subsystem/Component/Part Definition. The WSS assembly and target wheel serve for determining wheel speeds for the electronic control unit.

3.1.1 Visual Requirements.

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October 2017

Page 1 of 18



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3.1.1.1 Appearance. The decorative surfaces of the WSS shall be free from scratches, sink marks, pin holes, nicks, knit lines, blisters, tears, cracking, scuffing, or any other surface irregularities.

3.1.1.2 Finish. The WSS shall have smooth corners and edges for all exposed surfaces.

3.1.1.3 Color. The color shall be black.

3.1.2 Content. The required physical and functional content for the sensor assembly and associated target wheel are identified in 3.1.2.1 through 3.1.2.2.

3.1.2.1 Physical Content. The WSS assembly typically consists of a sensor, a mount fastener, an electric cable, an electric connector, and fasteners to attach the cable to vehicle structure. The exact sensor assembly design shall be defined by a particular vehicle application.

3.1.2.2 Functional Content. The WSS assembly shall provide a signal proportional to wheel rotational speed to an Electronic Brake Control Module (EBCM). The WSS cable transmits the signal the system electronic control unit utilizing a two wire, twisted pair conductor.

3.1.3 Ambient Environment. The components shall withstand all reasonable combinations of these conditions under such usage that includes, but are not limited to those defined in GMW3172.

3.1.4 Interfaces. The WSS assembly interfaces with surrounding entities that will affect or constrain its functionality, packaging, and/or design.

3.1.4.1 Sensor Mounting. The WSS shall be mounted to a device in the vehicle and held in place securely and precisely. The mounting shall allow the sensor to meet product characteristic requirements specified in 3.2. If applicable, the interface of sensor to mounting device shall be sealed from road environment.

The sensor body shall have four (4) crush ribs, as shown in Figure 1, to keep the sensor body centered in the mounting hole. The ribs must have sufficient thickness in the radial direction to provide clearance between the bore hole wall and the sensor body. Thick crush ribs reduce the potential of sensor damage and ease sensor removal during service should the bore surface corrode. One (1) rib shall be located perpendicular to the sensor read face and the remaining three (3) ribs spaced 90 degrees apart. With the sensor installed in the bore hole, the ribs shall exist at both ends of the bore hole. The center portion may be removed as an aid to reduce insertion force, as shown in Figure 1.

The sensor shall have a metallic insert to absorb clamp load of the fastener, while minimizing transfer of clamp force to the sensor body (see Figure 2).

The tolerance stack of the crush ribs and the sensor bore hole, along with the design (geometry) of the crush ribs, shall allow a 45 N maximum insertion force in the minimum bore diameter/maximum crush rib diameter condition. This shall be achieved concurrently with realizing line to line contact in the maximum bore diameter/minimum crush rib diameter condition.

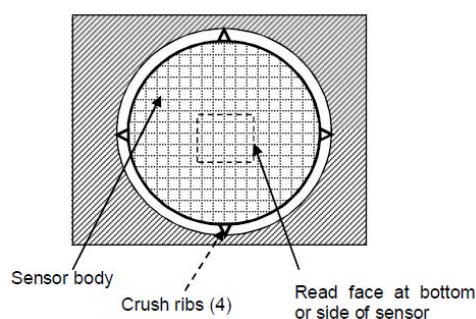


Figure 1: Sensor Mounting

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Page 2 of 18



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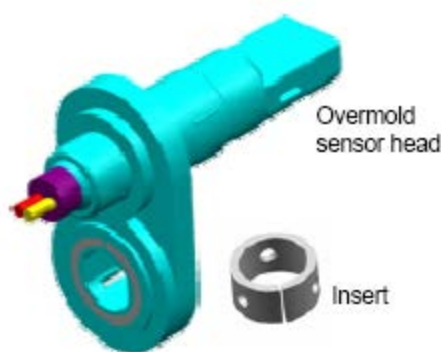


Figure 2: Sensor Head Mounting

3.1.4.2 Target Wheel.

3.1.4.2.1 Ferromagnetic Metal Tooth Wheel. If the WSS system will require a new metal tooth wheel, the sensor supplier shall provide the ferromagnetic metal tooth design that is optimized for magnetic interface providing the maximum air gap range. If GM and/or the sensor supplier have selected an existing metal tooth wheel, the sensor supplier shall determine the magnetic interface performance and measure the air gap range. The air gap range must be greater than or equal to the air gap range required for a robust WSS system.

