



Performance Evaluation of Seat Heating Systems

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 describes the evaluation of the performance of seat heating systems in the seat assembly.

1.2 Applicability. To all seat heating system types.

1.3 Remarks. This Test Procedure shall measure the seat heater mat's temperature control behavior and heating characteristics during the heat-up curve (temperature over time) on seats

- in the climate chamber (single component)
- in the vehicle in the climate chamber
- in the vehicle during driving conditions (i.e., a road test).

This standard shall also subjectively evaluate the seats in the vehicle to determine the overall Vehicle Technical Specification (VTS) performance rating.

Note: Tests with a single seat in a climate chamber are defined as a component test. Validation tests are conducted during the in-vehicle condition.

Note: This standard is not suitable for initial heater mat sampling tests.

2 References

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

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

None

2.3 Additional References.

GM Serviceability Design Guidelines: GM handbook describing design methods and techniques to ensure that the operation of servicing GM vehicles is an efficient one.

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 Test lab with a temperature test chamber. The minimum requirements for the test chamber are described in Table 1.

Table 1: Test Chamber Requirements

Chamber	Requirement
Test Area (L x W x H)	2.0 m x 1.5 m x 2.0 m
Temperature Range	(-15 to +25) °C
Temperature Stability	±2 °C
Relative Air Humidity	(10 to 90) %
Rate of Temperature Variation	1.5 °C/minute
Electrical Connection	Controllable

3.2 Equipment.

3.2.1 Portable, shock and climate resistant measurement system with a valid calibration label. Measurement computer must be capable of capturing the data described in Table 2.

Table 2: Measured Values

Data	Value
Temperatures	(-15 to +60) °C
Voltages	(0 to 20) V
Currents	(0 to 20) A
Acquisition Rate	1 Hz

3.2.2 Laptop computer for interpretation of measured data.

3.2.3 Adapter for measurement signal conversion (shunt).

3.2.4 Sixteen (16) thermocouples for determination of the seat surface temperature, vehicle interior temperature and ambient temperature.

3.2.5 Voltage/current measurement module for measuring system.

3.2.6 Thermography camera or infrared thermometer for the localization of the heating wires. The thermography camera is required to perform the thermography picture of the heated surface distribution.

3.2.7 External battery or transformer for measurement computer power supply or adapter for onboard supply system.

3.2.8 Stop watch or onboard computer timer function.

3.3 Test Vehicle/Test Piece.

3.3 Test Vehicle/Test Piece. A seat heater mat, which shall be tested and evaluated in the seat and vehicle type for which it is intended. The vehicle electrical system shall be dimensioned for connection of seat heating.

Note: If the same seat heater mat is utilized for different seat equipment and trim levels, the heater mat shall be evaluated and validated separately for each equipment level.

3.4 Test Time. Test time is dependent upon the control design of the heater mat to be tested. Cumulative test times including data recording time are shown.

Note: Winter sessions are preferred for vehicle tests.

Calendar time: 1 day

Test hours:

Objective Evaluation:

Heat-up curve measurement for determination of the temperature levels = **1-2-3 Measurement**

- 1 Stage Control: 45 minutes
- 3 Stage Control: 70 minutes
- 5 Stage Control: 110 minutes

Subjective Evaluation and Measurement of heating performance under customer conditions =
3-2-1 Measurement

- 1 Stage Control: 45 minutes
- 3 Stage Control: 90 minutes
- 5 Stage Control: 150 minutes

Coordination hours: 10 h

3.5 Test Required Information.

3.5.1 The evaluation of the performance of the seat heating system shall be performed in the order described in 3.5.1.1 thru 3.5.1.3.

3.5.1.1 Climate chamber test with single seats (component test).

3.5.1.2 Vehicle test in the climate chamber or in comparable climate condition during driving operation.

3.5.1.3 Subjective evaluation during driving operation.

3.5.2 No vehicle test shall be performed until the results from a single seat test (component test) in the climate chamber are not according to specification.

3.5.3 A subjective evaluation of the seat heating system in the vehicle during driving shall always be preferred to an evaluation in the climate chamber.

3.5.4 Comfort evaluations in the climate chamber can only serve development purposes.

3.6 Personnel/Skills.

3.6.1 Tester. Test Engineer or lab technician with the proper training required to perform the seat heating test procedure.

Standard Tester:

Weight: (75 ± 5) kg

Height: (178 ± 3) cm (178.6 cm equates to 50-percentile male in Germany)

3.6.2 Comfort Evaluators. For subjective evaluation of comfort, five (5) individuals shall be chosen as a representative customer group. One (1) individual shall be of the standard size as described in 3.6.2.1. The remaining four (4) comfort evaluators shall be of varying body measurements.

3.6.3 Required Clothing.

- Jeans, without long underwear.
- Cotton T-shirt.
- Light pullover (i.e., medium thick cotton or cotton mixed sweat shirt $\approx (250 \text{ to } 300) \text{ g/m}^2$).

No jackets, no specific winter/ski wear, no belts or braces.

