



# Standard Test Method for Electrical Resistance of Tires Under Load On the Test Bench<sup>1</sup>

This standard is issued under the fixed designation F 1971; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope

1.1 This test method describes the measurement of the electrical resistance between the wheel of a mounted and inflated tire-wheel assembly and a flat conducting surface in loaded contact with the tire.

1.2 The method specifies procedures and equipment such that electrical resistance can be accurately determined for tires with values up to  $10^{12} \Omega$  (ohms).

1.3 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

## 2. Referenced Documents

### 2.1 ASTM Standards:

F 538 Terminology Relating to Characteristics and Performance of Tires<sup>2</sup>

F 1082 Practice for Tires—Determining Precision for Test Method Standards<sup>2</sup>

### 2.2 Other Standards:

The Tire and Rim Association Inc. Yearbook (TRA), current issue<sup>3</sup>

The European Tyre and Technical Organization (ETRTO), current issue<sup>4</sup>

The Japan Automobile Tire Manufacturer's Association, Inc. Yearbook (JATMA), current issue<sup>5</sup>

## 3. Terminology

### 3.1 Definitions:

<sup>1</sup> This test method is under the jurisdiction of ASTM Committee F-09 on Tires and is the direct responsibility of Subcommittee F 09.30 on Laboratory (Non-Vehicular) Testing.

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<sup>2</sup> Annual Book of ASTM Standards, Vol 09.02.

<sup>3</sup> Available from the Tire and Rim Association, 175 Montrose West Ave., Suite 150, Copley, OH.

<sup>4</sup> Available from the European Tyre and Rim Technical Organization, 32/2 avenue Brugmann, B-1060 Brussels, Belgium.

<sup>5</sup> Available from the Japan Automobile Tire Manufacturers' Association, 9th Floor, Toranomon Building, 1-12, Toranomon 1-Chome, Minato-Ku, Tokyo, Japan.

3.1.1 *connection point, n*—any point on the wheel or metal loading plate where the resistance measuring instrument's leads are connected.

3.1.2 *rim, n*—the specially shaped circular periphery to which a tire may be mounted with appropriate bead fitment.

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3.1.3 *test load, n*—the force applied to a tire through the rim; it is normal to the metal loading plate onto which the tire is loaded.

3.1.4 *tire electrical resistance, n*—the electrical resistance (in ohms) measured between the wheel of a mounted and inflated tire-wheel assembly and a metallic plate onto which the tire is loaded at a specified load.

3.1.5 *wheel, n*—a rigid structure consisting of a rim connected to a central disk that permits rotationally centered attachment to an axle.

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## 4. Summary of Test Method

4.1 The electrical resistance of an inflated tire-wheel assembly<sup>6</sup> is measured between the wheel and the conducting surface against which the tire is loaded. This measurement involves the use of an appropriate resistance meter and voltage application system, as well as a special test fixture or measuring stand.

## 5. Significance and Use

5.1 Occasions exist where static charges on the vehicle must be dissipated by way of the tires. Electrical resistance inversely measures the tire's ability to dissipate static charge from the vehicle.

## 6. Apparatus

6.1 *Resistance Measuring Instrument (ohmmeter)*—Resistance shall be measured by a commercial instrument capable of measuring electrical resistance in ohms and having a power source capable of 1000 V. The voltage shall be controlled as described in Table 1 and shall not dissipate more than 3 W in the test sample. The instrument shall be capable of determining the resistance up to a value of  $10^{12} \Omega$  with an accuracy of  $\pm 5\%$ . The input impedance shall be at least  $10^{14} \Omega$ .

<sup>6</sup> A tire mounted on an approved wheel and inflated to a specified pressure.

TABLE 1 Test Voltage

Tire Resistance Range ( $\Omega$ )	Test Voltage (V)
$10^3$ to $10^4$	1
$10^4$ to $10^5$	10
$10^5$ to $10^6$	100
$10^6$ to $10^{12}$	1000

6.2 *Metal Loading Plate*—A flat plate of dimensions sufficient to encompass the entire contact surface of the tire under test and with sufficient thickness to support the test loads described in Section 8 without visible deformation. This plate shall be made of a conductive noncorrosive metal, for example, brass or stainless steel, free from any coating or obvious surface contamination, such as oxidation or corrosion. Aluminum shall not be used for the plate because of its high susceptibility to the rapid development of surface oxides, which may adversely affect reading accuracy.

6.3 *Loading Apparatus*—A loading fixture (Fig. 1) capable of applying the tire load, in a radial direction, against the metal loading plate. Test load measurement accuracy shall be  $\pm 1\%$ .

