



HVAC Brush Blower Motor Assembly

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 component performance, design, test, manufacture and acceptance requirements for a fractional horsepower, brush Direct Current (DC) Heating Ventilation Air Conditioning (HVAC) blower motor assembly (blower motor, mounting method, and fan). The blower motor supplied to this specification shall meet all requirements defined herein unless specifically waived in writing by GM's Lead Engineer. Components that do not meet the requirements specified herein are subject to rejection. This document specifies minimum requirements; the motor supplier shall perform any additional testing or more stringent testing that the supplier feels is necessary to meet all requirements and ensure a high quality component.

1.2 Applicability. All GM HVAC Brush Blower Motors.

1.3 Remarks. This blower motor generates air flow for an automotive HVAC module.

1.4 Terminology. Figure 1 as follows explains the terminology of blower motor components in this specification.

- The term "motor only" shall mean the motor without the flange/holder and without the fan.
- The term "motor assembly" shall mean the motor with the flange/holder but without the fan.
- The term "blower assembly" shall mean the motor with the flange/holder and the fan installed.
- The term "scroll" shall mean the plastic housing surrounding the blower assembly that directs airflow from the blower assembly.
- The term "HVAC" or "HVAC module" shall mean the full HVAC assembly including the blower assembly, scroll, heat exchangers, doors, etc.

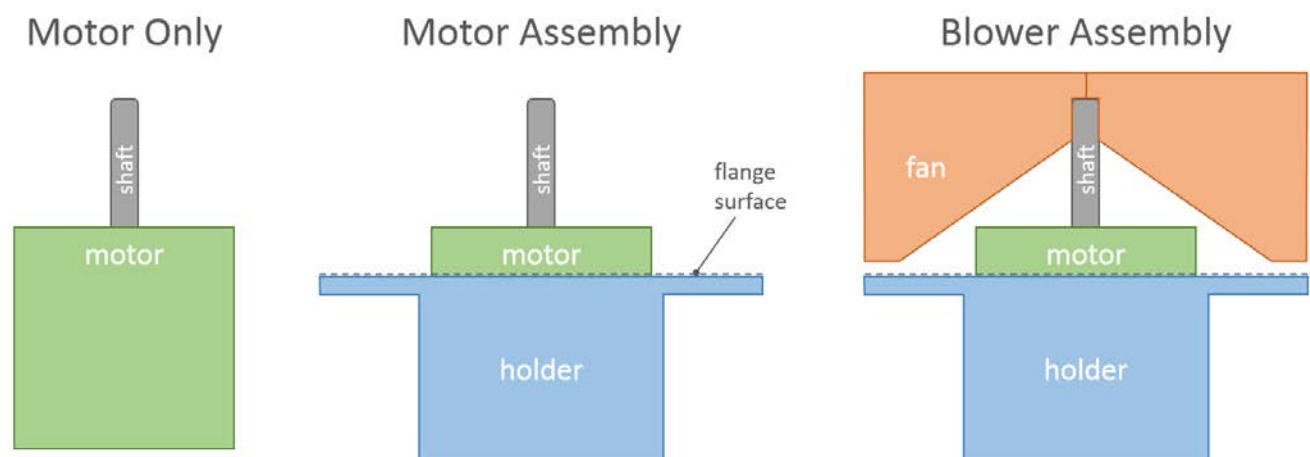


Figure 1: Blower Motor Terminology

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2 References

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

2.1 External Standards/Specifications.

FMVSS 302	SAE J1344	SAE J1351
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2.2 GM Standards/Specifications.

GMW3059	GMW3191	GMW14780	GMW16151
GMW3097	GMW3235	GMW15634	GMW17625
GMW3103	GMW8464	GMW15635	
GMW3116	GMW14264	GMW15760	
GMW3172	GMW14482	GMW16044	

2.3 Additional References.

- CG2069 Brushed Blower Motor Analysis/Development/Validation Plan and Report (ADVPR).