Note: pay attention to double stitches and multiple layer (pockets)

4 Procedure

4.1 Preparation.

4.1.1 Number of Temperature Measuring Points on the Seat.

4.1.1.1 There shall be fourteen (14) thermocouples fixed onto the upholstered seat surface; seven (7) on the seat cushion and seven (7) on the seat back as shown in Figure 1.

4.1.1.2 The fourteen (14) individual thermocouples shall each be soldered onto a piece of 15 mm x 15 mm (thickness of ≈ 0.2 mm) blackened copper foil.

4.1.2 Location of Temperature Measuring Points on Seat and in Vehicle.

4.1.2.1 Seat. Affix fourteen (14) thermocouples on the upholstered seat surface directly above the heating wire as shown in Figure 1 and described in Table 3.

Note: For the exact determination of heating wire location during seat heating running (Figure 2), perform a thermography survey or measure surface temperature with an infrared temperature measuring unit.

Should be a seam or stitches exist in the measurement area, then the temperature sensor shall be positioned next to this above the heating wire.

4.1.2.2 Vehicle Interior Temperature. Install one (1) thermocouple in the vehicle interior at face level of the driver. This thermocouple shall be used to measure the vehicle interior temperature.

4.1.2.3 Ambient Temperature. Install one (1) thermocouple on the vehicle interior roof. This thermocouple shall be used to measure ambient temperature.

4.1.2.4 Temperature Sensor (optional). Install one (1) thermocouple directly on the heater wire in the vicinity of the temperature sensor. This thermocouple shall be used to obtain exact information on the control response of the heater mat.

4.1.3 Document Seat Surface Installation Positions.

4.1.3.1 In order to have the ability of reproducing the test environment, the positions of the temperature measuring points on the heater wire shall be documented by means of a photo (preferred) or a drawing. Record the dimensions described in 4.1.3.1.1 and 4.1.3.1.2. Use Figure 1 as a guide.

Note: For the determination of these values, the seat back shall be positioned vertically.

4.1.3.1.1 Seat Surface.

4.1.3.1.1.1 Seat Surface Y. Distance of thermocouple from center line.

4.1.3.1.1.2 Seat Surface X. Distance of thermocouple from seat rear edge.

4.1.3.1.2 Back Surface.

4.1.3.1.2.1 Back Surface Y. Distance of thermocouple from center line.

4.1.3.1.2.2 Back Surface Z. Distance of thermocouple from seat cushion surface.

4.1.3.2 If several measurements are performed at the same seat level, the measuring positions shall be determined at the start of the measurement sequence. Measurement positions shall be reused maintaining a tolerance of ± 10 mm.

Figure 1: Thermocouple Positions

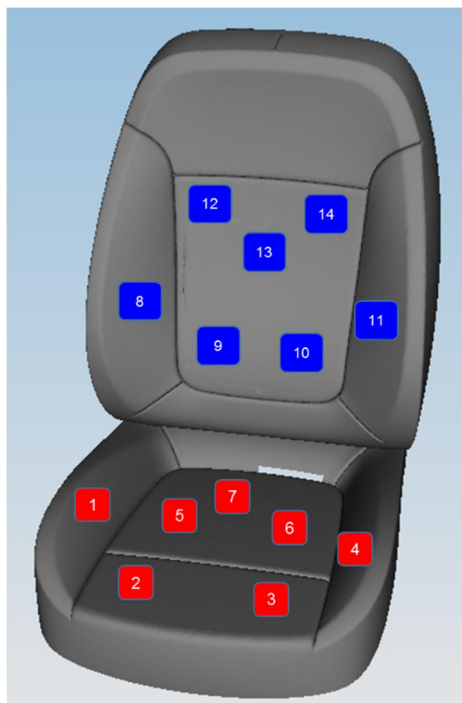
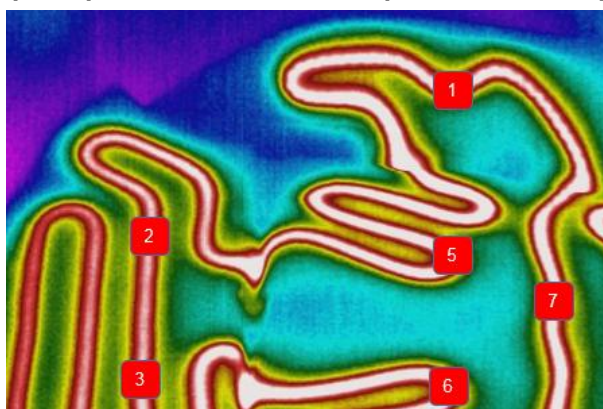


Table 3: Thermocouple Position Location Key

Seat	Back
1. Side bolster - tunnel (if heated)	8. Side bolster - tunnel (if heated)
2. Front - tunnel	9. Bottom - tunnel (kidney area)
3. Front - door	10. Bottom - door (kidney area)
4. Side bolster - door (if heated)	11. Side bolster - door (if heated)
5. Center - tunnel	12. Center - tunnel
6. Center – door	13. Center - back
7. Rear - center	14. Center - door

Figure 2: Infrared View of Thermocouple Locations
(example of cushion and complete heated seat)

4.1.4 Connect Volt/Ampere Measurement Module. Connect the volt/ampere measuring module between the heater mat and the vehicle power supply to measure the applied voltage and the current consumption of the heater mat.

