



Fuel Pump Module Ultrasonic Fuel Level 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.

Note: The program specific technical specification may include additional program specific requirements that are not referenced in this standard and may supersede any requirements included in this standard. In the case of any conflicts between this standard and the program specific technical specification, the program specific technical specification takes precedence.

1.1 Purpose. This standard is intended to be a supplement to "Fuel Pump Module Specification", GMW14081, and establishes the component and integration requirements for ultrasonic fuel level sensor devices. These documents complement other requirements included in the Statement of Requirements (SOR).

1.2 Applicability. This standard applies to systems which feature an ultrasonic fuel level sensing technology as an alternative to a conventional variable resistor and buoyant float device.

2 References

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

2.1 External Standards/Specifications.

ASTM D4169	LIN 2.0	SAE J2602-2
ISO 12103-1	SAE J2602-1	SAE J2602-3

2.2 GM Standards/Specifications.

GMW3059	GMW3103	GMW14801
GMW3091	GMW3172	GMW15311
GMW3097	GMW14081	GMW15570

2.3 Additional References.

CG2999	GMPT-4-015	GMPT-6-001	GMPT-6-037
CG4259	GMPT-4-019	GMPT-6-017	
GMPT-4-002	GMPT-5-020	GMPT-6-022	
GMPT-4-008	GMPT-5-022	GMPT-6-032	

3 Requirements

3.1 System/Subsystem/Component/Part Definition. The fuel level sensor assembly shall measure fuel within the fuel tank assembly and provide means of fixing to the fuel tank bottom to ensure accurate fuel level indication.

3.1.1 Appearance. See program document(s).

3.1.2 Content. The fuel level sensor assembly Bill of Materials (BOM) shall be developed based upon this document accompanied by program-specific documents.

3.1.2.1 Physical Content. The fuel level sensor assembly BOM shall describe all components, materials, surface treatments (including surface treatment thicknesses, other qualifications).

3.1.2.2 Functional Content. See program document(s).

3.1.3 Ambient Environment. See GMW14081.

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3.1.3.1 Operating Environment. See GMW14081.

3.1.3.2 Fuel Environment. See GMW14081.

3.1.4 Interfaces.

3.1.4.1 Assembly Attachment. The fuel level sensor shall provide for engagement during assembly and disengagement during service to either the fuel pump module or fuel tank retaining bracket. The sensor shall be located at the bottom of the fuel tank and oriented to measure fuel above the sensor.

3.1.4.2 Electrical Attachment. The fuel level sensor shall feature a unique electrical connector to enable connection to the fuel tank interface or flange during assembly and disconnection for service.

3.1.4.3 Electrical Input.

3.1.4.3.1 Voltage Maximum Conditions. The fuel level sensor shall receive the following electrical input without damage.

- Supply voltage minimum: ≥ -13.5 Vdc.
- Supply voltage maximum: ≤ 26.5 Vdc.
- Supply power ground minimum: ≥ -0.5 Vdc.
- Supplier power ground maximum: ≤ 0.5 Vdc.

3.1.4.3.2 Voltage Operating Range. The fluid level sensor shall be fully operational at voltages between 9 Vdc and 16 Vdc, and shall remain fully operational for at least one hour for input voltages between 16 Vdc and 18 Vdc. The fluid level sensor shall continue to attempt level measurement at voltages below 9 Vdc and above 18 Vdc.

3.1.4.4 Fluid Level Input. The fuel level sensor shall be capable of sensing fuel level between a minimum fluid height equal to or less than 18mm and the maximum fluid height attainable within the fuel tank. The minimum agreed upon value shall be determined per 3.2.1.3. See program specific document(s) for specific requirements.

