GM	WORLDWIDE ENGINEERING STANDARDS	General Specification	GMW16226

Brake Up-Level Electric Vacuum Pump Assembly 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 establishes the quantitative requirements for an Up Level Electric Vacuum Pump assembly for future General Motors (GM) vehicles. It was created to support the GM advance purchasing activity for the electric vacuum pump assembly and is derived from the Brake Subsystem Technical Specification (BSTS). The vacuum pump will be applied to passenger cars and light trucks up to 3500 kg Gross Vehicle Weight Rating (GVWR).

This document shall only be used when invoked by a program specific technical specification. References to the program specific technical specification are included in this document where program specific requirements are expected to exist.

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

1.2 Applicability. The Up Level Electric Vacuum Pump Assembly is designed to either be the only source of vacuum or to increase the vacuum level of the air intake manifold for the hydraulic brake boost system.

The brakes apply system works in conjunction with the foundation brakes to provide the vehicle with smooth, safe deceleration, retardation and retention performance under all driving conditions.

The apply system family is intended to provide world class performance from right sized components with interfaces flexible enough to support the diverse packaging and processing requirements of the corporation.

Consideration shall be given to the selection of recyclable materials.

1.3 Remarks. Not applicable.

2 References

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

2.1 External Standards/Specifications.

SAE J2044

2.2 GM Standards/Specifications.

GMW3059	GMW3191	GMW14573	GMW15841
GMW3097	GMW14089	GMW14635	GMW15862
GMW3103	GMW14387	GMW14872	
GMW3172	GMW14558	GMW15272	

2.3 Additional References.

Brake Electric Vacuum Pump Assembly Program Specific Technical Specification.

Brake Subsystem Technical Specification (BSTS).

Chassis Bracket Test and Analysis Procedure Analysis

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3 Requirements

3.1 System/Subsystem/Component/Part Definition. The Electric Vacuum Pump Assembly shall provide a sufficient level of vacuum to the brake systemto achieve a smooth, safe deceleration, retardation and retention performance under all driving conditions. See the program technical specification.

3.1.1 Appearance.

3.1.1.1 All Electric Vacuum Pump Assembly components shall have identification tags/labels, supplier logos, and marking indicated on the outline drawing and shall be approved by GM.

3.1.1.2 All Electric Vacuum Pump Assembly components that are visible to the customer shall be in black, gray, and/or silver. The supplier shall receive GM approval for production intent component appearance. This approval, or other appropriate agreement, is required prior to supplier commencing any activity related to component appearance that would force GM to incur cost penalties if a change is subsequently required.

3.1.1.3 Any components with painted, coated, and plated surfaces shall exceed a fifteen-year life without loss of function due to corrosion when mounted in their production intent environment.

3.1.2 Content.

3.1.2.1 Physical Content.

3.1.2.1.1 The Electric Vacuum Pump Assembly includes the following major components. None of the physical content shall require calibration prior to use in the GM vehicles.

- Electrical Powered Vacuum Pump Assembly (1).
- Isolation grommets (minimum of 2).
- Pump fasteners (minimum of 2).
- Electrical wiring harness connection.
- Vacuum hose connection.
- Power circuit. (See the program technical specification.)

3.1.2.1.2 All of the fittings shall be covered to prevent contamination and provide protection during shipping. The air intake port and electrical wiring harness shall be covered by conduit.

3.1.2.2 Functional Content. Not applicable.

3.1.3 Ambient Environment.

3.1.3.1 Mechanical. The Electric Vacuum Pump Assembly shall be possible to mount anywhere in the engine compartment or other closed suitable areas close to brake booster.

3.1.3.2 Electrical. The Electric Vacuum Pump Assembly components shall be capable of enduring the environment found in an automotive mounting location in the engine bay. Fusing will be applied to vehicle architecture for protection of the vacuum pump assembly as needed.

3.1.3.3 Atmospheric Pressure. The vacuum pump shall be designed to be exposed from (45 to 115) kPa during storage.

3.1.3.4 Shipment. Electric Vacuum Pumps Assembly shall withstand shipment by air. The vacuum pump shall not degrade when exposed to a temperature of -50°C and to a pressure of 15 kPa.

3.1.3.5 Component Drop. The Electric Vacuum Pump Assembly shall not be dropped from any height. Components that are dropped from any height are to be considered scrap and not shipped to the customer.

