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Electrical relays - Part 5: Insulation tests for electrical relays

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Relais électriques - Partie 5: Coordination de l'isolement des relais de mesure et des dispositifs de protection - Prescriptions et essais

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Electrical relays

Part 5: Insulation tests for electrical relays

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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FOREWORD

1) The formal decisions or agreements of the IEC on technical matters, prepared by Technical Committees on which all the National Committees having a special interest therein are represented, express, as nearly as possible, an international consensus of opinion on the subjects dealt with.

2) They have the form of recommendations for international use and they are accepted by the National Committees in that sense.

3) In order to promote international unification, the IEC expresses the wish that all National Committees should adopt the text of the IEC recommendation for their national rules in so far as national conditions will permit. Any divergence between the IEC recommendation and the corresponding national rules should, as far as possible, be clearly indicated in the latter.

PREFACE

This standard has been prepared by IEC Technical Committee No. 41: Electrical Relays.

Drafts were discussed at the meetings held in Sofia in October 1972 and in Baden-Baden in June 1974. As a result of this latter meeting, a draft, Document 41(Central Office)20, was submitted to the National Committees for approval under the Six Months' Rule in January 1975.

The following countries voted explicitly in favour of publication:

Australia	Romania
Austria	South Africa (Republic of)
Belgium	Sweden
Canada	Switzerland
Denmark	Turkey
France	Union of Soviet Socialist Republics
Israel	United Kingdom
Italy	United States of America
Japan	Yugoslavia
Netherlands	

The German National Committee abstained from voting. It considers that this standard is not far enough advanced, essentially with regard to Appendix B, to permit its complete adoption in Germany and is therefore not listed as having voted explicitly in favour.

Other IEC publications quoted in this publication:

Publications Nos. 38: IEC Standard Voltages.
60: High-voltage Test Techniques.
65: Safety Requirements for Mains Operated Electronic and Related Apparatus for Household and Similar General Use.
112: Recommended Method for Determining the Comparative Tracking Index of Solid Insulating Materials under Moist Conditions.
144: Degrees of Protection of Enclosures for Low-voltage Switchgear and Controlgear.
348: Safety Requirements for Electronic Measuring Apparatus.
364: Electrical Installations of Buildings.
364-1: Part 1: Scope, Object and Definitions.
14: Safety Requirements for Indicating and Recording Electrical Measuring Instruments and their Accessories.

ELECTRICAL RELAYS

PART 5: INSULATION TESTS FOR ELECTRICAL RELAYS

1. Scope

This standard states general requirements for the insulation of electrical relays used in many of the electrotechnical fields covered by the IEC.

This standard applies also to associated ancillary devices such as shunts, series resistors, transformers, etc., used and tested together with electrical relays as above, except where the devices are covered by other IEC publications.

For each type of relay, degrees of severity for the test requirements will be stated in the relevant part of IEC Publication 255 series.

While the relevant degrees of severity for particular types or families of relays are under consideration, the guidance given in Appendix A to this standard should be followed.

Additional requirements may be necessary for particular types of relays, e.g. static relays, and will be stated in the relevant part of IEC Publication 255 series.

2. Object

The object of this standard is:

- to define the terms used which relate to the insulation of electrical relays;
- to specify requirements for voltage tests (including impulse withstand tests) and insulation resistance tests;

- to provide guidance for the selection of degrees of severity for clearances and creepage distances and other aspects related to the insulation of electrical relays.

3. Definitions

For the purposes of this standard, the following definitions apply:

Note. – For definitions of general terms not defined in this standard, reference should be made to the relevant parts of Publication series 255 and to the IEC International Electrotechnical Vocabulary (I.E.V.).

3.1 *Live part**

Any conductor or conductive part which is at voltage in normal use.

3.2 *Exposed conductive part*

A conductive part which can readily be touched and which is not a live part but which may become live under fault conditions.