3 Requirements

Note: The Blower Motor will meet or exceed **all** requirements stated in this standard. If a supplier has any concerns about meeting any of the requirements as stated herein, they must note those concerns in all quotes or proposals to GM. All exceptions to the content of this standard must be clearly stated, in bold print, at the front of the quote or proposal, and must reference the exact section number of the exception. Design Failure Mode and Effects Analysis (DFMEA) will be baselined for sourced Program and any subsequent changes to the design Fit, Form, or Function will be appropriately communicated to the downstream customer(s).

3.1 Physical Requirements.

3.1.1 Color. All external surfaces visible after installation into the HVAC module (except part number label) shall be black.

3.1.2 Materials.

3.1.2.1 Materials must comply with GMW3059 – GM Material Requirements, GMW15634, and GMW15635.

3.1.2.2 Supplier is responsible for designing recyclable and recoverable parts using GMW3116.

3.1.2.3 Materials used in motor(s) shall meet specifications per GMW3235 - B - T1 – 2 mg maximum.

3.1.2.4 Motor assembly must be lead-free.

3.1.2.5 Motor assembly must not use rare earth materials unless specifically disclosed to and approved by GM.

3.1.2.6 Silicone products (such as mold release) are prohibited in the motor assembly and manufacturing process, including at sub-suppliers. This reduces the susceptibility of the motor commutator to exhibit silicone contamination failure.

3.1.3 Label Requirements. Basic label requirements shall include part number, serial number, manufacture date, and country of origin via a one-dimensional barcode, two-dimensional barcode, or QR code. GM recommends to use a QR code including the part number, serial number, and the motor speed and current measured by the End of Line (EOL) tester.

3.1.3.1 Traceability. Motors and blower assemblies shall have traceability back to EOL testing based on the serial number, and be retained for a period of ten (10) years.

3.1.4 Marking of Plastic Parts. Plastic parts shall be marked per SAE J1344 to designate the type of material from which the part was fabricated. Where applicable, cavity number shall be marked.

3.1.5 Finish. Unless specifically defined on the engineering drawings, external surfaces of parts shall conform to good commercial practice (reasonably free of gates, flash, ridges, roughness, tool marks, and mold and tool lubricants and other contaminants).

3.1.6 Cleanliness. All parts and surfaces shall be free from dirt, oil, grease, scale, and other foreign materials that may detrimentally impact appearance, performance, durability, or assembly.

3.1.7 Safe Handling. The blower assembly and its component parts must be free from flash, burrs or other surface conditions, which could prohibit safe handling of the product. Dropped components or assemblies shall be scrapped and not reworked.

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3.1.8 Safe Fan Assembly. The fan press force and inclination angle must be measured and be within the supplier's specification when the fan is press fit to the motor shaft, to avoid bearing damage. If a press force is detected above the limit, the blower assembly must be scrapped on the line and not reworked. Minimum press force must also be detected to ensure the shaft was engaged during fan assembly to absorb the press force, rather than the motor's bearings.

3.2 Mechanical Requirements.

3.2.1 Mass. The mass of the motor only (without fan, without holder) shall be ≤ 1.10 kg.

3.2.2 Shaft/Fan Direction of Rotation. A marking should exist on the motor assembly to denote the clockwise or counterclockwise rotation.

3.2.3 Mounting to Scroll. The blower assembly shall be mounted into the HVAC module via a plastic holder. The interface options defined in Table 1 shall be used, which utilize a 3-point screw attachment with tongue and groove, unless a deviation is granted by the blower motor Bill of Material Functional Owner (BFO).

Table 1: Common Holder Definition

Size	Open Area Diameter	3 Dimensional Data	2 Dimensional Drawing
Medium	157 mm	OPW81234/001.0001LHD	D2XX, Diagram 157 Interface Groove
		OPW81235/001.0001RHD	D2XX, Diagram 157 Interface Tongue