3.1.4.2.2 Magnetic Encoder Wheel. If the WSS system will require a new magnetic encoder wheel, the sensor supplier shall provide the magnetic encoder wheel design that is optimized for magnetic interface providing the maximum air gap range. If GM and/or the sensor supplier have selected an existing encoder wheel, the sensor supplier shall determine the magnetic interface performance and measure the air gap range. The air gap range must be greater than or equal to the air gap range required for a robust WSS system.

3.1.5 Usage Definition.

3.1.5.1 Operating Voltage Range. The sensor shall function with voltage at the EBCM within the following conditions:

- Supply Voltage Minimum: 4.5 V.
- Supply Voltage Maximum: 16.0 V.
- Supply Voltage Nominal: 12.0 V.
- Peak Voltage: 26 V.
- Reverse Voltage: -18.0 V.

3.1.5.2 Power On/Off Cycles. The number of power on/off cycles for the WSS over the 322 000 km (200 000 miles) target life will be 94 000 cycles.

3.1.5.3 Power-On Time. The total power-on time for the WSS over a 322 000 km (200 000 miles) target life will be 12 400 h.

3.2 Product Characteristics. The verifiable technical requirements for the WSS assembly and target wheel are identified in 3.2.1.

3.2.1 Performance Requirements.

3.2.1.1 Sensor Assembly. For the product characteristics on a sensor assembly drawing see the program specific technical specification.

3.2.1.2 Sensor Over-Mold Material.

3.2.1.2.1 Material Requirements. The wheel speed sensor over-molded material shall be Polyamide (PA) reinforced with Glass fiber. The equilibrium water absorption (at 50% Relative Humidity (RH)) of the over-mold material shall be < 1.5% by mass and at saturation < 3.0% by mass. The over-mold material shall be pore/void free. Material shall be approved by GM Materials Engineering.

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October 2017

Page 3 of 18

3.2.1.2.2 Regrind Material. Regrind material may be considered, but must be approved by GM product engineering, GM supplier quality, GM materials engineering, and must meet all applicable performance requirements.

3.2.1.2.3 Material Thickness over IC. The sensor overmold thickness at the sensing Integrated Circuit (IC) surface shall be agreed to between GM and the supplier. The supplier shall provide experimental data to GM to demonstrate their capability. The nominal value will be selected based on the sensor operating environment, and will typically be between 0.6 mm and 1.0 mm.

3.2.1.3 Electromagnetic Compatibility. The wheel speed sensor shall meet all applicable component level requirements for Electromagnetic Compatibility (EMC) and for Electrostatic Discharge (ESD) in GMW3097. The wheel speed sensor shall meet all applicable requirements for vehicle level EMC in GMW3091. The wheel speed sensor is considered an electronic module with a magnetically sensitive element ("AM" category in GMW3097). The supplier shall submit test plans for GMW3097 validation via the CEMENT database in accordance with the process defined in GMW3103. This process shall be followed according to the timing specified in GMW3097. Test plans must be formally approved in CEMENT by GM EMC Engineering prior to beginning any formal testing. Test results shall also be submitted via CEMENT by the supplier for consideration of validation buy-off prior to request of saleable status. The results will be reviewed by GM product design release and EMC component validation engineering. The load box used during GMW3097 testing shall match the representative circuit provided by the GM EMC Engineer and GM Design Release Engineers (DRE) for the brake controller(s) that will be used with the sensor in production.

Note: These representative circuits may change between Design Validation (DV) and Production Validation (PV) iterations of Wheel Speed Sensor testing."

3.2.1.4 Operating Temperature. The wheel speed sensor shall be functional in the entire ambient temperature range of $-40\text{ }^{\circ}\text{C} \pm 150\text{ }^{\circ}\text{C}$ and for excursions of $150\text{ }^{\circ}\text{C}$ for up to thirty minutes.

