



Heating, Ventilation and Air Conditioning (HVAC) Module

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 document specification establishes the Heating, Ventilating and Air Conditioning (HVAC) module technical requirements in accordance with the Vehicle Technical Specification (VTS) and Master Timing Chart (MTC). The functions, performance, reliability, and validation requirements are defined in this document. Any changes will require final approval by GM.

1.2 Applicability. All vehicles with front air flow HVAC module.

1.3 Remarks.

1.3.1 Classification and Definition of Option Codes. Quotes shall be provided for configurations listed in the actual version of the Product Program (see SOR Appendix B1).

1.3.2 Order of Precedence. The VTS shall always supersede the Subsystem Technical Specification (SSTS), which always supersedes the Component Technical Specification (CTS) or component drawing. Nothing in this specification, however, supersedes applicable government laws and regulations unless a specific exemption has been obtained.

2 References

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

2.1 External Standards/Specifications.

FMVSS305	SAE J2602	SAE/USCAR-2	UN R21
ISO 20653			

2.2 GM Standards/Specifications. See Appendix A, Table A1 for GMW Titles.

GMW3043	GMW7293	GMW14718	GMW16001
GMW3049	GMW7294	GMW14780	GMW16151
GMW3055	GMW8518	GMW14787	GMW16154
GMW3059	GMW8738 (ID)	GMW14872	GMW16295
GMW3070	GMW14011	GMW15010	GMW16571
GMW3097	GMW14082	GMW15259	GMW16661
GMW3116	GMW14101 (ID)	GMW15272	GMW16839
GMW3172	GMW14131	GMW15447	GMW16853
GMW3191	GMW14178	GMW15634	GMW17110
GMW3205	GMW14212	GMW15635	GMW17144
GMW3235	GMW14264	GMW15753	GMW17389
GMW3259	GMW14319	GMW15760	GMW17615
GMW3286	GMW14322	GMW15841	GMW17655
GMW3425	GMW14323	GMW15862	GMW17988
GMW3428	GMW14444	GMW15922	
GMW3600	GMW14482	GMW15966	

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2.3 Additional References.

- Component Technical Specification (CTS).
- Electronic Interface Control Document (ICDe).
- GM Best Practices; ECEC86-27, ELEC86-69, HVACPTC-345, HVACPTC-355, HVACPTC-357.
The supplier shall work with the GM Design Responsible Engineer to comprehend this requirement.
- GM Drawing 13301804 (Quick Connect interface drawing for heater pipe end form).
- GM1829 Analysis, Development, Validation Plan and Report (ADVP&R).
- Mechanical Interface Control Document (ICDm).
- SAE Cooperative Research Project (CRP1234).
- SOR Appendix A, Responsible, Approval, Support, Inform, Consult (RASIC) chart.
- SOR Appendix B1.
- SOR Appendix C2.
- SOR Appendix F12.
- SOR Appendix F20.
- SOR Appendix G2.
- SOR Appendix G3, VCRI.
- SOR Appendix H.
- Subsystem Technical Specification (SSTS).
- USCAR drawing EWCAP-001
- Vehicle Technical Specification (VTS).

3 Requirements

3.1 System/Subsystem/Component/Part Definition.

3.1.1 Appearance. Not applicable.

3.1.2 Content.

3.1.2.1 Physical Content.

3.1.2.2 Functional Content.

3.1.2.2.1 The HVAC module is to provide the following functions.

- a. Provide cooled and dehumidified air to the air duct system.
- b. Provide heated air to the air duct system (e.g., floor-side vents).
- c. Provide airflow to the windshield and front side windows in defrost, defog, and heater modes.
- d. Provide ventilation to the vehicle via the HVAC module's duct system with continuous blower speed control.
- e. Provide 100% Outside Air (OSA), partial recirculated air, and 100% recirculated air functions for interior air.
- f. Provide, as required, air filtered from particle and/or odor to the passenger compartment.
- g. Provide on an optional basis, pollution/odor reduction to the passenger compartment for outside air (controls and sensing are not part of the HVAC module).
- h. Provide a Thermal Expansion Valve (TXV) to control the refrigerant flow into the evaporator. A separate setting may be needed for R134a refrigerant and R1234yf refrigerant. The recommended TXV cooling capacity is 2 ton for HFO1234YF systems and 1.5 ton for R134A systems (subject to change based on system development, see **Note**).
- i. Provide conditioned air to a wireless phone charger cooling module.
- j. Provide means to protect debris from entering HVAC (before the filter) e.g., 10 mm hexagon grid.

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Note: The cooling capacity recommendation is based on the following items. Programs may allow 1.5 ton if documented that there is no Noise and Vibration degradation and it was proven that there is a loss of refrigerant control using a 2 ton.

- Typically cost neutral when used early in program but a cost increase when introduced late.
 - Proven Noise and Vibration benefits.
 - SAE Cooperative Research Project (CRP1234) recommendation for R1234yf usage.
 - Proven inability to control refrigerant in GMW16571 with 2 ton valve.
 - Due to system control and compressor flooding risks, each system is required to demonstrate the TXV's ability to regulate compressor inlet and outlet superheat per GMW16571, 4.3.4.4.5. Retesting is required for any major changes (compressor, refrigerant, TXV, etc.)
- k. Provide a sump and drain to allow the condensate to leave the HVAC module.
- l. Provide, on an optional basis, heated air to the 2nd row floor ducts.
- m. Provide on an optional basis, cooled and dehumidified air to the 2nd row vents.
- n. Provide Discharge Air Temperature Sensors (this only applies for automatic HVAC systems) for temperature control (one (1) for Regular Production Option (RPO) C68; two (2) for RPO CJ2) upper and (one (1) for RPO C68; two (2) for RPO CJ2) lower sensor is required for each zone.
- o. Provide Evaporator Air Temperature Sensor for compressor control.
- p. Provide on an optional basis, a Corporate Common Positive Temperature Coefficient (PTC) air electric heater.
- q. Provide integrated front of dash pass-through seal interfaces.

3.1.2.2.2 The supplier will have full responsibility for the fulfilment of all functional requirements specified in this document.

3.1.3 Ambient Environment. Not applicable.

3.1.4 Interfaces.

3.1.4.1 Interfaces for Electrical Architectures Global A and Global B.

3.1.4.1.1 Physical Interfaces. Interfaces are defined in the Mechanical Interface Control Document (ICDm) for mechanical interface's and for all the electrical interfaces in the Electronic Interface Control Document (ICDe).

3.1.4.1.1.1 The HVAC subsystem shall include the following:

- a. Mode and air intake and air mixing flaps.
- b. Blower motor; blower wheel and blower motor holder.
- c. Blower speed controller.
- d. Particle or combination filter.
- e. Evaporator core.
- f. Heater core.
- g. Temperature Expansion Valve (TXV).
- h. Cable and/or actuators with kinematics as needed.
- i. Air-side electrical PTC heater and wiring harness with interface to control unit and battery power connection.
- j. Hose interface to drain condensate water.
- k. Sensors Evaporator Air Temperature/Discharge Air Temperature (EAT/DAT/etc.)
- l. Wire Harness.
- m. Vehicle Interfaces: Front of Dash (FOD) seals (Air Inlet, TXV, Heater Pipe)/drain hose/Instrument Panel (IP) Beam, etc.
- n. Wireless phone charger cooling port.
- o. Interior Air Quality Sensor mounting.
- p. Removable cabin air filter door.
- q. Heater core tube cover.

