



Propshaft Induced 2nd Order Vibration 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 procedure is used to provide an objective measurement of launch shudder and coast down vibrations for rear wheel drive (RWD) and all wheel drive (AWD) vehicles with Cardan joints located in the driveline.

1.2 Applicability. The test is applicable to RWD and AWD passenger vehicles with Cardan joints.

1.3 Remarks. Vehicle launch shudder is a vibration that one may experience in the first few seconds of a vehicle launch. It occurs at low speed typically < 20 mph for seat track vibration and < 30 mph for steering wheel vibration with a moderate to high acceleration of the vehicle. Launch shudder is a transient 2nd order excitation of the driveline system and vehicle/body initiated by Cardan joints operating at high angles. Coast down/steady state vibrations can be caused by high operating angles (generally > 4 degrees) at the rear pinion and center bearing joint locations.

2 References

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

2.1 External Standards/Specifications.

IEC 651

2.2 GM Standards/Specifications.

GMW14227 GMW14264

2.3 Additional References.

Vehicle Technical Specification (VTS)

3 Resources

3.1 Facilities. This test will be performed on a test surface that is smooth and straight. The 7.2% hill at the Milford Proving Ground (MPG) is the preferred test track; however, a smooth road takes precedence over grade. Flat smooth road surface is also acceptable.

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 Accelerometers. Four (4) triaxial low mass accelerometers with flat response from 2 Hz to 2000 Hz and an operating range of 10 °C to 50 °C.

3.2.2 Tachometer. Generally, high-speed controller area network (CAN) transmission output shaft velocity signal or 1 pulse per revolution optical tachometer is also acceptable. For low-speed vibration occurring right at launch it is recommended to use CANBUS signal or four (4) equally spaced pieces of reflective tape (4 pulses per revolution) to obtain a more accurate reading of instantaneous Propshaft Revolutions per Minute (PRPM).

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3.2.3 Portable Data Acquisition System (DAS). A multi-channel (14 or more) DAS capable of digitally sampling all channels of data at 10 kHz, with a minimum of 120 dB dynamic range. This hardware shall meet Class 1 accuracy corresponding to IEC 651 or be equivalent for the application (precision ± 0.7 dB or $\pm 8\%$). The preferred DAS consists of a personal computer running Leuven Measurement System (LMS) Test Lab software. Refer to GMW14227 for more information regarding data acquisition procedures.

3.3 Test Vehicle/Test Piece.

3.3.1 Vehicle. This procedure may be performed on development vehicles, production vehicles or competitive vehicles.

Prior to conducting the evaluation, note the following vehicle configuration information. Record the configuration information electronically such that it is stored with the test data.

- Vehicle Identification Number
- GM fleet number
- Build stage (if appropriate)
- Engine displacement
- Cylinder Configuration (Vee or in-line)
- Driveline Configuration:
 1. Rear Wheel Drive (RWD)
 2. All Wheel Drive (AWD)
- Transmission:
 1. Automatic
 2. Manual
- Tire Make
- Tire Model
- Tire Size
- Testing Date
- Test Location

3.4 Test Time.

Calendar time: 2 days
Test time: 8 hours
Coordination time: 4 hours

3.5 Test Required Information. Not applicable.

3.6 Personnel/Skills. One (1) qualified engineer or technician trained in the use of data acquisition and having basic knowledge of digital signal processing of acoustic or vibration signals.

4 Procedure

4.1 Preparation.

4.1.1 Vehicle. The test shall be performed on a production vehicle or development vehicle which represents the current release status. Eliminate any unwanted content or known problems. Verify and note the status of all hardware relative to the current release status. Adjust tire pressures to nominal values as stated by the vehicle manufacturer (cold). Ensure fuel tank is at least $\frac{3}{4}$ full. Also ensure the radio/entertainment system and Heating Ventilation and Air Conditioning (HVAC) is turned off. Position the seats and headrests in the middle positions. If equipped with tilt and/or telescoping steering column, position the column in the center position of travel.

The test shall be run at both of the following vehicle loading conditions: Curb Weight and Gross Vehicle Weight (GVW). This is necessary to ensure that the extremes of driveline angle and vehicle inertia are evaluated. When running the test in the GVW condition, ensure that the ballast is securely positioned in the cargo area, and that mass dummies (if used) are securely positioned in the occupant positions.

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4.1.2 Instrumentation.

4.1.2.1 Tachometers. Utilize LMS CANBUS, with appropriate .dbc file (see 7.1) and On-Board Diagnostics II (OBD2) connector to obtain high-speed CAN signals. For example, propshaft speed can be tracked off a static channel with the signal name "TrnsOutShftAngVel." An optical tachometer with 1 pulse per revolution can also be utilized for propshaft speed (see Appendix A, Figure A1). Vehicle speed, engine speed and accelerator pedal are also useful static channels that can be tracked/recorded via CANBUS.

4.1.2.2 Accelerometers.

4.1.2.2.1 Transducer Locations. Install triaxial accelerometers at the following locations:

- Front Outboard Seat Track
- Pinion Nose
- Center bearing (if applicable)
- Transfer Case/Transmission Tail
- Steering Wheel 12 o'clock

Note: See Appendix A, Figure A1 for illustration of the transducer locations. The seat track location is used to evaluate the vehicles performance against a standard such as a program VTS. The other four (4) positions may be used for diagnostic and development purposes.

4.1.3 Acquisition System. Assure the acquisition system is safely secured in the vehicle.

4.1.3.1 Acquisition Parameters. These key acquisition system parameters should be set to the following:

- Tracking Mode: "Tacho"
- Method: Tracked
- Slope up from 75 PRPM to 1400 PRPM for launch shudder
- Slope down from 75 mph to 15 mph for coast down (PRPM range will vary based on final drive ratio)
- Bandwidth: 4096 Hz
- ΔF : 1.6 Hz
- Save Throughput: Enabled

4.1.3.2 Online Data Processing Parameters. These parameters are used for propshaft 2nd order cuts and vector sum calculations for seat track and steering wheel vibrations.

- Autopower or spectrum
- Root Mean Square (RMS) linear vibration levels
- Save waterfalls
- Order: 2.0
- Tracking Width: 0.5 order (confirm by checking color map)
- Derived calculations: Seat track and steering wheel top X,Y,Z vector sums (optional)

4.2 Conditions.

4.2.1 Environmental Conditions. The test surface should be dry to allow the maximum torque to be applied.

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 Vehicle Warmup. To bring the vehicle to the correct operating temperature, complete two (2) laps around the ride and handling loop at MPG.

4.3.2 Measurement of Launch Shudder. Begin data acquisition at the bottom of the 7.2% hill or on a smooth flat road surface. Operate the vehicle in the lowest gear available at approximately 75 PRPM. Abruptly accelerate the vehicle at wide-open throttle until the vehicle reaches 1200 PRPM to 1500 PRPM. Allow the vehicle to slow until the PRPM returns below 75 PRPM. The vehicle is now ready for the next launch to be performed. Perform sufficient launches to obtain three (3) repeatable runs for averaging. The PRPM slope should be linear and equivalent for all three (3) runs (see Appendix A, Figure A2). Seat track RMS levels at the vibration peaks should

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