



Overall Steering Ratio

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.

Note: This standard uses terminology related to the directional control of vehicles as defined by SAE J670.

1.1 Purpose. The purpose of this test procedure is to measure the relationship between the steering wheel angle and the left and right road wheel angles.

1.2 Applicability. This procedure is applicable to all two-axle vehicles with one (1) set of steerable wheels. Parts of this procedure may also be used for vehicles with more than one (1) set of steerable wheels, or vehicles with more than two (2) axles.

1.3 Remarks. The overall steering ratio as a function of steering wheel angle is derived from this test. This test also yields Ackermann error measurements, intermediate shaft phasing errors and curb to curb turn diameter.

2 References

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

2.1 External Standards/Specifications.

ISO 9001 SAE J670

2.2 GM Standards/Specifications.

None

2.3 Additional References. None.

3 Resources

3.1 Facilities. This test procedure requires a facility with a level surface and a fixture capable of constraining the lateral movement of the vehicle during the test.

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 Steering wheel angle transducer.

3.2.2 Road wheel angle transducers (quantity: two (2)).

3.2.3 Data acquisition system (DAS).

3.2.4 Shop air supply (if needed for air bearings).

3.2.5 Low friction bearings.

3.2.6 Vehicle front lateral motion constraints.

3.3 Test Vehicle/Test Piece. The test vehicle shall be representative of the desired test condition. Tires, suspensions, steering system and center of gravity height must represent the intended conditions.

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3.4 Test Time.

Calendar time: 1 day
Test time: 1 hour
Coordination time: 0.5 to 1 hour

3.5 Test Required Information.

3.5.1 Steering Wheel Angle.

3.5.2 Left Road Wheel Angle.

3.5.3 Right Road Wheel Angle.

3.5.4 Sample Rate: All data is to be sampled at 100 Hz. Typical anti-aliasing filter frequency is 25 Hz.

3.6 Personnel/Skills. The test operator must be qualified and documented as capable of performing this test as required by ISO 9001.

4 Procedure

4.1 Preparation. During setup and preparation, the measurement equipment locations, vehicle content and vehicle loading should be documented in the Test Vehicle Description (TVD) worksheet (or similar). Refer to Appendix A, Data Sheets A1 and A2 for example TVD sheets.

4.1.1 Vehicle Preparation.

4.1.1.1 Inspect the test vehicle to ensure that the proper tires, suspension and steering components are installed and are operating correctly.

4.1.1.2 Check the torque of all fasteners in the steering system and re-torque if necessary.

4.1.1.3 Check the steering gear preload settings to determine if they are within the manufacturer's specifications.

4.1.1.4 Check all steering joints for wear. Lubricate if requested by the test engineer.

4.1.1.5 Fill the vehicle fuel tank.

4.1.1.6 Check the front suspension alignment to ensure that any front wheel misalignment is within the alignment resetting limits stipulated in the manufacturer's service manual. Record the measured values. If any values are found to be out of the specified limits, realign the wheels and record the final settings.

4.1.2 Test Equipment Installation.

4.1.2.1 Disable the airbag and remove the steering wheel. Remove the steering column covers if necessary.

4.1.2.2 Install the instrumented angle measuring steering wheel.

4.1.2.3 Install the DAS and cabling. Alternatively, a DAS on a bench at the steering ratio facility may be used.

4.2 Conditions.

4.2.1 Environmental Conditions. The facility must provide a smooth horizontal surface under the front wheels for the operation of low friction bearings.

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 Ensure that the vehicle is dry and that no water will drip from the vehicle during testing. Water will interfere with the operation of the low friction bearings and transducers.

4.3.2 Adjust the lateral position of the low friction bearings to match the vehicle's track width and align them with the center of the road wheels.

4.3.3 Position the vehicles' steered wheels on the fore/aft center of the low friction bearings checking that the wheels are also centered laterally on each low friction bearing.

4.3.4 Set the parking brake or otherwise lock the rear wheels.

4.3.5 Set the front lateral constraints tightly to prevent the vehicle from yawing during the test.

4.3.6 Center the steering wheel with the road wheels straight ahead.

4.3.7 Connect an exhaust gas vent system as required.

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4.3.8 Start engine. Turn on air supply if air bearings are used. Check for grounding of low friction bearings. Check that the road wheel transducers have enough angular travel by turning the steering wheel lock-to-lock in each direction.

4.3.9 With the road wheels and steering wheel positioned straight ahead, begin collecting data and immediately begin smoothly turning the steering wheel clockwise at a rate of approximately 30 degrees per second. Continue turning the steering wheel until the right turn stop is reached. Hold this position momentarily (approximately 0.5 s).

4.3.10 Turn the steering wheel smoothly in the counter clockwise direction at a rate of approximately 30 degrees per second until the left turn stop is reached. Hold this position momentarily (approximately 0.5 s).

4.3.11 Turn the steering wheel smoothly in the clockwise direction at a rate of approximately 30 degrees per second until the right turn stop is again reached. Hold this position momentarily (approximately 0.5 s).

4.3.12 Repeat 4.3.10 and 4.3.11 until three (3) full steering cycles have been completed. Stop collecting data after passing through zero (0) steer. The entire three-cycle segment should take approximately 4 minutes.

4.3.13 Check the data on the Data Acquisition Computer screen. Ensure that three (3) full lock-to-lock cycles have been completed. An example of raw data is shown in Appendix B, Figures B1 thru B3.

4.3.14 Typical values for ratios on vehicles range from 11:1 up to 25:1.

4.3.15 Complete the test by turning off the air supply if air bearings are used, removing specific steer ratio test equipment, lateral constraints and the exhaust hose.

5 Data

5.1 Calculations. The data stored on the data acquisition computer should be uploaded to the appropriate storage location for processing, using documented procedures and the dataset names specified on the test request sheet.

5.2 Interpretation of Results. An example of test results processed by the Vehicle Handling Test Resource Information Management System (VHTRIMS) is shown in Appendix C, Figures C1 thru C4.

5.3 Test Documentation. All required information should be recorded on the TVD worksheet (or similar). Inform the assigned engineer when the dataset is loaded. Be prepared to provide a full vehicle description at this time. This description should include the following:

- Vehicle description and fleet number or Vehicle Identification Number (VIN)
- Vehicle option content
- Wheelbase and track
- Steering wheel diameter
- Location (x, y, z) of the inertial transducers
- Tire brand, size and pressures
- Channel assignments and scaling if different from standard
- First and last calibration segment numbers
- Total number of segments
- Test loads
- Test date, time and operator
- Dataset name

Note: All data gathered, via the sample TVD worksheets or similar methodology, will be subsequently uploaded to the VHTRIMS database.

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

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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.

Ackerman Error: Delta in front wheel angle.

7.2 Acronyms, Abbreviations, and Symbols.

DAS	Data Acquisition System
TVD	Test Vehicle Description
VHTRIMS	Vehicle Handling Test Resource and Information Management System
VIN	Vehicle Identification Number

8 Coding System

This standard shall be referenced in other documents, drawings, etc., as follows:

Test to GMW14798

9 Release and Revisions

This standard was originated in November 2005. It was first approved by the Global Vehicle Dynamics Testing Sub-Team in March 2006. It was first published in June 2006.

Issue	Publication Date	Description (Organization)
1	JUN 2006	Initial publication.
2	DEC 2011	Five year refresh. (Vehicle Dynamics)
3	JAN 2012	Corrected clerical error Sample Rate: Three (3) samples/s should read Sample Rate: Thirty (30) samples/s.
4	AUG 2017	Revised to current template. (Global Vehicle Dynamics Test Team)

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