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The interface information shall be provided per interface definition in Table 1.

Table 1: Physical Interface Definition by Version

Interface	Manual A/C (RPO C60)	Manual A/C (RPO C67)	Auto Dual Zone (RPO CJ2)	Auto Single Zone (RPO C68)	Auto Tri Zone (RPO CJ4)	Auto Quad Zone (RPO C24)	Manual A/C (RPO C4P)
Mode Doors	Pull-Pull cable Note 3	Actuator Note 1	Actuator Note 1	Actuator Note 1	Actuator Note 1	Actuator Note 1	Actuator Note 1
Air Intake Door	Actuator	Actuator Note 1	Actuator Note 1	Actuator Note 1	Actuator Note 1	Actuator Note 1	Actuator Note 1
Air Temp Door Single	Pull-Pull cable	Actuator Note 1	Actuator Note 1	Actuator Note 1	Actuator Note 1	Actuator Note 1	Actuator Note 1
Air Temp Door Dual	N/A	N/A	Actuator Note 1	N/A	Actuator Note 1	Actuator Note 1	N/A
Air Temp Door Rear Single	N/A	N/A	N/A	N/A	Actuator Note 1	Actuator Note 1	N/A
Air Temp Door Rear Dual	N/A	N/A	N/A	N/A	N/A	Actuator Note 1	N/A
Slave Temp Door Rear	N/A	N/A	Optional	N/A	N/A	N/A	N/A
Blower Motor	CMS Interface Note 2	CMS Interface Note 2	CMS Interface Note 2	CMS Interface Note 2	CMS Interface Note 2	CMS Interface Note 2	CMS Interface Note 2
Blower Speed Control	LPM/BLDC	LPM/BLDC	LPM/BLDC	LPM/BLDC	LPM/BLDC	LPM/BLDC	LPM/BLDC
Heater pipe to Hose	Quick connector	Quick connector	Quick connector	Quick connector	Quick connector	Quick connector	Quick connector
TXV to Pipe	CCC Interface TXV	CCC Interface TXV	CCC Interface TXV	CCC Interface TXV	CCC Interface TXV	CCC Interface TXV	CCC Interface TXV
EAT Sensor	Applicable Note 1	Applicable Note 1	Applicable Note 1	Applicable Note 1	Applicable Note 1	Applicable Note 1	Applicable Note 1
DAT Sensor	N/A	N/A	Optional (Qty. 4) Note 1	Optional (Qty. 2) Note 1	Optional (Qty. 4) Note 1	Optional (Qty. 4) Note 1	Optional (Qty. 2) Note 1
Air Intake to Dash	Seal	Seal	Seal	Seal	Seal	Seal	Seal
Dash Pass-through	Seal	Seal	Seal	Seal	Seal	Seal	Seal
Condensate Drain	Drain hose interface	Drain hose interface	Drain hose interface	Drain hose interface	Drain hose interface	Drain hose interface	Drain hose interface
Rear Heating Duct	Seal (if N/A, blocked)	Seal (if N/A, blocked)	Seal (if N/A, blocked)	Seal (if N/A, blocked)	Seal (if N/A, blocked)	Seal (if N/A, blocked)	(if N/A, blocked)

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PTC Heater	PWM/LIN control ^{Note 1}	PWM/LIN control ^{Note 1}	PWM/LIN control ^{Note 1}	PWM/LIN control ^{Note 1}	PWM/LIN control ^{Note 1}	PWM/LIN control ^{Note 1}	PWM/LIN control ^{Note 1}
Wiring Harness	Pre-assembled ^{Note 1}	Pre-assembled ^{Note 1}	Pre-assembled ^{Note 1}	Pre-assembled ^{Note 1}	Pre-assembled ^{Note 1}	Pre-assembled ^{Note 1}	Pre-assembled ^{Note 1}
Glovebox Cooling/WLC	(if N/A, blocked)	(if N/A, blocked)	(if N/A, blocked)	(if N/A, blocked)	(if N/A, blocked)	(if N/A, blocked)	(if N/A, blocked)
Heater Tube Cover	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Cabin Air Filter and Serviceable Door	Yes see SOR Appendix C2	Yes see SOR Appendix C2	Yes see SOR Appendix C2	Yes see SOR Appendix C2	Yes see SOR Appendix C2	Yes see SOR Appendix C2	Yes see SOR Appendix C2
Interior Air Quality Sensor Mounting	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Note: BLDC = Brushless Direct Current (DC), CCC = Corporate Common Component, CMS = Corporate Managed Solution, DC = Direct Current, LIN = Local Interconnect Network LPM = Linear Power Module, N/A = Not Applicable, PWM = Pulse-Width Modulation, Qty. = Quantity, Temp = Temperature, WLC = Wireless Charger.

Note 1:

- For the detail mechanization and interface, refer to Global A HVAC Control Remote SOR.
- For Global B, see GMW17655 for network and signal definition.

Note 2: All blower motors must be mechanically interchangeable to the HVAC scroll without new tooling. The interface is specified in GMW15259 for brush motors, and GMW16661 for BLDC.

Note 3: The cable for Air Delivery/Air Mixing/Air Intake actuating shall be as a part of the HVAC module.

3.1.4.2 System Load.

3.1.4.2.1 Engine Coolant Flow Rate and Pressure Drop.

- Test with program released heater and pipes.
- Test conditions:
 - Heater core bench test. See GMW14322 for heater core bench test and additional requirements.
 - Coolant Type: 50% water, 50% glycol by volume.
- The maximum coolant side pressure drop of the heater core shall be according to Table 2.

Table 2: Maximum Coolant Side Pressure Drop of the Heater Core

Coolant Flow	Pressure Drop
6 L/minute	1.8 kPa
12 L/minute	6 kPa

- The heater core should withstand a continuous coolant flow of minimum 54 L/minute at a heater core inlet coolant pressure of 1 bar (absolute (abs)) and coolant temperature of 90 °C.

3.1.4.2.2 Electrical Load.

Test on bench as follows.

- Brush Direct Current (DC): 25 A at 12 V, based on listed standard restriction in Table 5 (unless deviation is specified, see SOR Appendix C2).
 - Brushless DC (BLDC): 25 A at 13 V, based on listed standard restriction Table 5 (unless deviation is specified, see SOR Appendix C2).

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- b. Brushed Motor and BLDC: load condition shown in the component ICDe sheet.
- c. Load: Vehicle allows maximum 27 A at 14 V applied to the blower airflow condition with no inlet or exit restrictions. This is to simulate high speed vehicle ram air condition for worst case current draw.