LHD Left Hand Drive
RHD Right Hand Drive

3.2.4 Motor Holder. The blower motor holder (not including the cooling tube, if applicable) design must:

- Prevent condensate inside the scroll inlet from dripping, penetrating, and/or otherwise coming in contact with the motor or its internal components. A wall of at least 10 mm should exist on the flange surface to avoid water from directly entering the motor.
- The holder must contain design elements (dams, shields, labyrinth, etc.) to keep condensate from contacting critical motor components (e.g., bearings, brushes, commutator). At least 10 mL of water should be able to enter the motor through the cooling channel and not contact the bearing, brushes, or commutator.
- The holder must consider water paths that could directly drip water onto the blower's connector or wire harness. An example water path is water on the flange surface that enters the tongue and groove and drips out over the connector; such a water path should be prevented by including an umbrella feature over the connector so that water drips away from the connector and harness.
- The motor holder design may contain an air outlet (hole) to allow the shaft to be supported during fan assembly, but it is recommended to be covered by a sticker, label, or plastic cover to stop dust/debris/water/fingers from entering the hole, and also block some airborne noise from exiting the motor.

3.2.5 Fan-to-Shaft Interface. Motor shaft shall be round, with 8 mm (nominal) diameter, unless a deviation is granted by the GM blower motor BFO.

3.2.6 Blower Motor Fan. The blower motor fan must have a closed hub design with no openings and/or holes, and must not have a flat surface which could collect water/ice; at least a 3 degree slope must be used to drain water.

3.2.7 Blower Assembly Unbalance. All blower assemblies shall have a maximum unbalance specification of the total rotating assembly per Table 2 and shall be 100% measured during production.

Table 2: Blower Motor and Fan Rotating Assembly Unbalance Requirement

Rotating Assembly	Per Plane Unbalance (g-mm)	Force Unbalance (g-mm) (a.k.a. Static)	Maximum Distance Between Correction Planes (mm)
Blower Motor and Fan	6 g-mm	4 g-mm	75 mm

a.k.a. Also Known As

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Note: The unbalance specifications in Table 2 are based on the following fan dimensions: 150 mm diameter with 75 mm distance between Tolerance Planes (a.k.a. fan height). The maximum allowable couple (a.k.a. dynamic) unbalance calculates to 450 g-mm².

The per plane, couple, and static unbalance of the HVAC blower motor and fan assembly must be measured on production intent balancing equipment with the blower motor powered at maximum vehicle operating speed (typically 14 V and maximum Pulse Width Modulation (PWM) duty cycle).

Any required balance correction should be made as close to the end planes of the fan as possible. Adding mass or material removal is allowable.

The blower fan base shall be defined as Correction Plane 1 and the blower fan top as Correction Plane 2. The defined Balance Reference Plane shall be at a point half way between the correction planes.

3.2.7.1 Balance Capability. The capability of meeting this requirement must be demonstrated using a statistical model, such as a Variation Simulation Model (VSM), accounting for variation of all components, processes, and dimensions influencing balance.

3.2.8 Motor Armature Unbalance. Armature dynamic unbalance must be 100% controlled during production at < 5 g-mm at a speed of 1200 rpm. Higher speeds are allowed at the same limit.

3.2.9 Motor Cooling. A blower motor cooling scheme which eliminates water entry into the motor is required. The cooling channel/tube opening should be located to achieve sufficient cool air and minimize water pick-up. The cooling channel/tube opening must not reside in a high condensate formation or flow area such as the floor of the HVAC scroll.

3.2.10 Connector Positive Assurance (CPA). The blower motor shall use a GM compliant connector that meets GMW3191. The blower motor must house a connector that accepts a CPA, or contain on the harness lead, a connector with a CPA feature.

3.2.11 Brush Requirements. The blower brushes shall be designed so that the dust byproduct shall not be at a level that will prohibit the HVAC Module from compliance of GMW16151 (Evaporator External Corrosion Test). The brush/commutator assembly must also be designed to limit the influence of organic silicone ingestion on motor noise and performance.

3.2.12 Commutator Requirements. The blower commutator shall be designed so that commutator strands are not created in the full operating range.

3.2.13 Bearing Requirements. The blower motor is recommended to use two (2) ball bearings. The motor supplier should measure vibration 100% during production to check for known failures, especially bearing damage. The requirements must be set specific to the supplier's motor.

