



Driveline Three Point Balance Method and Sensitivity 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 has been written for vehicle-level driveline balancing in the specific environment of a noise and vibration chassis dynamometer. It is intended to address the specific case of single-plane driveline balancing in the context of noise and vibration testing.

This procedure may be used to determine and minimize the first order balance vector of a vehicle driveline using the single-plane three point method. The most common usage of this procedure is to measure and correct unbalance of a driveline with relatively uncoupled balance planes near the ends of each prop shaft segment.

This procedure may also be used to evaluate noise and vibration sensitivity to first order driveline unbalance.

1.2 Applicability. This test procedure is appropriate for use with all passenger cars and light trucks utilizing prop shaft systems to drive the rear and/or front axles. Although this procedure was written with reference terminology based on rear drivelines, the procedure may also be used to balance front drivelines that utilize a prop shaft to drive the front axle.

1.3 Remarks. The three point balance method described in this procedure calculates the phase (angular position) of the imbalance and correction vectors using the known angular position of the trial mass as it is moved to three different positions. This method has proven more robust than the single point method which relies on the measured dynamic phase of the reference accelerometer response. In particular, the single point method is less robust than the three point method for low levels of imbalance and/or insensitive response locations, where the measured dynamic phase suffers from poor signal-to-noise ratio.

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.

Vehicle Technical Specifications (VTS)

3 Resources

3.1 Facilities. The test facility shall be a chassis dynamometer capable of speed control and load control up to 140 kph and 4500 N tractive effort respectively.

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.

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3.2 Equipment.

3.2.1 Tachometer. A prop shaft tachometer is required. Output must be compatible with data acquisition system (DAS) input requirements. Angular resolution of one or more pulses per revolution is required.

3.2.2 Fiberglass Reinforced Tape. This is required to attach trial balance weights to the driveline.

3.2.3 Trial Weights. Standard automotive adhesive-backed wheel balance weights may be used. Standard wheel balance increments may be replaced or supplemented with partial increments by trimming material from the weight before application if required. Hose clamps may also be used.

3.2.4 Data Acquisition System (DAS). A multi-channel data acquisition system is required (minimum four channel capability).

3.2.5 Accelerometers. A minimum of one triaxial accelerometer and cable is required. The accelerometer(s) must have appropriate temperature capability for the operating driveline environment to be evaluated. Refer to GMW16178 for detailed specifications.

3.2.6 Microphones. The balancing procedure does not require microphones. If vehicle occupant interface noise and vibration sensitivity to driveline unbalance is to be evaluated, microphones must be used to determine the first order driveline induced interior sound pressure using GMW16178.

3.2.7 Adhesive. Epoxy tape or equivalent adhesive effective in the 0 Hz to 800 Hz frequency range is required to attach accelerometers.

3.3 Test Vehicle/Test Piece. The test vehicle must be qualified to ensure that it represents design intent. Deviations from design intent must either be corrected or noted. For development tests, this is subject to the specification of the test requester.

3.4 Test Time.

Calendar time: 1 d

Test time: 4 h to 8 h

Coordination time: 4 h

3.5 Test Required Information. Service procedures are required for removal of any shields or access panels that would prevent access the prop shaft balance planes of interest.

3.6 Personnel/Skills. To complete this procedure, one dynamometer operator and one engineer and/or technician skilled in noise and vibration data acquisition are required.

4 Procedure

4.1 Preparation.

4.1.1 Vehicle Preparation. Install the vehicle on the chassis dynamometer per GMW16178.

4.1.2 Instrumentation Preparation.

4.1.2.1 Connect all transducers to the DAS. Use the following recommended channel assignments.

- Driveline Response Point Lateral Acceleration
- Driveline Response Point Vertical Acceleration
- Driver's Ear Sound Pressure Level (if microphone is used)
- Additional channels may be assigned for driver interface or driveline response locations if required to meet program development or validation needs. Refer to GMW16178.

4.1.2.2 Set the DAS to acquire order-tracked run-up data from all instrumented locations. Track the first order of the prop shaft. If online order processing is used, select an order resolution fine enough to separate driveline orders from nearby tire/wheel orders. The relationship between tire and driveline orders is calculated using the final drive ratio of the vehicle. For example, for a 3.91 final drive ratio, first order driveline will correspond to 3.91 order tire. Conversely, fourth order tire will correspond to 1.023 order driveline. Therefore, a prop shaft order resolution of ± 0.02 order or finer would be needed to ensure fourth order tire related data could be separated from first order driveline related data. Similarly, use transmission/transfer case/Power Take-Off Unit (PTU) gear ratios (if known) to check for possible alignment or close spacing of known engine and transmission orders with first order driveline. Set minimum order resolution accordingly to prevent smearing of major engine and

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transmission/transfer case/PTU orders with first order driveline. Annotate the data acquisition setup with applicable vehicle configuration and identification information as specified in GMW16178.

4.1.3 Verify Instrumentation Calibration.

4.1.3.1 Verify the accelerometer calibration using appropriate reference signal per GMW16178.

4.1.3.2 If interior microphones are used, verify the microphone calibration using appropriate reference signal per GMW16178.

4.1.4 Transducer Placement/Installation. For the accelerometer location, choose the driveline response point closest to the balance plane of interest: axle pinion nose, prop shaft center bearing mount, or transmission/transfer-case/PTU output. Center bearing accel to be added to active side as available, in cases its allowed to be added on non-active side, see Figure 1.

Figure 1: Active Side Accelerometer Location



4.1.4.1 Orient the accelerometer such that the lateral and vertical sensing directions are aligned with corresponding vehicle coordinates.

4.1.4.2 Attach the accelerometer(s) with the appropriate high temperature adhesive.

4.1.4.3 If optional interior microphones are used, position the microphones at the standard seat locations as specified in GMW16178.

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