



Ball Joint Friction and Elasticity Measurements

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. To measure the functional characteristics of suspension ball joints including control arm/link joints, steering tie rods, and stabilizer bar link ball ends.

1.1.1 Determination of the Rotating Release Moment and Friction Moment. See Appendix A, Figure A1, and Figure A4.

1.1.2 Determination of the Oscillating Release Moment and Friction Moment. See Appendix A, Figure A1, and Figure A4.

1.1.3 Determination of the Axial Travel and Elasticity. See Appendix A, Figure A2, and Figure A5.

1.1.4 Determination of the Radial Travel and Elasticity. See Appendix A, Figure A3, and Figure A5.

1.2 Applicability. This standard applies to all passenger cars, light duty trucks, and multipurpose vehicles.

1.2.1 The measurements described in this procedure are applicable for joint development, design validation, and production validation. It is also applicable for determining the wear behavior of ball joints, coming out of either laboratory tests or vehicles.

1.3 Remarks. These tests are intended to be performed by or at the direction of the supplier, as well as in GM test laboratories.

2 References

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

2.1 External Standards/Specifications.

None

2.2 GM Standards/Specifications.

GMW15760

2.3 Additional References.

- Component Technical Specification (CTS)
- Statement of Requirements (SOR)

3 Resources

3.1 Facilities. Not applicable.

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.

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3.2 Equipment.

3.2.1 Computer aided test machine for measurements on ball joints.

3.2.2 Elasticity test device stiffness must be > 100 kN/mm in order to minimize the influence to measurement results.

3.2.3 Equipment for data recording, data processing, and monitoring (plots and data files).

3.3 Test Vehicle/Test Piece. Each test sample must meet the drawing requirements and be design intent as installed on the vehicle. Therefore, if the ball joint is retained via a press fit, the part must be measured as assembled in the parent part or a representative test fixture. Data to verify compliance needs to be supplied with final test report. A minimum of six (6) samples shall be tested for Design Validation (DV) and six (6) samples shall be tested for Product Validation (PV). Use GMW15760 to select samples for test.

3.4 Test Time. Not applicable.

3.5 Test Required Information. All required test information shall be supplied by the GM Design Engineer or Validation Engineer.

3.6 Personnel/Skills. The test technician should be familiar with the test machine and the instrumentation required for obtaining test data. Prior experience/training in setting up and running similar tests and experience/training in the use of the referenced test equipment are required for a successful evaluation.

4 Procedure

4.1 Preparation. All samples must be checked to ensure conformance to all print dimensional requirements, material and if applicable, weld requirements. Reference 3.3.

4.1.2 Before measuring the friction, (rotating as well as oscillating) the joints must be prepared per 4.1.2.1 through 4.1.2.4, in order to ensure a complete distribution of grease inside the joint.

4.1.2.1 Oscillate the ball stud through the articulation angle and tumble it around the main axis of the housing without any loading, five (5) times.

4.1.2.2 Rotate the stud around its main axis one (1) time.

4.1.2.3 Assembly must be left at rest for a minimum of 24 h prior to measuring the Release Moment.

4.1.2.4 If a separate thermal conditioning chamber is used, the performance measurements must be taken within three (3) minutes of removal from the chamber.

4.2 Conditions.

4.2.1 Environmental Conditions.

4.2.1.1 Standard Temperature. Standard temperature for performing these measurements is $23^{\circ}\text{C} \pm 2.5^{\circ}\text{C}$.

4.2.1.2 Extreme Temperature: For DV phase only, high and low temperature tests are recommended to probe for any extreme deviation in performance. Soak the test parts for a minimum of 24 h prior to performing the test at the desired temperature. Suggested temperatures are -30°C and 60°C .

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 Deviations must be approved by GM Design Release Engineer (DRE), GM Validation Engineer (VE), and GM Subject Matter Expert (SME) or Bill of Materials (BOM) Family Owner (BFO).

4.3 Instructions.

4.3.1 General Instructions.

4.3.1.1 During the setup, any movement of the stud must be avoided in order to capture true results for the release moment.

4.3.1.2 The measurements are to be carried out on completely assembled parts with respect to the installation in the parent part. Therefore, any press fit influence and any friction of the seal to mating surface must be included in the test setup and measurements.

4.3.1.3 The measurements are performed with ball joint initially in design position.

4.3.1.4 If one (1) of the types of movement (Appendix A, Figure A1, Figure A2, Figure A3) does not occur in practical operation, then that characteristic does not need to be measured.