3.2.1.5 Handling.

3.2.1.5.1 The wheel speed sensor as a stand-alone component shall remain functional when dropped to a concrete surface from a height of 1 m.

3.2.1.5.2 The wheel speed sensor cable shall maintain continuity with the sensor and not crack or separate from the over mold material when pulled with a minimum force of 150 N.

3.2.1.6 Insulation Breakdown. The wheel speed sensor assembly shall show no sign of insulation breakdown when exposed to 200 V.

3.2.1.7 Pothole Shock. When mounted in the vehicle or an applicable fixture the wheel speed sensor assembly and target wheel shall withstand repeated vibration shocks of 20 G in 11 ms duration and 30 G in 6 ms duration.

3.2.1.8 Gravel Impingement. The wheel speed sensor assembly shall withstand the gravel impingement encountered in the vehicle usage environment.

3.2.1.9 Articulation. The wheel speed sensor assembly shall function as designed and shall not interfere with any vehicle parts and other potential obstacles that may prevent it from proper function at all vehicle conditions of steering linkage position, suspension travel, and wheel alignment. Refer to best practice BRAKES-236 for a summary of clearance requirements and procedure GMW15105 for evaluating articulated routing.

3.2.1.10 Mounting Insert Retention. The wheel speed sensor mounting insert shall show no sign of movement or rotation in the over-mold when a maximum axial force of 270 N or a maximum torque of 11 Nm is applied in any direction.

3.2.1.11 Sensor Calibration/Learning During Varying Magnetic B Signal.

3.2.1.11.1 Sensor Learning During Very Small Magnetic Signal. The wheel speed sensor shall be capable of readjusting its internal gain and offset to changing Magnetic Flux Density (B). If the sensor learns during a very small magnetic B (minimum detectable level) it shall be able to maintain the fidelity of the output signal when the magnetic B increases up to 60 mT as shown in Figure 3.

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Page 4 of 18



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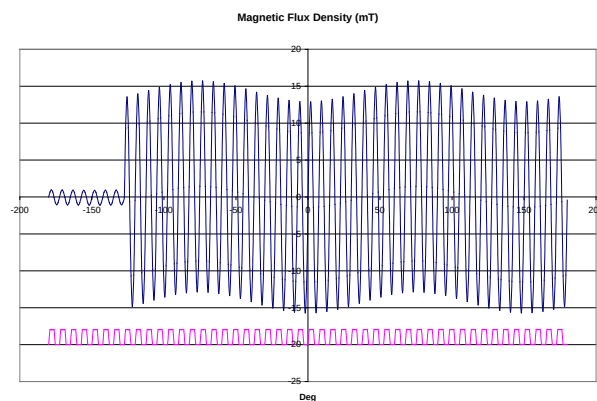


Figure 3: Example of Sensor Learning During Very Small Magnetic B

3.2.1.11.2 Sensor Learning During Large Magnetic Signal. The wheel speed sensor shall be capable of readjusting its internal gain and offset to changing magnetic flux density (B). If the sensor learns with a larger flux density, the output shall not be adversely affected if the subsequent signal is still higher than the minimum threshold level, as shown in Figure 4.

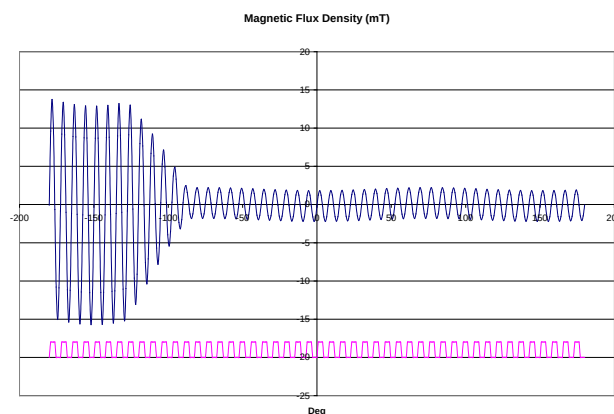


Figure 4: Example of Sensor Learning During Large Magnetic B

3.2.1.11.3 Sensor Adaptation to Magnetic Input Change. The wheel speed sensor shall be capable of readjusting its internal gain and offset to changing magnetic flux density (B). The output shall not be adversely affected as long as the flux density is higher than the minimum threshold level, as shown in Figure 5.

