



Low Speed Driveway Vibration Evaluation Procedure for Transverse Drivelines

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 procedure is to objectively measure powertrain and driveline induced vibration during low speed driveway conditions. This includes vibration generated by tripot type constant velocity (CV) halfshaft joints.

1.2 Applicability. This procedure is applicable to front wheel drive vehicles and all wheel drive vehicles with transverse powertrains.

1.3 Remarks. None.

2 References

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

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

None

2.3 Additional References.

- Leuven Measurement Systems (LMS) International Test.Lab software is available at www.lmsintl.com/testlab.
- Vehicle Technical Specification (VTS).

3 Resources

3.1 Facilities. 7.2% grade test track is preferred, but smooth surface is the priority. Testing can also be performed on level grade road with smooth surface.

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 Tachometers. CANBUS is the preferred method for tracking transmission output/halfshaft speed (Signal name: TrnsOutShftAngVel) on automatic vehicles. For manual transmission vehicles, it is necessary to use an optical tachometer positioned on one of the front wheels to pick up halfshaft speed. Reflective tape should be equally spaced on several wheel spokes to obtain at least 5 pulses per revolution (PPR). See Appendix A, Figure A2 for example pictures.

3.2.2 Accelerometers Two tri-axial low mass accelerometers with flat response from 2 Hz to 2000 Hz and an operating range of 10 °C to 50 °C are required. Additional accelerometers may be used for engine side vibration measurements.

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3.2.3 Data Acquisition Equipment. The preferred digital data acquisition system (DAS) is a personal computer running Leuven Measurement Systems (LMS) Test.Lab software connected to an LMS Scadas mobile front end, or equivalent as approved by the Global Noise and Vibration Center (GNVC) Infrastructure Team. This setup allows simultaneous digital recording of time domain data and online or post processing of frequency and order domain data.

3.3 Test Vehicle/Test Piece. Not applicable.

3.4 Test Time.

Calendar time: 2 d
Test time: 4 h
Coordination time: 8 h to 12 h

3.5 Test Required Information. The following information is required to properly and efficiently run this procedure.

3.5.1 Operating Conditions. Low speed driveaway vibration commonly occurs under two principal operating conditions. This procedure may be used for either one or both test conditions. Prior to starting the test, determine the operating conditions of interest.

Caution: If using subjective evaluation to identify conditions of interest, conduct multiple runs and stagger front left hand (LH) vs. right hand (RH) tire pressures. For example, if the placard tire pressure is 35 PSI, set one side to 32 PSI and the other side is 38 PSI. The pressure differential will make one tire slightly larger than the other resulting in a speed differential that will induce tire phasing. This increases the occurrence of maximum vibration when halfshaft axial forcing functions acting on the power cube are in phase.

- **Condition 1: Maximum Accelerator Pedal Driveaway.** Tripot joint generated vibration risk under this test condition is high for vehicles where outboard end of the halfshaft is lower than the inner at curb weight, a condition where the joint angle is referred to as “shedding water”. This test condition must also be used when engine generated vibration is to be measured.
- **Condition 2: Light Driveaway.** Tripot joint generated vibration risk is high under this test condition for vehicles where the outboard end of the halfshaft is higher than the inner at curb weight, a condition where the joint angle is often referred to as “holding water”.

3.5.2 Vehicle Information.

- Revolutions per kilometer (RPK) of vehicle tires.
- Gross Vehicle Weight (GVW).
- Nominal halfshaft angles for curb and design conditions.
- Nominal trim height.

3.5.3 Vehicle Setup. Vehicle should be evaluated at the following trim heights and vehicle weights to understand how the vehicle responds to worst case build and operating conditions. The conditions to test are:

- Setup 1: Nominal trim height at curb weight.
- Setup 2: Maximum in-specification trim height at curb weight.
- Setup 3: Minimum in- specification trim height at curb.
- Setup 4: Minimum in- specification trim height at Gross Vehicle Weight (GVW).

Test Setups 1 and 2 are for evaluating maximum accelerator pedal driveaway. Test Setups 1, 3, and 4 are for evaluating light driveaway. Increasing trim height can be accomplished by placing spacers in between the coils of the front suspension spring or adding spacers between the spring and upper seat. Decreasing trim height can be accomplished by adding ballast in the front foot wells. Halfshaft angles should be measured for each condition and recorded, see Appendix A, Table A2.

3.6 Personnel/Skills. One qualified engineer or technician trained in the use of data acquisition and recording equipment and having basic knowledge of digital signal processing of acoustic or vibration signals. Experience using LMS Test.Lab for on road acquisition is also helpful.

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4 Procedure

4.1 Preparation.

4.1.1 General Vehicle Preparation. All vehicles shall begin the test at curb weight plus instrumentation. Ensure all fluid levels are full. Ensure fuel tank is full. Ensure tires are inflated to recommended pressure level. Ensure that all storage locations are empty (no stored development parts or unnecessary instrumentation left in areas such as the trunk). Halfshaft generated vibration is often dependent on the operating angle of the tripot joints. Therefore, the working angle of left and right inboard halfshaft joints must be measured prior to test, and verified to be within allowable tolerances. If joint angles are found to be out of tolerance, this condition must be corrected before proceeding with test. Suspension trim height affects driveline angles. If halfshaft joint angles are out of tolerance, check trim height to determine if angles are within specification.

4.1.1.1 Halfshaft Preparation. Before testing the vehicles, halfshafts must be properly broken in to ensure correct friction characteristics. To break in the halfshafts, perform 50 best-effort wide open throttle (WOT) launches, accelerating through the 1 to 2 upshift.

4.1.2 Vehicle Instrumentation.

4.1.2.1 Accelerometers. Install a tri-axial accelerometer at the 12 o'clock position of the steering wheel, using a machined accelerometer mounting pad with two tape bands to secure the pad to the wheel rim. Install a tri-axial accelerometer at the front inboard seat track of the driver's seat track. Install additional accelerometers if desired for reference. Commonly used optional locations include one or more powertrain mounts, and suspension components of interest. See Appendix A, Figure A2 for the orientation and location of accelerometers.

4.1.2.2 Recommended CANBUS Channels.

- Engine torque vs. time: EngActStdYStTorq.
- Accelerator pedal position vs. time: AccActPos.
- Vehicle speed vs. time: VehSpdAvgDrvn.

4.1.2.3 Data Acquisition Parameters.

- Sampling rate 8192 Hz (4096 Hz Bandwidth)
- Tracking mode: "Tacho"
- ΔF : 1.6 Hz
- Save Throughput: Enabled

4.1.2.4 Online Data Processing Parameters. The following parameters are used for halfshaft 3rd order data processing.

- Autopower or spectrum.
- Hanning Window.
- Amplitude Correction.
- Peak.
- Save waterfalls.
- Order: 3.0.
- Tracking Width: 0.8 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. Ensure that the road surface is dry to prevent wheel spin and ensure proper weight transfer.

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.

4.2.2.1 Vehicle Mass. Refill fuel tank if it falls to $< \frac{3}{4}$ full. Establish desired test mass condition (curb plus driver, GVW, etc.) based on subjective evaluation or direction of test requestor, and note the vehicle mass condition on the Vehicle Preparation Test Data Sheet found in Appendix A, Table A1.

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