3.1.4 Interfaces. The Electric Vacuum Pump Assembly shall be designed to interface with the subsystems and components described in the following paragraphs. The desire is for an architecture that will allow assembly plant processing flexibility. The exact details of the interfaces will be developed with the supplier. The packaging emphasis is on reducing the overall packaging size. See the program technical specification.

3.1.4.1 Vacuum Pump Mounting. The Electric Vacuum Pump Assembly mounting can be to the cockpit module, body, or engine.

For information only:

The priority for pump location is:

a. On the engine or transmission.

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b. On the vehicle frame or powertrain cradle.

c. On the body rails.

d. Other closed suitable areas close to brake booster (shall be negotiated with Manufacturing Engineering).

The vacuum pump architecture shall allow for service reinstallation on a complete vehicle.

3.1.4.2 Interfaces to Other Brake System Assemblies.

3.1.4.2.1 Vacuum Hose. The booster and the booster check valve will interface to the Electric Vacuum Pump Assembly with a vacuum hose quick fit connection using 9.49 mm, 9.89 mm or 12 mm connector according to SAE J2044. The version to be used shall be specified in the program technical specification.

3.1.5 Usage Definition. The passenger car customer usage data given in this section are for high levels of usage in 150 000 km of retail customer driving. The truck customer usage data given in this section are for high levels of usage in 300 000 km of retail customer driving. Note that low levels of usage may be more appropriate for certain failure mechanisms, such as corrosion.

3.1.5.1 Maximum Continuous Run Time. Maximum pump continuous run time is required to be > 10 h to compensate the vacuum demand for any kind of customer drive maneuver. The vacuum pump must withstand one occurrence of the heat conditions that occur from self heating over full operating temperature per ignition cycle.

3.1.5.2 Number of Vacuum Pump Cycles. The Electric Vacuum Pump Assembly shall be capable of enduring a minimum of 1.300 000 cycles, as described in Table 1, and still fulfill performance levels specified in paragraphs 3.2.1.3.2 and 3.2.1.3.3. One cycle of the vacuum pump equals pressure of 300 $mbar_{abs}$ to 100 $mbar_{abs}$ and back to 300 $mbar_{abs}$.

Table 1: Vacuum Pump Cycles

Number of Cycles/Cycle time	Test Temperature
180 000/30 s	+120 °C
630 000/20 s	+80 °C
90 000/12 s	-40 °C

3.1.5.3 Cumulative Vacuum Pump Run Time. The Electric Vacuum Pump Assembly shall be capable of operating for 1300 h minimum.

3.2 Product Characteristics.

3.2.1 Performance Requirements.

3.2.1.1 Electrical Characteristics. The following paragraphs define the electrical performance Electrical Vacuum Pump Assembly.

3.2.1.1.1 Operating Voltage Range. The normal operating voltage is (9 to 16) V.

3.2.1.1.2 Operating Temperature for the Electronics. The operating temperatures for the mounting location of the Electrical Vacuum Pump Assembly are (-40 to +140) °C as shown in Table 2.

Table 2: Temperature and Humidity Range

Minimum Temperature	-40 °C
Maximum Sustained Temperature > 10 minutes	+120 °C
Maximum Excursion Temperature < 10 minutes (TMAX10)	+140 °C
Maximum Excursion Temperature < 5 minutes (TMAX5)	+150 °C
Relative Humidity Range	(0 to 100) %

3.2.1.1.3 Start-up Current. The start-up current for the EVP motor shall not exceed the characteristics of a 30 A fuse over full operating voltage and temperature range.

3.2.1.1.4 Steady State Current. The steady state current shall be < 20 A at 13.5 V and +23 °C.

3.2.1.1.5 Short Circuits. The Electric Vacuum Pump Assembly shall be protected against short circuits to operating battery voltage and ground.

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3.2.1.1.6 Electrostatic Discharge. The Electric Vacuum Pump Assembly shall be capable of surviving without damage by electrostatic discharge voltages between -25 kV and +25 kV for a storage representative of the human body.

3.2.1.1.7 Conducted Transients. The electric vacuum pump assembly components shall be capable of surviving without damage, sinusoidal and transient conducted bursts representative of actual amplitudes, durations, and waveforms experienced on motor vehicles due to inductive and capacitive disturbances. Reference GMW3097 and GMW3103.

3.2.1.1.8 Voltage Overstress. The Electric Vacuum Pump Assembly components shall be capable of surviving voltage overstress without damage.

