BRITISH STANDARD

BS EN
117000 : 1997

Incorporating
Amendment No. 1 to
BS CECC 17000 : 1992
(renumbers BS as
BS EN 117000 : 1997)

Harmonized system of quality assessment for electronic components

Generic specification:

Solid state all-or-nothing relays of assessed quality. Generic data and methods of test

The European Standard EN 117000 : 1991 has the status of a British Standard

ICS 29.120.70

BSi
British Standards

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Electronic Components Standards Policy Committee (ECL/-) to Technical Committee ECL/1, upon which the following bodies were represented:

Association of Control Manufacturers (TACMA (BEAMA Ltd.))
British Telecommunications plc
Electronic Components Industry Federation
Ministry of Defence
National Supervising Inspectorate
Transmission and Distribution Association (BEAMA Ltd.)

This British Standard, having been prepared under the direction of the Electronic Components Standards Policy Committee, was published under the authority of the Standards Board and comes into effect on 1 May 1992

The following BSI references relate to the work on this standard:
Committee reference ECL/1
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Amendments issued since publication

Amd. No.	Date	Text affected
9626	October 1997	Adoption as a European Standard

Summary of pages

The following table identifies the current issue of each page. Issue 1 indicates that a page has been introduced for the first time by amendment. Subsequent issue numbers indicate an updated page.

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Change of identifier

Wherever BS CECC 17000 : 1992 appears in this standard, it should be read as BS EN 117000 : 1997.

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National foreword

This British Standard has been prepared by Technical Committee EPL/94 (formerly ECL1), and is the English language version of EN 117000 : 1991 *Generic specification: Solid state all-or-nothing relays of assessed quality. Generic data and methods of test*, published by the European Committee for Electrotechnical Standardization (CENELEC).

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the BSI Standards Catalogue under the section entitled 'International Standards Correspondence Index', or using the 'Find' facility of the BSI Standards Electronic Catalogue.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

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EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 117000

October 1991

Descriptors: Quality, electronic components, relays

English version

Generic Specification: Solid state all-or-nothing relays of assessed quality. Generic data and methods of test

Spécification Générique:
Relais statiques de tout-ou-rein de qualité assurée.
Généralités et méthodes d'essai

Fachgrundspezifikation:
Gütebestätigte Halbleiterrelais.
Allgemeine Daten und Prüfverfahren

This European Standard was approved by the CENELEC Electronic Components Committee (CECC) on 14 October 1991. The text of this standard consists of the text of CECC 17000 Issue 2 : 1990 of the corresponding CECC Specification. CENELEC members are bound to comply with CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the General Secretariat of the CECC or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom. The membership of the CECC is identical with the exception of the national electrotechnical committees of Greece, Iceland and Luxembourg.

CECC

CENELEC Electronic Components Committee
Comité des Composants Electroniques du CENELEC
CENELEC Komitee für Bauelemente der Elektronik

Central Secretariat: rue de Stassart 35, B-1050 Brussels

Ref. No. EN 117000 : 1991 E

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FOREWORD

The CENELEC Electronic Components Committe (CECC) is composed of those member countries of the European Committee for Electrotechnical Standardization (CENELEC) who wish to take part in a harmonized System for electronic components of assessed quality.

The object of the System is to facilitate international trade by the harmonization of the specifications and quality assessment procedures for electronic components, and by the grant of an internationally recognized Mark, or Certificate, of Conformity. The components produced under the System are thereby accepted by all member countries without further testing.

This specification has been formally approved by the CECC, and has been prepared for those countries taking part in the System who wish to issue national harmonized specifications for **Solid state all-or-nothing relays of assessed quality. Generic data and methods of test.** It should be read in conjunction with the current regulations for the CECC System.

At the date of printing of this specification, the member countries of the CECC are Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom, and copies of it can be obtained from the addresses shown on the blue fly sheet.

PREFACE

This specification was prepared by CECC WG 16: Relays.
It is based, wherever possible, on the Publications of the International Electrotechnical Commission.

The text of this specification was circulated to the CECC for voting in the document indicated below and was ratified by the President of the CECC for printing as a CECC Specification.

Document	Voting Date	Report on the voting
CECC(Secretariat)2326	January 1989	CECC(Secretariat)2574

Note:
This Issue 2 of CECC 17 000 is the first specification related to solid state relays. Issue 1 of CECC 17 000 was titled 'Mercury wetted make contact units' and has been withdrawn in connection with the revision of the specifications for reed contact units. The latter will in future be covered by the generic specification CECC 19 000. These decisions were made during the meeting of CECC WG 16 on 3rd to 5th October 1990 in Great Malvern (GB).

Issue 2 is published initially in English and German only; the French text will follow as soon as it has been prepared.