3.1.4.2.2.1 Ignition Voltage Range Requirements. Requirements are specified in SOR Appendix C2.

3.1.4.2.2.2 Miscellaneous Electrical Specifications.

3.1.4.2.2.2.1 Electrical Connectors - Subsystem Components – Global A and Global B.

- a. Connectors shall meet or exceed SAE/USCAR-2 and additional requirements specified in SOR Appendix C2 and the SSTS. The supplier shall work with the GM Design Responsible Engineer to comprehend this requirement.
- b. Detailed performance and testing procedures/specifications are available from the SAE/USCAR-2 Standard for Automotive Electrical Connection Systems document.
- c. There may be cases where the device itself will not meet the test specifications in item **a**. In these cases, an agreement between the Wiring and Device Release Engineers and approval from the Connector Bill of Material Functional Owner (BFO) is required to deviate from the specifications.

3.1.4.2.2.2.1.1 Connector Requirements.

- a. All electric connector types must fulfill the requirements of the CTS for Connection Systems, SOR Appendix C2 and GMW3191. The supplier shall work with the GM Design Responsible Engineer to comprehend this requirement.
- b. All electrical components and in-line connectors must be packaged to prevent water intrusion into the connection system per GM best practice ELEC86-69 (The supplier shall work with the GM Design Responsible Engineer to comprehend this requirement.)
- c. All connections must use Connector Position Assurance (CPA) as defined by SOR Appendix C2
- d. The GM connector BFO is required to buy-off on any deviation.
- e. Electrical connections must meet FMVSS305 when applicable.
- f. System and component ICDe in SOR Appendix F20 used for all components. In particular, the following items are to be noted:
 - Connector locking mechanism.
 - Single sealing of each cable.
 - Radial sealing of the housing.
 - Parts out of prototype tools: Green dot marking.
 - First parts out of series tools: Pink dot marking.
 - Connectors must be designed to prevent misassembly by using:
 - Color.
 - Mechanical fit.
 - Wire Lengths.

3.1.4.2.2.3 System Fuse Protection (GM) Vehicle Side. See ICDe power management SOR Appendix F20.

3.1.4.3 Electrical Interface.

- a. The automatic HVAC module shall be connected with points identical with Global Mid/Compact Electronic Climate Control (ECC) HVAC module. Refer to relevant SORs.
- b. The supplier should provide connector and pin in/out information for inter-subsystem electrical connections via ICDe format (SOR Appendix F20) to ensure that the connections comply with requirements for vehicle assembly and service.
- c. The system shall comply with GM general requirements for electrical systems and components (IP5K2 (GMW3172), GMW14082 (Global A only), and GMW3191).
- d. All wires must be retained at intervals no greater than 100 mm in accordance with GM best practice ECEC86-27 (The supplier shall work with the GM Design Responsible Engineer to comprehend this requirement.) Molded clips are acceptable but must have a snug fit. If using a separate wire clip, it must be

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approved in the GM clip catalog, reference GM best practice ELEC86-27 (The supplier shall work with the GM Design Responsible Engineer to comprehend this requirement.)

3.1.4.3.1 Electrical Mechanization Interface Diagram. GM Design Release Engineer (DRE) will review and show pin addresses in the ICDe.

3.1.4.3.2 Electrical Load.

- a. The electrical load is subject to change based on program specific fuel economy targets defined by the GM Energy Integration Engineer. See SOR Appendix C2 for the program specific energy target.
- b. The HVAC module supplier is responsible to integrate the blower motor speed controller into the HVAC module so that it meets all performance requirements.

3.1.4.4 Diagnostic Communications. See CTS for the following.

- BLDC/On Board Diagnostics (OBD)-II (see SOR Appendix C2).
- LIN stepper (GMW17655).
- PTC heater (GMW17615).

3.1.5 Usage Definition. Not applicable.

3.2 Product Characteristics.

3.2.1 Performance Requirements.

3.2.1.1 Module Components. The HVAC module supplier shall select either CCC or components from the recommended supplier list. The HVAC module supplier is responsible for the integration of CCC components and responsible for integrating and validating of non-CCC components including the components on the recommended supplier list. See SOR Appendix C2.

3.2.1.1.1 Blower Motor and Blower Motor Controller.

- a. The blower motor and blower motor speed controller should have an ISO water protection rating of IP5K2 (GMW3172), per ISO 20653, for areas of the component exposed to the environment outside of the module.
- b. The blower motor and blower motor speed controller should have an ISO water protection rating of IP5K4K (GMW3172), per ISO 20653, for areas of the component exposed to the environment inside of the module (see GMW16661).
- c. All electronic parts of blower motor and motor controller (internal and external to the HVAC module) are required to meet water and dust resistance as defined in GMW16661 and GMW3172.

3.2.1.1.1.1 General Blower Controller Requirements.

- a. The blower controller shall provide adequate current to overcome a temporary stall situation at start up conditions where 50% and less control speeds are requested, for a duration of up to 5 s prior to normal current limit protection (function of inrush current see LPM, BLDC controller CTS/GMW documents).
- b. The Electrical Controller (manual cable control; HVAC control remote (Silverbox), Body Control Module (BCM)), shall provide a variable number of outputs that meet the following parameters in Table 3.

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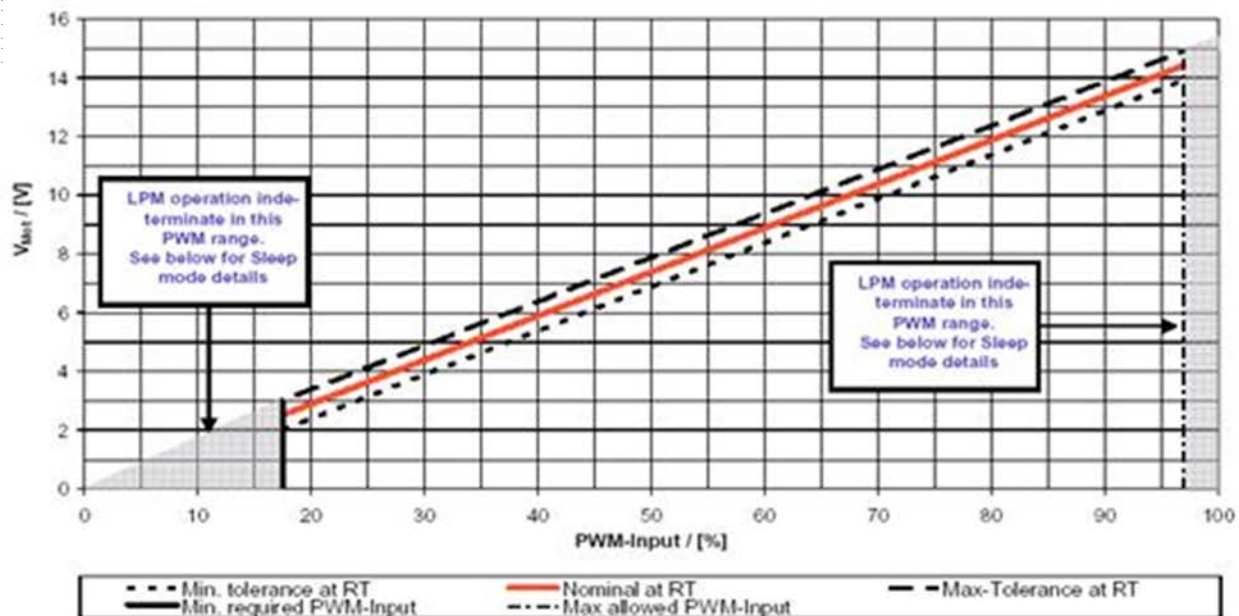
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Table 3: Electrical Controller Requirements