Notes 1. – For relays which are not enclosed, the frame, the fixing devices, etc., form the exposed conductive parts.

2. – For relays which are enclosed, the conductive parts which are accessible when the relay is mounted in its normal position of use, including those of its fixing surface, form the exposed conductive parts.

Small parts such as inscription plates, screws and rivets which are isolated from the circuits are not taken into consideration.

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* This definition is the same as that given in Sub-clause 3.20 of IEC Publication 364-1, Electrical Installations of Buildings, Part 1: Scope, Object and Definitions, and therefore does not correspond to the definition of "live part" given in IEC Publication 65, Safety Requirements for Mains Operated Electronic and Related Apparatus for Household and Similar General Use. The term "live part" is under consideration by ACOS.

3.3 *Rated insulation voltage (of a relay circuit)*

The value of voltage which conventionally designates a relay circuit and to which dielectric tests, clearances and creepage distances are referred.

3.4 *Clearance*

The distance between two conductive parts along a thread stretched the shortest path between these two conductive parts.

3.5 *Creepage distance*

The shortest distance between two conductive parts along the surface of an insulating material or along the joint between two insulating bodies.

3.6 *Dielectric test*

A test of short duration which consists of applying a specified voltage to the insulation to prove that it is in accordance with the rated insulation voltage of the circuit, as stated by the manufacturer.

3.7 *Impulse voltage test*

A test which consists of applying a specified impulse voltage to the insulation to prove the ability of the relay to withstand without damage overvoltages of very high values and very short durations.

4. Assessment of rated insulation voltages

4.1 *Standard values of rated insulation voltages*

The rated insulation voltage of one or all circuits of a relay shall be chosen from the following series of values: 30, 60, 127, 250, 380, 500, 660, 750, 1 000 V.

4.2 *Assessment of the rated insulation voltage*

The rated insulation voltage shall be assessed as follows:

a) for insulation between live parts and exposed conductive parts: not less than the rated voltage of the circuit under consideration;

b) for insulation between the parts of one circuit, except as provided in Item *e)*: not less than the rated voltage of the circuit under consideration;

c) for insulation between the parts of two independent circuits: the rated insulation voltage should be at least equal to the higher rated voltage of these circuits;

d) for insulation of circuits to be energized directly via instrument transformers: at least 250 V;

e) for the gap between open contacts: unless otherwise agreed between manufacturer and user, no rated insulation voltage is specified;

f) for circuits of a relay having rated voltages exceeding 1 000 V: no rated insulation voltage is specified and tests for such circuits shall be agreed between manufacturer and user.

4.3 Unless otherwise specified in the relevant part of IEC Publication 255 series, the rated insulation voltage, as determined in Sub-clause 4.2, shall be declared by the manufacturer.

If the rated insulation voltage is higher than the circuit rated voltage (see Sub-clause 4.2 *a)*), the relay may be operated at this higher potential with respect to earth.

4.4 For relays which are used in equipment that is not subject to safety requirements, zero rated insulation voltage may be declared, provided that this is specified in the relevant part of IEC Publication 255 series.

Such relays shall be marked with the symbol (0) of Table II

Note. Zero rated insulation voltage denotes that the relay is not subjected to the insulation test requirements.

5. General requirements regarding insulation tests

5.1 Insulation tests include:

- dielectric (steady-state voltage) tests, see Clause 6;
- measurements of the insulation resistance, see Clause 7;
- impulse voltage tests, see Clause 8.

These tests, which are type tests, sampling tests or routine tests as indicated in these clauses, are applicable to relays in a new condition.

5.2 Unless otherwise specified in the relevant part of IEC Publication 255 series, the atmospheric conditions for insulation tests shall not be outside the following ranges:

- ambient air temperature: 15 °C to 35 °C;
- relative humidity: 45% to 75%;
- air pressure: $86 \cdot 10^3$ Pa to $106 \cdot 10^3$ Pa (860 mbar to 1 060 mbar).

