GM WORLDWIDE ENGINEERING STANDARDS	Test Procedure	GMW16148

Manual Transmission and Drivetrain – Strength in Reverse Gears

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 standard describes the evaluation of manual transmission/transaxle drivetrain strength in reverse gears during drive and overrun conditions.

1.2 Applicability Passenger cars, Multipurpose Vehicles (MPV) and light-duty trucks (with 2WD, 4WD, all-wheel drive, front and rear wheel drive).

1.3 Remarks. This test is usually used for validation in a vehicle test plan.

It may also be used to give an initial evaluation of drivetrain strength in development phases, whereas required consolidation may apply at engineer's discretion, in particular with regard to total number of test pieces in differentiation concerning Drive and Overrun test part or to test to fail.

This test is also used by platform measurement groups to define procedures for obtaining maximum loads for powertrain interface systems such as engine mounts, etc.

The project team is responsible to ensure that test is to be executed as specified.

Deviations from the requirements shall have been agreed upon within the responsible project team.

1.3.1 The Test Summary.

1.3.1.1 Drive Direction Launches. 3 cycles in drive direction with snap clutch engagement launches each at 1000 min^{-1}, 2000 min^{-1}; 3000 min^{-1} and 4000 min^{-1} in reverse gear.

1.3.1.2 Overruns. 10 cycles with engine at idle speed performance each at 5 km/h; 10 km/h; 20 km/h and 30 km/h (≈ 3 mph; ≈ 6 mph; ≈ 12 mph and ≈ 18 mph). All performed with snap clutch engagement. Maximum vehicle speed is 75 % of the maximum permissible engine speed in the gear to be tested (reverse gear).

2 References

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

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

GMW14264

2.3 Additional References. ADV Plan, SOR, SSTS, VCRI, VTS.

3 Resources

3.1 Facilities.

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.

3.1.3 Use the following (or frictional equivalent) in order of preference:

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3.1.3.1 GM certified proving ground or equivalent automotive test facility.

3.1.3.2 Test to be performed on even level, dry antiskid pavement (concrete or asphalt with constant friction characteristics).

3.2 Equipment.

3.2.1 Optional for Development. Torque measurement instrumentation such as propshaft or torque wheels (preferred) and appropriate recording equipment.

3.2.2 Calibrated tachometer or other means of measuring accurate engine speed.

3.2.3 Instrumentation to measure transmission sump temperature.

3.2.4 Precision vehicle speed recording equipment or calibrated vehicle speedometer.

3.3 Test Vehicle/Test Piece.

3.3.1 Test material such as transmission, axle, propshaft, etc. installed in a vehicle representative of production or test intent. Validation specifications are set using untested components.

3.3.2 Tires. Tires that give the highest driveshaft reaction torque, if available. This is typically the largest diameter released tire size, however, other factors such as tread design, tread width, etc. may influence this.

Note: New tires shall be run in.

3.3.3 Engine. The regular production option available having the highest torque.

3.3.4 Transmission. The regular production option available producing the highest driveshaft reaction torque.

3.3.5 Axle. Use axle drive with limited slip differential if released, otherwise regular.

3.3.5.1 Drive Direction. The lowest numerical ratio released for the above engine/transmission combination that gives the highest driveshaft reaction torque.

3.3.5.2 Overrun Direction. The highest numerical ratio released for the above engine/transmission combination that gives the highest driveshaft reaction torque.

3.3.6 Clutch. Highest capacity released clutch for the above engine/transmission combination. It must be qualified to the print high-tolerance pressure-plate load. This is the maximum pressure-plate load a new clutch package could have, not the maximum possible pressure-plate load with a worn-out disk.

Note: New clutches shall be run in

3.3.7 Driver Assistance Systems. Switch driver assistance systems to standard conditions, i.e. electronic stability program and traction control to ON, adaptive ride chassis to NORMAL, STOP&START to on. Other than standard settings shall be denoted.

3.3.8 Hardware Requirements/Test Pieces.

3.3.8.1 The launch and over-run portion comprise one test procedure.

3.3.8.2 One (1) set of hardware must pass the drive and one (1) set of hardware must pass over-run portion of each test. In total two (2) sets of hardware are required to perform one complete test.

3.3.8.3 Based on regional requirements it is accepted to perform drive and overrun portion with one (1) set of hardware only. This has to be communicated and agreed within the project team.

3.3.8.4 These requirements do not apply to hardware validated to previous requirements.

3.4 Test Time.

Calendar time:	3 days
Test hours:	8 h
Coordination hours:	16 h

3.5 Test Required Information. Possible sources are:

- SOR
- VTS
- SSTS
- ADV Plan

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- VCRI
- Application engineer
- Development Groups
- Drawings

3.6 Personnel/Skills. Not applicable.

4 Procedure

4.1 Preparation.

4.1.1 Engineer Test Data. Engineer shall perform as follows and record on Data Sheet 1 (see Appendix A).

4.1.1.1 Determine and record who (e.g. GM or supplier) will disassemble components after test.

4.1.1.2 Determine, record and supply correct tires and axle for Drive direction and Overrun direction tests. Record tire pressure specification.