4.1.5 Cool Seat before Testing. To assure a steady temperature of the seat before starting the evaluation, the seat must be soaked at a test condition temperature of $(-10 \pm 2) ^\circ\text{C}$ for a time period as specified in 4.1.5.1 thru 4.1.5.3.

4.1.5.1 Seat in the vehicle with vehicle doors or windows open. Soak seat ≥ 5 h.

4.1.5.2 Seat in the vehicle with closed vehicle doors and windows (closed condition). Soak seat ≥ 10 h.

4.1.5.3 Single seat in the climate chamber. Soak seat ≥ 5 h.

4.2 Conditions.

4.2.1 Environmental Conditions.

4.2.1.1 For Heat-up Curve Measurement with Single Seats or a Vehicle in a Climate Chamber. When testing single seats or a vehicle in a climate chamber, temperature of climate chamber shall be $(-10 \pm 2) ^\circ\text{C}$.

4.2.1.2 For Heat-up Curve Measurement during Driving Evaluation.

4.2.1.2.1 Ambient Outside Temperature. When testing a vehicle outside, outside temperature should be in the range of $(-10 \pm 3) ^\circ\text{C}$. When outside temperature is not in the range of $(-10 \pm 3) ^\circ\text{C}$, the vehicle should be soaked in a climate chamber (4.2.1.1) prior to the road test. When the vehicle shall be soaked in climate chamber, outside temperatures shall be $< 0 ^\circ\text{C}$.

4.2.1.2.2 Driving distance. Driving distance is variable and at the discretion of the Test Engineer.

4.2.1.2.3 Driving speed. Driving speed shall conform to traffic and road condition.

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.

4.3 Instructions.

4.3.1 Pre-test.

4.3.1.1 Validate Test Setup. After the thermocouples are installed on the seat and the measuring instruments are connected, the Test Engineer shall perform a test of the measurement setup. The operation of the measurement equipment shall be validated and the desired seating position shall be adjusted on the basis of the test drive.

4.3.1.2 Perform a Test Seating. The Test Engineer shall perform a Test Seating to ensure that all measurement points are covered.

Note: When a smaller sized test engineer is seated during a performance evaluation, the measuring points on the side bolsters (Figure 1) may not be covered. Record this discrepancy in measurement software on measurement computer or on Appendix A, Data Sheet A1 or A2.

4.3.2 Measurement of Heating Performance.

4.3.2.1 Measurement Equipment Recording of Heating Performance of single seats in a Climate Chamber.

4.3.2.1.1 Heater Mat with Single-Stage Temperature Control.

Note: Single-stage heater mat heat-up curve recording is performed for duration of 45 minutes.

The external voltage supply, to use when not running in a vehicle, should be set to (14.0 ± 0.2) V or as described in a CTS.

4.3.2.1.1.1 Enter the climate chamber for acclimatization of the test person.

Acclimatization time: (1 to 2) minutes.

4.3.2.1.1.2 Start measurement software on measurement computer.

4.3.2.1.1.3 Seat the Test Engineer (Tester) on the test seat. The Tester shall sit quietly and relaxed during test. The Tester shall not lean forward or rise from the seat during test.

4.3.2.1.1.4 Start time measurement device and heater mat simultaneously and directly when seating on the test seat.

4.3.2.1.1.5 Raise climate chamber temperature from (-10 ± 2) °C to $(+20 \pm 3)$ °C in (20 ± 5) minutes. Then hold climate chamber temperature constant during test.

4.3.2.1.1.6 After 45 minutes turn off time measurement device, heater mat, and measurement computer. Heat-up curve measurement is complete.

4.3.2.1.1.7 Take a thermography picture for analyzing the temperature distribution.

4.3.2.1.2 Heater Mat with Multi-Stage Temperature Control.

Note: For multi-stage seat heater heat-up curve recording, to determine the control temperatures (1-2-3 Measurement), the first stage shall be run for 30 minutes and each remaining stage shall be run for 20 minutes.

Note: For multi-stage seat heater heat-up curve recording, to determine the heat-up response time and the temperature graduation of the setting-levels under customer conditions (3-2-1 Measurement), the highest stage shall be run for 30 minutes, and each remaining stage shall also be run for 30 minutes.

4.3.2.1.2.1 Enter the climate chamber for acclimatization of the test person.

4.3.2.1.2.2 Start measurement software on measurement computer.

4.3.2.1.2.3 Seat the Test Engineer (Tester) on the test seat. The Tester shall sit quietly and relaxed during test. The Tester shall not lean forward or rise from the seat during test.

4.3.2.1.2.4 Start time measurement device and heater mat simultaneously and directly after seating on the test seat.

Note: start on lowest setting.

4.3.2.1.2.5 Raise climate chamber temperature from (-10 ± 2) °C to $(+20 \pm 3)$ °C in (20 ± 5) minutes then hold climate chamber temperature constant during test.