Parameter	Requirement
Maximum Number of Outputs Supported	3
Minimum Number of Outputs Supported	2
V _{OL} Voltage Allowed in Active State	0.76 V
Pull up Voltage Source at the Blower	Battery
Pull up Voltage Source Resistance	4 kΩ to 6 kΩ
I _{OL} Current Requirement in Active State @ 25 °C	2.5 mA @ 16 V (BATT)
I _{LEAK} Maximum Leakage Current Allowed in Inactive State	200 A @ 12.8 V (BATT)
Output Frequency Controlled via Software (SW) Calibration	35 Hz +5 Hz/-0 Hz
Duty Cycle for Motor Operation	See transfer function in Figure 1
Over Current Shut-off	Required
Electrostatic Discharge (ESD) Protection – Handling	GMW3097 @ 8 kV
ESD Protection – Powered	GMW3097 @ 15 kV

Note: @ = at, BATT = Battery.

Figure 1: Transfer Curve Used in GM Blower Speed Controller to be Matched to Control Low Current PWM Signal Example



- c. All HVAC module variants must be capable of packaging LPM HVAC blower motor speed controller.
- d. The blower motor flange must use the GM common interface as defined by GMW15259 and GMW16661.
 - BLDC.
 - Brush/LPM controller.
- e. The low current PWM signal content for BLDC and LPM controller needs to be common.
- f. Output - Low Side Driver (LSD) PWM - LPM/BLDC Blower Control Front and Rear-Global A and Global B shall drive the all speed controller (see CIRCUIT diagram in Figure 2).
- g. The HVAC electrical controller (Cable Control Panel (CCP), HVAC control remote, BCM) shall provide a variable number of outputs that meet the parameters defined in Table 3.

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3.2.1.1.1.2 LPM.

- a. The HVAC module supplier is responsible for the selection and integration of a LPM controller that meets GM's requirements in GMW17988. HVAC module supplier will also cooperate and assist GM in the future adoption of a directed-buy LPM blower controller.

Note: The LPM will not support OBD-II blower feedback requirements.

3.2.1.1.1.3 Electrical Connector Interface.

- a. The water protection rating of the component within the HVAC module is IP5K4K (GMW3172).
- b. The water protection rating of the component outside of the HVAC module is IP5K2 (GMW3172).
- c. Connector orientation shall be a minimum of minus 15 degrees to the horizontal line to not allow condensate water drop contamination.
- d. The connector must have a water protection rating of IP5K2 (GMW3172) if the actuator cannot be oriented in the manner described in item c.

3.2.1.1.1.4 Brushless Blower Motor.

- a. The brushless motor solutions shall be interchangeable to the blower scroll housing by using a common motor holder flange and cooling channel.
- b. The interface definition for blower motor scroll flange is in GMW16661 for BLDC.
- c. HVAC module supplier will also cooperate and assist GM in the future adoption of a directed-buy Brushless Blower Motor.

3.2.1.1.1.5 Brushed Blower Motor.

- a. The brushed motor solutions shall be interchangeable to the scroll housing by using a common motor holder flange and cooling channel. The common motor holder flange as defined in GMW15259.
- b. The brushed blower motor shall be a CMS part meeting the requirements of GMW15259.
- c. HVAC module supplier will also cooperate and assist GM in the future adoption of a directed-buy Brushed Blower Motor.

3.2.1.1.2 TXV.

- a. The TXV must meet the latest released revision of GMW16154.

3.2.1.1.3 EAT/DAT Sensors.

- a. The EAT and DAT sensors shall be Corporate Guided Solution (CGS) components, see recommended supplier list in SOR Appendix C2.
- b. HVAC module supplier will provide quotes for DAT and EAT sensors as Tier 2 commodities that comply with GMW16839.
- c. HVAC module supplier will also cooperate and assist GM in the future adoption of the directed-buy DAT and EAT sensors.
- d. Characteristic curves for the sensors shall be provided by the supplier in accordance with the sensor GMW16839.
- e. All DAT sensors must be located in the HVAC module and able to read the airflow temperature in all air distribution modes for all the requested test points within GMW15922.
- f. EAT sensor shall be positioned no greater than 10 mm from the surface of the evaporator. The heater core shall have < 1 °C increase on the EAT temperature reading when tested in accordance to GMW16571 (with and without an active heater core). The EAT temperature sensor reading shall be no greater than 1 °C above the average surface temperature of the evaporator the EAT is measuring when tested in accordance to 3.2.1.4.1.1 all blower speeds.

3.2.1.1.4 Actuators.

- a. The HVAC housing, kinematics, and doors must be design in such that a LIN stepper and a uni-polar stepper actuator are interchangeable.
- b. Supplier shall complete the actuator evaluation sheet. The evaluation sheet will be attached in SOR Appendix C2.

