



Speaker Performance Test Specification

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.

This document is the GM Worldwide Standard for loudspeaker component performance testing procedures for automotive and light duty truck applications.

The Component Technical Specification (CTS) and Subsystem Technical Specification (SSTS) shall take precedence over this document.

In the event of a conflict between the text of this standard and the documents cited herein, the text of this standard takes precedence.

1.1 Purpose. This document establishes a centralized set of electrical and mechanical performance tests for GM loudspeaker components and subsystems. Performance requirements shall be established in accordance to the SSTS, and CTS for each appropriate level.

The supplier is required to support and participate in subsystem or vehicle level Analysis/Development/Validation (ADV) tasks as specified in the Statement of Requirements (SOR), CTS, or by GM Engineering.

Provides established common loudspeaker performance tests or methods for GM that will be delegated to be performed either on the vehicle, buck, subsystem, component, and/or bench.

1.2 Applicability. GM loudspeaker components and subsystems.

2 References

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

2.1 External Standards/Specifications.

EIA RS-426-B	IEC 60225	IEC 60651	ISO/IEC 17025
IATF 16949	IEC 60268-5	IEC 62548	

2.2 GM Standards/Specifications.

GMW3059

2.3 Additional References.

- Component Technical Specification
- Statement of Requirements
- Subsystem Technical Specification

3 Test Preparation and Evaluation

3.1 Resources.

3.1.1 Facilities. The test facilities shall be IATF 16949, and/or ISO/IEC 17025 certified.

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

3.1.1.2 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.

3.1.2 Equipment.

3.1.2.1 Anechoic test chamber according to IEC 60268-5.

3.1.2.2 Klippel Analyzer Hardware with the modules.

- a. Linear Parameter Measurement (LPM)
- b. Large Signal Identification (LSI)
- c. Transfer Function Measurements (TRF)

3.1.2.3 Sine wave noise generator 10 Hz to 20 000 Hz.

3.2.1.4 Test signals:

- a. Sine wave signals to IEC 60268-5
- b. Broadband/narrow band noise according to IEC 60268-5

3.2.1.5 Low Frequency (LF) amplifier according to IEC 60268-5.

3.2.1.6 Microphone amplifier and measuring microphone according to IEC 60268-5.

3.2.1.7 Third octave filter according to IEC 60225.

3.2.1.8 Ohmic resistors suited to the nominal impedance of the loudspeaker with an accuracy of $\pm 1\%$ and a loading capacity of ≥ 20 W.

3.2.1.9 Sound baffle to IEC 60268-5.

3.2.1.10 Voltmeter according to IEC 60651.

3.2.1.11 Frequency analyzer.

3.2.1.12 Acoustic measuring environment according to IEC 60268-5.

3.2.1.13 Timer.

3.1.3 Test Vehicle/Test Piece. The test samples shall be production intent design and materials for performance testing. The supplier shall test at least 10 sample parts to this specification.

3.1.4 Test Time.

Calendar time: Not applicable

Test time: Varies with component specification

Coordination time: Not applicable

3.1.5 Test Required Information.

3.1.5.1 Design Cycle Requirements. Loudspeaker Component Validation is a multilevel matrix requiring analysis, testing, inspection or other activities. The subsystem validation consists of reliability estimates (e.g., Reliability Block Diagram (RBD), or Fault Tree Analysis (FTA) with the parts reliability information from parts databases or vendor life test results, and for mechanical parts, from mechanical engineering stress/strength or finite element analysis), Failure Mode and Effects Analysis (FMEA), of Design Failure Mode and Effects Analysis (DFMEA) and Process Failure Mode and Effects Analysis (PFMEA), and reliability validation or demonstration testing. DFMEAs may be required at different phases of the design cycle (Four Phase Vehicle Development Process (4ΦVDP)). Each of these (analyses and/or tests) may be performed at a vehicle level or at a component level.

