



Steering Wheel – Flexural Modes Evaluation Procedure

1 Introduction

The Hand Held Force Input Frequency Response Function Acquisition, GMW14181, shall be referenced for more detailed information corresponding to the following procedure.

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. Define the process of determining the first flexural mode of a steering wheel/airbag assembly mounted to-ground at the steering wheel hub. The product of this procedure will be a lowest flexural frequency value in Hertz (Hz).

1.2 Applicability. This test procedure is appropriate for use with steering wheel/airbag assemblies from passenger cars and trucks.

1.3 Remarks. If a steering wheel/airbag as mounted in-vehicle has a first resonant frequency at or near engine firing frequency at idle (25 Hz to 65 Hz, depending on vehicle), or other vibration source frequencies (e.g., engine cooling fan, HVAC blower fan), it could amplify energy from the powertrain to the driver. The Steering Wheel Subsystem Technical Specification (SSTS) contains a requirement for steering wheel/airbag assembly as mounted to-ground lowest flexural frequency. This provides an assessment of performance prior to vehicle hardware or full system model.

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.

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

3 Resources

3.1 Facilities. A bedplate.

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. Refer to GMW14181.

- One (1) single axis acceleration transducer (e.g., PCB352A24 with Integrated Circuit Piezoelectric (ICP) signal amplifiers, available from PCB Piezotronics, Inc.)

GM Confidential

© Copyright 2015 General Motors Company All Rights Reserved

May 2015

Page 1 of 8

- Modally tuned impulse hammer (e.g., PCB-086D05 with PCB-084A51 Adaptor and hammer tips range from 084A50 to 086C05, the soft tip (Black 084C05) is recommended and available from PCB Piezotronics, Inc.)
- Hot glue or lightweight mounting clamps are used for positioning the accelerometer transducer 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.

3.2.2 Test Fixtures. Refer to GMW14181. For this test, the steering wheel shall be fixed to ground via a bolt and nut through the steering wheel hub. The bolt and nut interface to the steering wheel shall be equal to the steering column attachment of the steering wheel. The bolt face shall be welded to rigid ground, typically a large bolt affixed to an appropriate device. See Appendix B, Figures B1 and B2 for examples.

3.3 Test Vehicle/Test Piece. A complete steering wheel/airbag assembly, including switches and back cover.

3.4 Test Time.

Calendar time: 1 day
Test time: 1 hour
Coordination time: 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.

4.1.1 Boundary Conditions. Refer to GMW14181. For this test, the boundary conditions are to ground. A bolt and nut through the steering wheel hub shall be welded to rigid ground, typically a large bolt affixed to an appropriate device. The nut should be tightened to the vehicle's design torque specification for the steering wheel nut. See Appendix B, Figures B1 and B2 for examples.

4.1.2 Component Preparation. Refer to GMW14181. For this test, after the steering wheel is affixed to ground, the airbag module shall be installed. If possible, an inert airbag module should be used. Care should be taken to tighten the airbag module to the steering wheel dish structure via the fasteners on the module.

4.2 Conditions. Wholly contained in GMW14181.

4.2.1 Environmental Conditions. Not applicable.

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.

- Frequency range: 0 Hz to 200 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.

GM Confidential

© Copyright 2015 General Motors Company All Rights Reserved

May 2015

Page 2 of 8

Documents
Document Sharing Hub

- Force level input: Select hammer tip to achieve an approximate 12 dB roll off 5 Hz to 100 Hz. Typical time domain input 20 N peak (approximately 1 N to 1.2 N Root Mean Square (RMS) from 5 Hz to 100 Hz). Check if it is necessary to add mass to impact hammer to achieve the force level input.

4.3.1 Measurement Locations. Mount the accelerometer to the steering wheel rim with hot glue or other appropriate material (steering wheel local coordinate system, see Table 1). See Appendix A, Figures A1 thru A4 for results and accelerometer locations.

Table 1: Accelerometer Locations and Directions

Locations	Directions
12 o'clock	Fore/Aft and Vertical
3 o'clock	Fore/Aft and Lateral
6 o'clock	Fore/Aft and Vertical
9 o'clock	Fore/Aft and Lateral

4.3.2 Impacting the Structure. Refer to GMW14181. For this test, use a modally tuned impulse hammer as described in 3.2.1. Impact in the steering wheel local coordinate system fore/aft direction, next to the accelerometer.

4.3.3 Data Acquisition. Refer to GMW14181. Acquire, verify and store a drive point FRF listed in 4.3.1 (steering wheel local coordinate system, see Appendix A, Figures A1 thru A4).

5 Data.

Refer to GMW14181.

5.1 Calculations. The result of this test is the frequency at which the first high amplitude peak occurs in the imaginary portion of the FRF and steering wheel sensitivities (acceleration/force) for each test position.

5.2 Interpretation of Results. The steering wheel/airbag to-ground first structural frequency should be compared to other previously measured steering wheels, and the SSTS requirement.

5.3 Test Documentation. Refer to Appendix A, Table A1 for how to document the steering wheel/airbag to-ground flexural frequencies and corresponding Acceleration by Force (A/F) linear amplitudes.

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.

7 Notes

7.1 Glossary. Not applicable.

7.2 Acronyms, Abbreviations, and Symbols.

A/D	Analog/Digital
A/F	Acceleration by Force
DAS	Data Acquisition System
FRF	Frequency Response Function
ICP	Integrated Circuit Piezoelectric
IDSR	Integration Driven Subsystem Requirements
N&V	Noise and Vibration
RMS	Root Mean Square

GM Confidential

© Copyright 2015 General Motors Company All Rights Reserved

May 2015

Page 3 of 8