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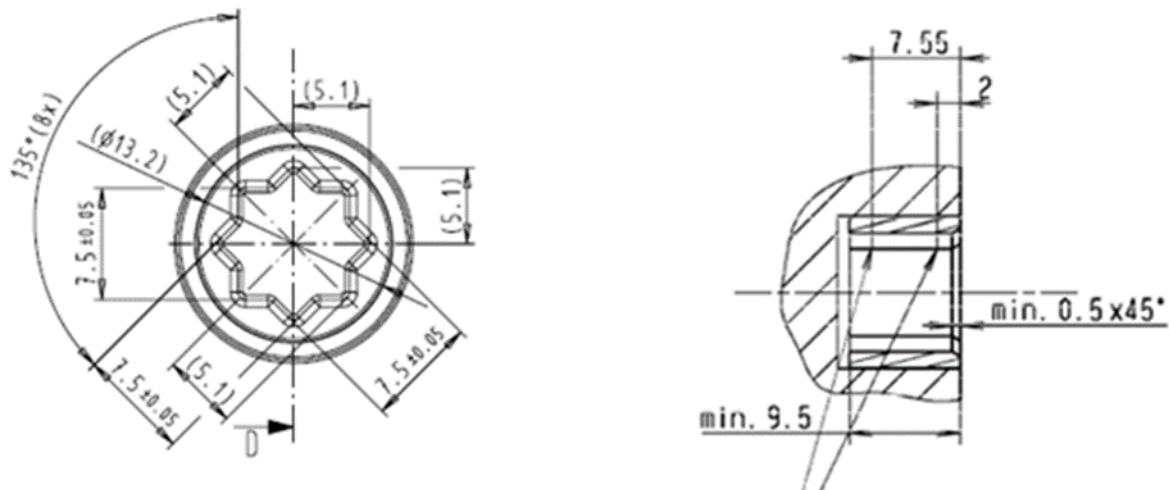
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- c. Supplier shall complete the calibration matrix for a unipolar actuator and release the calibration matrix for step range on all drawings submitted to GM for every design of the HVAC module. For a prototype HVAC module, the calibration matrix shall be available prior to delivery of parts. Obtain the latest calibration matrix from the actuator BFO.
- d. The actuator evaluation sheet and the calibration matrix shall be reviewed at the Technical Review and whenever a change impacts this information.
- e. The HVAC module supplier needs to use the GM control hardware on all the validation and durability testing for non-Global B architecture. For Global B, software that follows the GM control strategy with values from the calibration sheet must be used (reviewed and agreed with by the GM actuator BFO).
- f. The HVAC module supplier shall inform the supplier of the control module (i.e., Silverbox, BCM) which actuator solution will be used and provide the component data sheets.
- g. HVAC LIN stepper actuator learn cycle must be able to detect if the shaft between the actuator and the door is broken (failure mode: actuator moves but door remains stationary) for OBD-II compliance. The actuator shaft shall have the interface defined in GMW17655 and referenced in Figure 3.

Figure 3: Actuator Shaft Interface Example



Note: Dimensions in millimeters, min. = minimum.

3.2.1.1.5 LIN Actuators.

- a. The HVAC module supplier will run the validation and durability testing as defined in 3.2.3.
- b. Test hardware according the LIN standards for SAE J2602 Interface.
- c. Connector details are listed in the LIN stepper component specification (GMW17655).
- d. The LIN actuator supplier will be chosen by the GM actuator BFO from the suppliers named within SOR Appendix C2.

3.2.1.1.6 Heater Core and Pipes.

- a. Heater core to comply with GMW14322.
- b. See SOR Appendix C2 for program specific tube interface design. HVAC tube interface (dimensions, surface finish, and other requirements) to comply with specified hose connection type (ex: quick connect, hose and clamp, etc.) Reference GMW17144 and GMW16295.

3.2.1.2 Common HVAC Module Strategy.

- a. Supplier must comply with the packaging envelope provided at the time of sourcing. That packaging file name and number is provided in SOR Appendix C2.

3.2.1.2.1 Instrument Panel (IP) Skin Bandwidth Absorption.

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- a. IP skin bandwidth will affect HVAC Module cross program usage of the HVAC front module. The Integration to Cross car beam package will need an adapter to the air outlet interface (Defrost and Vent). This needs to be reviewed with GM Duct BFO to consider the IP assembly concept.
- b. Boss feature or snap in features must be provided on the HVAC Module defrost and ventilation flange to allow future transition ducts to be added for applications.

3.2.1.3 Interior Ventilation Air Management.

3.2.1.3.1 General Air Path Requirements. The HVAC module shall meet all the requirements in GMW14780.

3.2.1.3.2 Airflow Resistance of Module Interfaces.

- a. The resistance (R) defined in Table 4 may be used to simulate the resistance of vehicle parts.
- b. The scope of Figure 4 and Figure 5 is the alignment of the communicated values between module requirements (HVAC SOR), Computational Fluid Dynamics (CFD) simulation and validation tests. See Figure 4 for cabin side and Figure 5 for plenum side.
- c. The module supplier must define the pressure drop (resistance) to be overcome by the HVAC module in the different modes.
- d. This target scalars should describe all resistance in the suction side (plenum) of the module as well as in the different modes in the high-pressure side (cabin air flow).

Table 4: Airflow Resistance

	$R \times 10^{-3}$ Note 1 Initial Resistance Target (Pa s²/l²)	Associated Airflow (Liter(s) per second (L/s))
Inlet (Figure 4)		
IP Recirculation Path	9 +2/-0	125
Leaf Screen/Plenum, (Figure 5)	12 +2/-0	125
Outlet (Figure 4)	Single Outlet System	Single Outlet
Front A/C Ducts/Outlets With Rear Vent Open	220 per Single Outlet/Duct Feed	25
Rear A/C Duct/Outlets	250	25
Front Heater	200 per side	30
Rear Heater	400 per side	20
Front Defroster	30 (Defrost Duct path plus Grille)	80
Side Window Defroster Ducts/Grilles	2000 ± 500 per side Note 1	10

Note 1:

- R value is an estimate that will be updated as the program progresses. Actual pressure drop curves should be used when available.
- The filter is considered part of the internal module restriction.
- The filter type needs to be considered with maximum resistance fine dust and charcoal filter for optional content.
- Both ducts side window defrost (LH and RH) must be within a range of 500 Pa s²/l².
- The reflected numbers in Table 4 show typical values. Actual values of program need to be provided to the GM HVAC Module DRE to ensure the HVAC Module will meet the internal airflow quantity requirements.

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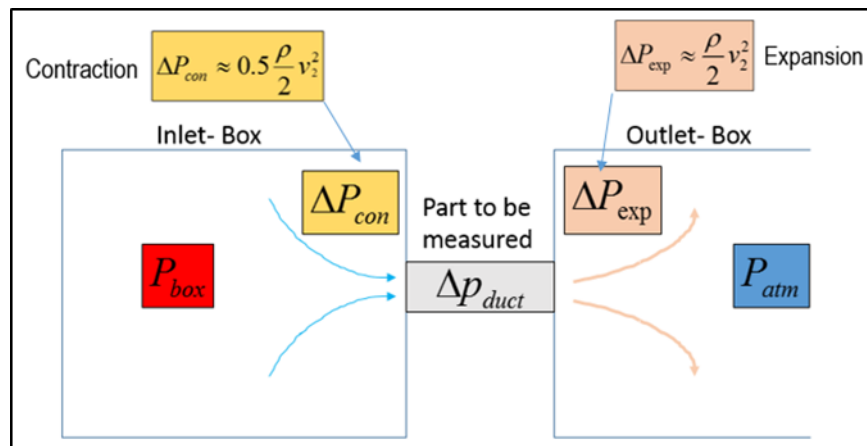
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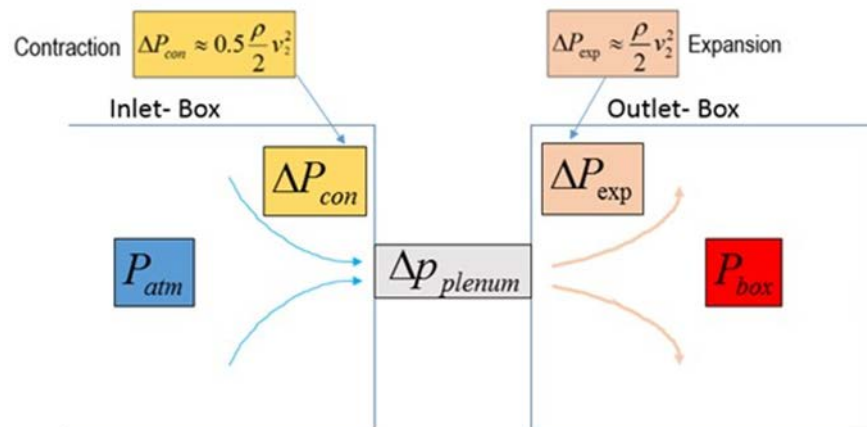
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Figure 4: Cabin Side



Note: atm = atmosphere, Con = Contraction, Exp = Expansion, P = Pressure, V = Volume.

