



Torque Converter Clutch Friction Material Performance Transmission on Electric Dynamometer

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 was developed to evaluate the performance of the bonded friction material on a Torque Converter Clutch (TCC) under standard conditions of temperature and pressure. This assessment describes procedures for a transmission bench test with the Torque Converter (TC) installed in a transmission. The procedures described in this GMW are not intended for component-only testing or vehicle testing. Reference the appropriate procedures for component-only or vehicle level TCC friction material performance outside of the transmission.

The results of this test provide baseline comparisons of the performance of the friction interface between the TCC friction material, transmission fluid, and reaction surface. This subsequently provides information to evaluate changes to the friction material and/or transmission fluid.

1.2 Applicability. This test is applicable to all stepped-gear transmissions that use the torque converter as a starting device. This procedure is not recommended for continuously variable transmissions even though the general concept may apply.

1.3 Remarks. Maintaining integrity of the original Automatic Transmission Fluid (ATF) may be a critical component to TCC friction material performance. Further fluid contamination or degradation (including thermal) may be undesirable. To that end, the fluid must be contained in the system while on test, preventing direct cooling. It is critical to monitor testing and ensure that fluid temperatures do not exceed design specifications. To prevent contamination, the fluid must be contained within the transmission system and must not be directly conditioned (e.g., by running the fluid through a conditioning cart).

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

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.

3.2 Equipment.

3.2.1 Loaded dynamometer setup with appropriate fixtures to mate with the TC and transmission output. The setup must be capable of holding steady input speed as the output speed is varied to induce the desired slip range, with slip being the difference between torque converter input and transmission input speeds.

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3.2.2 Instrumentation necessary to measure and record torque, speed, delta pressure, and sump temperature are required.

3.3 Test Vehicle/Test Piece. The focus of this test is on the friction performance of the TCC. Test materials include a full converter installed onto a stepped-gear transmission.

3.4 Test Time. The information provided in this section is for one torque converter. Time required for test setup will vary depending on test location. Coordination time is not expected to vary with additional test articles.

Calendar time: 1 d

Test time: 4 h

Coordination time: 4 h

3.5 Test Required Information. Minimum required inputs from the requestor follows:

- Input speed.
- Forward gear and gear ratio.
- Final drive ratio when applicable.
- TCC slip range.
- TCC apply pressures.
- ATF sump temperatures.
- Line pressure.
- Torque limit (for transmission and cell warnings/shutdown).

Output speeds are to be calculated per instructions provided in 4.3.3. Further, the requestor shall specify whether sections 4.3.1 or 4.3.2 are necessary.

3.6 Personnel/Skills. Test technician familiar with test facilities and equipment.

4 Procedure

4.1 Preparation. Special preparations (e.g., thermal coupling friction interface) and shall be requested in writing. It is recommended that the ATF cooler inlet and outlet be connected through a loop with a flow meter. Indirect cooling must be utilized to maintain ATF temperature; measurement through the sump is acceptable. Temperatures may be maintain by using vortex blowers directly on the transmission main body and TC shell.

4.2 Conditions.

4.2.1 Environmental Conditions. Testing shall be performed in an air conditioned room such that requested conditions may be achieved.

4.2.2 Test Conditions. Deviations from the requirements of this standard shall have been agreed upon in writing. Such requirements shall be specified on component drawings, test certificates, reports, etc.

4.3 Instructions.

4.3.1 TCC Post-Flush Steady State Break-in.

Note: Some studies require the system to be flushed with fresh ATF prior to TCC friction performance measurement. Detail procedures of the flush shall be supplemented in-writing by the requestor when needed. Post-flush clutch break-in must be performed after each set of ATF flushes.

Note: Sump temperature shall be monitored throughout the test and maintained < 80 °C.