Analytical results of reliability estimates, when detailed and defensibly accurate, may be a substitute for reliability testing. Also, reliability demonstration test may be done in lieu of a complex reliability analysis. The optimal deliverables would include both, analytical estimates and the demonstration test results with the description of the test methodology that was applied in reliability demonstration.

3.1.6 Personnel/Skills. Test engineer shall be knowledgeable in speaker transducer test measurement as outlined in this standard.

3.2 Preparation. Not applicable.

3.3 Conditions.

3.3.1 Environmental Conditions.

3.3.2 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.

3.3.3 Measurement Conditions. For each test, the supplier will detail the following:

- Test room: Manufacturer, Model
- Test room size (in meters): Length × Height × Width
- Test room lower cut off frequency
- Measurement microphone
- Measurement equipment
- Microphone distance
- Measurement signal

3.4 Instructions.

3.4.1 Klippel LPM Module Configuration. The LPM module parameters shall be configured as follows.

While a test input voltage level (V_{rms}) of 0.1 V is the default, depending on other impedances, a different voltage may be required to meet the 20 dB signal to noise requirement. Reference Figure 1.

Test Module	LPM Linear Parameter Measurement		
Properties Tab	<i>Stimulus</i>		
Properties	Fmax		2000 Hz
	Relative resolution		1/30 oct. above 20 Hz
	Low Frequency lines		Full
	Averaging		8x
	Noise Floor +DC		on
	Volatge	Specified CTS Nominal Impedance	Test Voltage (Vrms)
		0.5	0.1
		1	0.1

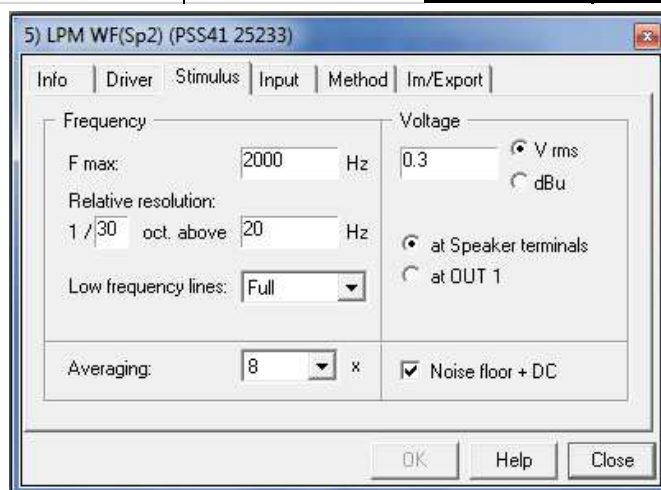


Figure 1: LPM Module Configuration

3.4.2 Klippel Large Signal Identification (LSI) Module Configuration. The LSI module parameters shall be configured as shown in Figure 2 and Figure 3.

Properties Tab	<i>Protection</i>		
Properties	Temperature increase (Delta Tv)		100 K
	Minimal Force factor ratio (Bl min)		50%
	Minimal Compliance ratio (C min)		30%
	Electric input Power (P)		20 W
	Small-signal gain (G small)		-10.0 dB

7)PSS LSI Woofer Nonl. P. Sp1 (PSS41 25233)

Info | Driver | Generator | Protection | Conditions | Im/Export | Series

states limits

Temperature increase Delta T_v Delta T_{lim} K

Minimal force factor ratio Bl_{min} Bl_{lim} %

Minimal compliance ratio C_{min} C_{lim} %

Electric input power P P_{lim} W

Small-signal gain G_{small} dB

OK Help Close

Figure 2: LSI Module Configuration - Protection

Properties Tab	<i>Conditions</i>		
Properties	Finish After		Nonlinear Mode 5(7)
	duration of nonlinear mode		5 min

7)PSS LSI Woofer Nonl. P. Sp1 (PSS41 25233)

Info | Driver | Generator | Protection | Conditions | Im/Export | Series

Duration of Measurement

Finish after Nonlinear Mode 5(7)

Duration of 'Nonlinear Mode 5(7)': min

OK Help Close

Figure 3: LSI Module Configuration - Conditions

3.4.3 Klippel Transfer Function Measurement (TRF) Parameter Configuration.

The TRF module parameters shall be configured as shown in Figure 4.