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4.3.2 Run the measurements from Table 1, Table 2, Table 3, and Table 4.

Table 1: Rotating Release Moment and Friction Moment

Performance	In zero oscillation position of the joint
Rotating Angle	± 35 degrees
Rotating Test Speed	30 degrees/s $\pm$ 2 degrees/s
Rotating Cycles	Three (3) full sine waves
Data Recording	Minimum of 300 data points/s

Table 2: Oscillating Release Moment and Friction Moment

Performance	Out of the zero position of the joint
Oscillating Angle	80% of the maximum articulation angle as per drawing
Oscillating Test Speed	30 degrees/s $\pm$ 2 degrees/s
Oscillating Cycles	Three (3) full sine waves
Data Recording	Minimum of 300 data points/s

Table 3: Axial Travel and Elasticity

Performance	In Zero Oscillation Position of the Joint
Axial Test Force: The test force applied should generate approximately 5 MPa of bearing pressure. Guidance forces in this table can be used, or bearing design dependent forces can be calculated.	Guidance Test Force Based on Ball Diameter: 38 mm to 32 mm - $F_{axial} = +1700 \text{ N} - 4000 \text{ N}$ 31 mm to 23 mm - $F_{axial} = +1000 \text{ N} - 2500 \text{ N}$ < 23 mm - $F_{axial} = +500 \text{ N} - 1200 \text{ N}$
Axial Test Force Apply Speed	500 N/s $\pm$ 100 N/s
Cycles	Three (3) full sine waves
Data Recording	Minimum of 300 data points/s

Table 4: Radial Travel and Elasticity

Performance	In Zero Oscillation Position of the Joint
Radial Test Force: The test force applied should generate approximately 5 MPa of bearing pressure. Guidance forces in this table can be used, or bearing design dependent forces can be calculated.	Guidance Test Force Based on Ball Diameter: 38 mm to 32 mm - $F_{radial} = \pm 4000 \text{ N}$ 31 mm to 23 mm - $F_{radial} = \pm 2500 \text{ N}$ < 23 mm - $F_{radial} = \pm 1200 \text{ N}$
Radial Test Force Apply Speed	500 N/s $\pm$ 100 N/s
Cycles	Three (3) full sine waves
Data Recording	Minimum of 300 data points/s

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5 Data

5.1 Calculations.

5.1.1 Data Recording.

5.1.1.1 Rotating release moment and friction moment, in relation to the rotating angle.

5.1.1.2 Oscillating release moment and friction moment, in relation to the oscillating angle.

5.1.1.3 Axial travel in relation to axial force.

5.1.1.4 Radial travel in relation to the radial force.

5.1.2 Data Processing and Monitoring.

5.1.2.1 Rotating and Oscillating Release Moment and Friction Moment.

5.1.2.1.1 Construct a graphic according to Appendix A, Figure A4 of the release moment and the friction moment in relation to the angle.

5.1.2.1.2 Analyze the data and report the results for each characteristic per Appendix B, Table B1 and Table B2. Change of torque analysis examples can be seen in Appendix B, Figure B1.

- Maximum release moment.
- Absolute average friction moment.
- Friction Moment Regression Line (Best Fit Line).
- Maximum measured delta from friction moment.
- Slope of the friction moment.
- Change of torque with respect to angle.
- Change of torque with respect to change of angle.

5.1.2.2 Radial and Axial Travel and Elasticity.

5.1.2.2.1 Construct a graphic according to Appendix A, Figure A5 of travel versus force.

5.1.2.2.2 Analyze the data and report the results for each characteristic per Appendix B, Table B2.

- Total Travel
- Average Spring Rate
- Minimum Allowable Spring Rate
- Minimum Measured Spring Rate

5.2 Interpretation of Results. Results must meet the specifications as prescribed in this document and any applicable requirements document including drawings, Statement of Requirement (SOR), and Component Technical Specification (CTS). Any conflicting requirements will be resolved by the GM responsible engineer.

5.3 Test Documentation. A thorough test report must be written to document the result of the test(s).

5.3.1 All standard and customary background data must be included:

- Part Name
- Part Number
- Design Level
- Test Date
- Manufacturing Date
- Drawing Number
- Specification Number and Keywords
- Test Setup Photographs

5.3.2 Photographs to show load application device and measuring points. All actual test parameters are to be documented.

5.3.3 Measurement data for each part must be reported in a data table. See example in Appendix B, Table B2.

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