



Damper Low Amplitude Dynamic Performance

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. The purpose of this test procedure is to quantify the performance of a suspension damper at low amplitude displacements (0.05 mm to 2.0 mm), and a low amplitude wheel hop frequency (~15 Hz).

1.2 Applicability. This procedure applies to all passive suspension dampers. It may also be applied to electronically controlled suspension dampers provided that appropriate control equipment, power source, logic, etc. is supplied or available. However, details specific to electronically controlled damper testing are not within the scope of this procedure.

This procedure applies to servo-hydraulic or electro-mechanical test stations capable of performing multiple test steps incorporating multiple frequency and displacement combinations (hence, multiple velocities).

1.3 Remarks. An otherwise smooth road can generate low amplitude inputs once per wheel revolution that induce vehicle fore-aft, vertical and lateral vibrations that tune up with suspension rigid body modes at highway speeds. Damper tuning to reduce or eliminate this **smooth road shake** vibration phenomenon can be hampered by the inability of the damper to act like an **ideal damper** (velocity only dependent device) and generate sufficient damping. This procedure quantifies the damper performance under these conditions.

2 References

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

2.1 External Standards/Specifications.

ISO 17025

2.2 GM Standards/Specifications.

GMW14243

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 Damper tests are normally performed using GM damper test stations. These stations can be either servo-hydraulic units (e.g., MTS) or fixed- waveform (sine) such as electro-mechanical units (e.g., VDA - standard test machine). Alternative test facilities and equipment may also be used provided they have the capacity to complete the test and processing per this test procedure.

Note: Refer to GMW14243, Damper Basic Performance Test, for machine capability requirements.

3.2 Equipment.

3.2.1 Basic damper test system as outlined in GMW14243.

3.2.2 Ball joint type non-binding attachment fixtures specific to damper being tested.

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3.2.3 Side loading mechanism (e.g., hydraulic actuator or lever with mass plates).

3.2.4 The equipment must be capable of accurately producing a sinusoidal input down to a peak-to-peak amplitude of 0.05 mm at 15 Hz, and measure forces generated by a damper at this amplitude (on the order of 10 N).

Note: A special control tuning and range setting may be needed to achieve this.

3.3 Test Vehicle/Test Piece. This procedure applies to all types of dampers that are used in vehicle suspension systems.

3.4 Test Time.

Calendar time: 0.1 d to 0.2 d

Test hours: 1 h

Coordination hours: 0 h to 0.5 h

Note: Typical test duration, including preparation, execution and teardown is 1 h.

Note: If necessary, multiple days may be required to fabricate fixtures to attach dampers to the load frame actuator.

3.5 Test Required Information.

3.5.1 Test frequencies, amplitudes and cycle counts.

3.5.2 Performance targets for:

- Phase angle of force relative to velocity.
- Dynamic impedance.

3.6 Personnel/Skills. Operators shall be qualified and documented as capable to perform this test as required by ISO 17025.

4 Procedure

4.1 Preparation. Refer to GMW14243, Damper Basic Performance Test, for general preparation guidelines.

4.2 Conditions.

4.2.1 Environmental Conditions. All tests shall be performed at room temperature (approximately 23 °C).

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.

If no condition is called out, then the following should be used as the default conditions. (See Table 1.)

Table 1: Low Amplitude Test Conditions

Step	Frequency (Hz)	Amplitude Peak-Peak (mm)	Cycle Count
1	1	20	10
2	15	0.05	200
3	15	0.10	200
4	15	0.15	200
5	15	0.20	200
6	15	0.25	200
7	15	0.50	200
8	15	1.0	200
9	15	2.0	200

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4.3 Instructions.

4.3.1 Fixture damper to load frame using low friction rod ends, spherical bearings, or a similar attachment scheme on both ends of the damper to minimize side load. These should be of sufficient quality and service condition so that there is no appreciable lash relative to the excitation amplitudes.

4.3.2 Run the damper test per the prescribed low amplitude test conditions.

4.3.3 The time, actual displacement, velocity and force should be measured and saved at a sample rate of 250 points/cycle.

4.3.4 Apply side load if specified and re-run test. Side load is induced and measured at the damper rod guide to seal interface. Once side load is induced or adjusted, start with 4.3.1 and repeat procedure for each specified side load.

5 Data

5.1 Calculations. Use the Damper Low Amplitude Dynamic Test Processing Software to analyze the data.

5.2 Interpretation of Results. The phase angle of force relative to velocity should fall within the target specification at 15 Hz with 100 N of peak-to-peak force. If no target value is provided, the default specification is a phase angle between 0 degrees and 5 degrees (i.e., within 5 degrees of ideal damping).

The dynamic impedance is also evaluated at 15 Hz with 100 N of peak-to-peak force. If no target value is provided, the default specification is a dynamic impedance between 50 N/mm and 400 N/mm.

5.3 Test Documentation.

5.3.1 General damper description as required per local test site. At a minimum, required information includes part number, damper type (monotube/twintube), stroke length, working fluid and gas charge.

5.3.2 The Damper Low Amplitude Dynamic test processing software produces a pdf file that includes a number of plots. For each test step, the following data plots are generated:

- Displacement vs. Time
- Velocity vs. Time
- Force vs. Time
- Force vs. Displacement
- Force vs. Velocity

The following summary plots are generated for the entire test:

- Force vs. Velocity
- Dynamic Impedance Factor vs. Single Amplitude Force
- Dynamic Velocity to Force Phase vs. Single Amplitude Force

Note: See Appendix A, Figures A1 thru A4 for sample plots.

6 Safety

This standard may involve hazardous materials, operations, and equipment. This standard does not propose to address all the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

Note: Refer to Section 6.1 of GMW14243, Damper Basic Performance Test, for safety protocol specific to servo-hydraulic test stations.

7 Notes

7.1 Glossary.

MTS MTS Systems Corporation

Smooth Road Shake: Refers to dynamic vehicle vibration that is experienced by the driver when there is no apparent road input (i.e., smooth road, refer to GMW14243, Damper Basic Performance Test, for general definitions of **passive** and **electronically-controlled** dampers).

VDA Verband der Automobilindustrie e. V., an Association of German Automobile Manufacturers

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