



Relative Humidity Sensor, Functions, Performance, Design Constraints, and Validation Required for the Sensor

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 defines the requirements for a Local Interconnect Network (LIN) based stand-alone Relative Humidity Sensor (RHS) variant (in this document referenced as "RHS"). The functions, performance, design constraints, and validation requirements for the RHS are defined in this document.

1.2 Applicability. This standard to be used for all Global A and Global B electrical architecture vehicle programs in GM with first Start of Regular Production (SORP) Model Year (MY) 2019.

1.3 Remarks. The RHS is a device that measures the relative humidity on the compartment side of the Windshield (W/S). It also detects the temperature of the windshield surface on the compartment side. Both values are used as control inputs for the climate control application to calculate the fogging risk on the windshield compartment side and ability to reduce fuel consumption by decreasing Air Conditioning (AC) compressor power to a minimum without causing any fogging. The sensor will also enable partial recirculation mode in order to improve heat-up performance of the passenger compartment under cold ambient temperature conditions without the risk of mist buildup on the windshield.

1.3.1 The RHS will only be available in one version common for all vehicle markets.

1.3.2 Deviations from this specification are permissible only with the express authorization of the responsible Bill of Material (BOM) Family Owner (BFO) at GM.

1.3.3 Discrepancies or deviations within this specification or between this specification and country-specific regulations in the customer countries shall be indicated without delay by the supplier; possible solutions shall be discussed directly with the responsible BFO at GM.

1.3.4 In the event of a conflict between the text of this specification and other documents cited herein, the text of this specification takes precedence. Nothing in this specification, however, supercedes applicable laws and regulations unless a specific exemption has been obtained.

1.3.5 The supplier has to consider all legal and other necessary requirements of the countries where the car is sold.

2 References

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

2.1 External Standards/Specifications.

CARB OBD 1968.2	ISO 11469	SAE J2602	SAE/USCAR-2
DIN 75220	ISO/DIS 18064	SAE J2602-1	SAE/USCAR-25
ISO 1043-2	LIN 2.0	SAE J2602-2	
ISO 1629	LIN 2.2.a	SAE J2606	

2.2 GM Standards/Specifications.

GMW3059	GMW3172	GMW14234	GMW17428
GMW3097	GMW3191	GMW15841	
GMW3103	GMW3600	GMW16331	

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2.3 Additional References.

Analysis/Development/Validation Plan and Report (ADVP&R)
Automotive Industry Action Group (AIAG) Production Part Approval Process (PPAP)
Comments and Implementation Status
Component/Subsystem Level Electromagnetic Compatibility Test
Component Technical Specification (CTS)
Electrical Appendix G2 Documents
Electromagnetic Compatibility (EMC) Test Procedures
EMC Validation Process and Test Plan
Environmental and Durability Test Procedures
Global EMC Component/Subsystem Validation Acceptance Process
GM Connector Catalog (Electrical Engineering internal database to ensure connector is listed)
GM Drawing Number: 13588643
GM Drawing Number: 39005091
GM Inherent Criteria
GM LIN Implementation Specification
GM LIN Supplier Questionnaire
GM LIN Questionnaire
GM LIN Questionnaire Template
GM Serial Data Test Results Template
LIN Test Requirements
Product Validation Plan
Reliability Program Plan
Statement of Requirements (SOR)
Subsystem Technical Specification (SSTS)
TLE-050046 (Electrical Technical Specification for Global A Electrical Architecture)
Validation Cross Reference Index (VCRI)
Vehicle Level Electromagnetic Compatibility Test

3 Requirements

3.1 System/Subsystem/Component/Part Definition. The RHS shall be classified as an On Board Diagnostic (OBD)-II Smart Device per the CARB OBD 1968.2 regulations for OBD-II markets.

3.1.1 Appearance. The mechanical appearance shall be as per package model: GM Drawing Number: 39005091: HUMIDITY SENSOR filed under GM Vehicle Assembly Structure (VAS).

The RHS shall appear black from outside vehicle.

3.1.2 Content.

3.1.2.1 Physical Content. The RHS assembly shall consist of:

3.1.2.1.1 A Housing With:

- Molded integrated three (3)-pin detail connector/terminal pins to interface with the LIN Master via vehicle wiring harness.
- Small ventilation slots/lugs to allow air flow inside.