3.1.4.5 Fuel Level Output.

3.1.4.5.1 Fuel Level Sensor Output Signal Determination. Raw fuel level measurements shall be executed at a periodic interval of ≤ 12.5 ms. For each raw fuel level measurement attempt that results in detection of both a reference echo and a surface echo, raw fuel level shall be calculated as follows (refer to Figure 1):

$$\text{Raw Fuel Level} = \left(\frac{\text{Surface Pulse Time of Flight}}{\text{Reference Pulse Time of Flight}} \right) \times \text{Reference Distance}$$

where:

Reference Pulse Time of Flight = the time between issuance of a sonic measurement pulse and detection of the reference echo.

Surface Pulse Time of Flight = the time between issuance of a sonic measurement pulse and detection of the surface echo.

Reference Distance = the distance between the ultrasonic transducer element and the fixed distance reference reflector.

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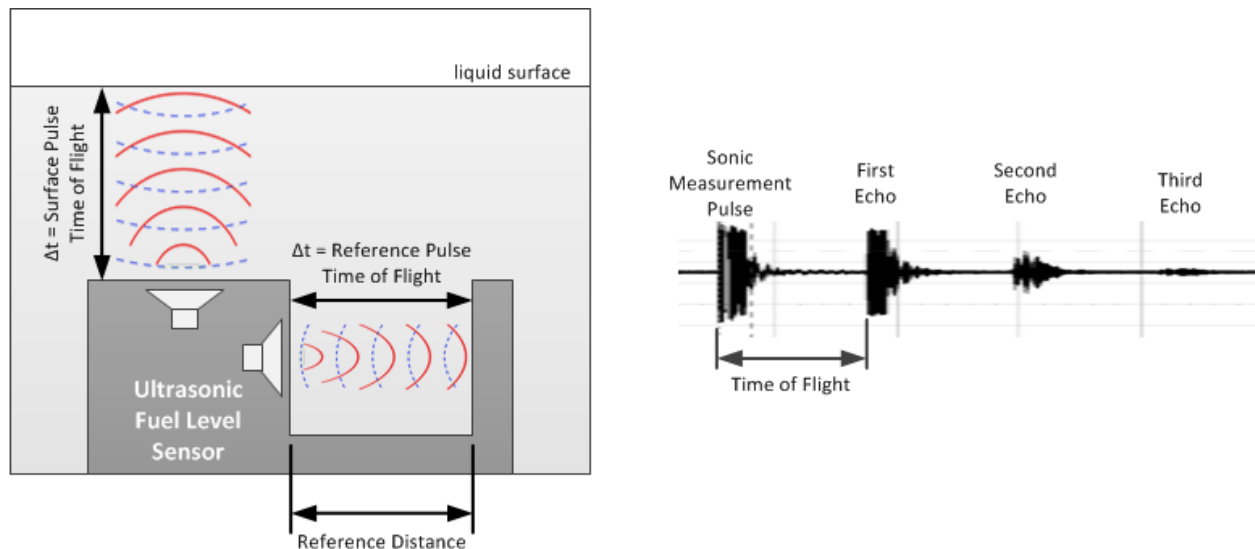


Figure 1: Time of Flight Measurement

For each raw fuel level measurement attempt that does not result in detection of both a reference echo and a surface echo, where the lack of echo is due to sensor failure, per 3.2.1.10, the raw fuel level shall be set to 0 mm. For each raw fuel level measurement attempt that does not result in detection of both a reference echo and a surface echo, where the lack of echo is not due to a sensor failure, per 3.2.1.10, the raw fuel level shall be set to the minimum assessed value per 3.2.1.3.

The ultrasonic fuel level sensor output signal shall be updated at a periodic interval of 12.5 ms, immediately following the raw fuel level measurement.

To prevent intermittent loss of echo (e.g., due to sensor failure, fuel boiling or slosh) from influencing the communicated fuel level, the output of the ultrasonic fuel level sensor shall be calculated as the median value of all non-zero raw fuel level measurements from the most recent 8 raw fuel level measurement attempts.

The following method shall be used to determine the median value for the most recent 8 raw fuel level measurement attempts:

- Sort non-zero raw fuel level measurements in ascending or descending order.
- If odd number of non-zero measurements, the median value is the middle value (equidistant from either end value).
- If even number of non-zero measurements, the median value is the average of the 2 middle values.