4.1.1.3 Determine if wheel or propshaft torques shall be measured. This is more often done for development.

4.1.1.4 Record transmission excursion and stabilized maximum temperature desired on data sheet.

4.1.1.5 Specify road surfaces to use if differences in road friction coefficients may affect comparisons of two different designs. Differences in coefficients shall range from (5 to 10) %. See paragraph 3.1.

4.1.2 Pre-test Inspections. Rate drivetrain for pre-test noise according to GMW14264 and record on Data Sheet 2 (see Appendix B).

4.1.2.1 Place vehicle on hoist and inspect the following:

- Engine mounts
- Suspension
- Frame/body supports
- Axle housing
- Other reaction supporting members
- Rate leaks using GMW14264

4.1.3 Pre-test Setup. As follows:

4.1.3.1 Install all instrumentation.

4.1.3.2 Remove clutch pedal pad.

4.1.3.3 Set tire pressure to specification on Data Sheet 1 (see Appendix A), record on Data Sheet 2 (see Appendix B).

Note: Different size tires may be required for Drive and Overrun portions of test.

4.1.4 Vehicle Ballast.

4.1.4.1 Vehicles rated up to 2040 kg (≈ 4500 lb) towing capacity:

- 2/3 (≈ 66 %) of carrying capacity (carrying capacity = Gross Vehicle Weight (GVW – Curb Weight with 100 % options)
- The drive axle shall be ballasted with maximum allowed axle weight.
- For AWD applications load each axle with 50 % of calculated ballast.
- Ballast to be placed in intended storage area such as passenger compartment or trunk.
- Stop at any ballast point if carrying capacity is reached.
- Secure the ballast, as required, to prevent movement during test execution.
- Record vehicle front and rear axle test weights on Data Sheet 2 (Appendix B).

4.1.4.2 Vehicles rated > 2040 kg (≈ 4500 lb) towing capacity:

- 100 % GVW
- Ballast (including driver + equipment) to maximum rated front and rear axle capacity with total loading not to exceed total rated GVW

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- Ballast to be placed in intended storage area such as passenger compartment or trunk.
- Stop at any ballast point if carrying capacity is reached.
- Secure the ballast, as required, to prevent movement during test execution
- Record vehicle front and rear axle test weights on Data Sheet 2 (see Appendix B)

4.1.5 Break-in. Recommended for new engines, and transmissions. For new axles a break-in is mandatory. Perform in such case as follows:

4.1.5.1 Accelerate lightly, while up-shifting lightly, to ≈100 km/h (≈ 60 mph), then

4.1.5.2 Vary speed (80 to 100) km/h [≈ (50 to 60) mph] for 5 km (≈ 3 miles) in top gear, then

4.1.5.3 Decelerate lightly, while lightly downshifting, to a stop.

4.1.5.4 Then Repeat cycles of paragraph 4.1.5.1 thru 4.1.5.3 for a distance of 200 km as above defined.

4.1.5.5 Engage reverse gear and accelerate WOT to 25 km/h.

4.1.5.6 Then decelerate lightly to a stop.

4.1.5.7 Repeat reverse gear portion of break in 10 times.

4.2 Conditions.

4.2.1 Environmental Conditions.

4.2.1.1 Road surface shall be dry.

4.2.1.1 Temperatures. Recommendations based on best practice:

- Ambient temperature shall be between -5 °C and +30 °C.
- Road surface temperature shall be above ambient temperature at start of test but not exceed melting point of asphalt. It is recommended to measure and denote road surface temperature at beginning and end of test.
- Tire temperature shall be above road temperature but not exceed graining temperature. It is recommended to measure and denote tire temperature at beginning and end of test.

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 Transmission/transaxle oil sump temperature shall be at +60 °C minimum at the start of the test.

4.3 Instructions.

Note: For validation purpose reverse drive portion shall be run in the order of launches (1000 min^{-1}, then 2000 min^{-1} etc.), reverse overrun portion shall be run with ascending speeds (5 km/h, 10 km/h, etc.). Development procedure may be run in any order at the engineer's discretion.

Terminate test if temperature of transmission oil exceeds permissible long or short term value according to oil type and specifications.

4.3.1 Launches.

4.3.1.1 From a stop, shift to reverse gear.

4.3.1.2 Bring engine to the test speed.

4.3.1.3 Release the clutch using snap clutch engagement.

4.3.1.4 Keep accelerator pedal position constant during snap event but 1 s mimimum.

4.3.1.5 Engine speed and cycles are as follows:

- 3 cycles at 1000 min^{-1}
- 3 cycles at 2000 min^{-1}
- 3 cycles at 3000 min^{-1}
- 3 cycles at 4000 min^{-1} (or engine redline whichever is lower)

Disengage clutch immediately after full engagement.

4.3.1.6 For base transmission development purpose: disable engine speed limitation at launch for vehicle applications with launch speed limitation < 4000 min^{-1} engine speed if possible.

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