3.1.2.1.2 A Sensing Unit With:

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- a) Sensing elements for measuring relative humidity and temperature.
- b) Processing unit, like microcontroller/Application Specific Integrated Circuit (ASIC).
- c) Discrete electronics.
- d) Supplier software.
- e) Breathable (gas porous) membrane (i.e., Gore-Tex, Teflon or similar) in order to protect it from contamination (e.g., condensation, icing) as needed to ensure proper operation.

3.1.2.1.3 A Clip To:

- a) Fix housing on the Inside Rear View Mirror (ISRV) bracket.

3.1.2.2 Functional Content. The RHS shall measure on the compartment side of the windshield surface.

The RHS shall provide raw data for Relative Humidity (RH) and Windshield Temperature (WST)/Relative Humidity Temperature (RHT), to allow dew point calculation in the processing Electronic Control Unit (ECU). Therefore, data acquisition can be performed:

3.1.2.2.1 Directly; By Thermally Contacting:

- a) The RHT element.
- b) The WST element on the windshield surface (WST = RHT).

3.1.2.2.2 Indirectly, By:

- a) Thermally contacting RHT element.
- b) Thermally contacting the RHT element on the compartment side.
- c) Thermally connecting the WST element on the windshield surface.

3.1.3 Ambient Environment. All environmental and electrical general requirements are referred to in GMW3172.

The RHS will be located on the compartment side of the windshield surface adjacent to the ISRV) bracket. The RHS will be exposed to direct sun load and will, therefore, be exposed to high temperature load.

3.1.3.1 The RHS shall pass environmental and durability validation when subjected to loads according to GMW3172.

The Environmental Load Coding Table (see Table 1) applies according to GMW3172.

Table 1: Environmental Load Coding

Electrical Load Code Letter	Mechanical Load Code Letter	Operating Temperature Code Letter	Climatic Code Letter	Chemical Load Code Letter	Dust and Water Protection Code Letter
C	C	D	D	A	IP5K3

3.1.3.2 RHS shall comply solar radiation requirements according to DIN 75220.

3.1.4 Interfaces.

Note: For Squeak and Rattle. The RHS shall not squeak or rattle due to internal parts or the mounting throughout the life of the part.

3.1.4.1 Mechanical Mounting. The RHS is to be attached to the ISRV) bracket, preferably in the centerline position in driving direction (0Y) on the compartment side of the windshield surface adjacent to the ISRV). The exact location will vary depending on car model. Design guidelines according to GM Inherent Criteria for this RHS must be followed. RHS shall not be glued to the W/S or using adhesive film to fix during installation.

The recommended snap-fit clip force of the sensor bracket to ensure a robust mechanical attachment in vehicle is 5 N to 10 N.

The maximum installation force of RHS shall be ≤ 75 N according GMW14234. A maximum installation force of RHS, when assembled in vehicle, of ≤ 30 N is agreed with GM Manufacturing.

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3.1.4.2 General Electrical/Electronic Interface Requirements. GMW17428 defines the requirements that all components shall meet, with Electrical/Electronic content. GMW17428 defines the requirements that thermal sensors shall meet with Electrical/Electronic content.

3.1.4.3 Electrical Connector Interface Requirements. The connector used in the RHS shall be recommended from the connector BFO.

3.1.4.3.1 The connector shall be approved/released in the GM Connector Catalog. The connector shall comply per:

- GMW15841 Connector and Terminal Design Specification.
- GMW3191 Connector Test and Validation Specification.
- SAE/USCAR-2 Performance Standard for Automotive Electrical Connection Systems.
- SAE/USCAR-25 Electrical Connector Assembly Ergonomic Design Criteria.