6.4 *Insulating Material*—A sheet of insulating material such as polyethylene, PTFE (polytetrafluoroethylene), or equivalent, with sufficient strength to support the test loads described in Section 8 without visible deformation. The insulating material should have dimensions of at least 50 mm (2.0 in.) greater, on all sides, than the metal loading plate.

6.4.1 With insulating sheet installed between the metal loading plate and the loading apparatus base (Fig. 1), the electrical resistance between the metal loading plate and the loading apparatus should be at least  $10^{14} \Omega$ . In practice, the electrical resistance of the plate relative to the loading apparatus must be at least two orders of magnitude higher than the tire being measured.

6.5 *Pressure Gage*—A commercially available gage with an accuracy of  $\pm 3$  kPa ( $\pm 0.5$  psi).

7. Conditioning

7.1 For at least 8 h prior to measurement of passenger, light truck and motorcycle tire applications (24 h for all other tires), the tire to be tested shall be kept at an ambient temperature of  $23 \pm 5^\circ\text{C}$  [ $73 \pm 9^\circ\text{F}$ ], and at a relative humidity less than 60 %.

8. Measurement Conditions

8.1 The test load applied during the measurement is  $80 \pm 5\%$  of the maximum load capacity of the tire as listed in the applicable TRA, ETRTO, or JATMA yearbook.

8.2 The inflation pressure is equal to  $80 \pm 5\%$  of the pressure corresponding to the maximum load of the tire.

8.3 If the tire size is not listed in the applicable TRA, ETRTO, or JATMA yearbook, the above percentages apply to the loads and inflations as marked on the sidewall of the tire.

8.4 Ambient temperature during the measurement shall be maintained at  $23 \pm 5^\circ\text{C}$  ( $73 \pm 9^\circ\text{F}$ ).

8.5 Relative humidity during the measurement shall be maintained at  $\leq 60\%$ .

9. Procedure

9.1 *Preparation of the Tire-Wheel Assembly:*

9.1.1 The approved wheel<sup>7</sup> (steel preferred) must be stripped clean in the bead seat area, as well as at the connection point. As an alternative, if the electrical resistance of the wheel

<sup>7</sup> A wheel whose rim meets the specifications of the Tire and Rim Association (TRA) yearbook or applicable document.

