



Torque Loss Measurement on FWD/RWD Transmissions at Zero Load

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. Determine the torque loss of FWD/RWD manual transmissions at zero load and at various speed and operating temperatures when engaged at different gear positions.

The torque loss of a manual transmission shall be measured on a test bench, driven by an electric motor.

1.2 Applicability. For FWD, RWD manual transmissions.

1.3 Remarks. The results from the measurements are used to compare different versions and modifications of a manual transmission.

2 References

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

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

GMW16916

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 The test bench requires an input engine (electric motor), which can drive a torque of 50 Nm. The output of the transmission is not connected (test set-up, see Appendix A).

3.2 Equipment.

3.2.1 The upper range of the torque transducer should be as low as possible to keep the accuracy as high as possible, e.g. HBM T10, upper range = 50 Nm).

3.2.2 An amplifier with an accuracy ≤ 0.005 % shall be used (e.g. HBM ML60B), in case an analog signal transmission is used. No Amplifier is used, if the signal transmission via CAN Bus is used (preferred version).

3.2.3 A signal transmission via CAN signals should be used if possible, to eliminate the error of the amplifiers.

3.2.4 Depending on the test, a digital measurement system (e.g. IMC Cronos PL) shall be used.

3.2.5 Depending on the test, it may be necessary to provide a cooling chamber, to prepare the transmission.

3.3 Test Vehicle/Test Piece. Complete FWD or RWD manual transmission. Clutch disk and axle shafts are not required.

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3.4 Test Time.

Calendar time: (2 to 8) days ^{Note 1}

Coordination hours: 4 h

Note 1: Depending on the test version

3.5 Test Required Information. Oil fill quantity and oil type.

3.6 Personnel/Skills.

3.6.1 Test Bench Operator. Knowledge is required about test bench control and torque transducers.

3.6.2 Development Engineer. Knowledge is required about torque transducers, measurement equipment and accuracy.

4 Procedure

4.1 Preparation.

4.1.1 Gather all information required to perform the test (see 3.5).

4.1.2 Create a test protocol (see Appendix B). The test protocol defines, which operating points shall be measured

4.1.3 Install the transmission on the test bench in its vehicle assembly position.

4.1.4 Install a temperature sensor in the oil sump. Fill in the oil type and volume specified for the transmission. If the transmission had been drained before, please watch the oil rest amount when filling oil to desired volume.

4.1.5 New transmissions will have higher losses than transmissions, which have seen a run in. If the desired results refer to a run in transmission and the transmission is new, a run-in program under load shall be performed first. The drag torque bench cannot produce loads. Therefore another test bench shall be used, e.g. an efficiency test bench. An appropriate procedure is described in GMW16916 (efficiency test).

4.1.6 Switch on the measurement system and amplifiers 30 minutes before the start of data acquisition. This warm up phase is required to allow a stable operating temperature of the measurement equipment. Use other warm up times, if recommended by the supplier of the measurement system supplier.

4.2 Conditions.

4.2.1 Environmental Conditions. See Test Version according to 4.3.

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 During the measurement process, it may be necessary to heat up or cool down the oil to a level, which cannot be reached during normal the operation. Therefore cooling or heating the transmission via an air fan could be required. It shall be ensured, that no hot spots or cold spots are created at the transmission (e.g. "don't heat the bearings by fan").

4.3 Instructions. The torque loss at zero load depends on the speed and temperature. In order to keep one of the two variables constant, two different tests have been created.

This Test Procedure therefore describes the two different tests:

Version A: The oil sump temperature shall be kept constant and the speed is variable. The test data shall be recorded with a digital measurement system. Input speed, input torque and oil temperature shall be recorded with a minimum sampling rate of 0.01 s (speed), 0.01 s (torque) and 0.5 s (temperature).

The result is the torque loss as a function of the speed at a constant temperature in all gears.

Version B: The speed shall be kept constant and the temperature is variable. The test data, input torque at defined oil temperatures, shall be written down.

The result is the torque loss as a function of the temperature at a constant speed in all gears.

4.3.1 Version A (Constant Temperature).

4.3.1.1 The operating points shall be defined in the test protocol (see Appendix B).

4.3.1.2 Mount the transmission on the test bench.

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4.3.1.3 Operate the transmission with a medium speed, until the desired oil sump temperature is approached (typically +40 °C or +80 °C).

To provide a proper lubrication of all parts of the transmission, all gears should be operated at 2000 min⁻¹ for at least 3 minutes during this warm up phase. If necessary use a fan to support this operation.

During the measurement, the oil temperature should stay at the defined value with a tolerance of ±5 °C.

4.3.1.4 Set the speed to zero and engage the desired gear.

4.3.1.5 Start the data acquisition at the digital measurement system.

4.3.1.6 Ramp up the speed from 0 min⁻¹ to 4200 min⁻¹ with a constant gradient of 50 min⁻¹/s.

4.3.1.7 Hold 4200 min⁻¹ for 5 s.

4.3.1.8 Ramp down the speed from 4200 min⁻¹ to 0 min⁻¹ with a constant grade of 50 min⁻¹/s.

4.3.1.9 Stop the data acquisition at the digital measurement system.

4.3.2 Version B (Constant Speed).

4.3.2.1 The operating points shall be defined in the test protocol (see Appendix B).

4.3.2.2 Put the transmission, including oil, into a cooling chamber. Keep it there until the temperature of the transmission is at least 5 °C lower than the lowest defined temperature according to the test protocol is reached. The best practice is, to cool the transmission down over night. This operation is not required, if the lowest defined temperature is above the ambient temperature.

4.3.2.3 Mount the transmission on the test bench.

4.3.2.4 Operate the transmission with the defined speed.

4.3.2.5 Each time a defined temperature is reached, write down the input torque.

4.3.2.6 If the desired temperature is considerably higher than the actual temperature, operate the transmission temporarily with a higher speed, to reduce the heat up time. If necessary, use a fan to support this operation.

5 Data

5.1 Calculations.

5.1.1 Test Version A. A program shall be written to evaluate the data recorded by the digital measuring system.

The first step is to filter the data, e.g. smoothing with an averaging interval of 1 to 2 points (in case of the FAMOS program is used, take the "glatt" function).

The second step is to extract the acceleration and deceleration segments of the data.

The third step is to calculate the average of the acceleration and deceleration. This is the torque loss as a function of the speed.

5.1.2 Test Version B. No calculations are necessary here.

5.2 Interpretation of Results. The results will show the influence of the speed, lube oil temperature at each gear position on the transmission losses.

5.3 Test Documentation.

5.3.1 The measurement results should be evaluated graphically (see Appendix C) and in tabular form. The constant parameters gearbox, final drive, gear set, oil type, oil volume and measurement number shall be recorded. The diagrams shall facilitate comparative statements concerning the reproducibility of results as well as a determination of interrelationships between individual parameters.

5.3.2 For the error assessment, a detailed error calculation shall be provided that includes all errors caused by the measuring chain.

For an example of the error assessment of the measuring chain (for Version A), see Appendix D.

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