



Main Engine Electric Water Pump Component Technical Specification (CTS)

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 stipulates the requirements and validation tests for electric coolant pumps that are to be used in any coolant circuit.

1.2 Applicability. This standard is for 12 V electric coolant pumps for automotive applications.

1.3 Remarks. The electric main coolant pumps are magnetically coupled, centrifugal pumps intended to be used in an engine mounted configuration for powering the main engine cooling circuit, and ancillary systems, including but not limited to: charge air cooler, heater, and after-run.

2 References

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

2.1 External Standards/Specifications.

IPC-A-610	ISO 16232-3	SAE J2602-1	SAE J2602-2
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2.2 GM Standards/Specifications.

9985010	GMW3059	GMW14089	GMW16037
9985809	GMW3091	GMW14264	GMW16625
9986086	GMW3097	GMW14386	GMW17144
9986117	GMW3103	GMW14387	GMW17332
9986153	GMW3155	GMW14671	GMW17698
9986177	GMW3172	GMW14872	GMW17699
9986196	GMW3191	GMW15272	
9986284	GMW3420	GMW15758	
GMW2	GMW14007	GMW15862	

2.3 Additional References.

- CG3043 (ID)
- GM1829 Analysis Development Validation Plan and Report (ADVP&R)
- GM Connector Part Number 13597387
- GMPT-5-005-A, Diesel Fuel
- GMPT-5-019-A, Diesel Fuel
- GM Top Engine Cleaner, 1052626
- Henkel Corporation, Rocky Hill, Connecticut (Loctite) (www.loctite.com)
- Interface Control Document (ICD) (ID)
- Statement of Requirements (SOR) Appendix C2
- Vehicle Technical Specification (VTS)

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3 Requirements

3.1 System/Subsystem/Component/Part Definition.

3.1.1 Appearance. Not applicable.

3.1.2 Content. Not applicable.

3.1.2.1 Physical Content. Not applicable.

3.1.2.2 Functional Content. Not applicable.

3.1.3 Ambient Environment.

3.1.3.1 The electric coolant pump complying with this specification shall be capable of operating in the environments as listed in 3.1.3.1.1.

3.1.3.1.1 GMW3172 Code Letter for Temperature, Code Letter "H". See Table 1.

Table 1: GMW3172 Temperature Code Letter "H" Details

Medium	Continuous	Excursion
Ambient	-40 °C to +125 °C	140 °C
Coolant	-40 °C to +120 °C	135 °C

3.1.3.2 Climatic Load. The electric coolant pump complying with this specification shall be capable of operating in GMW3172 Climatic Loads Code Letter "B".

3.1.3.3 Chemical Load. The electric coolant pump complying with this specification shall be capable of operating in GMW3172 Chemical Loads Code Letter "E".

3.1.3.4 Dust and Water Intrusion. The electric coolant pump complying with this specification shall be capable of operating in GMW3172 Dust and Water International Protection Codes IP6K9K and IP6K8.

3.1.4 Interfaces. See 3.2.5.

3.1.5 Usage Definition. See 1.3.

3.2 Product Characteristics.

3.2.1 Performance Requirements. The pump must comply with GMW3172. See Section 4 for required tests to be conducted. All requirements listed shall be met throughout the expected life of the component and at the conclusion of all validation tests.

3.2.1.1 Mechanical.

3.2.1.1.1 Flow Rate. The pump design shall be based on three (3) operating points (hot, cold, target), defined as flow rate versus a specified pressure drop at a given coolant temperature (50% dexcool®, 50% water mix). These three (3) operating points will be described in the Statement of Requirements (SOR) Appendix C2.

Production variation of flow performance shall be no greater than $\pm 5\%$ at maximum pump speed, 35 °C coolant temperature, 13 V $\pm$ 0.1 V.

- Target operating point; see SOR Appendix C2.

3.2.1.1.2 Life Durability. Life Durability requirement shall be application specific as described in SOR Appendix C2.

3.2.1.1.3 Overall Peak Efficiency. The electric coolant pump complying with this specification shall achieve one (1) of the overall peak efficiencies per SOR Appendix C2.

Note: Overall Peak Efficiency = Hydraulic Power/Electrical Power Consumed.

3.2.1.1.4 In-Vehicle Mounting. The electric coolant pump complying with this specification shall operate under one of the mechanical loads conditions (3.2.1.1.4.1 and 3.2.1.1.4.2), see SOR Appendix C2 for the pump mounting capability selection:

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3.2.1.1.4.1 Pump will be powertrain mounted; GMW3172 Mechanical Load Code Letter "A".

3.2.1.1.4.2 Pump will be body (including Condenser Radiator Fan Module (CRFM)) mounted; GMW3172 Mechanical Load Code Letter "G".