3.2.14 Wire Requirements. The blower motor armature windings must have the appropriate temperature rating for the operating environment of the application (cabin or engine compartment) per 3.3.2.

3.3 Environmental Requirements.

3.3.1 Environmental and Durability. The blower motor shall meet all requirements of GMW3172.

3.3.2 Operating Temperature Range. The blower motor operating temperature range shall be -40 °C to +85 °C with performance degradation allowed above +65 °C. For engine compartment applications, the blower motor operating temperature range shall be -40 °C to +105 °C.

3.3.3 Storage Temperature Range. The blower motor storage temperature range shall be -40 °C to +105 °C.

3.3.4 Odor. Materials shall have an odor scale rating of three (3) or less when tested per SAE J1351 and GMW14780.

3.3.5 Fogging. Materials shall meet specifications per GMW3235 - B - T1 - 2 mg maximum.

3.3.6 Federal Motor Vehicle Safety Standard (FMVSS) 302. All components shall comply with FMVSS 302 where applicable.

3.4 Electrical Requirements.

3.4.1 Operating Voltage. The blower motor shall operate in a vehicle voltage range of 4.0 Volt Direct Current (VDC) to 16.0 VDC.

3.4.2 Blower Motor Load Point. The HVAC supplier shall use the HVAC restriction from GMW17625 to determine the worst case blower motor load point, which should be documented on the blower motor drawing(s),

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and will be used in this specification hereby termed "load point". The load point should anticipate a 1 minute warm up at the rated load. The speed tolerance on the drawing must be $\leq 8\%$. Nominal motor efficiency at the specified load point shall be $\geq 69\%$. The load point must be verified 100% during production at the rated load, unless a deviation is granted by the GM blower motor BFO by showing correlation to the production load.

3.4.3 Electrical Design Disclosure. The blower motor electrical operating points and their respective conditions must be supplied to and reviewed with GM blower motor BFO. The supplier shall send the following information to the GM BFO when Design Validation (DV) and Process Validation (PV) test reports are submitted:

- Plot - Blower Motor Operating Curve [Speed (rpm), Torque (N·m), Efficiency (%)].
- Nominal Operating Point - unless otherwise specified, 13.0 VDC, or specify if deviation.
- Motor Stall Condition - [Current (A) and Torque (N·m)].
- Maximum Motor Velocity under No-Load Condition (rpm).
- Surge Current Peak - Peak Current (A), Time to Peak (ms) @ -40 °C, 25 °C, and 85 °C.
- Capacitance (μF).

3.4.4 Capacitor Type. Ceramic type capacitors for blower motor applications are prohibited. Any capacitor utilized in the blower motor must demonstrate "self-healing", in that it has the ability to clear a fault area where a momentary short occurs due to dielectric breakdown under voltage. If a capacitor is applied in the blower motor, it shall be declared to the HVAC supplier to ensure it will not be damaged by a PWM controller (if applied).

3.4.5 Interfaces. Supplier to provide all applicable interfaces to complete application specific Interface Control Document (ICD), at a minimum the electrical circuit, maximum power, and connector pinout.

3.5 Reliability.

3.5.1 Service Life. The blower motor service life shall meet requirements of GMW14780.

3.5.2 Reliability Requirement. The blower motor supplier shall demonstrate a reliability of 99% at a 50% confidence level (R99C50) by using Weibull analysis to determine sample size and number of lives. Supplier to provide the data and calculations to GM blower motor BFO. The profile usage can be found in 4.5.2.1.1 Durability Test. Supplier shall demonstrate this reliability for Design Validation (DV) and Process Validation (PV) separately. PV parts shall be selected per GMW15760.

4 Validation

4.1 General. The supplier shall run all applicable validation tests as defined in GMW3172, in addition to all other blower motor specific validation tests required in this specification.

4.2 Validation Cross Reference Index. Supplier shall use the Test Matrix Format outlined in the Validation Cross Reference Index (VCRI), CG2069 Brushed Blower Motor ADVPR in the Statement of Requirements (SOR) to generate the VCRI, including tests required to meet all requirements in this document. The supplier shall work with the GM Design Responsible Engineer to comprehend this requirement.