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October 2017

Page 5 of 18



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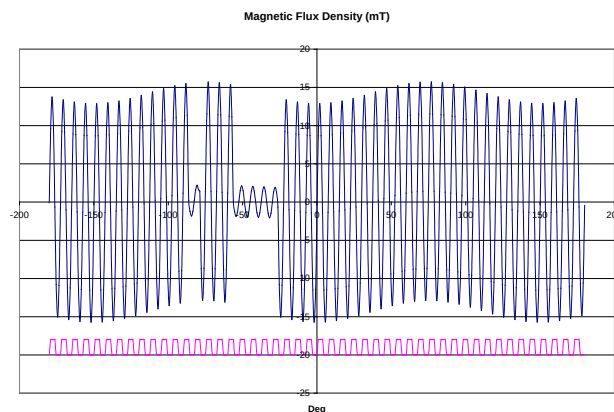


Figure 5: Example of Sensor Adaptation to Magnetic B Changes

3.2.1.12 Input Interface Protection. According to GMW3172.

3.2.1.13 Output Interface Protection. According to GMW3172.

3.2.1.14 Mechanical Interfaces.

3.2.1.14.1 Dimensions. The wheel speed sensor shall meet all requirements stipulated in the GM wheel corner Interface Drawing. Contact GM Engineering before tooling kickoff to obtain the latest interface requirement drawing.

3.2.1.14.2 Cable to Vehicle Attachment Clips. Wheelspeed sensors retaining clips are expected to meet all requirements of SAE/USCAR-44. In cases where a validated clip design is used in a new application that uses the same supplier, manufacturing equipment, and interface dimensions (hole/slot dimensions and material thickness), surrogate data may be used. If the supplier, the clip design, and/or the interface dimensions or material thickness changes, then the clip must be validated to some or all of SAE/USCAR-44, as agreed upon by the Production Development Team and General Motors Validation.

3.2.1.14.2.1 First and Second Removal. Per SAE/USCAR-44.

3.2.1.14.2.2 Insertion in Minimum Hole. Per SAE/USCAR-44.

3.2.1.14.2.3 Retention in Maximum Hole. Per SAE/USCAR-44.

3.2.1.14.2.4 Retention at High Temperature. Per SAE/USCAR-44.

3.2.1.14.2.5 Shear Force Tolerance. Per SAE/USCAR-44.

3.2.1.14.2.6 Retention at End of Life. Per SAE/USCAR-44.

3.2.1.14.2.7 Fluid Resistance. Per SAE/USCAR-44.

3.2.1.14.2.8 Sealing (if applicable). Per SAE/USCAR-44.

3.2.1.14.2.9 Tie Strap Strength. Per SAE/USCAR-44.

3.2.1.14.2.10 Offset Deflection (if applicable). Per SAE/USCAR-44.

3.2.1.14.3 Cable to Cable Clip Attachment Force.

3.2.1.14.3.1 Ends of a dynamic loop (where suspension and/or steering travel is accommodated). The minimum pull-out force in a dry, ambient condition for the cable within a cable clip at the ends of a dynamic loop is 75 N.

3.2.1.14.3.2 Static positions. The minimum pull-out force in a dry, ambient condition for the cable within a cable clip in the static portion of the harness is 45 N.

3.2.1.14.4 Grommet Sliding Force. The minimum force (applied along the axis of the cable conduit) to slide over-molded or fitted attachment aids such as grommets is 30 N.

3.2.1.14.5 Sensor/Cable Retention. The WSS shall maintain operation and there shall be no visible cracks in the cable or sensor head while a force of 150 N is applied axially through the cable and resisted by the sensor

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Page 6 of 18



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