- a. Shift into requested gear with TCC opened and ramp up to requested speeds to achieve zero (0) rpm slip.
- b. Increase TCC apply pressure from (0 to 300) kPa in 50 kPa/s increments.
- c. Ramp down output over 30 s to achieve 20 rpm slip and hold this condition for 60 minutes. Ensure a constant pressure of 300 kPa over the span of the specified period.
- d. Ramp down TCC apply pressure from (300 to 100) kPa in 50 kPa/s increments.
- e. After reaching 100 kPa, ramp down output over 30 s to achieve 40 rpm slip. Hold this condition for 264 minutes (4.4 h) while ensuring constant pressure.

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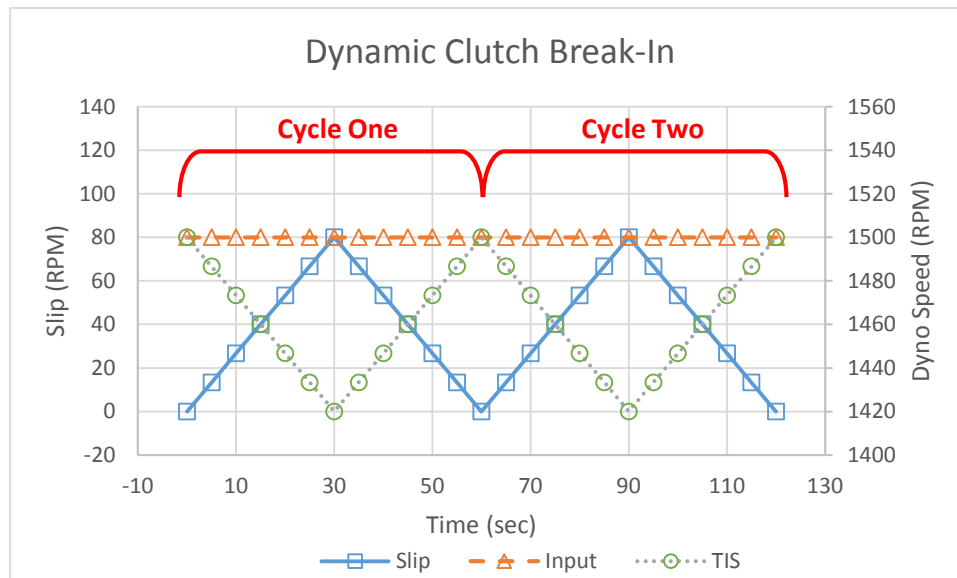
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- f. Post-flush break-in is complete. Ramp down TCC command pressure from (100 to 0) kPa. Ramp down input and output dyno speeds to zero (0) rpm.

4.3.2 Dynamic Clutch Break-in.

Note: Dynamic clutch break-in will not be necessary if a flush and steady-state break-in was performed prior to the friction material performance measurement.

Dynamic clutch break-in may be performed while warming up the transmission to the requested test temperature. One cycle constitutes one apply and one breakaway, varying TCC slip from (0 to 80) rpm and back down to zero (0) rpm in a triangular wave pattern as depicted in Figure 1 example. Number of cycles and desired clutch pressure shall be specified by the requestor.



Note: Figure represents two complete cycles. Input is the commanded speed for the input dyno; Transmission Input Speed (TIS) is the desired Transmission Input Speed corresponding to commanded output dyno speed and gear ratio.

Figure 1: Example Dynamic Clutch Break-in Cycles

4.3.3 TCC Friction Material Performance Procedure.

Note: ATF temperatures to be stabilized at requested temperatures while the TCC is in open mode prior to measurement.

Note: Common slip range is from (0 to 80) rpm slip in the TCC and should be the default range. The procedure will use this range to simplify the language.

Using standard methods, the output speeds shall be calculated as follows:

$$\omega_{out} = \frac{\omega_{in} - \omega_{slip}}{i_t i_a} \quad (i_a = 1 \text{ if differential is not used})$$

i_t = gear ratio, i_a = final drive

Note: Transmission Input Speed (TIS) is the difference between ω_{in} and ω_{slip} .

Reference information in the following Table 1 and submit table as part of the final report.

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