



Linearity Test at Passenger Vehicle Heating and A/C Systems on Heater Test Bench and in the Climatic Wind Tunnel

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. Determination of air temperatures at the outlets of the air duct parts in passenger vehicles heating and air conditioning systems, dependent on temperature air mix door setting or coolant control valve position.

1.1.1 Determination on module on heater test bench.

1.2 Applicability. Heating and air conditioning systems for all passenger vehicles.

2 References

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

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

GMW15845

2.3 Additional References.

- Subsystem Technical Specification (SSTS)
- Vehicle Technical Specification (VTS)

3 Resources

3.1 Facilities.

3.1.1 Calibration. The test facilities and equipment shall be in good working order and shall have a valid calibration label.

3.1.2 Alternatives. Alternative test facilities and equipment may also be used. However, all measuring variables as specified in this standard shall be determined correctly with respect to their physical definition.

3.1.3 Tests on Test Bench.

3.1.3.1 Cold chamber (air cooling device) with adjusting possibility for the ambient temperature $\leq -20\text{ }^{\circ}\text{C}$ and $> +25\text{ }^{\circ}\text{C}$.

3.1.3.2 Heating coolant tank with circulating pump, controllable delivery pump and flow meter.

3.1.3.3 Air flow meter to measure the air flow of the compartment blower with capability $> 100\text{ L/s}$.

3.1.3.4 Refrigerant loop test stand capable to supply evaporator with required refrigerant flow rate.

3.1.3.5 A graphic of a typical linearity bench shown in Appendix C, Figure C1.

3.1.4 Tests in the Climatic Wind Tunnel. Climatic wind tunnel including a chassis dynamometer with adjusting possibilities for vehicle speed ($\geq 60\text{ km/h}$), wind speed ($\geq 60\text{ km/h}$) and ambient temperature capability $\leq -20\text{ }^{\circ}\text{C}$ and $> +25\text{ }^{\circ}\text{C}$.

3.2 Equipment.

3.2.1 Temperature measuring and recording equipment for at least 30 measuring points.

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3.2.2 Measuring and recording equipment for voltage and current for the compartment blower.

3.2.3 Measuring and recording equipment for the blower speed (bench test only).

3.2.4 An external power supply (15 V, 40 A) for the compartment blower.

3.2.5 Measurement device for the recording of travel or angles in heater control units.

3.2.6 Measuring and recording equipment for the engine speed (climatic wind tunnel tests only).

3.3 Test Vehicle/Test Piece.

3.3.1 Heater or air conditioning system module.

3.3.2 Passenger vehicle equipped with heating or air conditioning system.

3.4 Test Time. Not applicable.

3.5 Test Required Information. Not applicable.

3.6 Personnel/Skills. One (1) climatic tunnel operator and one (1) driver.

4 Procedure

4.1 Preparation. The module or vehicle shall be prepared for the test and be equipped with the devices according to Sections 3.2 and 4.2.2.

For bench tests, the module shall be assembled completely with compartment blower, ventilation ducts, nozzles, front and rear floor air distribution, defroster duct, and control unit. The assembly shall be installed at the air flow meter outlet.

The mode flaps and the temperature flap(s) shall be adjusted by the production intent control unit. The position of the control unit and the cables shall be the same as that in the vehicle.

4.2 Conditions.

4.2.1 Environmental Conditions.

4.2.1.1 Heater, Defrost and Defog mode testing shall be run at temperature conditions of -20 °C, 0 °C and +10 °C.

4.2.1.2 Bi-level and Tri-level mode testing shall be run at temperature conditions of +10 °C.

4.2.1.3 Ventilation mode test shall be run at temperature conditions of +25 °C.

4.2.1.4 Relative humidity shall be 60% for tests at +10 °C and +25 °C.

4.2.1.5 Tolerance on temperature is ± 1 K.

4.2.1.6 Tolerance on humidity is $\pm 5\%$ Relative Humidity.

4.2.2 Test Conditions. Deviations from the requirements of this standard shall have been agreed upon. Such requirements shall be specified on component drawings, test certificates, reports, etc.

