



Assembled Steering Column - Modal Frequencies 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. Evaluation of the dynamic behavior in the low frequency range of the steering system in the vehicle.

1.2 Applicability. This test procedure is appropriate for benchmarking competitive and GM passenger vehicles in the full vehicle state. The procedure is valid for use both Body Frame Integral (BFI) and Body on Frame (BOF) full vehicles.

The testing standards defined in this document are intended to pertain only to work being done for the corporate database and validation. Other testing methods and interpretations are useful and valid, and should continue to be used for normal powertrain mounting system development work where appropriate.

1.3 Remarks. In road-induced and powertrain-induced conditions, vibrations of the steering column and wheel can be perceived by the driver as unacceptable Noise and Vibration (N&V) tactile vibration and thus lower perceived quality and refinement. The purpose of this Test Procedure is to establish the conformity to standards when validating targets and for benchmark purposes. Additional testing may be desirable for development work.

2 References

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

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

GMW14181

2.3 Additional References. None.

3 Resources

3.1 Facilities. All measurements are performed in a test room that is equipped for vibration measurements. The test setup can include a test fixture for component mounting if necessary.

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.

- Two (2) triaxial acceleration transducers (e.g., PCB-356A15 with Integrated Circuit Piezoelectric (ICP) signal amplifiers, available from PCB Piezotronics, Inc.)
- Modally tuned impulse hammer (e.g., PCB-086D05 with PCB-084A51 Adaptor and hammer tips range from 084A50 to 086C05, the super soft tip (Grey 15.101, 1 in 10SS) is recommended and available from PCB Piezotronics, Inc.)

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- Hot glue or light weight mounting clamps are used for positioning the accelerometer transducers on the rim of the steering wheel. It shall be ensured that no relative motion between the accelerometer and rim is possible.
- Multi-channel spectrum analyzer front end with Analog/Digital (A/D) converter, computer and software for measurement and analysis (e.g., LMS SCADAS Front End and LMS Test Lab software, available from Siemens PLM Software, Siemens Industry, Inc.). A multi-channel Data Acquisition System (DAS) is required to receive all signals simultaneously.

Note: See GMW14181, Appendix A, Transducer Examples for transducer key characteristics.

3.3 Test Vehicle/Test Piece. Test objects can be complete vehicles as well as trimmed bodies with a complete mounted steering system.

3.4 Test Time.

Calendar time: Not applicable

Test hours: 4 hours

Coordination hours: 2 hours

3.5 Test Required Information. Not applicable.

3.6 Personnel/Skills. Engineer and/or technician skilled in vibration data acquisition and analysis, and operation of the equipment.

4 Procedure

4.1 Preparation. The steering wheel is in straight-ahead (12 o'clock) position and not locked. When the column is adjustable, middle positions are to be chosen for all settings.

4.1.1 Positions and Leveling. The drive point accelerometer mounting positions are **12 o'clock** and **3 o'clock** (see Appendix A, Figures A2 and A3). The acceleration transducers shall be fixed with respect to the global vehicle coordinate system of the steering wheel. It is recommended to use a digital level to ensure that an accurate mounting of the accelerometers to the global Cartesian coordinate system is verified to within 1 degree.

4.2 Conditions.

4.2.1 Environmental Conditions. When no other specifications are defined explicitly, the test shall be performed at $23\text{ }^{\circ}\text{C} \pm 5\text{ }^{\circ}\text{C}$.

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.

4.3 Instructions.

4.3.1 Setup for Measurement System.

- Frequency range: 0 Hz to 128 Hz
- Resolution: 0.25 Hz
- Trigger mode: Hammer Input channel
- Time windows: Uniform Window. If event cannot be completely observed, use Force/Exponential Windows.
- Trigger level: 10% to 50% slope channel. Sign of the slope may vary depending on transducer type and DAS.
- 1% (of time block) trigger delay (pre-trigger) for all channels
- AC Coupled (1 Hz high pass filter) Enable overload detection
- Measuring function: Frequency Response Function (FRF) with force as reference
- Number of average: Five (5) minimum
- Force level input: Select hammer tip to achieve an approximate 12 dB roll off 5 Hz to 100 Hz. Typical time domain input 40 N peak (approximately 1 N to 1.2 N Root Mean Square (RMS) from 5 Hz to 100 Hz).

4.3.2 Measurement. During the acquisition time, impact the wheel with the modally tuned impulse hammer near one transducer position. Conduct this measurement three (3) times for repeatability comparison. Perform the following drive point FRF measurements: 12 o'clock vertical, 12 o'clock fore/aft, 3 o'clock fore/aft and 3 o'clock lateral. Successively impact the wheel at the wheel drive point measurement set for the two (2) transducer

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