3.1.4.3.2 Mating Vehicle Harness Connector Details:

- Supplier: Sumitomo
- Supplier Part Number (P/N): 99561800
- GM P/N: 13588643
- GM Drawing Number: 13588643

3.1.4.3.3 The terminal pin number and function applies (see Table 2).

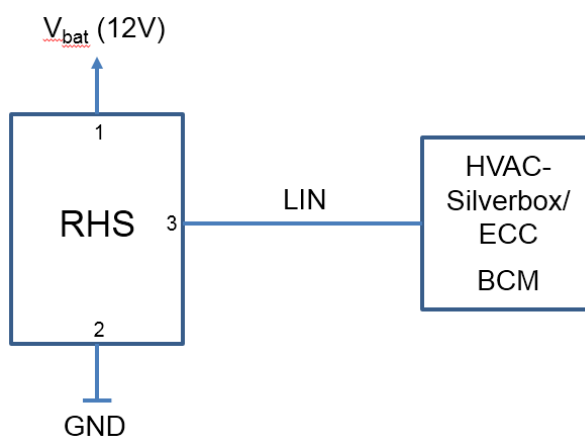
Table 2: Pin Out

Connector Terminal Pin Number	Function
1	V _{BAT}
2	GND
3	LIN

Note: Ground (GND), Local Interconnect Network (LIN), Vehicle Battery Voltage (V_{BAT}).

3.1.4.4 Component to Electrical Subsystem. The RHS is electrically connected to the LIN Master as per Figure 1.

Figure 1: Electrical Connection



Note: Body Control Module (BCM), Electronic Climate Control (ECC), Heating, Ventilation and Air Conditioning (HVAC), Relative Humidity Sensor (RHS).

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3.1.4.5 Power Supply. The power supply shall use hardware guidelines in Table 3 per GMW17428.

Table 3: Power Supply Hardware Guidelines

Name	V _{RUN}
Type	Power Input, Battery, Electrical Characteristics (V _{batt_x})
Supply Voltage (Maximum Rating)	-13.5 V to +26.5 V
Supply Voltage Range, Normal	0 V to V _{max}
Voltage Range, Normal Operating	V _{min} to V _{max}
Load Current (Maximum Rating)	3A (minimum)
Inrush Current (Maximum Rating)	Maximum Load Current x 10, (Duration < 1 s)
Reverse Polarity Protection Mechanization	Diode/Schottky (hot carrier diode)/MOSFET
Power Switch-Off Time, i.e., Time to Output Voltage (V _O < 0.5 V)	Typical = 1 s (Resistive Path Shall Exist to Power_Gnd)

Note: Maximum Voltage (V_{max}), Metal Oxide Semiconductor Field-Effect Transistor (MOSFET), Minimum Voltage (V_{min}), Output Voltage (V_O), Running Voltage (V_{RUN}).

3.1.4.6 Power Ground. The power ground shall use hardware guidelines in Table 4 per GMW17428.

Table 4: Power Ground Hardware Guidelines

Name	Power Ground
Type	Ground, Power Ground, Electrical Characteristics (Power_GND_x)
Return Current (Maximum rating) Sum of internal and external load return currents.	3A (minimum)
Inrush current (Maximum rating)	Maximum return current x 10 (duration < 1 s)
Reverse Polarity Protection Mechanization	Not applicable
Ground voltage gradients (Maximum rating Ground lines/planes to Power_Gnd, Signal_gnd and Signal_rtn)	Typical 10 mV (within the same E/E Component)

Note: Electrical/Electronic (E/E), Return (rtn).

3.1.4.7 LIN Bi-directional Data Signal. The Input/Output (I/O) shall use hardware guidelines according to SAE J2602-1 and SAE J2602-2.

3.1.4.8 Radiated Emission (RE) and Conducted Emission (CE) Requirements. Refer to GMW3097.

3.1.4.9 Radiated Immunity (RI) Requirements. Refer to GMW3097.

3.1.4.10 Transients Requirements. Refer to GMW3097.

3.1.4.11 Electrostatic Discharge (ESD) Requirements. Refer to GMW3097.

3.1.4.12 Parasitic (Quiescent) Current Requirements. Refer to GMW3172.

3.1.4.13 Subsystem Short Circuit Protection Requirements. Refer to GMW3172.

3.1.5 Usage Definition. The estimated usage of the RHS by a severe customer during 241 400 km of usage is 54 300 ignition on/off cycles with a total duration time of 11 500 h.

3.1.6 LIN Communication. Refer to SAE J2602-2 LIN Conformance Test. See Appendix A for communication details.

3.1.7 OBD-II Diagnostic Requirements. To fulfill California Air Resource Board (CARB) requirements the RHS shall have (at least) diagnostic capabilities as identified in 3.1.7.1.

