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# Test methods for electrical properties of electric cables and wires - Part 14: DC voltage test

电线电缆电性能试验方法 第 14 部分：直流电压试验

(IEC 60060-1:1989, High-voltage test techniques - Part 1: General definition and test requirements, NEQ)

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# Test methods for electrical properties of electric cables and wires - Part 14: DC voltage test

## 1 Scope

This Part of GB/T 3048 specifies terms and definitions for DC voltage test of electric cables and wires, test equipment, specimen preparation, test procedures, test results and evaluation, precautions and test records.

This Part is applicable to DC voltage test of electric cables and wires.

This Part shall be used together with GB/T 3048.1.

## 2 Normative references

The provisions in following documents become the provisions of this Part of GB/T 3048 through reference in this Part. For dated references, the subsequent amendments (excluding corrigendum) or revisions do not apply to this Part, however, parties who reach an agreement based on this Part are encouraged to study if the latest versions of these documents are applicable. For undated references, the latest edition of the referenced document applies.

GB/T 311.6-2005, V*oltage measurement by means of standard air gaps* (IEC 60052:2002, IDT)

GB/T 2900.19-2001, *Electrotechnical terminology - High-voltage test technique and insulation co-ordination*

GB/T 3048.1, *Test methods for electrical properties of electric cables and wires - Part 1: General*

GB/T 16927.2, *High-voltage test techniques - Part 2: Measuring systems* (GB/T 16927.2-1997, eqv IEC 60060-2:1994)

## 3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

**3.1 value the test voltage**

The value the test voltage refers to the arithmetic mean value.

composed of a voltage regulator (or pulse width modulation, frequency conversion device), a rectifier transformer, a rectifier element, a filter capacitor, a polarity conversion device and a discharge resistor.

**4.2.3** The rated output current of the power supply shall charge the specimen capacitor in a relatively short time. However, charging times of up to several minutes are also allowed when the specimen capacitance is large. The power supply (including the storage capacitor) shall also be able to supply leakage current and sink current, as well as any internal and external non-destructive discharge current. Its voltage drop shall not exceed 10%.

### 4.3 Measurement of test voltage

#### 4.3.1 Use the measurement device that meets GB/T 16927.2 to measure

Usually, use the measurement device that is approved by the specified programs in GB/T 16927.2 to measure arithmetic mean, maximum value, ripple factor and instantaneous voltage drop of test voltage. When measuring ripple, transient voltage or voltage stability, the response characteristics of the measurement device shall meet the requirements.

The general requirement is that the overall uncertainty of the measurement of the arithmetic mean of the test voltage shall not exceed ±3%.

#### 4.3.2 Use approved measurement device to calibrate unapproved measurement device

This method is usually to establish a relationship between the displayed value of some instrument related to the test voltage and the measurement of the same voltage. The measurement of its voltage can be carried out according to 4.3 or use the ball gap in accordance with GB/T 311.6-2005. This relationship may be related to factors such as the specimen, the access to the spherical gap, the amount of rainfall in the wet test. Therefore, these conditions shall remain the same during calibration and actual testing. To prevent spark discharge, the distance of the ball gap shall be wide enough. It shall be noted that the relationship between supply voltage and output voltage may not be reliable enough for measurement.

Resistive voltage dividers are currently used. The voltage divider ratio error shall not exceed ±1%. The measuring current of the voltage divider shall be greater than 0.5mA under the rated voltage. The low-voltage arm of the voltage divider is connected to a low-voltage readout instrument with an error of no more than ±0.5% through the measuring coaxial cable.

When using ball gap to measure the DC voltage, precautions must be taken because the fibers can cause discharges at lower voltages. The voltage shall be applied several times. The highest voltage value shall be used as the actual measurement value.

**NOTE 1:** The influence of fibers can be eliminated by blowing air with a speed of not less than 3m/s through the spherical gap.

**NOTE 2:** When ripple is present, the ball gap cannot measure the arithmetic mean of the DC voltage.

During calibration, extrapolation of the test voltage value of not less than 50% can usually be used. If the current in the test loop does not vary linearly with the applied voltage, the extrapolation method may have large errors.

### 4.4 Measurement of test current

When measuring the current flowing through the specimen, several independent components can be distinguished. For the same specimen and the same test voltage, the magnitude of each component may vary by several orders of magnitude. These components are:

a) Capacitive current due to the initial application of the test voltage or due to ripple or other fluctuations in the test voltage.

b) Dielectric absorbs current due to the slow charge displacement that occurs in the insulation. This current can last from a few seconds to a few hours. The process is locally reversible. When the specimen is discharged or shorted, reverse polarity current can be observed.

c) Continuous leakage current when components a) and b) decay to zero. At constant voltage, this current will be steady state DC.

d) Partial discharge current.