Figure 5: Plenum Side



3.2.1.3.3 Air Flow Volume.

- Minimum HVAC airflow quantities shall meet requirements Table 5. Power of 12 V applied to brushed blower (or PWM% at system airflow target) with the filter installed in the module (Report airflow with standard and worst case optional filter).
- R values per 3.2.1.3.2 Airflow Resistance of Module Interfaces are to be used for initial system sizing and for module minimum airflow testing as shown in the preceding table. Realistic duct resistances shall be used as soon as such are available. Supplier is responsible to request new duct resistance values from the GM HVAC module DRE.
- Follow SOR Appendix C2 values for program specific requirements.
- Phone charger cooling airflow is in addition to the minimum airflow requirement.

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Table 5: Air Flow Volume

Mode	Minimum Required Airflow (L/s) @ 12 V	Phone Cooler Duct Airflow (L/s)	Maximum Current Draw (Amps (A)) in all modes
Airflow, Vent, F/C, OSA (with rear Vent)	125	2.5	25 (Brush) @ 12 V 25 (BLDC) @ 13 V
Airflow, Vent, F/C, OSA (without rear Vent)	125		
Airflow, Floor, F/H, OSA	90		
Airflow, DEF, F/H, OSA	100		

Note: Def = Defrost, F/C = Full Cold, F/H = Full Hot.

3.2.1.3.4 Air Flow Distribution.

- The air flow distribution test must also be run at 6 V and 14 V applied to the blower and the data and distribution results provided to the responsible GM Engineer. For BLDC (blower motor) data, use PWM in percent; 40% and 95% (or maximum useable PWM).
- Test to be run and reported with both directions of cam travel with vehicle controller logic (to understand distribution change with hysteresis and tolerance).
- Zero values within Table 6 and Table 7 have a tolerance of up to +1% and GMW14780 must still be met (not over constrained as the HVAC pressure may be higher than that specified in GMW14780).
- The airflow distribution across similar outlets (i.e., IP vent, LH/RH Defroster, LH/RH Side Window Defrost (SWD), LH/RH heater) shall be within 5% of each other from lowest to highest airflow.
- R values per 3.2.1.3.2 Airflow Resistance of Module Interfaces are to be used for initial system sizing and for module minimum airflow testing as shown in Table 6. Realistic duct resistances shall be used as soon as such are available. Supplier is responsible to request new duct resistance values from the GM HVAC module DRE.
- Dual zone will be forced by console HVAC booster blower RPO C77 and tri-zone module RPO CJ4, see Table 7.
- The required values within Table 6 and Table 7 must be achieved at all operating temperature (-40 °C to 65 °C) and with hot engine coolant through the heater core (as in the vehicle). Ensure that all materials chosen will not influence the ability of the HVAC module to achieve the values within Table 6 and Table 7.
- Bleed to outer vents in heating modes should be in its own channel (no leakage over to inner vents).

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Table 6: Air Flow Distribution

Mode	Inlet Air	Tempera- ture Lever Set Position	Outlet Air														
				W/S		Inner Vents		Outer Vents Note 3		Rear Vent		Front Floor		Rear Floor		Front SWD	
				Dr	Pa	Dr	Pa	Dr	Pa	Dr	Pa	Dr	Pa	Dr	Pa	Dr	Pa
Vent with Rear Vent	Rec	F/C	%	0		40 -2/+3		40 -2/+3		20 -2/+3		0		0		0	
			L/s														
Vent without Rear Vent	Rec	F/C	%	0		50 -2/+3		50 -2/+3		0		0		0		0	
			L/s														
Vent with Rear Vents	OSA	F/C	%	0		40 -2/+3		40 -2/+3		20 -2/+3		0		0		0	
			L/s														
Vent without Rear Vent	OSA	F/C	%	0		50 -2/+3		50 -2/+3		0		0		0		0	
			L/s														
Bi-level with Rear Vent	OSA	30% from F/C	%	0		23 -2/+3		23 -2/+3		12 -2/+3		27 -2/+3		15 -2/+3		0	
			L/s														
Bi-level without Rear Vent	OSA	F/C	%	0		26 -2/+3		26 -2/+3		0		33 -2/+3		15 -2/+3		0	
			L/s														
Floor with Rear Floor	OSA	F/H	%	15 -0/+3 Note 1		0		6 -0/+2		0		44 -2/+3		25 -2/+3		10 -0/+2 Note 1	
			L/s														
Floor without Rear Floor	OSA	F/H	%	15 -0/+3 Note 1		0		6 -0/+2		0		69 ± 5		0		10 -0/+2 Note 1	
			L/s														
Defog with Rear Floor	OSA	F/H	%	25 -0/+5		0		6 -0/+2		0		39 -2/+3		20 -2/+3		10 -0/+2 Note 1	
			L/s														
Defog without Rear Floor	OSA	F/H	%	25 -0/+5		0		6 -0/+2		0		59 ± 5		0		10 -0/+2 Note 1	
			L/s														
Defrost	OSA	F/H	%	72 -2/+3		0		6 -2/+3		0		0		0		18 -2/+3	
			L/s														
Park Note 2	OSA	F/H	%	0		0		6 -2/+5		0		94 -5/+2				0	
			L/s														
Hi-level Note 4	OSA	F/C	%	40 -2/+3		20 -2/+3		20 -2/+3		10 -2/+3		0		0		10 -0/+2	
			L/s														
Tri-level Note 4	OSA	F/H	%	15 -0/+3		20 -2/+3		20 -2/+3		10 -2/+3		20 -2/+3		10 -2/+3		5 -0/+2	
			L/s														

Note: Dr = Driver, Pa = Passenger, Rec = Recirculated, W/S = Windshield.

Note: Bi-Level, Hi-Level, Tri-Level, see 6.1.

Note 1: Minimum airflow is 9 L/s.

Note 2: Park mode can be replaced to an existing mode with GM DRE approval.

Note 3: Vent DAT sensor should be placed in outboard outlets with air bleed to allow reading when vent door is closed.

Note 4: For vehicles without rear vent or floor, the rear vent (or floor) air percentage will shift to the corresponding front outlet.

