Designation: B 667 – 97

# Standard Practice for Construction and Use of a Probe for Measuring Electrical Contact Resistance [1]

This standard is issued under the fixed designation B 667; 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 practice describes equipment and techniques for measuring electrical contact resistance with a probe and the presentation of results.

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

1.3 *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:*

B 542 Terminology Relating to Electrical Contacts and Their Use [2]

## 3. Terminology

3.1 *Definitions*—Many terms used in this practice are defined in Terminology B 542.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *contact resistance*—the resistance to current flow between two touching bodies, consisting of constriction resistance and film resistance.

3.2.2 *Discussion*—Constriction resistance originates in the fact that mating surfaces touch in most cases at only their high spots, which are often called “asperities” or, more commonly, *a-spots*. The current flow lines are then forced to constrict as they funnel through these tiny areas. If oxide films or other insulating layers interfere with these metal-to-metal contacts, the contact resistance will be higher than when such layers are absent (see 4.4 for bulk resistance limitation).

3.2.3 *contact resistance probe*—an apparatus for determining electrical contact resistance characteristics of a metal surface. *Probe*, in this instance, should be distinguished from the classical tool whose function it is to touch or move an object.

## 4. Significance and Use

4.1 Electrical contact resistance is an important characteristic of the contact in certain components, such as connectors, switches, slip rings, and relays. Ordinarily, contact resistance is required to be low and stable for proper functioning of many devices or apparatus in which the component is used. It is more convenient to determine contact resistance with a probe than to incorporate the contact material into an actual component for the purpose of measurement. However, if the probe contact material is different from that employed in the component, the results obtained may not be applicable to the device.

4.2 Information on contact resistance is useful in materials development, in failure analysis studies, in the manufacturing and quality control of contact devices, and in research.

4.3 Contact resistance is not a unique single-valued property of a material. It is affected by the mechanical conditions of the contact, the geometry and roughness of contacting surfaces, surface cleanliness, and contact history, as well as by the material properties of hardness and conductivity of both contacting members. An objective of this practice is to define and control many of the known variables in such a way that valid comparisons of the contact properties of materials can be made.

4.4 In some techniques for measuring contact resistance it is not possible to eliminate bulk resistance, that is, the resistance of the metal pieces comprising the contact and the resistance of the wires and connections used to introduce the test current into the samples. In these cases, the measurement is actually of an overall resistance, which is often confused with contact resistance.

## 5. General Description of a Probe

5.1 A probe generally includes the following:

5.1.1 Fixtures for holding specimens of varied size and shape and for attaching electrical leads to them.

5.1.2 A mechanism that applies a measurable load to the specimen that can be increased, decreased, or held constant.

5.1.3 A shock mounted table to prevent any indigenous

[1] This practice is under the jurisdiction of ASTM Committee B-2 on Nonferrous Metals and Alloys and is the direct responsibility of Subcommittee B02.11 on Electrical Contact Test Methods.

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[2] *Annual Book of ASTM Standards*, Vol 03.04.

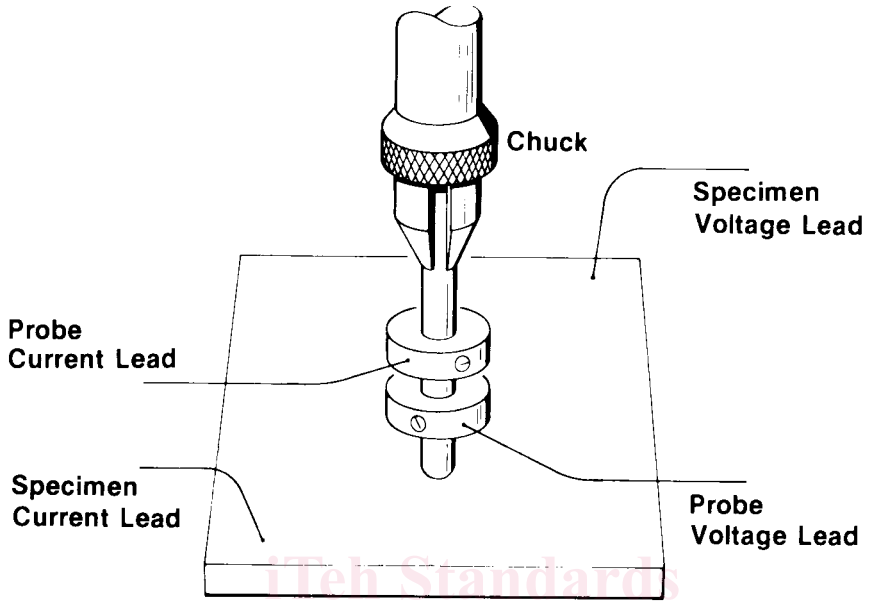
vibrations from inadvertently altering the conditions at the contact interface.

5.1.4 A reference surface (the probe) that is pressed against the specimen and which is normally made of a noble metal. Noble metals such as pure gold are used because they are substantially free of oxide films and have the best likelihood of obtaining reproducible results.

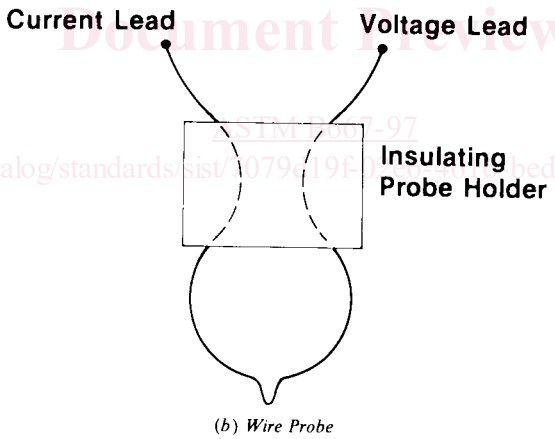
5.1.5 A current source with current and voltage measuring instrumentation for determining contact resistance. Ordinarily, contact resistance is determined at dry circuit conditions [3] to avoid changes that may occur due to voltage breakdown or heating at the contact interface.

5.2 Additional electrical circuitry may be included to permit related measurements to be obtained, such as the voltage breakdown or the current versus voltage characteristics of film-covered surfaces.

5.3 Probes are also convenient for determining the dependence of contact resistance on sliding or *wipe* when a slide is incorporated in the specimen holder. This permits the probe to be moved small measurable distances after loading.




(*a*) *Rod Probe* with hemispherical end having the voltage lead secured as close as possible to the point of contact




(*b*) *Wire Probe*

**FIG. 1 Arrangement of Current and Voltage Leads to Probe and to Specimen (Typical)**

## 6. Design Aspects

6.1 The probe is mounted on one end of a pivoted beam, a cantilever, or a coil spring. Force is applied by dead weight, compression of the spring, bending of the cantilever, or electromagnetically.

6.2 Probe holders have been designed so that force may be applied to the contact and to an electronic load cell which is mounted between the probe contact and a micrometer spindle that can be advanced. An alternative design is to mount the specimen on the load cell and to advance the probe directly with the micrometer spindle. Load and contact resistance are

[3] See ASTM Standard B 539, Measuring Contact Resistance of Electrical Connections (Static Contacts), in the *Annual Book of ASTM Standards*, Vol 03.04.