3.1.7.1 The RHS shall:

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3.1.7.1.1 Provide Status Bits (Current Status) for:

- Out of Range Low (OORL) Voltage
- Out of Range High (OORH) Voltage
- Relative Humidity Signal
- Relative Humidity Temperature Signal
- Windshield Temperature Signal

3.1.7.1.2 Change the clamped value when a fault is detected in the relative humidity element to 110%.

3.1.7.1.3 Change the clamped value when a fault is detected in the relative humidity temperature element detected to -50 °C.

3.1.7.1.4 Change the clamped value when a fault is detected in the windshield temperature element detected to -50 °C.

3.1.7.1.5 Provide rolling count to each response frame.

3.2 Product Characteristics.**3.2.1 Performance Requirements.**

3.2.1.1 Relative Humidity Sensing. The accuracy of the relative humidity shall be (at least) according Table 5.

Table 5: Parameters for Relative Humidity Accuracy

Relative Humidity (%)	Accuracy at 25 °C	Accuracy at -40 °C to +45 °C
20% to 80%	< ± 3.0%	< ± 5.0%
80% to 100%	< ± 5.0%	< ± 7.0%

3.2.1.1.1 The RHS shall broadcast relative humidity values to the vehicle via LIN in the range of 0% to 100%.

3.2.1.1.2 Changes of the relative humidity shall be converted with a time constant $T_{63} < 10$ s or faster.

3.2.1.1.3 When exposed to humidity or after multi condensation the relative humidity value shall recover to its initial value (prior event) with a time constant $T_{63} < 10$ s or faster.

3.2.1.2 Windshield Temperature Sensing. The RHS shall consist of a Negative Temperature Coefficient (NTC) thermistor element with following Resistance versus Temperature (R/T) characteristics according to Table 6.

Table 6: Parameters for Windshield Temperature Transfer Function

Design Parameter	Value
Temperature Range	-40 °C to +85 °C
Nominal Resistance at +25 °C	3 kΩ
Nominal Resistance Tolerance at 0 °C	± 1.0%
B-Value	4100
Maximum Beta Tolerance from -40 °C to +85 °C	± 2.0%

3.2.1.2.1 The accuracy of the windshield temperature shall be (at least) according to Table 7.

Table 7: Parameters for Windshield Temperature Accuracy

Temperature Degree Celsius (°C)	Accuracy (°C)
-20	≤ ± 1.0

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Temperature Degree Celsius (°C)	Accuracy (°C)
0	$\leq \pm 0.65$
15	$\leq \pm 0.8$
25	$\leq \pm 1.0$
85	$\leq \pm 1.8$

3.2.1.2.2 The RHS shall broadcast windshield temperature values to the vehicle via LIN.

3.2.1.2.3 Changes of the windshield temperature shall be converted with a time constant $T_{63} < 30$ s or faster.

3.2.1.3 Relative Humidity Temperature Sensing. The RHS shall consist of an NTC thermistor element with R/T characteristics according to Table 8.

Table 8: Parameters for Relative Humidity Temperature Transfer Function

Design Parameter	Value
Temperature Range	-40 °C to +85 °C
Nominal Resistance at +25 °C	3 kΩ
Nominal Resistance Tolerance at 0 °C	$\pm 1.0\%$
B-Value	4100
Maximum Beta Tolerance from -40 °C to +85 °C	$\pm 2.0\%$

3.2.1.3.1 The accuracy of the relative humidity temperature shall be (at least) according to Table 9.

Table 9: Parameters for Relative Humidity Temperature Transfer Accuracy

Temperature (°C)	Accuracy (°C)
-20	$\leq \pm 1.0$
0	$\leq \pm 0.65$
15	$\leq \pm 0.8$
25	$\leq \pm 1.0$
85	$\leq \pm 1.8$

3.2.1.3.2 The RHS shall broadcast relative humidity temperature values to the vehicle via LIN.

3.2.1.3.3 Changes of the relative humidity temperature shall be converted with a time constant $T_{63} < 30$ s or faster.