4.3 Supporting Paragraphs.

4.3.1 Validation Test Plans. The supplier shall submit the following test plans and receive approval from GM Validation Engineering before the start of both DV and PV testing:

- CG2069 Analysis/Development/Validation Plan and Report (ADVP&R). The supplier shall work with the GM Design Responsible Engineer to comprehend this requirement.
- GMW3172 Appendix B.
- GMW3103 Appendix A.

After DV testing is complete, and again after PV testing is complete, the results of the testing must be approved by GM Engineering and documented per CG2069 (the supplier shall work with the GM Design Responsible Engineer to comprehend this requirement), GMW3172, and GMW3103.

4.3.2 Facility Information. A record of all environmental equipment, test/management equipment and personnel utilized while performing each test, observation or measurement shall be documented. Calibration certification and traceability shall also be noted. Out of certification or tolerance equipment shall not be used. This information shall be considered part of the formal validation or revalidation documentation package and should be included with the test data sheets when the test completion reports are collated.

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4.4 Electromagnetic Compatibility (EMC). The EMC performance of the blower motor shall be validated according to GMW3097. A GMW3103 EMC Test Plan shall be completed by the supplier and submitted to GM for approval 60 days prior to the start of EMC testing. The test setup shall be documented in the EMC Test Plan and comply with GM EMC requirements. Once approved, the required EMC tests shall be added to the ADVP&R. The test report(s) shall be submitted in accordance with GM EMC requirements. All GM component level EMC tests shall be required unless there are approved deviations agreed upon by the GM EMC Validation Engineer.

Blower motors are also tested in full vehicle EMC tests. If a blower motor does not meet the vehicle-level test requirements, the supplier shall cooperate with GM in determining a root cause and resolution for the condition.

All Electromagnetic Compatibility testing shall be performed by GM approved test facilities. If there is a discrepancy between supplier tests and testing performed by GM Vehicle Engineers, GM's vehicle test results will supercede the supplier's test results.

4.5 Blower Motor Validation Tests/Requirements.

4.5.1 Electrical Validation per GMW3172. The blower motor shall meet the requirements for the GMW3172 Code Letter Sequence shown in Table 3.

Table 3: Code Letter Sequence

Electrical Loads	Mechanical Loads	Temperature Loads	Climatic Loads	Chemical Loads	Dust and Water Protection
C	G	C	D	A	IP5K2 (With Fan in HVAC)

4.5.2 Additional Electrical Validation – HVAC Blower Motor Specific Tests. The following tests shall be additionally listed in the GMW3172 Test Plan. Pre and post functional/parametric tests and component measurements shall be defined and agreed to as part of this test plan.

4.5.2.1 Durability. Durability testing is designed to validate, in priority, the weakest functions of the blower assembly (critical failure modes found in the Failure Mode and Effects Analysis (FMEA)). The durability of the product is measured through two complementary tests made on the same samples:

- The Durability Test** - Verifies the ability of the product to perform a given number of hours without damage. This duration represents one (1) life.
- The Kill Test** - The prolongation of the Durability Test until blower assembly failure. It enables the observance of failure modes, provides statistical distribution of failure times (for Weibull analysis), and defines the limits of the technology used.

Based on the Weibull model, as required in 3.5.2, the sample sizes must be calculated by the supplier and it must be based on the time to complete the Kill Test with a R99C50 confidence interval.

4.5.2.1.1 Durability Test.

Objective: This test is to ensure that the blower assembly does not fail during a simulated lifetime.

Test Setup: The blower assembly test samples shall be configured to represent the suppliers "worst-case" unbalance from Table 2 requirements. Assemble blower assembly into HVAC module or scroll in vehicle orientation. Restrict module or scroll to the load point, ensuring voltage is measured at the motor terminals.

Test Procedure:

Duration: 2000 h.

Number of Temperature Cycles: 10 Temperature Cycles.

Number of Electrical Cycles: 1000 Electrical Cycles.

One Temperature Cycle definition: (See Figure 2).

- 40 h at -30 °C;
- 120 h at +23 °C;
- 36 h at +50 °C;

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