3.2.1.1.5 Mounting Orientation. Pump performance shall not be affected by pump spatial orientation. That is the relationship of the axis of the impeller rotation to global coordinates.

3.2.1.1.6 Bracket Natural Frequency. If the electric coolant pump complying with this specification shall have a bracket as part of the assembly used to attach to the vehicle, and will meet one of the following natural frequencies; see SOR Appendix C2 for the pump mounting capability selection:

3.2.1.1.6.1 Bracket is to be greater than 45 Hz for body mount.

3.2.1.1.6.2 Bracket is to be greater than 240 Hz for powertrain mount.

3.2.1.1.7 Burst. Minimum burst strength of pump/impeller housing shall be no less than 400 kPa.

3.2.1.1.8 Noise and Vibration.

3.2.1.1.8.1 Vibration Source. The vibration generated due to component operation, as installed on engine assembly, shall not exceed $1.0 \times 10^{-5} m_{RMS}$, where RMS is Root Mean Squared, measured as the power sum of the 1st order imbalance response at all powertrain mounting locations (tips of the active side brackets) and in all directions. Higher harmonics shall meet the same requirement, individually. Validation to this requirement may be completed in-vehicle, or alternately using a test fixture or free component according to GMW14386, provided an analytical or experimental transfer function from component-level vibration to mount bracket tip vibration is established. Measurement locations in the latter case should be established to match those used to generate the transfer function.

3.2.1.1.8.2 Resonant Frequency. The first resonant frequency of the component inclusive of its attachment structure shall be greater than the frequency of the first order imbalance excitation at maximum operating speed, plus 20%.

3.2.1.1.8.3 Radiated Noise. Component noise shall be assessed considering all relevant noise radiating surfaces which may be excited by the pump source (via Engine Level Allocable Test (ELAT) test setup GMW14007), although supplier component level assessment according to GMW14387 for development purposes is also recommended. Radiated noise shall be reported as sound power (decibels (A weighted) dB(A)) relative to a 1 pW reference, overall level, and $\frac{1}{3}$ octave spectrum between 20 Hz and 20 kHz, or to the largest range within those limits, achievable with available measurement facilities and equipment. Sound power may be calculated from sound pressure in a qualified measurement environment, or may be measured directly using a sound intensity probe scanned over the radiating surface area.

3.2.1.1.8.3.1 The pump and associated electronic control components, as installed and functioning independent of other systems, shall produce a radiated sound power overall level of not more than the values specified in Table 2.

Table 2: Noise, Vibration, Harshness (NVH) $\frac{1}{3}$ Octave Noise Targets

Test Condition: Frequency band (Hz)	"Not to Exceed" Spectral Requirements	
	Nominal Idle	All Other
	$\frac{1}{3}$ octave dB(A)	$\frac{1}{3}$ octave dB(A)
200	45.6	52.5
250	48.1	55.0
315	49.5	58.3
400	49.3	56.8
500	52.6	58.8
630	55.1	60.7
800	56.0	63.4
1000	56.8	63.5
1250	60.2	64.4

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Test Condition: Frequency band (Hz)	“Not to Exceed” Spectral Requirements	
	Nominal Idle ½ octave dB(A)	All Other ½ octave dB(A)
1600	55.7	62.4
2000	56.4	62.4
2500	55.0	62.2
3150	55.3	60.7
4000	55.6	58.7
5000	53.8	57.1
6300	56.1	59.1
8000	49.8	54.8
10000	48.7	51.1
12500	44.3	48.3
16000	39.8	43.2
20000	37.1	39.8
Overall Level Requirement 250 Hz to 10 000 Hz (sum less than “not to exceed” contributions)	65.0	70.0

3.2.1.1.8.3.2 Tonal Noise. The tonal noise radiated from the pump and associated electronic control components, shall in all operating conditions meet a subjective and objective rating of eight (8) tonal noise requirement per GMW14264. The objective measure will be determined by using a narrow band sound power spectral calculation of the first four (4) pump orders relative to their associated masking noise band (provided on request and corresponding to the two rightmost columns in Table 2). The tonal level shall be no more than 6 dB(A) above the masking level at all operating conditions (this is an objective restatement of the subjective rating of eight (8) requirement given in GMW14264).

3.2.1.1.9 Leakage. Pump shall not leak when subjected to test per GMW3155.

3.2.1.1.10 Bracket Corrosion. Where bracket is applied, shall comply with GMW14872 and GMW15272 for Vehicle Technical Specification (VTS) template requirement suffix underhood “H”.

3.2.1.1.11 Cleanliness. The parts as delivered to the assembly location shall be clean and free of debris, residual abrasive material, water and corrosion products adversely affecting function or appearance. The internal parts shall be free of burrs, sharp corners, etc., which may be detrimental to assembly and function.