3.2.1.4 Dew Point Sensing. The accuracy of the dew point shall be (at least) according to Table 10 and Figure 2.

Table 10: Parameters for Dew Point Accuracy

Temperature (°C)	Relative Humidity (%)	Dew Point Accuracy (°C)
-20 to 0	20% to 100%	± 2.0
0 to 15	20% to 100%	± 1.5

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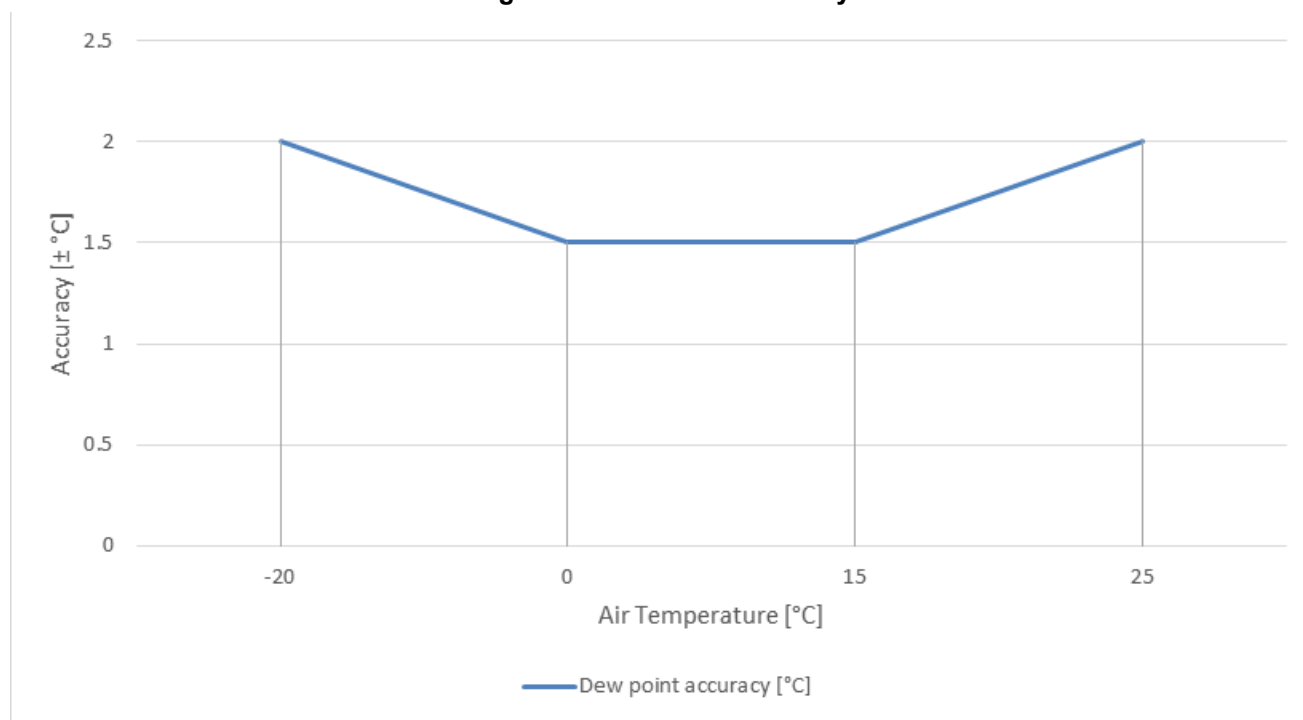
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15 to 25	20% to 100%	± 2.0
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Figure 2: Dew Point Accuracy



3.2.1.4.1 The RHS shall broadcast dew point values to the vehicle via LIN (optional content).

3.2.1.4.2 Changes of the dew point shall be converted with a time constant $T_{63} < 10$ s or faster.

3.2.2 Physical Characteristics.

3.2.2.1 Dimensions and Capacity. The RHS and Rain/Light-Sensor (RLS)/Rain/Light/Humidity-Sensor (RLH-S) shall share the same mounting location. Therefore, dimension of RHS shall not exceed RLS/RLH-S.

As illustrated in Figure 3 the RHS shall be completely contained within the envelope of an 80 mm x 35 mm x 12 mm box (including the connector shrouds). The housing may have a growth of 10 mm in the local area of the connectors.