Properties:	Stimulus			
Properties:	Fmin		20 Hz	
	Fmax		20,000 Hz	
	Resolution		.37 Hz	
	Shaping		on	
	Noise Floor +DC		on	
	Voltage		1W	$P = \frac{V^2}{R_{nom}}$
	* averaging + preloo		2	

Figure 4: TRF Module Configuration

3.5 Data. Not applicable.

3.6 Safety. This Engineering Standard may involve safety requirements for hazardous materials, the method of operations and equipment. This standard does not propose to address all the safety issues associated with its use. It is the responsibility of the user of this standard to ensure compliance with all appropriate safety and health practices. This would include any specific training that may be required. The safety and health standards include site specific rules and procedures, company rules and procedures, and Government Standards. Contact shall be made with the appropriate site Safety and Health personnel for further direction and guidance in these matters.

3.7 Documentation. Samples of components or material released to this standard shall be tested for conformity with the requirements of this standard and approved by the responsible GM Department prior to the start of delivery of production level components or materials.

Any change to the component or material, e.g., design, function, properties, manufacturing process and/or location of manufacture requires a new release of the product. It is the sole responsibility of the supplier to provide the customer, unsolicited, with documentation of any change or modification to the product/process, and to apply for a new release.

If not otherwise agreed to, the entire verification test shall be repeated and documented by the supplier prior to start of delivery of the modified or changed product. In some cases, a shorter test can be agreed to between the responsible GM department and the supplier.

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3.7.1 Test Results. All test results shall be included in a test report. This report shall be delivered to the responsible GM department. All running records of data collection shall be retained and made available to GM if requested. All data reports will be on standard size paper.

3.7.1.1 Test Results Numerical Data. Sections that have a numerical result shall be listed as:

- Section Number
- Test Name
- Sample Number
- CTS Defined Requirement
- Test Result
- Deviation
- Pass/Fail

Example: 4.1.6, Sensitivity, Sample Number (No.) 1, 88 dB, 89 dB, 1.1%, Pass.

3.7.1.2 Test Results with Data Plots. Each section that has a result that includes data plots shall be printed on single page(s). The requirements for the plots are detailed in each section (e.g., 4.1.1.3 Resonance Frequency, 4.1.2.1 Effective Frequency Response, 4.1.6 Sensitivity, etc.)

3.8 Deviations from Procedure. Deviations from the requirements of this standard shall have been agreed upon prior to the start of testing. Such requirements shall be specified on component drawings, test certificates, reports, etc.

3.9 Parameter Definition and Tolerance.

3.9.1 Tolerance. Unless stated otherwise, Table 1 shall define the test environment parameters and tolerances to be used for all validation testing.

Table 1: Parametric Tolerances

Parameter	Tolerance
Room Ambient Temperature	+23 °C ± 5 °C
Test Time	As specified +2%, -0%
Room Ambient Relative Humidity	50% ± 20%
Chamber Humidity	As specified ± 5%
Voltage	As specified ± 0.1 V (as measured at the module)

3.10 General Test Procedures.

3.10.1 Preconditioning. All speakers are to be conditioned prior to testing per IEC 60268-5 section titled, Preconditioning.

3.10.2 Crossover Network. Unless otherwise specified, if a crossover external to the loudspeaker driver exists, testing shall be done with the external crossover in place.

3.10.3 Test Discrepancies or Nonconformance. All nonconforming parts shall be analyzed using a Five (5) Phase evaluation and answer process. A complete documented response, in the format shown, must be provided for each nonconformance.

Phase 1: Analysis Findings

- What is learned from the incident at component, assembly, and vehicle levels?
- Measures taken to search for the root cause. How did the responsible person proceed with the investigation?

Phase 2: Root Cause

- Ultimate root cause of the incident

Phase 3: Immediate Fix

- What will be done to quarantine and correct contaminated stock?