If all of the most recent 8 raw fuel level measurement attempts yielded a result of 0mm, then the ultrasonic fuel level sensor output signal shall be set to 0 mm.

3.1.4.5.2 Signal Initialization. The fuel level sensor output signal shall be initialized to zero during sensor power-up initialization, before first transmission of the fuel level sensor output signal. All elements of the array used to store the results of the most recent 8 raw fuel level sampling attempts shall be set to zero during sensor power-up initialization, before first transmission of the fuel level sensor output signal.

3.1.4.5.3 Signal Range. The fuel level sensor shall communicate the measured fuel height in a 12-bit output signal scaled between 0 mm and 819 mm, with a resolution of 0.2 mm.

3.1.4.5.4 Failure Determination. Any failure determinations performed within the ultrasonic fuel level sensor shall be based on raw signal evaluations. For the purpose of this requirement, raw means no application of filtering, averaging, counting, rate-limiting or any other statistical method that impacts anything other than the current fuel level measurement or results in a signal time constant that exceeds one half of the fuel level sensor output signal update period. To enable immediate recovery from failsafe operation, any failure determinations made by the ultrasonic fuel level sensor shall be conducted continuously.

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3.1.4.5.5 Failure Determination Action. In response to any detected failures, the fuel level sensor shall not take any action affecting the performance of fuel level measurements that is not immediately recoverable upon removal of the condition that caused the failure. In the absence of any detected failures, the fuel level sensor shall not take any action affecting the performance of fuel level measurements.

3.1.4.6 Part Identification. The fuel level sensor shall not communicate a part number, calibration verification number, or any other part identification data.

3.1.4.7 Programmability. The ultrasonic fuel level sensor shall not be reprogrammable unless the reprogramming procedure satisfies both of the following conditions:

- A specialized reprogramming method is required, meaning that the ultrasonic fuel level sensor cannot be reprogrammed using the tools and procedures defined for the reprogramming of a Diagnostic or Emissions-Critical Electronic Control Unit (DEC ECU), and,
- Disassembly of the ultrasonic fuel level sensor is required to accomplish the reprogramming. For the purpose of this requirement, disassembly does not include removable covers that expose only the area of access required to facilitate reprogramming.

3.1.4.8 Power Moding Requirements.

3.1.4.8.1 Sensor Wake Up Voltage. The fuel level sensor wakeup voltage shall be defined as 6 Vdc. The fuel level sensor shall wake up and assume normal operation when the voltage is greater than or equal to the fuel level sensor wakeup voltage threshold.

3.1.4.8.2 Sensor Shutdown Voltage. The fuel level sensor shutdown voltage threshold is 2 Vdc. The fuel level sensor shall cease normal operation and enter a low power shut down state when the supply voltage is less than the shutdown voltage threshold.

3.1.4.9 LIN Communications.

3.1.4.9.1 Subsystem Electrical Mechanization. The block diagram of Figure 2 illustrates a typical method of integration of the LIN Slave into the vehicle subsystem. This section of the specification deals only with the LIN/SAE J2602 communications between the LIN Master and the LIN Slave, and not with the exact method it will be implemented in the vehicle system.