3.2.2.1.1 Housing shall be as small as possible.

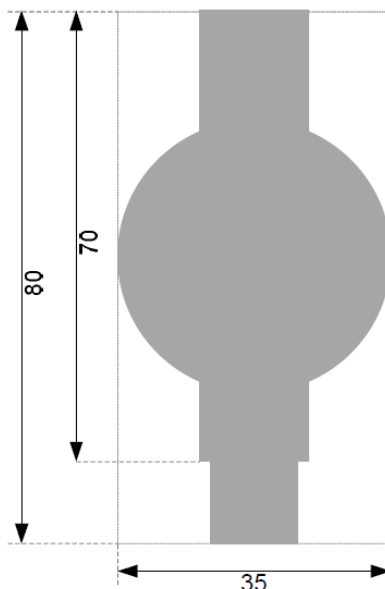
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Figure 3: Relative Humidity Sensor Package (All Dimensions are in Millimeters)



3.2.2.2 Mass Properties. The RHS shall have a weight of ≤ 20 g.

3.2.3 Reliability.

3.2.3.1 Reliability Evaluation Point. The Reliability Evaluation Point (REP) is the point where reliability is determined.

3.2.3.1.1 The REP is 241 400 km (150 000 mi) of customer usage and 15 years of environmental exposure. Compliance with the durability requirements will be evaluated using severe levels of customer usage through 241 400 km plus 15 years of severe environmental exposure.

3.2.3.2 Reliability Requirements. The sensor shall have a demonstrated test reliability of 99.8% under a REP profile of a severe customer. The test reliability shall be demonstrated at a confidence level of 50%.

- a) Reliability demonstration profiles shall be consistent with a severe customer usage profile (loads, cycles, etc.,) in combination with environmental stress extremes identified in the product requirements section of the Component Technical Specification (CTS). One severe customer usage shall represent a severe customer at 15 years of exposure and 241 400 km of usage.
- b) A failure is defined as a loss of function and/or non-compliance to performance requirements described in Section 3 Requirements of this specification. Unless otherwise specified, refer to Section 3 Requirements for rates of allowable degradation.
- c) Whenever relevant, the component development and validation testing shall be completed through test to failure.
- d) If there is no historical data regarding the statistical distribution of test results, the supplier will establish the number of samples required by testing initial samples to failure.
- e) Validation testing requires a statistical estimate of reliability that must equal or exceed the requirement. If success testing is approved by GM, success test rules for sample size and test duration apply with one restriction: the Weibull slope assumption shall be one (1) until proven otherwise in a failure test.
- f) Besides confirming product reliability, a benefit of testing to failure is the determination of the Weibull slope that applies to a design in a given test. Once known, the slope parameter (beta) can be used to reduce test time or sample size during subsequent success tests. Examples of such opportunities are Product Validation (PV) and tests for future programs that use a similar design.
- g) In case the sample size cannot be established, a rule of thumb is: Start by testing minimum three (3) to seven (7) on system level and five (5) to 15 at component level.

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- h) The supplier is responsible for demonstrating the sensor reliability during both Design Validation (DV) and PV testing. The reliability may be demonstrated by means of either physical or analytical testing.
- i) See 3.2.3. Reliability shall be validated and be planned in the Validation Cross Reference Index (VCRI).
- j) The entire Reliability Program Plan must be approved by GM prior to the start of testing.

3.2.3.2.1 Reliability in Development Phases. The design and development phases shall include reliability activities such as design reviews, Failure Modes and Effects Analysis (FMEA), Fault Tree Analysis (FTA), reliability analysis, and Design of Experiments (DOE). A reliability program plan shall be presented within 60 days of contract signing and must be approved by the GM responsible engineer.

3.2.3.2.2 Reliability in Verification Phases. The reliability requirements can be divided into two (2) groups, short term and long term requirements.

3.2.3.2.2.1 Short Term Requirements. The short term requirements concern the warranty outcome during the first 12 months to 36 months of usage.

