



Seat Vibration Response Evaluation Procedure

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 test procedure supports the Seat Subsystem Technical Specification (SSTS) requirement for vibration input profile considering seat vibration response.

1.2 Applicability. This test procedure applies to passenger seats for vehicles and light duty trucks operated on shaker table vibration profile.

1.3 Remarks. The SSTS vibration levels are used to evaluate unoccupied seat vibration performance. The Seat SSTS specifies vibration levels at seat to table input and quantifies seat component response vibration levels at prescribed locations.

2 References

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

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

GMW14264

2.3 Additional References.

- PCB Piezotronics, Inc., 3425 Walden Avenue, Depew, NY 14043-2495 USA
- Seat Subsystem Technical Specification (SSTS)
- Siemens PLM Software - Global Headquarters, 5800 Granite Parkway, Suite 600, Plano, TX 75024 USA

3 Resources

3.1 Facilities. A multi-axis shaker table to provide broadband frequency (5 Hz to 100 Hz) excitation. The multi-axis shaker table must be capable of providing degrees of freedom and level excitation specified in the program SSTS.

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.

3.2 Equipment.

3.2.1 Test Equipment. Appendix A, Tables A1 thru A3, contain more detailed information regarding acquisition system, accelerometers, and response location examples.

3.2.1.1 Data Acquisition Equipment. Use the preferred digital data acquisition hardware system and software capable of performing this procedure (e.g., LMS SCADAS Mobile and LMS Test Lab software, available from Siemens PLM Software, Siemens Industry, Inc.) See Appendix A, Table A1 for minimum acquisition system specifications.

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3.2.1.2 Accelerometers. High sensitivity and low mass triaxial accelerometers with a flat frequency response between 1 Hz and 1000 Hz and a temperature range of 18 °C to 30 °C or greater shall be used. Accelerometer specifications and examples in Appendix A, Tables A2 and A3.

3.3 Test Vehicle/Test Piece. Properly contented and full trimmed seat.

3.4 Test Time.

Calendar time: 1 day

Test time: 2 to 4 hours

Coordination time: 2 to 4 hours

3.5 Test Required Information. Not applicable.

3.6 Personnel/Skills. To complete these tests, one (1) technician or engineer skilled in noise and vibration data acquisition is required. For data analysis, one (1) engineer skilled in vibration data acquisition and analysis is required.

4 Procedure

4.1 Preparation.

4.1.1 Seat Mass. Weigh and record seat mass.

4.1.2 Seat Fixture. Attach seat to rigid fixture, center fixture on shaker table, and secure fixture to multi-axis shaker table.

4.1.3 Seat Positioning. Adjust seat track, back, head rest and display screen positions to design position.

4.1.4 Input Shaker Table Profile. Use input shaker table profile provided in Seat SSTs. Provided shaker table profile is typically common with the Seat Shake and Rattle (S&R) shaker table profile with some refinement.

4.1.5 Instrumentation Calibration. The calibration should be checked periodically.

Note: If accelerometers are replaced, the calibration file must be updated. All transducers are precision, high cost instrumentation. Transducers must be handled with extreme care. Do not drop transducers.

4.1.6 Accelerometer Placement.

4.1.6.1 Shaker Table Reference Accelerometer. Install triaxial accelerometer on shaker table under the rear outboard seat track attachment, see Appendix A, Figure A1.

4.1.6.2 Seat Response Accelerometers. Install triaxial accelerometers on following locations:

- Rear inboard and outboard seat track attachment locations
- Top of the seat back inboard and outboard locations
- Top of the rear seat display inboard and outboard locations, see Appendix A, Figure A1

4.1.6.3 Additional Accelerometer Locations. Additional accelerometers can be added as needed to characterize other sub component response locations and operating deflection shapes.

Note: Additional points are not limited to the preceding.

4.1.7 Data Acquisition System (DAS) Installation.

4.1.7.1 Ensure that all cable connections are made for power, sensors, and computer.

4.1.7.2 Data acquisition parameters can be set up as described in Section 5 if online processing is desired when acquiring data, or time domain data may be captured and processed at a later time.

4.2 Conditions.

4.2.1 Environmental Conditions.

4.2.1.1 The shaker table and seat must be free of debris.

4.2.1.2 Limited objective data exists describing the effect of ambient temperature on measure shake performance. Additionally, temperature effects may be dependent on specific vehicle design characteristics. To improve the accuracy of measured data, it is recommended that the ambient temperature for testing at room temperature be between 18 °C and 24 °C (65 °F and 75 °F).

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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 Turn on the instrumentation to begin warm up.

4.3.2 Pretest: Shake the seat for 10 minutes to 20 minutes to precondition the test property.

4.3.3 Time domain accelerations shall be measured with the data acquired for 30 s to 60 s using the specified profile in SSTs. A minimum of three (3) test runs are to be recorded and compared to assure repeatability.

4.3.4 Repeatability from run-to-run and setup-to-setup are influenced by the following listed items:

- Seat Positions
- Transducer Location and Orientation
- Profile replication
- Ambient Temperature

5 Data

5.1 Calculations. Power Spectral Density (PSD) shall be calculated from time domain data, resulting in frequency domain acceleration amplitude, decibel(s) (dB) (i.e., $(\text{m/s}^2)^2/\text{Hz}$), versus frequency in Hertz (Hz). PSD units allow the quantification of acceleration amplitude regardless of the Fast Fourier Transform (FFT) resolution used. See response data plot example in Appendix A, Figure A2.

The following digital signal processing parameters shall be used:

- Function: Autopower Spectrum
- Format: Power Spectral Density (PSD)
- Scale: Root Mean Squared (RMS)
- Time Length: 30 s to 60 s
- Frequency Resolution: Recommend 0.25 Hz
- Frequency Range: 0 Hz to 100 Hz
- Window Type: Hanning
- Amplitude Correction Factor: Energy
- Averaging Type: Linear
- Overlap: 75%
- Average all Available Runs

5.2 Interpretation of Results. An acceleration response of 3 dB to 5 dB difference between two (2) configurations generally corresponds to a difference of one (1) subjective rating point if it is at one of the largest amplitude peaks in the spectrum. For details on the Subjective Rating Scale, refer to GMW14264.

The $1 (\text{m/s}^2)^2/\text{Hz}$ acceleration reference value is a large number. Most measurements are much less than $1 (\text{m/s}^2)^2/\text{Hz}$, which results in the decibel (dB) value being negative. A difference of 3 dB corresponds to a ratio of 2:1 on a power scale $((\text{m/s}^2)^2)$.

The data should be compared to previously measured seats and to the SSTs requirement.

5.3 Test Documentation. The data should be plotted, see example at Appendix A, Figure A2. All data should be stored in the PSD plot summary.

5.3.1 All PSD plot summaries should include the following information:

- Date
- Seat Regular Production Option (RPO) name(s)/ Part number(s)
- Axes labeled as follows:
 - x: Frequency: Hz
 - y: Decibel (dB) referenced to $1 (\text{m/s}^2)^2/\text{Hz}$

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