The tests are to be applied to the relays in a dry condition and without self-heating.

5.3 Insulation tests shall be performed:

a) between each circuit and the exposed conductive parts, the terminals of each independent circuit being connected together;

b) between independent circuits, the terminals of each independent circuit being connected together;

c) when specified, between the terminals of a given circuit (applicable only to impulse voltage tests - see Clause 8); this condition will be specified, if necessary, in the relevant part of IEC Publication 255 series and applies also to static relays in general.

Unless obvious, the independent circuits are those which are so described by the manufacturer.

Further, by agreement between manufacturer and user, the insulation of open-contact circuits may be tested.

Circuits having the same rated insulation voltage may be connected together when being tested to the exposed conductive parts.

The test voltages shall be applied directly to the terminals.

For relays with an insulating enclosure, the exposed conductive parts shall be represented by a metal foil covering the whole enclosure except the terminals around which a suitable gap shall be left so as to avoid flashover to the terminals. Insulation tests requiring this metal foil shall be performed as type tests only.

6. Dielectric tests

6.1 *General*

Dielectric (steady-state voltage) tests shall be performed as type tests and routine tests, unless otherwise specified in the relevant part of IEC Publication 255 series.

6.2 *Value of the test voltage*

Dielectric tests shall be made by applying the voltage given in Table I unless otherwise specified in Sub-clauses 6.2.1, 6.2.2 and 6.2.3. The test voltage series shall be as specified in the relevant part of IEC Publication 255 series or, if not specified, the guidance given in Appendix A, Sub-clause A1, should be followed. Column N shows the test voltages specified in parts of IEC Publication 255 series issued previously and is temporarily retained.

6.2.1 For circuits to be energized directly via instrument transformers, the test voltage shall be not less than 2 kV.

6.2.2 When testing between two circuits which are intended to be always at the same potential (e.g. directly connected to the same phase), the test voltage shall be reduced to 500 V or twice the rated insulation voltage, whichever is the higher.

6.2.3 When, by agreement between manufacturer and user, a dielectric test between open contacts is to be performed, the value of the test voltage shall also be agreed.

TABLE I

Dielectric test voltages

Rated insulation voltage	Test voltage			
	N	Series A	Series B	Series C
V	kV	kV	kV	kV
30	0.5	0.5	0.5	1.0
60	0.5	0.5	1.0	1.0
127	2.0	0.5	1.0	1.5
250	2.0	1.0	1.5	2.0
380	2.0	1.0	1.5	2.5
500	2.0	1.5	2.0	2.5
660	-	1.5	2.5	3.0
750	-	1.5	3.0	3.0
1 000	-	2.0	3.0	3.0

6.3 *Test voltage source*

The test voltage source shall be such that, when applying half the specified value to the relay under test, the voltage drop observed is less than 10 %.

The source voltage shall be verified with an accuracy better than 5 %.

The test voltage shall be substantially sinusoidal and at a frequency between 45 Hz and 65 Hz. However, by agreement, tests may alternatively be performed with a d.c. voltage the value of which shall be 1.4 times that given in Table I.

6.4 *Test method*

The open-circuit voltage of the testing equipment is initially set to not more than 50 % of the specified voltage. It is then applied to the relay under test. From this initial value, the test voltage shall be raised to the specified value in such a manner that no appreciable transients occur and maintained for 1 min. It shall then be reduced smoothly to zero as rapidly as possible.

For sampling tests and routine tests, and unless otherwise agreed between manufacturer and user, the test voltage may be maintained for 1 s, then removed. In this case, the test voltage shall be 10 % higher than the value specified in Table I.

6.5 *Test requirements*

During the dielectric test, no breakdown or flashover shall occur.

Other criteria (for example, a leakage current limit) shall be observed when so specified in the relevant part of IEC Publication 255 series.

6.6 *Repetition of dielectric tests*

For a relay in a new condition, dielectric tests may be repeated, if necessary, to verify its performance, the test voltage value being the specified value.

