Designation: F 1971 – 05

Standard Test Method for Electrical Resistance of Tires Under Load On the Test Bench[1]

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 (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This test method covers 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 This test method specifies procedures and equipment such that electrical resistance can be accurately determined for tires with values up to 10^{12} Ω (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 the Characteristics and Performance of Tires[2]

2.2 *Other Standards:*

The Tire and Rim Association Inc. Yearbook (TRA), current issue [3]

The European Tyre and Rim Technical Organization (ETRTO), current issue [4]

The Japan Automobile Tire Manufacturers Association, Inc. Yearbook (JATMA), current issue [5]

International Standard ISO 16392 Electrical Resistance—Test Methods to Measure the Electrical Resistance of Tyres on a Test Rig[6]

Wirtschaftsverband der deutschen Kautschukindustrie e.V. (W.d.K) 110 Measurement of the Electrical Resistance of Tyres

3. Terminology

3.1 *Definitions:*

3.1.1 *connection point*, *n*—any point on the wheel or metal loading plate where the resistance measuring instrument's leads are connected. **F 538**

3.1.2 *rim*, *n*—the specially shaped circular periphery to which a tire may be mounted with appropriate bead fitment. **F 538**

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. **F 538**

3.1.4 *tire electrical resistance*, *n*—the electrical resistance in ohms (Ω) 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. **F 538**

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. **F 538**

3.1.6 For additional definitions of terms used in this test method, refer to Terminology F 538.

4. Summary of Test Method

4.1 The electrical resistance of an inflated tire-wheel assembly (see Note 1) 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.

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[1] This test method is under the jurisdiction of ASTM Committee F09 on Tires and is the direct responsibility of Subcommittee F09.30 on Laboratory (Non-Vehicular) Testing.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from the Tire and Rim Association, Inc., 175 Montrose West Ave., Suite 150, Copley, OH 44321.

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

[5] Available from the Japan Automobile Tire Manufacturers Association, No. 33 Mori Building, 8th Floor, 3-8-21 Toranomon, Minato-Ku, Tokyo, Japan 105-0001.

[6] Available from International Organization for Standardization (ISO), 1 rue de Varembé, Case postale 56, CH-1211, Geneva 20, Switzerland.

NOTE 1—A tire mounted on an approved wheel and inflated to a specified pressure.

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} Ω with an accuracy of ±5 %. The input impedance shall be at least 10^{14} Ω.

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 ±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} Ω. 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 ±3 kPa (±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 ± 5°C [73 ± 9°F], and at a relative humidity less than 60 %.

TABLE 1 Test Voltage

Tire Resistance Range (Ω)	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

8. Measurement Conditions

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

8.2 The inflation pressure is equal to 80 ± 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 standards, 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 ± 5°C (73 ± 9°F).

8.5 Relative humidity during the measurement shall be maintained at ≤60 %.

9. Procedure

9.1 *Preparation of the Tire-Wheel Assembly*:

9.1.1 The approved wheel (see Note 2) (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 is known to be two orders of magnitude lower than the tire to be measured, stripping is not necessary.

NOTE 2—A wheel whose rim meets the specifications of the Tire and Rim Association (TRA) Yearbook or applicable document.

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 one tire sidewall with a nonconductive material. The reference point could be at a specific tire marking such as the United States Department of Transportation "DOT" mark, the Economic Commission for Europe (ECE) "E" mark, or other selected tire marking.

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. Alternatively, 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. (This second preload may be omitted provided the

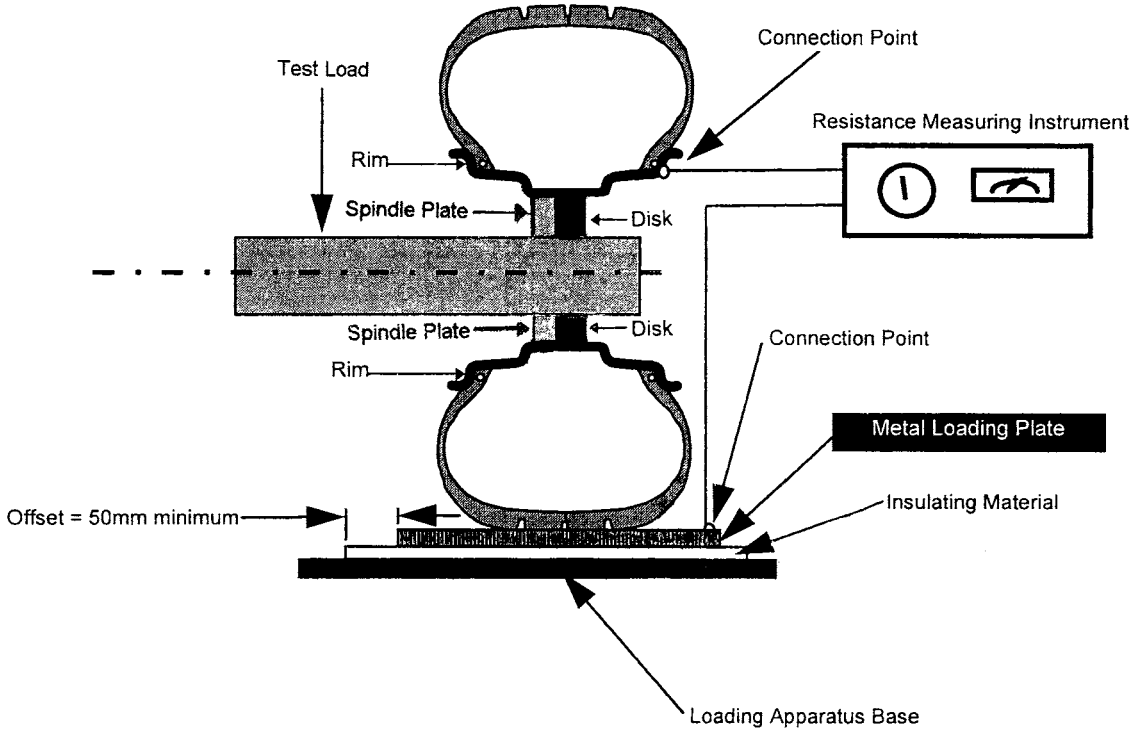

FIG. 1 Apparatus

tester can demonstrate sufficiency of a single preload based on measurement capabilities and supporting data.) The second load-unload cycle provides harmonization with other standards.

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 to the test load and immediately apply the test voltage in accordance with Table 1 (see 9.3.2 regarding sufficiency for testing following one load-unload cycle).

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 Full (including the tire production date) United States Department of Transportation (DOT) tire identification number that follows the “DOT” marking.

11.1.12 Location of the reference point, for example, “DOT,” “E,” or other marking, and on which tire sidewall, for example, inside or outside.

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

Electrical resistance: a.aEyy Ω

where:

a.aEyy	=	a.a times 10 to the power yy (Example 5.1E06 = 5.1×10^6)
Temperature	=	xx°C,
Relative humidity	=	xx %,
Load	=	xxxx N,
Inflation	=	xxx kPa, and
Voltage	=	xxxx V.

12. Precision and Bias

12.1 *Precision*—No precision data presently exists for this test method. A program to evaluate precision will be completed on or before January 2009.

12.2 *Bias*—A reference value does not exist for this test method since the value or level of the test property is exclusively defined by the test method. Bias, therefore, cannot be defined.

13. Keywords

13.1 electrical resistance; load; test bench; tires