



Wheel Uniformity Test

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 uniformity of vehicle wheels before and after various tests are performed. Wheel uniformity testing is an important quality aspect of wheel and tire design/warranty, since proper balance and uniformity are significant contributors to a vehicles "smooth ride" performance.

1.2 Applicability. This test procedure is applicable for steel and aluminum wheels intended for normal highway use, and temporary use for passenger car vehicles, light duty trucks including dual wheel usages, or multipurpose.

2 References

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

2.1 External Standards/Specifications.

ISO 16833

SAE J1982

2.2 GM Standards/Specifications.

GMW16590

2.3 Additional References.

- European Tyre and Rim Technical Organisation (ETRTO) Yearbook, Brussels, Belgium (www.etrto.org)
- GM Wheel Drawing
- Part Specific Drawing(s)
- Tire and Rim Association, Incorporated (TRA) Yearbook, Copley, Ohio (www.us-tra.org)

3 Resources

3.1 Facilities. Controlled and roofed facilities to protect equipment from weather hazards and ensure stable temperature.

3.1.1 Calibration. The test facilities and equipment shall be in good working order and shall have a valid calibration label.

3.1.1.1 Equipment must comply with calibration instructions from manufacturer.

Note: Equipment should be calibrated at least once per year.

3.1.1.2 A wheel of known uniformity parameters shall be measured and documented as a control method (i.e., master wheel).

3.1.1.3 Suppliers and all external facilities are expected to perform a correlation periodically with GMNA.

3.2 Equipment. Wheel Uniformity Machine (see Figure A1, Appendix A for example) or other measurement equipment.

3.2.1 Equipment must be able to engage the inner and outer bead seat of the wheel with a gauging method (ball or disk) 16 mm ($\frac{5}{8}$ in) in diameter. Refer to the applicable standardization organization yearbook (i.e., Tire and

GM Confidential

© Copyright 2016 General Motors Company All Rights Reserved

June 2016

Page 1 of 17

Rim Association (TRA), European Tyre and Rim Technical Organisation (ETRTO) for the applicable size). (See Figures A2 thru A4, Appendix A for examples.)

3.2.2 Equipment must obtain a minimum of 256 evenly distributed measurements/coordinates around the entire wheel for both inner and outer bead seats.

3.2.3 Equipment should calculate/obtain:

- Total Indicated Runout (TIR) for both inner and outer bead seats.
- Radial first and second harmonic averages to pilot (R1H and R2H).
- Pilot average lateral TIR using the obtained coordinates and Fourier Transforms.

3.2.3.1 Wheel diameter, width and offset are optional. These values can be manually calculated if equipment does not have that capacity. (See Sections B1 and B2, Appendix B for sample calculations.)

3.2.3.2 In some cases dent depth may be required. This value may also be manually calculated if equipment does not have the capacity. (See Section B4, Appendix B for sample calculation.)

3.2.4 Coordinates and Orientations. It is recommended for the wheel to be measured using polar coordinates. (See Figure A6, Appendix A, for example of polar coordinate system.)

3.2.4.1 Circumferential Angle Coordinate. The angle between the point and the valve hole.

3.2.4.2 Radial Coordinate. The distance between the point and the rotational axis when using absolute coordinates. Relative coordinates will be the displacement of the point relative to an established reference.

Note: The rotational axis is defined to be the axis through the center of the pilot and perpendicular to the mounting surface of the wheel.

3.2.4.3 Lateral Coordinate. The distance between the point and the mounting surface (absolute coordinate) or the distance between the point and a reference location parallel to the mounting surface (relative coordinate).

3.2.4.4 At a minimum, machine should perform relative measurements of coordinates (lowest value is equal to a constant reference, e.g., zero (0.000), that is precise to at least three (3) decimal places).

3.2.4.5 An alternative would be absolute coordinates to pilot center (i.e., zero (0.000) value at center when radial, or mounting surface when lateral).