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Table 7: Air Flow Distribution with Booster Blower Console

Mode	Inlet Air	Temperature Lever Set Position	Outlet Air (%)						
			W/S	Inner Vents	Outer Vents	Rear Vent	Front Floor	Rear Floor	Front SWD
Vent	Rec	F/C	0	35 -2/+3	3 -2/+3	30 -2/+3	0	0	0
Vent	OSA	F/C	0	35 -2/+3	35 -2/+3	30 -2/+3	0	0	0
Bi-level	OSA	30% from F/C	0	22 -2/+3	22 -2/+3	15 -2/+3	23 -2/+3	15 -2/+3	0
Floor	OSA	F/H	10 -0/+3	0	6 -0/+3	0	44 -2/+3	30 -2/+3	10 -2/+3
Defog	OSA	F/H	20 -0/+5	0	6 -0/+2	0	39 -0/+2	25 -0/+2	10 -0/+2
Defrost	OSA	F/H	72 -2/+3	0	6 -2/+3	0	0	0	18 -2/+3
Tri-level	OSA	F/H	15 -2/+3	15 -2/+3	15 -2/+3	15 -2/+3	20 -2/+3	15 -2/+3	5 -0/+2
Hi-level	OSA	F/C	30 -2/+3	20 -2/+3	20 -2/+3	20 -2/+3	0	0	10 -0/+2

3.2.1.3.5 Subsystem Blower Control Linearity (Manual Control-Resistor). Not applicable.

3.2.1.3.6 Mode Sequence for Main Single Mode and Dual Mode Sequence. See Note.

Note: To fulfill OBD-II requirements, Defrost mode must be positioned at an end stop of the Mode cam disc.

- Test condition and requested runtime, see Table 10.
- Mode sequence shall be according to Table 8.

Table 8: Mode Sequence

Description	Mode Sequence	Comment
Electronic Climate Control and Actuator Driven Manual Systems for single mode and dual mode solution	Defrost - Defog (Pass-Through with no detent) - Heater - Defog - Tri-level - Bi-level - Vent - Hi-level	For OBD-II market certification, the defrost position on one (1) end of the cam is mandatory.
Passenger mode sequence for dual mode and Airflow Based on Occupant (ABO)	Heater - Bi-level - Vent	Mode sequence will be used on the passenger side vent and floor cam for modules with Dual Mode.
Cable Driven Manual Systems (RPO C60)	Defrost - Defog - Heater - Bi-level - Vent	Cable Driven Manual Systems (RPO C60) Mode locations (with the exception of the Defog Pass-Through with no detent) shall be identified to meet Interior Airflow Quantities Table 7. Test data must be provided for the worst-case position. Cam Disk sequence shall Operate CW and CCW to the nominal position for hysteresis effect identification.

Note: CCW = Counter Clockwise, CW = Clockwise.

- Park mode preference is outside side of five main modes (Defrost-Defog-Heater-Bi-level-Vent). Requests to change mode sequence to manage cam rotation angles must be agreed to by the GM HVAC BFO.

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3.2.1.3.7 Module Door Actuators. See Table 9.

- The HVAC module control has the ability to control either Uni-Polar stepper actuator = Global A (Silverbox) and LIN Stepper = Global B (BCM).
- Refer to the electrical interface information GMW17110 (Unipolar Stepper) and GMW17655 (LIN Stepper).
- Doors are required to be center pivot due to torque limitations for cable driven systems and actuator driven systems.
- Supplier responsible to design a HVAC that meets the actuator torque at all the defined temperature and voltage extremes.

Table 9: HVAC Module Torque Level on Actuator Shaft Interface

Function	Transport/Travel
Mode (N cm) @ 23 °C	15 N cm + 15%
Temperature Door/Air Mixing (N cm) @ 23 °C	10 N cm + 15%
Recirculation Door (N cm) @ 23 °C	10 N cm + 15%

3.2.1.3.7.1 Stepper Motor Actuators.

- The actuation time for Mode (air distribution) Blend door and recirculation door shall be per Table 10.

Table 10: Test Conditions for Automatic Systems

	Condition	Condition	Condition	Comments
Voltage	11 V to 16 V	11 V to 16 V	11 V to 16 V	This is also the input voltage to the GM control device
Temperature	-30 °C	23 °C	85 °C	Needs to operate at -40 °C
Air Distribution Actuation Time	≤ 12 s	≤ 12 s	≤ 12 s	From one mode to any other mode (both directions)
Temperature Door Actuation Time	≤ 6 s	≤ 6 s	≤ 6 s	From fully cold to fully hot (both directions)
Fresh Air/Recirculation Actuation Time	≤ 3 s +1 s/-0 s	≤ 3 s +1 s/-0 s	≤ 3 s +1 s/-0 s	100% fresh air to 100% recirculation (both directions)

3.2.1.3.8 Interior Air Recirculation.

- The module must use an actuator to move the air inlet door from outside air (fresh) to recirculated inside air.
- The recirculation door default position is on fresh air position. The door needs to provide a mechanical hard stop.
- Air inlet design to be capable of operating and sealing OSA under ram pressure and not creating abnormal noises. Up to 350 Pa at the air inlet unless vehicle data dictates higher pressure.

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3.2.1.3.9 Partial Recirculation and Ram Air Compensation.

- a. It shall be possible to adjust any mixture ratio between recirculation and outside air, independent from blower speed, between 100% (full recirculation air) and 0% (full outside air). The ratio should be set in steps $\leq 5\%$, taking into account the resolution of the actuators and the mechanical play of the flap(s).
- b. Air bypass in partial recirculation is not allowed.
- c. Partial recirculation (air inlet door travel of 20% to 80%) must be functional at a blower voltage of 3 V or until the blower air inlet (plenum-side) pressure to cabin pressure exceeds 200 Pa.

3.2.1.3.10 Air Inlet Protection.

- a. Design must accommodate the addition of a coarse screen grid on the fresh (e.g., 10 mm hexagon debris grid) and recirculation air inlet.
- b. If recirculation air inlet is placed near the open glove box such that particles can be sucked into the inlet, then a screen mesh is necessary and the glove box ingestion test must be passed per GMW3070.

3.2.1.3.11 Air Filtration.

- a. Filtration for both OSA and Recirculation Air Inlet Modes. The system must be equipped with a fine dust filter, particle filter or charcoal filter per GMW14323 and GMW14787.
- b. Filter dimensions: See filter drawing. Filter box must follow filter box criteria (Teamcenter file number: OPY27721).
- c. Particle (Freudenberg) and combination filter (Mann + Hummel) are corporate common components (CCC).
- d. The design of the filter cassette for service must reflect the necessity of removing the filter without allowing debris to fall from filter. Therefore, height clearance must be maximized.
- e. Filter door should have screw bosses (as back-up) built in to HVAC case and door design if a fastener-free design is used.
- f. Fastener free filter door designs must be designed to prevent the door from disengaging during shipping/IP assembly/etc.

3.2.1.3.11.1 Particle Filter Specifications.

- a. The HVAC particle filter shall comply with GMW14323.
- b. Only fine dust filters are required to meet the fine particle section of GMW14323 and GMW14787 (Range of Small Particles (sodium chloride (NaCl))).