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Phase 4: Irreversible Corrective Action

- Action to prevent the incident from ever occurring again
- Traceable document (engineering change, process change, etc.)
- Projected date of implementation

Phase 5: Planned Action Verification

- Verification that irreversible corrective action works

3.10.4 Electrical Connections. The devices under test (DUT) should be terminated with production intent connectors and all harness side mating connectors, terminals and wiring even if unpowered for testing.

4 Requirements and Procedure

Note: The qualification and validation requirements specified herein shall be conducted using one or more of the validation methods defined as follows:

Test: Verifying that a specification requirement is met by; thoroughly exercising the item being validated under specified conditions in accordance with a test procedure; collecting quantitative data via test instrumentation; reducing and analyzing the collected data; and, comparing the results to the specified requirement.

Analysis: Verifying that a specification requirement is met by technical or mathematical evaluation of equations, algorithms, recorded data, charts, graphs, circuit diagrams, and representative data; and/or simulation of the item being validated using a mathematical representation (i.e., mathematical models, algorithms, or equations).

Inspection: Verifying that a specification is met by the physical examination of the item being validated and comparing the observed physical characteristics with the specifications and/or drawings.

Demonstration: Verifying that a specification requirement is met by exercising the item being validated, under specified conditions in accordance with a test procedure, observing the results, and comparing the results to the specified requirements. The collection of test data via test instrumentation is normally not required.

Validation: The formal process of confirming, through analysis, demonstrations, inspections, and/or tests, that a product meets its requirements.

4.1 Speaker Component Performance Test. All testing must be conducted with actual vehicle loads or equivalent (simulated loads require GM Engineering approval) and requires a vehicle interface harness that has a terminal and wire inserted into each connector cavity per the production intent design.

4.1.1 Resonance Frequency and Impedance Measurement. The speaker resonance shall be measured in free air by means of the circuit in Figure 5. The voltage at V1 is varied based on speaker impedance such that the power input to the speaker shall be 1 W or slightly less so as to prevent the speaker from going into the nonlinear range. Any external crossover components shall be removed or bypassed. The output frequency of the test generator shall be adjusted for a voltage minimum across the sense resistor R1 as measured by voltmeter V2 to determine the free air resonance. R1 shall have a resistance value not exceeding one-tenth of the rated impedance value of the loudspeaker under test.

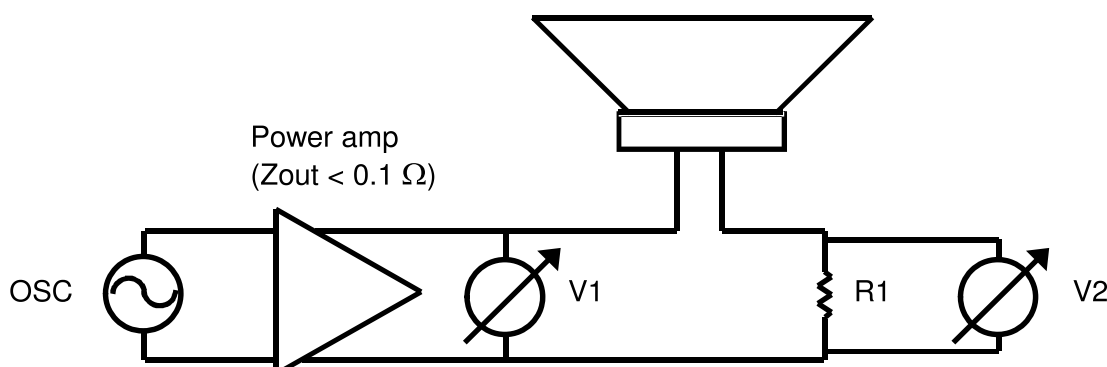


Figure 5: Circuit for Speaker Resonance Measurement

4.1.1.1 Impedance Curve. The impedance curve shall be measured per IEC 60268-5. The measured impedance shall not fall below the impedance curve specified in the relevant Speaker CTS.

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