3.3 Test Vehicle/Test Piece. The test wheel shall include all primer, topcoat, clear coat and/or plating normally applied, less any additional finishing provided by General Motors.

3.4 Test Time.

Calendar time: 1 day

Test hours: 0.1 hours

Coordination hours: 0.5 hours

3.5 Test Required Information. Test parameters, per GM wheel drawing or as stated by the requestor including:

3.5.1 Wheel diameter.

3.5.2 Wheel width and offset.

3.5.3 Pilot diameter or bolt circle parameters (bolt circle diameter, number of bolts, and bolt size).

3.6 Personnel/Skills. Test operator shall be qualified on the basis of appropriate education, training, experience, and/or demonstrated skills.

4 Procedure

4.1 Preparation. Wheel must be cleaned, free from impurities and obstructions.

4.2 Conditions.

4.2.1 Environmental Conditions. Room temperature of $22^{\circ}\text{C} \pm 3^{\circ}\text{C}$ ($70^{\circ}\text{F} \pm 5^{\circ}\text{F}$).

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.

GM Confidential

© Copyright 2016 General Motors Company All Rights Reserved

June 2016

Page 2 of 17



Documents

Document Sharing Hub

4.3 Instructions.

4.3.1 Secure wheel to test machine so that it is not able to move in any way other than rotation about its rotational axis (clockwise or counterclockwise). (See Figure A5, Appendix A, of a secured wheel using an expanding wheel collet.)

4.3.2 Measure wheel by obtaining data points (coordinates) along the entire inboard and outboard bead seats. It is recommended that coordinates be obtained in polar form.

4.3.2.1 Measurements must be obtained in a counterclockwise direction (when wheel is viewed from its face) using valve hole as starting point.

4.3.3 Remove and store wheel.

4.3.4 Log data.

5 Data

5.1 Calculations.

5.1.1 Can be done online (on machine) or offline (by operator/test supervisor).

5.1.2 See Sections B1 thru B5, Appendix B for required calculations.

5.1.2.1 Wheel diameter, width and offset (see Sections B1 and B2, Appendix B).

Note: Can only be calculated with absolute coordinates.

5.1.2.2 Individual radial TIR on inboard and outboard bead seat (Section B3, Appendix B).

5.1.2.3 Pilot average lateral TIRs and their pretest and posttest differences, if applicable (Section B3, Appendix B).

5.1.2.3.1 See Figure B1, Appendix B, for lateral coordinate sign convention.

5.1.2.4 Dent depth (Section B4, Appendix B).

5.1.2.5 Average radial first and second harmonic with respect to wheel pilot (R1H and R2H) and their pretest and posttest differences, if applicable (Section B5, Appendix B).

5.1.2.5.1 To calculate R1H and R2H, Fast Fourier Transform (FFT) must be applied to average radial coordinates (average of inboard and outboard radial coordinates).

Note: In order to calculate FFT there must be 2^n number of data points.

5.1.2.5.2 The first harmonic magnitude will be the peak to peak amplitude (see Figure A8, Appendix A for example) of the FFT calculated first harmonic mode (first magnitude value, see Section B5, Appendix B for example).

Note: Some FFT algorithms provide a semi-amplitude (peak to center). In these cases it is necessary to multiply this value by two (2).

5.1.2.5.3 Similarly, the second harmonic magnitude will be the peak to peak amplitude (see Figure A8, Appendix A for example) of the FFT calculated second harmonic mode (see Section B5, Appendix B for example).

5.1.2.6 Associated R1H low point angle location.

5.1.2.6.1 This is the phase angle associated with the R1H minimum location on the FFT calculated first harmonic mode.

Note: It would be 180 degrees from FFT reported phase angle, if the FFT algorithm used provides the high point phase angle instead of the low point.