Debris on the interior and exterior of the finished parts shall be regularly monitored and controlled using statistical methods, upper control limits, and procedures approved by GM Manufacturing Engineering and defined in the supplier process control plan.

The shipped volume of water shall be less than 0.1% of the internal volume. Contamination in all shipping liquids shall be counted towards total contaminants. All liquid used shall be checked to ensure that it carries less than 10 ppm of silicates and 10 ppm of borates (by volume).

The soluble and solid residues of internal surface area of the component which can be washed away with solvent shall not contain any abrasive materials.

No particle size shall be > 1 mm in its largest dimension.

All residues shall be < 15 mg/L of internal coolant volume of the component.

GM may require the supplier to alter or suspend the use of unacceptable manufacturing process materials.

3.2.1.1.12 Flow Performance Robustness to Cooling System Debris. The electric coolant pump complying with this specification shall maintain performance flow requirements (3.2.1.1.1) with presence of cooling system debris as specified in 4.3.2.11 and 4.3.2.12.

3.2.1.2 Electrical.

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3.2.1.2.1 Supply Voltage. The electric coolant pump complying with this specification shall operate with Supply Voltage = 9 V to 16 V; GMW3172 electrical load code letter “C”.

3.2.1.2.2 In-Rush Current. When the pump is wired directly to the battery (without a relay), and the Printed Circuit Board (PCB) capacitors are not switchable, then no in-rush current specification is required.

3.2.1.2.3 Communication, Command. The electric coolant pump complying with this specification shall operate using one of the command options in 3.2.1.2.3.1 through 3.2.1.2.3.3. See SOR Appendix C2 for the command selection.

3.2.1.2.3.1 Pump is to be on/off by supply voltage on/off.

3.2.1.2.3.2 If pump is to be Pulse Width Modulation (PWM) controlled using percent speed; 0% to 10%, pump is off; 11% to 90%, pump speed is linearly distributed from minimum to maximum speed; 91% to 100%, pump is off.

3.2.1.2.3.3 If pump is to be Local Interconnect Network (LIN) controlled using percent speed, see SOR Appendix C2 for LIN Component Technical Specification (CTS).

3.2.1.2.3.3.1 LIN Protocol Specification and LIN Network. LIN network shall be (SAE J2602-1) compliant serial data bus with the following definitions/modifications: The referenced requirements for the “Slave Node” only shall apply to this device. The ECM is the “Master Node”. The LIN interface shall be tested in accordance with SAE J2602-2, repeat the baud rate related tests using a baud rate of 19.23 kb/s.

3.2.1.2.4 Communication, Feedback. The electric coolant pump complying with this specification shall provide impeller speed (rpm) and fault conditions. For fault definitions see SOR Appendix C2 for LIN CTS.

3.2.1.2.5 Speed Resolution (Variable Speed Pumps). All variable speed pumps must be capable of controlling pump speed to a minimum resolution of 2% of requested speed.

3.2.1.2.6 Self-Protection Software. The electric coolant pump complying with this specification shall use one (1) of the self-protection logic statements (3.2.1.2.6.1 or 3.2.1.2.6.2), see SOR Appendix C2 for LIN CTS.

3.2.1.2.6.1 Pump shall not have any self-protect software. Internal hardware self-protection, such as for over voltage or under voltage, is acceptable.

3.2.1.2.6.2 Pump software shall perform the self-protection actions (Table 3). Internal hardware protection, such as for over voltage or under voltage, is acceptable. The feedback as duty cycle assumes PWM communication; LIN feedback will follow specifications in LIN CTS.

Table 3: Software Self-Protection Actions

Condition/Fault	Duty Cycle Feedback	Software Logic
Normal Operation	10%	When the pump is not in a fault condition, normal operation, this duty cycle shall be communicated continuously.
Over Current	20%	Report the failure, shut pump off and keep pump latch until it will be replaced by service. Internal current limit checks five (5) times (5 s intervals for total of 25 s) for fault to clear, and then stays off until power to pump (enable pin) is cycled (“key cycle”). Save fault in pump internal memory and keep pump off on re-enable to ensure pump is removed from vehicle.
Stalled Rotor	30%	Report the failure, shut pump off and keep pump latched off to ensure pump is removed and replaced in service. Retry five (5) times with a 5 s on time and a 5 s off time for total time of 50 s, then set fault code in EEPROM. At temperatures of -20 °C and below, keep this function without latching.
Dry Run	40%	Report the failure, shut pump off for a period of time sufficient to allow bearing surface to cool to prevent damage (to be determined by supplier) and then retry pump for correction (coolant present), continue cycling as needed. Optional to continuous cycling, pump is to latch off until next re-enabled (“key cycle”) after a fixed number of cycles to prevent pump damage (to be determined by supplier).

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