3.2.1.1.9 Reverse Battery. The Electric Vacuum Pump Assembly components shall be protected against reverse polarity.

3.2.1.1.10 Sealing. The Electric Vacuum Pump Assembly shall be completely sealed and be capable of preventing water ingestion through the case, the connection system, the wiring/header connector and the exhaust vent. The pump must be capable of being cycled on and off for a minimum of 20 times, under 300 mm of water. Exceptions to this requirement may be granted at the sole discretion of GM, based on the final mounting location.

3.2.1.2 Mechanical Characteristics.

3.2.1.2.1 Mechanical Vibration. The Electric Vacuum Pump Assembly shall encounter vibration inputs according to Figure A1 in Appendix A, using the sprung mass data for body or chassis mounted pumps, and the engine data for engine or transmission mounted pumps. Reference: Chassis Bracket Test and Analysis Procedure Analysis, Heewook Lee et.al.

3.2.1.2.2 Mechanical Shock. The Electric Vacuum Pump Assembly shall be exposed to 40 half sine wave mechanical shocks in the upward, rearward and both lateral directions based on Table 3.

Table 3: Mechanical Shock Exposure

Component Location	Maximum G-Level (Zero-to-Peak)		Total Duration in ms
	Upward, Rearward	Left, Right	
Under Hood	14	7	10

3.2.1.2.3 Bracket Natural Frequency. The pump mounting bracket, if used, should have a first mode natural frequency of ≥ 30 Hz if mounted on the chassis. If mounted on the powertrain, the first mode natural frequency should exceed the firing frequency of the engine at maximum engine speed. See example below in Table 4.

Table 4: Example of Bracket Natural Frequency for Powertrain Mounted Pump

	Engine Firing Frequency (Hz)		
Engine Maximum Rotational Speed in min^{-1}	4 Cylinder Engine	6 Cylinder Engine	8 Cylinder Engine
5000	167	250	333

3.2.1.3 Pump Operation.

3.2.1.3.1 Pressure Range. The vacuum pump shall operate between P_{abs} = 500 mbar (On) to 100 mbar (Off), unless otherwise specified. See the program technical specification.

3.2.1.3.2 Electro Pneumatic Rating. The vacuum pump shall be capable of pumping volume per Table 5 through a 10 mm inside diameter tube 100 cm long as listed below.

3.2.1.3.2.1 Voltage = (13 ± 0.1) V.

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3.2.1.3.2.2 Ambient temperature = (+23 ± 2) °C.

3.2.1.3.2.3 Pressure generation time at 100 kPa (1 bar):

- P_{abs} = 50 kPa in 3.1 s maximum
- P_{abs} = 30 kPa in 6.1 s maximum
- P_{abs} = 10 kPa in 15 s maximum

Table 5: Pumping Volume

Pump Version	1	2
Maximum weight target (in kg)	1.7	1.7
Test volume (in dm^3)	4.5 ± 0.1	5 ± 0.1

3.2.1.3.3 Electro Pneumatic Ratings at -40°C and +100°C. The Electric Vacuum Pump shall be capable of pumping a test volume per Table 3 through a 10 mm inside diameter tube 100 cm long as listed below at -40 °C and +100 °C.

3.2.1.3.3.1 Voltage = (13 ± 0.1) V.

3.2.1.3.3.2 Ambient temperature = (-40 ± 2) °C and (+100 ± 2) °C.

3.2.1.3.3.3 Pressure generation time at 100 kPa (1 bar):

- P_{abs} = 50 kPa in 5 s maximum.
- P_{abs} = 30 kPa in 11 s maximum.
- P_{abs} = 10 kPa in 60 s maximum.

3.2.1.3.4 Electric Vacuum Pump Assembly Noise and Vibration.

3.2.1.3.4.1 Disturbance. The vibration level and noise level produced by the Electric Vacuum Pump Assembly shall not be discernible in the passenger compartment under engine idling, window closed, and normal driving conditions.

3.2.1.3.4.2 Isolation. The Electric Vacuum Pump Assembly shall provide a means of vibration isolation, such as rubber mounts.

3.2.1.3.4.3 Manage Vacuum Pump Noise and Vibrations. The vacuum pump shall support compliance with the program vehicle level powertrain noise and vibration requirements found in the current GM program Vehicle Technical Specification (VTS) with GM in determining the root cause and resolution of any vacuum pump generated vehicle level noise and vibration deviations from the program VTS paragraphs for Powertrain Noise and Vibration.

3.2.1.3.4.3.1 Vacuum Pump Radiated Sound Power. The vacuum pump sound power level shall not exceed the 1/3 octave levels specified in Table 6 when tested according to GMW14387.

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