- a) The short term requirements are usually expressed in terms of Incidents per Thousand Vehicles (IPTV). The short term requirements are to be defined in each CTS/Subsystem Technical Specification (SSTS)/GM Worldwide (GMW) Engineering Standard. It shall initially be demonstrated by a comparison method that the short term requirements are fulfilled. Later on, the comparison method shall be complemented by testing.
- b) For RHS it is targeted to be a "zero defect" part (0 IPTV).

3.2.3.2.2.2 Long Term Requirements. The long term requirements consider the reliability of 15 years or 241 400 km (150 000 mi), whichever comes first. Long term reliability could be expressed in terms of a survival probability (reliability).

- a) The CTS/SSTS shall define the requirement for long term reliability. If the CTS/SSTS/GMW do not define any long term reliability requirements, the requirements in GMW3172 shall apply. The validation procedure for long term reliability shall be defined in the subsystem specification, the component specification or GMW3172.

3.2.3.3 Electrical System Safety. Qualitative system safety analyses such as FMEA, FTA, and Event Tree Analysis (ETA) shall be carried out for systems where potential hazardous events and conditions may occur. The choice of analysis method shall be discussed with and approved by GM.

3.2.4 Serviceability. During W/S repair/replacement, the RHS shall be able to be moved from the original W/S to new W/S without RHS replacement or any performance degradation. All reliability requirements as defined in 3.2.3 shall be met.

Spare parts with original part number must fulfill the quality requirements of the original part, during its lifetime. No special tools shall be required for replacing the unit.

3.2.5 User System/Subsystem/Component/Part Interface. Not applicable.

3.3 Design and Construction.

3.3.1 Materials, Processes and Parts Selection Guidelines.

3.3.1.1 Material Guidelines. Polyvinyl Chloride (PVC) shall be avoided as a product material.

3.3.1.2 Processes Guidelines. See GMW17428.

3.3.1.3 Parts Guidelines. The chosen components shall if possible **not** be included in the American export regulations and if any, they shall be listed.

3.3.2 Design Guidelines and Constraints. The supplier is responsible for not using other companies' patents without license on them.

3.3.3 Identification and Marking. The parts shall be marked:

- GM Trademark
- GM Part Number
- Date Code, Day and Year
- Two Dimensional (2D) barcode
- Marking (Pin Number) of the Connectors

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- According to GMW16331. If printed on part, ensure that color provides good readability and contrast to component material.

3.3.3.1 Marking of Polymeric Parts. All polymeric parts shall be marked using ISO 11469 format.

3.3.3.2 Marking of Rubber Parts. Material designations for rubber parts according to ISO 1629. Fillers and reinforcing materials should not be specified.

3.3.3.3 Marking of Thermoplastic Elastomer Parts. Material designations for thermoplastic elastomer parts according to ISO/DIS 18064 and filler and reinforcing material designations according to ISO 1043-2, with amounts specified by weight, with an accuracy of $\pm 2.5\%$, by increments of five (5).

3.3.4 Workmanship. The decorative surfaces of the RHS shall be free from scratches, sink marks, pin holes, nicks, knit lines, blisters, tears, cracking, scuffing, or any other surface irregularities. All exposed surfaces shall have smooth corners and edges.

3.3.5 Interchangeability. The RHS shall be mounted so that it can be easily replaced by service. Neither connector nor locking shall be damaged.

3.3.5.1 The pull out force of clip shall be $25\text{ N} \pm 5\text{ N}$ (vertical) according GMW14234.

3.3.5.2 The supplier has to ensure that spare parts will have identical interfaces as the original part.

3.4 Documentation. The supplier is responsible for all government certification and documentation listed in Section 2 References.

3.4.1 Drawings and math data shall be available on magnetic media, and consist of a functional assembly drawing, in Unigraphics (UG) format, with principle measurements, surfaces and connector pinning plus a CTS preferably in Microsoft (MS) word format.

