



Drag Torque Measurement at Idle Conditions and Various Temperatures on FWD/RWD Transmissions

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 Test Procedure is to determine the drag torque of FWD/RWD manual transmissions at idle conditions and at various operating temperatures. The results are an input for a simulation model to calculate idle rattle conditions and input data for clutch dimensioning.

The drag torque 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. Not applicable.

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 blocked (test set-up, see Appendix A).

3.1.4. A cooling chamber shall be provided to prepare the transmission. It shall be able to cool down the transmission to at least -50 °C.

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. A cooling chamber shall be provided to prepare the transmission. It shall be able to cool down the transmission to at least -50 °C.

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: 5 days

Test hours: -

Coordination hours: 4 h

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. It is also used to write down the measured values.

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, watch the remaining oil 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.

4.1.7 Create a bracket, which holds the transmission during the cooling phase in the cooling chamber in the vehicle assembly position.

4.2 Conditions.

4.2.1 Environmental Conditions. See instructions 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.

4.3 Instructions.

4.3.1 Mount the transmission on the test bench. Run the transmission ≥ 30 minutes with an input speed between 1000 min^{-1} and 2000 min^{-1} . The oil temperature shall be between $(+60 \text{ to } +80)^\circ\text{C}$ at the end of this run. This shall provide a sufficient oil distribution in the transmission, when it is transferred to the cooling chamber. A normal test run, as described below, is also sufficient for this purpose.

4.3.2 Move the transmission to the cooling chamber. The oil temperature shall be $(+30 \text{ to } +50)^\circ\text{C}$, when the transmission is positioned in the cooling chamber on the prepared bracket. The shifter shall be in the neutral position.

4.3.3 Set the target temperature of the cooling chamber at -50°C or lower, depending on the capabilities of the chamber. Keep the transmission in the chamber at low temperatures for (10 to 20) h.

4.3.4 Mount the transmission on the test bench. Connect the drive motor and the sensors and block the output side. The shifter shall stay in the neutral position. This operation should be fast enough to be able to start the test with an oil temperature of -30°C .

4.3.5 Wait until the oil sump temperature has reached the start temperature of $(+30 \pm 3)^\circ\text{C}$.

4.3.6 Run the transmission with 1400 min^{-1} . The acceleration to this speed shall be slow enough in order to keep the torque below the maximum torque of the drive motor and the maximum torque of the torque sensor. Wait (20 to 30) s. Write down the torque and temperature on the test protocol.

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4.3.7 Change the speed to 1000 min⁻¹. Wait (20 to 30) s. Write down the torque and temperature on the test protocol.

4.3.8 Repeat 4.3.7 successively with the speeds 900 min⁻¹, 800 min⁻¹ and 700 min⁻¹.

4.3.9 Run the transmission with 1400 min⁻¹. The acceleration to this speed shall be slow enough in order to keep the torque below the maximum torque of the drive motor and the maximum torque of the torque sensor. Wait until the oil sump temperature has reached the start temperature (-20 ± 3) °C. Write down the torque and temperature on the test protocol.

4.3.10 Repeat 4.3.7 successively with the speeds 1000 min⁻¹, 900 min⁻¹, 800 min⁻¹ and 700 min⁻¹.

4.3.11 Repeat 4.3.8 to 4.3.10 successively with start temperatures -10 °C, 0 °C, +20 °C, +40 °C and +80 °C, each with a tolerance of ±3 °C.

The time to reach the start temperature will increase at the higher temperatures. To shorten the time to reach the temperature, it is possible to heat up the transmission externally with a fan (see also 4.2.3) and/or increase the speed temporarily.

4.3.12 The test run according 4.3.1 to 4.3.11 shall be repeated at least three times.

5 Data

5.1 Calculations.

5.1.2 Repeat 5.1.1 for all test runs.

5.1.3 Compare the results in a diagram. It shall be decided, if a test run deviates from the others too much and shall be deleted. This is subject to experience. It is suggested to eliminate those test runs, which differ > 1 Nm at -20 °C or > 0.5 Nm at 0 °C from the average. At least three valid test runs for each speed should remain.

5.1.4 Carry out a cubic regression for each valid test run. The result of each test run has therefore the form:

$M = a \cdot T^3 + b \cdot T^2 + c \cdot T + d$, with M = torque in Nm and T = Temperature in °C

The average of all test runs with one speed is the result.

5.2 Interpretation of Results. The results will show the influence of the lube oil temperature on the transmission idle losses.

5.3 Test Documentation.

5.3.1 The measurement results should be evaluated graphically (example see Appendix C) and in tabular form (example see Appendix D). The constant parameters gearbox, final drive, gear set, oil type, oil volume and measurement number shall be recorded.

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 see Appendix E.

6 Safety

This Engineering Standard may involve safety requirements for hazardous materials, the method of operations and equipment. This standard does not propose to address all the safety issues associated with its use. It is the responsibility of the user of this standard to ensure compliance with all appropriate safety and health practices. This would include any specific training that may be required. The safety and health standards include site specific rules and procedures, company rules and procedures, and Government Standards. Contact shall be made with the appropriate site Safety and Health personnel for further direction and guidance in these matters.

7 Notes

7.1 Glossary. Not applicable.

7.2 Acronyms, Abbreviations, and Symbols.

FWD Front Wheel Drive

RWD Rear Wheel Drive

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