Care shall be taken to ensure that the measurement of a certain current component by the instrument is not affected by other components. For non-destructive tests, the insulation properties can often be known from the observation of the current changing law with time. Wire and cable products generally only require measurement of leakage current.

**NOTE:** Attention shall be paid to the value of the current that may flow during a destructive discharge. The ammeter can be damaged if not properly protected.

## 5 Specimen preparation

**5.1** The number and length of the specimen shall be in accordance with the product standard.

**5.2** The length of the terminal part of the specimen and the preparation method of the terminal head shall be such that no flashover discharge or internal breakdown occurs along its surface under the specified test voltage.

NOTE 2: "0" in the table represents metal sheath, metal shield, armor or additional special electrode (referring to water tank, metal bead chain, graphite coating, wrapping metal foil and so on).

NOTE 3: "+" in the table represents mutual electrical connection.

**6.2.3** For multi-core cables with five cores and above, a second test is usually required. The first test is to apply voltage between odd-numbered (parallel) and even-numbered (parallel) cores in each layer. The second test is to apply a voltage between the cores of all odd-numbered layers (parallel) to the cores of even-numbered layers (parallel). If the number of cores contained in the same layer in the cable is an odd number, the specified voltage test shall be carried out between adjacent cores which have not been subjected to the voltage test.

**NOTE:** A core (or cores) in the center of a multi-core cable as the first layer. If there is a metal sheath (shield) or armor as the last layer, the test is grounded.

**6.2.4** For split-phase lead sheathed (or aluminum sheathed) cables, each core shall be connected to the high-voltage end in turn. The other cores are connected to each other and grounded together with the ferrule, shield or armor (if any), or wired in parallel as a single-core cable.

**6.2.5** All conductors of the specimen shall be connected to the metal sheath (shield) and the armor (if any) during the insulating jacket test. Connect to the negative terminal of the high voltage terminal. Additional special electrodes (such as sink or graphite coating) are connected to ground terminal.

**6.2.6** When testing the inner lining between the metal sheath (shield) of the specimen and the armor, all cores shall be connected to the metal sheath (shield). Connect to the high-voltage end of the test power supply. But the armor is connected to ground terminal.

### 6.3 Test requirements

**6.3.1** Unless otherwise specified in the product standard, the test shall be carried out at an ambient temperature of (20 ± 15)°C. During the test, the difference between the temperature of the sample and the ambient temperature shall not exceed ±3°C.

**6.3.2** The voltage applied to the sample shall start from a sufficiently low value (shall not exceed 40% of the test voltage value specified in the corresponding product standard), so as to prevent overvoltage effects caused by operating transients. The voltage shall then be raised slowly so that it can be read accurately on the meter. But it shall not be too slow so as not to cause the withstand voltage to be too long when approaching the test voltage. If the test voltage value reaches more than 75%, increase the voltage at a rate of 2% per second of the test voltage. The above requirements are usually met. After maintaining the test voltage for a specified time, then cut off the charging power. Discharge the loop capacitance, including the specimen capacitance, through an appropriate resistance, to remove the voltage.

# 7 Test results and evaluation

**7.1** If the specimen does not have any flashover discharge during the application of the corresponding specified test voltage and duration, or the test loop current does not increase with time, the specimen shall be considered to pass the DC voltage test. If a sharp increase in current occurs during the test period, or even the switch of the DC high voltage generator circuit trips, and it is impossible for the specimen to withstand the same test voltage again, the specimen shall be considered to have broken down.

**7.2** When the specified test voltage is applied to the specimen, if its leakage current does not exceed the specified value of the corresponding standard, the leakage current test of the specimen shall be considered as qualified.

**7.3** If during the test, the test terminal of the specimen has a flashover discharge or internal breakdown along its surface, it is allowed to make another test terminal. Repeat the test.

**7.4** During the test, if the test is continued after a power failure for some reason, the time shall be re-timed unless otherwise specified in the product standard.

# 8 Precautions

**8.1** The DC high voltage generator shall be equipped with a fast overcurrent protection device, so as to ensure that the test power supply can be quickly cut off when the specimen is broken down or the end of the specimen or the terminal head has flashover discharge along its surface or internal breakdown.

**8.2** A sufficient safety distance shall be maintained between the DC high-voltage terminal (including the DC high-voltage generator, the measuring device and the specimen) and the surrounding grounding body, so as to prevent air discharge. There shall be reliable safety measures around the test area, such as metal grounding barriers, signal lights or safety warning signs.

**8.3** There shall be a ground electrode in the test area. Ground resistance shall be less than 4Ω. The grounding end of the DC high voltage generator and the grounding end of the specimen shall be reliably connected to the grounding electrode.

**8.4** The equipment that is prone to inductive charges adjacent to the DC high-voltage terminal (including the DC high-voltage generator, the measuring device and the sample) shall be reliably grounded.

**8.5** The DC voltage proof test of the wire and cable specimen shall be carried out after the insulation resistance of the specimen is measured.

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