3.4.1.1 The supplier shall provide documents 3.4.1.1 a thru 3.4.1.1 t.

- a) Circuit Diagram.
- b) Component List with Data Sheets.
- c) Performance/Functional Specification.
- d) Interface Specification.
- e) Printed Circuit Board (PCB) layout.
- f) Board Part Location Drawing.
- g) Engineering Validation Plan (Including Reliability, and System Safety Activities).
- h) Analysis/Development/Validation Plan and Report (ADVP&R).
- i) Design/Product Component Validation Plan (CVP) (GMW3172).
- j) Interface FMEA.
- k) Design FMEA.
- l) Process FMEA.
- m) Design Reviews.
- n) Worst Case Analysis, Sneak Circuits, Electrical and Thermal Analysis.
- o) Reliability Growth Management (Durability Prediction).
- p) Failure Analysis and Resultant Corrective Action.
- q) Design for Six-Sigma (DFSS).
- r) Test Specification.
- s) Test Methods.
- t) Test Reports, which on request of GM include insert and retention test results.

Note: Data are **only** to be used by GM and by designated supplier and shall not be brought to the knowledge of a third party. It's the supplier responsibility to store all data and documentation.

3.5 Support of System/Subsystem/Component/Part After Sale. The supplier shall be able to supply components 10 years after last car is manufactured.

Spare parts with original part number must fulfill the same requirement of quality as the original part, during its lifetime.

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3.6 System/Subsystem/Component/Part Operator Training. The supplier shall provide installation guideline on how the RHS shall be mounted. This shall be used by GM manufacturing to optimize assembly sequence in GM plant and update Master Process Document (MPD).

3.7 System/Subsystem/Component/Part Characteristics.

3.7.1 System/Subsystem/Component/Part Definition. For interfacing to ECU use GMW17428 and the TLE-050046.

4 Validation

4.1 General. The supplier shall be responsible for the validation of all component requirements in this specification and its references.

4.1.1 Supplier Validation Plan. During the initial part of the project, the supplier shall present a Design Validation Plan and a Product Validation Plan, each containing a list of all relevant tests, reference to test procedures and a time schedule upon completion of each test. The test report registration number and Pass/Fail information shall be included.

4.1.1.1 To ensure a well-defined high quality level of all parts, a Functional Integration Test shall be performed prior to release of any new hardware. The specification for this test shall be made by the supplier and approved by GM engineering.

4.1.1.2 For the final approval, documents 4.1.1.2 a thru 4.1.1.2 e are required.

- a) Product validation report and a Product Validation Complete Letter (PVCL).
- b) Complete Automotive Industry Action Group (AIAG) Production Part Approval Process (PPAP) File.
- c) Design FMEA.
- d) Reliability Prediction.
- e) Simulation and Stress Analysis.

4.1.1.3 To start validation, the Design Validation Plan and the Product Validation Plan must exist. The validation shall follow the process and meet the requirements stated in GMW3172. All environmental tests on component/subsystem level, according to GMW3172 shall be performed by the supplier. The environmental validation shall be performed as defined in component/subsystem environmental test plan according to GMW3172. This environmental test plan shall be provided by the supplier using the defined template and approved by the responsible GM validation engineer (with approval authority for environmental).

4.1.1.4 For the design review and the Statement of Requirements (SOR) document, the documents in 4.1.1.4 a thru 4.1.1.4 c shall be available one (1) week prior to the scheduled meeting:

- a) Comments and Implementation Status of GMW17428.
- b) Environmental and Durability Test Procedures and number of test samples according to the Design Validation Plan for appropriate vehicle mounting location specified in GMW3172.
- c) Electromagnetic Compatibility (EMC) Test Procedures and number of test samples according to GMW3103.

4.1.1.5 Supplier needs to provide ADVP&R for DV and PV. This plan is to be created per 4.2. Action items/open issues come out of the component Design Failure Mode and Effects Analysis (DFMEA) (supplier responsibility) and the system Interface Failure Mode and Effects Analysis (IFMEA) (product development team GM plus the supplier, but not limited to).

This plan shall be approved at the latest four (4) weeks prior to when the supplier would start the execution of the plan.

4.1.2 Testing Required by Component Change. Any change in the design and manufacture of a component (e.g., part value and/or type, function, manufacturing process or location, packaging location, etc.,) shall be communicated to GM and must be approved by GM engineering and may require retest of the component and subsystem.

4.1.3 EMC Validation Process and Test Plan. Supplier shall conform to process requirements stated in GMW3103.

4.1.4 LIN Conformance Testing. Supplier shall conform to requirements stated in GM LIN Implementation Specification, LIN 2.0, SAE J2602-1 and SAE J2602-2.

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