3.2.1.3.11.2 Combination Filter Specifications.

- a. The HVAC air pollutant (combi fine dust) and odor filter shall comply with GMW14787.

3.2.1.3.11.3 Air Quality Detection. Mounting features required for Interior Air Quality sensors.**3.2.1.3.12 Stale Air Odor Reduction/Smell.**

- a. The HVAC subsystem shall be designed to eliminate stale air odor.
- b. Evaporator Surface. See GMW16151 and GMW17389.
 - 1. In order to prevent odors caused by microbial activity on the evaporator, all applicable evaporator surfaces shall have antimicrobial properties that last the life of the evaporator.
 - 2. In order to promote surface cleaning during use, reduce the risk of condensate spitting, and improve heat transfer, the surfaces of the evaporator shall be hydrophilic for the life of the evaporator core.
- c. The HVAC subsystem shall be capable of accepting an "After-blow" function as an optional module in service. "After-blow" is a function to run cabin blower on mid speed, on parked vehicle, with ignition off.
- d. For the HVAC/PTC system, the supplier shall ensure that HVAC system's components and HVAC Module components do not create noticeable odors that would be unacceptable to customers (i.e., evaporator odor or out-gassing).
 - 1. All interior parts and materials shall be rated 6 or better when evaluated as described in GMW3205.
 - 2. All interior parts and all interior materials shall pass test method GMW3259 Water Intrusion Management.

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- e. The blower control unit (LPM or resistors) and blower motor shall be located in an area where no water or soap suds accumulation can occur by default (e.g., condensate water, splash from air intake), or the components shall be protected to guarantee full function over vehicle life time.
- f. Blower fan wheel design shall not have a horizontal surface(s) that can collect water. See GMW16661 and GMW15259.
- g. Compliance to GMW15259 must be demonstrated.
- h. For BLDC motor application testing for water intrusion per GMW16661 is mandatory.

3.2.1.3.13 Water Condensate Management.

- a. Water formed on the evaporator or other internal system parts shall be drained to the vehicle exterior through a HVAC case drain spigot using a strategically defined fluid flow path. The condensate drain hole inner diameter to be designed based on GM Best Practice HVACPTC-357 (The supplier shall work with the GM Design Responsible Engineer to comprehend this requirement.) which includes an angled downward HVAC case condensate drain spigot design feature. Spigot Inside Diameter/Outside Diameter (ID/OD) to be designed based on GM Best Practice for external hose attachment compatibility while being protected from damage during module handling. The exterior surface of the drain spigot shall provide a non-disrupted sealing surface at an appropriate extended hose overlap length for the mating drain hose and include a suitable hose retention feature. The supplier shall work with the GM DRE to comprehend this requirement.
- b. The HVAC module case design is to include features (i.e., ribs, shielding, shielding attachment points, etc.) which prevent external condensate dripping onto electrical components, the occupant, or other components or from being perceived negatively by the vehicle occupant. The supplier shall work with the GM DRE to comprehend this requirement.
- c. The HVAC module shall satisfy the requirements of GMW3055 and GMW15966.
- d. No water (drops, fog, steam, or mist) shall escape from the air outlets when the blower is operated at high speed.
- e. When the vehicle is tilted 15 degrees in any direction, no condensate shall escape from the air conditioning unit. Test per GMW3055.
- f. No water shall touch the heater core or enter the heater core area.
- g. No water shall pool/accumulate inside the HVAC module.
- h. The fin density of the evaporator needs to be confirmed to not spit water with high of airflow.
- i. Design Validation (DV) testing is still required with a new HVAC module, even if the evaporator is reused.

3.2.1.3.14 Envelope Condensation Management.

- a. Condensate Build Up. There shall be no condensate build-up on the exterior of the HVAC module when tested in a climate chamber set to $32\text{ }^{\circ}\text{C} \pm 1\text{ }^{\circ}\text{C}$ and $85\% \pm 1\%$ relative humidity. The HVAC module boundary conditions shall be set to the following parameters:
 - Air Intake Temperature 32 °C
 - Air Intake Relative Humidity 85%
 - Evaporator Pressure 310 kPa (absolute)
 - Condensing Pressure 1700 kPa (absolute)
 - Liquid Temperature Before Expansion Valve 50 °C
 - Superheat 3 K
 - Refrigerant R134a
 - Heater Core Flow 12 L/minute
 - Heater Core Inlet Temperature 85 °C
- b. Pictures of results to be reported to Validation Engineer/DRE.
- c. Consider the component orientation to meet IP5K2 (GMW3172) outside the module for the connectors and electric components.
- d. If the chamber is not capable of the refrigerant side condition, then other methods to produce 5 °C air through the module can be proposed but must be agreed by the GM HVAC module BFO.

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e. See GMW3172 definition for dust and water protection level for electrical components on the HVAC module.

3.2.1.4 Interior Cooling Performance.

3.2.1.4.1 Heat Rejection Capacity.

3.2.1.4.1.1 R134a Heat Rejection Capacity.

a. The air-side cooling capacities should be calculated based on temperatures measured at the module exit (duct interface) in ventilation mode, full cold for the selected airflows in Table 11.

Table 11: R134a Airflows

Air Flow	R134a
70 L/s (280 kg/h)	4.9 kW (11 °C)
105 L/s (420 kg/h)	6.4 kW (11 °C)
130 L/s (520 kg/h)	8.4 kW (11 °C)

Note: The **Air Flow** (reference value) is noted due to L/s being different at different air temps because of density. Similarly, for **R134a**, the Celsius is a reference outlet temperature but the requirement is the kW.

b. The maximum surface temperature distribution across the evaporator core under the airflow conditions in Table 11 shall be < 5 K.

c. The boundary conditions of the HVAC module for preceding items a. and b. are listed as follows.

- Air Intake Temperature 40 °C
- Air Intake Relative Humidity 40%
- Evaporator Pressure 310 kPa (absolute)
- Condensing Pressure 1700 kPa (absolute)
- Liquid Temperature Before Expansion Valve 50 °C
- Superheat 3 K
- Refrigerant R134a
- Heater Core Flow 12 L/minute
- Heater Core Inlet Temperature 85 °C

d. The evaporator test points within GMW16151 shall be run as a standalone evaporator and installed within the module. The evaporator performance shall be within 3% of each other (standalone vs. in-module), and reported in the Analysis Development Validation Plan (ADVP). Airflow leakage and heat pickup should be minimized such that refrigerant cooling capacities are within 5% of the airside cooling capacity as measured at the module outlet and no unconditioned bypass leak to EAT sensor, charger cooling duct or other feature requiring conditioned air.

3.2.1.4.1.2 R744 Heat Rejection Capacity. Not applicable.

3.2.1.4.1.3 HFO1234yf Heat Rejection Capacity.

a. The airside cooling capacities should be calculated based on temperatures measured at the module exit (duct interface) in ventilation mode full cold for the selected airflows in Table 12.

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