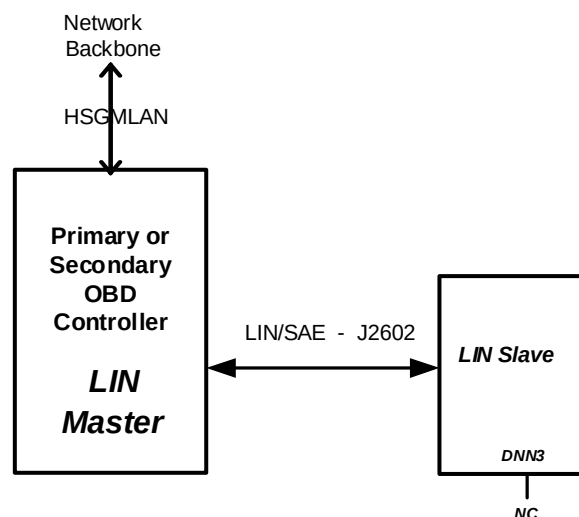


Figure 2: Typical Single LIN Slave Application Block Diagram

The block diagram of Figure 3 illustrates a exceptional method of integration of Fuel Tank Zone Module (FTZM) LIN Master (On-board Diagnostics (OBD) Smart Device) with Ultrasonic Level Sensor (ULS) LIN Slave into the vehicle subsystem. Even though FTZM is a LIN Master in this subsystem, FTZM shall not perform any diagnostics since it is an OBD smart device. Therefore FTZM shall gate the necessary data required to perform

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diagnostics from ULS sensor, to Engine/Electronic Control Module (ECM) and ECM shall perform the diagnostics and report faults.

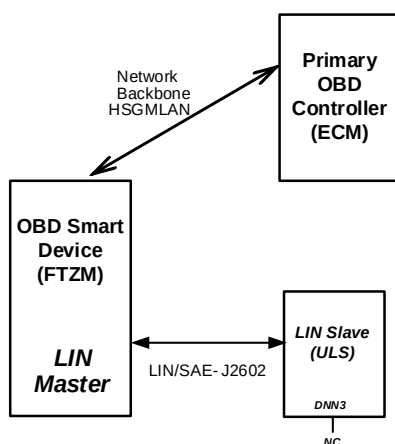


Figure 3 Specific Single LIN Slave Application Block Diagram

3.1.4.9.2 Functional Requirements. The ULS shall be classified as an OBD “Smart Sensor” In the role of an OBD “Smart Sensor” the device shall perform all actions requested by the LIN OBD Master acting as a LIN slave and shall provide information to the LIN OBD Master as defined in 3.1.4.9.2.1.

3.1.4.9.2.1 Moding and Behavior Requirements. The LIN SLAVE communications and moding behavior shall be implemented in accordance with LIN 2.0, except for those requirements either waived or modified by the SAE J2602-1 document. It should be clearly understood that this LIN SLAVE will likely not be the single slave on the GMLIN network, as depicted in Figure 3, and therefore must strictly adhere to the network behavior rules defined in the LIN 2.0 specifications and the SAE J2602-1 specification.

3.1.4.9.3 LIN Slave Node Addressing. The ULS device shall assume the network node address (NAD) indicated in Table 1.

Table 1: NAD Assignment For A LIN Slave Device

Slave	Base Network NAD	J2606 NAD							
		Bit7 (msb)	6	5	4	3	2	1	Bit0 (lsb)
		Fixed	Fixed	fixed	Fixed	DNN3	DNN2	DNN1	DNN0
ULS	0x68	0	1	1	0	1	0	0	0

The NAD assignment(s) for the LIN slave shall be identified in Table 1. A LIN slave device may be deployed multiple times to the same GMLIN network as long as the NAD assignment is unique for each slave device. Differentiating the NAD is required to personalize the frames for each device on the bus. By virtue of the specific NAD assignments, the LIN Slave device is mapped to the normal messaging protected identifier specified in section 5.7.2.2 in SAE J2602-1. For example, a device with a NAD of \$6C will use Message IDs in the range from <\$30> through <\$33> whereas NAD of \$64 will use Message IDs in the range from <\$10> through <\$13>. The manufacturer of the LIN Slave shall create a unique part variant and set the “Device Node Number” DNN0, DNN1, DNN2, DNN3 in internal memory for each variant.

Note: The defined protected identifier represents only 6 bits of the identifier byte. When the identifier parity bits are considered, the identifier byte may have a different hexadecimal value. For this reason, the protected identifier is provided, followed by the parenthetical value of the complete identifier byte hex value in this

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