4.2.2.1 Test Bench. See Figure C1 shown in Appendix C:

- Coolant: 50% antifreeze, 50% water.
- Air intake temperature at blower per environmental conditions.
- Coolant temperature at heater core in: $+90\text{ °C} \pm 1\text{ °C}$.
- Coolant flow rate: 0.2 L/s.
- Air flow rate of 40 L/s and 60 L/s. (60 L/s is required and 40 L/s is run as reference.) If different SSTS test points are specified for airflow rate, they shall be used instead of the standard points.
- For ambient temperatures at or $> 10\text{ °C}$ – Evaporator Out Pressure 310 kPa (absolute), Condenser Pressure 1700 kPa (absolute), before expansion device subcool of 8 K, Evaporator Out superheat to be controlled by the production intent thermal expansion valve (TXV) (if TXV is not available, use a superheat setting of 3 K).
- Additional condition for HVAC modules in A/C systems with an externally controlled variable displacement compressor (EVDC) or Evaporator Temperature Control: For ambient temperatures at $+25\text{ °C}$ – Evaporator out Pressure 410 kPa (absolute), Condenser Pressure 1100 kPa (absolute), before expansion device subcool of 8 K, Evaporator Out superheat to be controlled by the production intent TXV.

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4.2.2.2 Vehicle.

- Coolant: 50% antifreeze, 50% water.
- Compartment blower: External power supply, test voltage: 4 V, 6 V and 9 V at the Blower motor (6 V point is required, 4 V and 9 V are run as reference for Heater, Ventilation and Bi-Level Modes). If different SSTS/VTs test points are specified for voltage or control head settings, they shall be used instead of the standard voltage test points.
- Vehicle speed and wind speed: 60 km/h at road load gear step or drive position according to Table 1.

Table 1: Gear Steps or Drive Positions

Transmission	Gear Step or Drive Position
Manual - 4 speed	4 th gear
Manual - 5 speed - wide ratio ^{Note 1}	4 th gear
Manual - 5 speed - close ratio ^{Note 2}	5 th gear
Manual - 6 speed	4 th gear
Automatic	Highest Drive Gear

Note 1: 5th gear = Over Drive.

Note 2: 5th gear = 1:1 gear ratio.

The specified vehicle speed is driven at road load (on level stretches without acceleration).

For repeat measurements on vehicles with automatic transmissions, it shall be ensured that same vehicle speeds are driven at the same lowest engine speeds.

4.3 Instructions. The following modes and control travels shall be tested (see Table 2).

Table 2: Modes and Control Travels

Mode	Test Points	Control Travel
HEATER	Heater Outlets and Side Window Defroster (SWD) Outlets and Defroster Bleed and Side Vent Outlets	0% to 100% to 0%
DEFROST	Defrost Outlets and SWD Outlets and Heater Bleed and Side Vent Outlets	0% to 100% to 0%
DEFOG	Heater and SWD and Defrost Outlets and Side Vent Outlets	0% to 100% to 0%
VENTILATION	Instrument Panel (IP) Outlets and Rear A/C Outlets	0% to 100% to 0%
BILEVEL	Heater and Instrument Panel Outlets and Rear A/C Outlets	0% to 100% to 0%
TRILEVEL	Heater and Defrost and IP Outlets and SWD Outlets	0% to 100% to 0%
Intermediate Modes (in between the above modes)	Test as required for development	0% to 100% to 0%

4.3.1 Test Bench. Set mode switch to the desired position. The temperature selector lever shall be adjusted from 0% ("FULL COLD") in 10% steps up to 100% ("MAX HOT"). If necessary (e.g., for non-distinctive curve response), a finer adjustment (e.g., 5% steps) shall be performed.

To check Hysteresis, the test points shall also be run from 100% back to 0%.

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