



Intermediate Shaft Rotating Friction Test 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. The purpose of this test is to measure the turning friction of an Intermediate (I) shaft. This test measures the torque required to rotate an I-shaft that is set up in its in-vehicle position.

1.2 Applicability. Any steering system I-shaft.

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.

- Component Technical Specification (CTS) (defines the component level testing and reliability requirements of the component)
- FARO Technologies UK Limited, United Kingdom (www.faro.com)
- Thermotron Industries, Holland, Michigan (www.thermotron.com)

3 Resources

3.1 Facilities. A bedplate that measures at least 1.2 m × 1.8 m (4 ft × 6 ft) with pneumatic (for air bearings) and electrical (for motor/controller) capacity. The bedplate and test equipment must be isolated from outside influences that can affect collected data.

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. Sections 3.2.1 through 3.2.9 include test rig, fixtures, transducers, instrumentation, and controllers typically used by the GMNA Global Steering Development Laboratory to perform this test. Other equipment may be substituted at the discretion of the local testing facility as long as it provides equivalent accuracy as specified herein or by the requestor. Any setup must be approved by the I-shaft Bill of Material (BOM) Family Owner (BFO).

3.2.1 Motor. The Driver Simulator (DS)-10 motor and appropriate software/controllers are used to rotate the I-shaft. The DS-10 is capable of applying up to 10 N·m of constant torque.

3.2.2 Fixtures. Fixtures with adequate adjustability and appropriate bearing sets are required to support each end of the I-shaft during the test. Total turning friction in bearings shall be ≤ 10% of the test specimen specification. Actual interfacing parts may be modified to fit on the bench (steering gear pinion, lower steering column attachment, etc.) The fixtures should be capable of reaching the in-vehicle position for each I-shaft.

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3.2.3 Three Dimensional (3-D) Measurement System. A measurement system is required to verify that the I-shaft is in its in-vehicle position. The steering lab in GMNA uses a FARO arm model number P12-02-11-09214 (available from FARO Technologies).

3.2.4 Environmental Box. An insulated box is required to contain the desired thermal environment for any tests requiring an environment that is not room temperature.

3.2.5 Thermal Source(s). Thermal sources must be capable of controlling temperature of the environmental box to temperatures between -40 °C and 85 °C. Temperature must be held within ± 5 °C of the desired temperature for the duration of the test, measured on or near the test specimen. Thermal sources shall not be applied directly to the test specimen. The steering lab in GMNA uses a Thermotron model number SE-600-6-6 (available from Thermotron Industries).

3.2.6 Torque Transducer. A torque transducer, isolated from all loads other than axial torque, must be between the DS-10 and the test specimen. The torque transducer must be capable of measuring up to 10 N·m of torque, rotating at speeds of up to 75 rpm, and a resolution less than or equal to 0.001 N·m.

3.2.7 Servo Couplings. Servo couplings are used on either side of the torque transducer to isolate the transducer from any loads that are not axial torsion loads.

3.2.8 Rotary Encoder. A rotary encoder is used to measure the angular displacement of the test specimen. The encoder must have a resolution ≤ 0.1 degrees and must be capable of turning up to 75 rpm. In the GMNA steering lab, the rotary encoder is built into the DS-10 motor. If properly equipped, the torque transducer can be used to measure the angular displacement in addition to torque.

3.2.9 Data Acquisition. Both the rotary encoder and torque transducer data is to be recorded at a minimum rate of 1000 samples/s.

3.3 Test Vehicle/Test Piece. The test specimen must be at its in-vehicle position. This is determined by measuring the angle of each Universal (U) joint as well as the extension length of the slip joint. Coordinates for the I-shaft in-vehicle position can be obtained from the Component Technical Specification (CTS) or from appropriate math data.

3.4 Test Time.

Calendar time: 0.5 days

Test hours: 1 hour

Coordination hours: 2 hours

3.5 Test Required Information. The requesting engineer is responsible for providing the CTS which must include the performance objectives (sample size and failure criteria) for development and/or validation tests.

3.6 Personnel/Skills. A test engineer is required to run this test. The test engineer shall be capable of proficiently setting up and running the test, which involves aligning/clamping down fixtures and ensuring proper test bench function. The test engineer shall also be able to interpret the test results and create reports as appropriate, which includes the use and/or programming of software to process data.

4 Procedure

4.1 Preparation. Reference Appendix A, Figure A1.

4.1.1 Place fixtures on bedplate and attach both sides of the I-shaft to the fixtures.

4.1.2 Arrange fixtures on bedplate such that the I-shaft is in its in-vehicle position, verifying with the 3-D measurement system. Clamp/tighten the fixtures to the bedplate once the in-vehicle position has been achieved.

4.1.3 For thermal tests, remove one or both ends of the I-shaft from the fixtures to install the environmental box.

4.1.3.1 Reinstall the I-shaft to the fixtures as needed.

4.1.3.2 Turn on the thermal source and allow temperature inside the environmental box to stabilize.

4.1.3.3 Allow test specimen to soak until desired temperature is homogeneously achieved.

4.2 Conditions.

4.2.1 Environmental Conditions. Unless otherwise specified, tests are typically conducted at room temperature of $22\text{ °C} \pm 3\text{ °C}$, with a Relative Humidity (RH) of $40\% \text{ RH} \pm 20\% \text{ RH}$.

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