When dielectric tests are repeated, e.g. for final measurement after an endurance test, they shall be made at the reduced values specified in the relevant part of IEC Publication 255 series.

7. Measurements of insulation resistance

7.1 Measurements of insulation resistance when specified in the relevant part of IEC Publication 255 series shall be performed in accordance with Sub-Clause 5.3.

7.2 The insulation resistance shall be determined when a steady value has been reached and at least 5 s after applying a d.c. voltage of about 500 V.

7.3 The insulation resistance so measured shall be not less than that specified in the relevant part of IEC Publication 255 series.

Note. – The minimum insulation resistance values may be different for safety purposes and for functional purposes.

8. Impulse voltage tests

A test which consists of applying a specified impulse voltage to the insulation to prove the ability of the relay to withstand without damage overvoltages of very high values and very short durations.

8.1 *General*

General guidance for the selection of test voltage values is given in Appendix D.

Impulse voltage tests shall be performed as type tests.

8.2 *Value of the impulse voltage*

Impulse voltage tests shall be made by applying an impulse voltage the peak value of which shall be chosen from the following values:

0, 1, 5 kV (tolerance: $^{+0}_{-10}$ %)

as specified in the relevant part of IEC Publication 255 series.

8.2.1 The test in accordance with Sub-clause 5.3*a*) shall be carried out, unless otherwise specified, between each circuit (or each group of circuits having the same insulation) and the exposed conductive parts at the impulse voltage specified for this circuit (or this group of circuits).

8.2.2 The test in accordance with Sub-clause 5.3*b*) between two independent circuits shall be carried out, unless otherwise specified, at the higher impulse voltage specified for the two circuits.

8.2.3 The test in accordance with Sub-clause 5.3*c*) shall be carried out at the impulse voltage specified for the circuit under test.

8.2.4 When zero impulse test voltage is specified, the relay or any of its circuits is exempted from the impulse voltage test.

8.2.5 The test voltage level shall be the open-circuit voltage of the generator before its connection to the relay.

8.3 *Waveform and generator characteristics*

A standard lightning impulse in accordance with IEC Publication 60, High-voltage Test Techniques, shall be used.

The parameters are:

- front time: 1.2 μs ± 30%;
- time to half-value: 50 μs ± 20%.

Note. – Tests performed with other waveforms, e.g. high-frequency oscillatory waveforms, may be specified but such tests are considered to be functional tests and are normally relevant only to static relays.

The recommended standard test circuit and impulse generator are shown in Appendix D.

If an alternative generator is used, it shall have the following characteristics:

- output impedance: 500 Ω ± 10%;
- output energy: 0.5 J ± 10%.

The length of each test lead shall not exceed 2 m.

8.4 *Test procedure*

Impulse voltage tests shall be carried out in accordance with Sub-clause 5.3. The impulse voltage shall be applied to the appropriate points accessible from the outside of the relay, the other circuits and the exposed conductive parts being connected together and to earth.

During these tests, no input or auxiliary energizing quantity shall be applied to the relay.

Three positive and three negative impulses shall be applied at intervals of not less than 5 s.

8.5 *Test requirements*

After the test, the relay shall still comply with all relevant performance requirements.

Note. – A flashover (disruptive discharge) which causes no damage is not necessarily a criterion of failure. The manufacturer shall decide whether or not to eliminate the cause, provided other criteria of acceptance are met.

8.6 *Repetition of impulse voltage test*

In general, the impulse voltage test shall be performed only once on a new relay. If a further test is required, it shall be performed at 60% of the specified impulse voltage.

9. Marking

9.1 The symbols indicated below shall be used when the marking of the test voltage(s) is specified in the relevant part of IEC Publication 255 series or when the manufacturer chooses to mark the relay. The marking is also applicable to relays in accordance with Sub-clause 4.4.

In the absence of marking of the test voltage, the manufacturer should state the insulation level(s) of the relay.