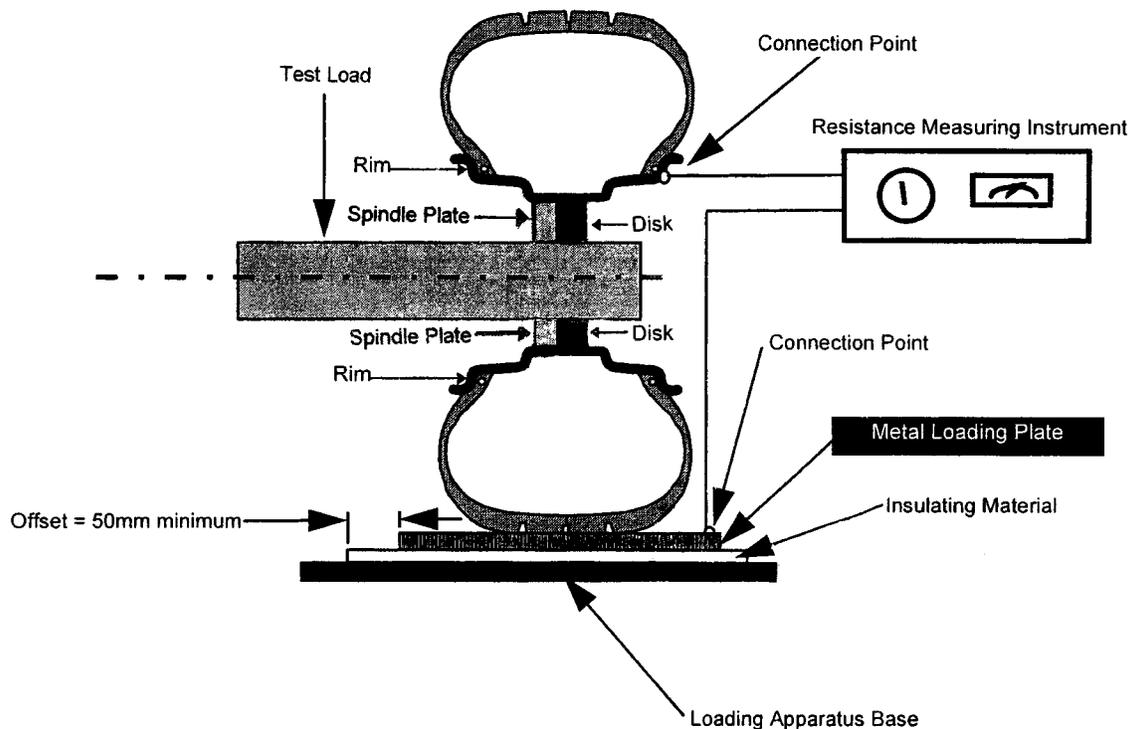


FIG. 1 Apparatus

is known to be two orders of magnitude lower than the tire to be measured, stripping is not necessary.

9.1.2 It is necessary to make sure that the tire is dry before taking the measurement. Dry mount the tire if possible. To avoid damage to tires in the case of difficult mounting conditions, a water-soluble mounting solution can be used. Any mounting solution on the sidewall or tread of the tire must be cleaned and dried.

9.1.3 Mark a reference point on the tire sidewall with a nonconductive material. If the tire has a DOT marking, this should be used as the reference point.

**9.2 Setup:**

9.2.1 Set up the apparatus as shown in Fig. 1.

9.2.2 Clean the metal loading plate with isopropyl alcohol or a similar agent and allow to dry.

9.2.3 Install the tire-wheel assembly on the loading fixture and clean the exterior of the tire with isopropyl alcohol or a similar agent and allow to dry. Conductive or nonconductive substances on the tire such as mold release agents, or paints, or both, which could affect the results, must be removed. The use of organic solvents likely to attack the rubber is prohibited.

9.2.4 Connect the ohmmeter leads to the metal loading plate and to the wheel. Alternately, a connection can be made on the loading fixture if the resistance between this point and the bead seat of the wheel is no more than 10 Ω.

**9.3 Preload Cycle:**

9.3.1 Load the tire-wheel assembly at the reference point to the value specified in Section 8, hold for 1 min, and then remove the load.

9.3.2 Repeat the load-unload cycle a second time, as stated in 9.3.1.

**9.4 Measurement:**

9.4.1 If the range of the resistance is unknown, initially apply 1000 V and decrease the voltage according to Table 1 as necessary. Load the tire a third time to the test load and immediately apply the test voltage in accordance with Table 1.

9.4.2 Record the resistance measurement 3 min ± 10 s after the voltage has been applied. The voltage and load are to be applied continuously to the tire until after the final measurement is recorded.

9.4.3 Unload the tire.

9.4.4 Repeat the preload cycle and measurement in accordance with 9.3 and 9.4 for at least two additional circumferential locations evenly spaced around the tire.

**10. Interpretation of Results**

10.1 The resultant electrical resistance of the tire is comprised of the mean of the electrical resistance measurements of all circumferential locations tested.

**11. Report**

11.1 Report the following information:

11.1.1 Individual electrical resistance measurements for each circumferential location tested.

11.1.2 The mean (resultant) and standard deviation of the electrical resistance measurements for all circumferential locations tested.

11.1.3 The value of the applied voltage.

11.1.4 The product(s) used for cleaning the tire and the plate.

11.1.5 Composition of mounting solution, if used.

11.1.6 Material of the test wheel. If the wheel has not been stripped, so indicate on the test report.

11.1.7 Ambient temperature during test.

11.1.8 Relative humidity during test.

11.1.9 Actual test inflation pressure and load

11.1.10 Rim width/contour (for example, 5½ J)

11.1.11 Pertinent tire descriptions to include:

11.1.11.1 Tire size.

11.1.11.2 Manufacturer.

11.1.11.3 Brand name.

11.1.11.4 Service description.

11.1.11.5 Load range.

11.1.11.6 DOT tire identification number.

11.1.12 Location of the reference point, for example, DOT mark, E-mark, etc.

11.2 *Reporting Units and Significant Digits*—As specified below:

Electrical resistance: a.aEyy Ω

where:

a.a Eyy = a.a times 10 to the power yy (Example 5.1E06 = 5.1 × 10<sup>6</sup>)

Temperature = xx°C,

Relative humidity = xx %,

Load = xxxx N,

Inflation = xxx kPa, and

Voltage = xxxx V.

**12. Precision and Bias**

12.1 *Precision*—Data are not yet available for making a statement on the repeatability or reproducibility of this test method.

12.2 *Bias*—Since there is no accepted reference tire available at this time for determining bias for this test method, no statement on bias is being made.

**13. Keywords**

13.1 electrical resistance; load; test bench; tires

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