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# INTERNATIONAL STANDARD

IEEE Std 1650™

## Test methods for measurement of electrical properties of carbon nanotubes

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

# TEST METHODS FOR MEASUREMENT OF ELECTRICAL PROPERTIES OF CARBON NANOTUBES

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# IEEE Standard Test Methods for Measurement of Electrical Properties of Carbon Nanotubes

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Approved 8 December 2005

**IEEE-SA Standards Board**

**Abstract:** Recommended methods and standardized reporting practices for electrical characterization of carbon nanotubes (CNTs) are covered. Due to the nature of CNTs, significant measurement errors can be introduced if the electrical characterization design-of-experiment is not properly addressed. The most common sources of measurement error, particularly for high-impedance electrical measurements commonly required for CNTs, are described. Recommended practices in order to minimize and/or characterize the effect of measurement artifacts and other sources of error encountered while measuring CNTs are given.

**Keywords:** carbon nanotube, electrical characterization, high-impedance measurement, nanotechnology

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## IEEE Introduction

This standard covers recommended methods and standardized reporting practices for electrical characterization of carbon nanotubes (CNTs). Due to the nature of CNTs, significant measurement errors can be introduced if not properly addressed. This standard describes the most common sources of measurement error, and gives recommended practices in order to minimize and/or characterize the effect of each error.

Standard reporting practices are included in order to minimize confusion in analyzing reported data. Disclosure of environmental conditions and sample size are included so that results can be appropriately assessed by the research community. These reporting practices also support repeatability of results, so that new discoveries may be confirmed more efficiently. The practices in this standard were compiled from scientists and engineers from the CNT field. These practices were based on standard operating procedures utilized in facilities worldwide. This standard was initiated in 2003 to assist in the diffusion of CNT technology from the laboratory into the marketplace. Standardized characterization methods and reporting practices creates a means of effective comparison of information and a foundation for manufacturing readiness.

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