5.1.3 Refer to ISO 16833 and SAE J1982 for additional measurement definitions.

5.2 Interpretation of Results. For part specific requirements, see the Part Specific Drawing.

5.3 Test Documentation.

5.3.1 Test results must be displayed on a readable and understandable format. See Figure A11, Appendix A for example.

5.3.2 Each test will display the required data and calculations in a separate document.

5.3.3 The test results documentation should include the information listed in 5.3.3.1 thru 5.3.3.3.

GM Confidential

© Copyright 2016 General Motors Company All Rights Reserved

June 2016

Page 3 of 17



Documents

Document Sharing Hub

5.3.3.1 Test coordinates (raw data file) and data plots (see Figures A7 thru A9, Appendix A).

5.3.3.1.1 Typical plots are lateral and radial translated data (radial and lateral coordinates vs. circumferential coordinates). See Figure A9, Appendix A for example.

5.3.3.2 Test results report, generated by Global Tire-Wheel Test System (GTWTS) if submitting Extensible Markup Language (XML) files. Sample report given in Figure A10, Appendix A.

5.3.3.3 Test result data files (XML format). For data being loaded into the GTWTS, submit electronically the test results data files (XML format) and other supporting files listed in 5.3. GMW16590 defines the electronic file details (e.g., file types, file naming convention, and detailed file formats) for the GTWTS.

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.

#	Number
AVG	Average
ETRTO	European Tyre and Rim Technical Organisation
FFT	Fast Fourier Transform
GSSLT	Global Subsystem Leadership Team
GTWTS	Global Tire-Wheel Test System
IB	Inboard
ID	Identification
LAT.	Lateral
max	maximum
min	minimum
MPG	Milford Proving Ground
N/A	Not applicable
OB	Outboard
PQMS	Program Quality Management System
R1H	Radial First Harmonic
R2H	Radial Second Harmonic
STA	Station
TIP	Test Improvement Process
TIR	Total Indicated Runout
TRA	Tire and Rim Association
TWS	Tire-Wheel Systems
XML	Extensible Markup Language

8 Coding System

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

Test to GMW17574

GM Confidential

© Copyright 2016 General Motors Company All Rights Reserved

June 2016

Page 4 of 17



Documents

Document Sharing Hub

9 Release and Revisions

This standard was originated in March 2016. It was first approved by Chassis Tire and Wheel Global Subsystem Leadership Team (GSSLT) in June 2016. It was first published in June 2016.

Issue	Publication Date	Description (Organization)
1	JUN 2016	Initial publication.

GM Confidential

© Copyright 2016 General Motors Company All Rights Reserved

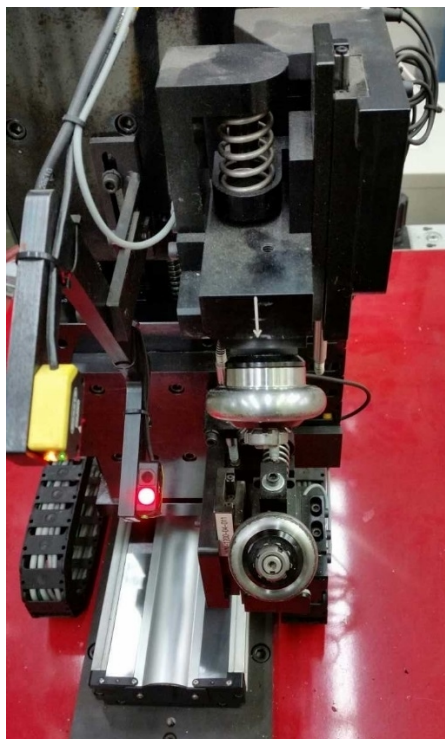
June 2016

Page 5 of 17

Appendix A



Figure A1: Example of a Wheel Uniformity Test Machine

Figure A2: GMNA Machine with 16 mm ($\frac{5}{8}$ in) Contact Rollers

GM Confidential

© Copyright 2016 General Motors Company All Rights Reserved

June 2016

Page 6 of 17

**Documents**
Document Sharing Hub