SECTION 1 - SCOPE

This generic specification lists the test and measurement procedures which may be selected for use in detail specifications for solid state relays of assessed quality. It also specifies the quality assurance procedures to be followed.

Relays covered by this specification have d.c. control circuits and output ratings not exceeding 100 A.
Note: d.c. output devices are under consideration.

SECTION 2 - GENERAL

2.1 Order of Precedence

Where any discrepancies occur for any reason, the documents shall rank in the following order of authority :-

1. The detail specification
2. The sectional specification
3. The generic specification
4. The Internal Regulations of the FEN e.V. (Association for the Promotion of Electrotechnical Standardization)
5. Any other international documents (for example IEC) to which reference is made.

The same order of precedence shall apply to equivalent national documents.

2.2 Related Documents

ISO 1000 (1973)	SI units and recommendations for the use of their multiples and of certain other units.
ISO 8601 (1988)	Data Elements and Interchange Formats
IEC 27-1 (1976)	Letter symbols to be used in electrical technology. General.
IEC 50 -	International Electrotechnical Vocabulary
IEC 68 -	Basic environmental testing procedures. The following points are referenced :
IEC 68-1 (1982)	General and guidance
*IEC 68-2-1 (1983)	Test A, Cold
*IEC 68-2-2 (1976)	Test B, Dry Heat
IEC 68-2-3 (1969)	Test Ca, Damp heat, steady state
*IEC 68-2-6 (1983)	Test Fc, Vibration (sinusoidal)
IEC 68-2-7 (1983)	Test Ga, Acceleration, steady state
*IEC 68-2-10 (1972)	Test J, Mould growth
IEC 68-2-11 (1981)	Test Ka, Salt mist
IEC 68-2-13 (1983)	Test M, Low air pressure

IEC 68-2-14 (1984)	Test N, Change of temperature
IEC 68-2-17 (1978)	Test Q, Sealing
IEC 68-2-20 (1979)	Test T, Soldering
IEC 68-2-21 (1983)	Test U, Robustness of terminations and integral mounting devices.
*IEC 68-2-27 (1983)	Test Ea, Shock
*IEC 68-2-29 (1983)	Test Eb, Bump
IEC 68-2-30 (1980)	Test Db, Damp heat cyclic (12 + 12 hour cycle)
IEC 68-2-45 (1980)	Test XA, Immersion in cleaning solvents

*Including all amendments or supplements issued to the year indicated.

IEC 144 (1963)	Degrees of protection of enclosures for low-voltage switchgear and control gear.
IEC 147-5 (1977)	Essential ratings and characteristics of semicondictor devices, Part 5, Test methods.
IEC 748 (1984)	Letter symbols for semiconductor devices and integrated microcircuits.
IEC 255 -	Electrical relays. The following parts are referenced :
IEC 255-1-00 (1975)	All-or-nothing relays
IEC 255-5 (1977)	Insulation tests for electrical relays
IEC 410 (1973)	Sampling plans and procedures for inspection by attributes (see CECC 00 007)
IEC 443 (1974)	Stabilised supply apparatus for measurement
IEC 617 -	Graphical symbols for diagrams
IEC 695 -	Fire hazard testing The following parts are referenced :
IEC 695-2-1 (1980)	Glow wire test
IEC 695-2-2 (1980)	Needle-flame test
CECC 00 007 (1973)	Basic specification : Sampling plans and procedures for ispection by attributes.
./. (1986)	The Internal regulations of the FEN e.V.
CECC 00 107 (1977)	Rule of procedure 7: Quality assessment procedures (with amdt 1 to RP7)

CECC 00 109 (1974)	Rule of procedure 9: Certified test records
CECC 16 000 (1979)	Generic specification : Electromechanical All-or-Nothing relays
CECC 19 000 (1978)	Generic specification : Dry reed make contact units
CECC 50 000 (1980)	Generic specification : Discrete semiconductor devices.

2.3 Units, symbols and terminology

Units, graphical symbols, letter symbols and terminology shall, whenever possible, be taken from the following documents :-

ISO 1000 (1973)	SI units and recommendation for the use of their multiples and of certain other units.
IEC 27-1 (1976)	Letter symbols to be used in electrical technology, Part 1 : General
IEC 50 -	International Elecrotechnical Vocabulary
IEC 748-1 (1984)	Letter symbols for semiconductor devices and integrated microcircuits.
IEC 617 (1983)	Graphical symbols for diagrams

2.4 Preferred Values

Preferred values shall be stated in the sectional specifications. They shall, as far as possible, adopt the relevant standard values of the IEC 255.

2.5 Marking

The sectional or detail specifications shall indicate the identification criteria and other information to be shown on the relay or packing. The letter or colour code shall be described in full or reference made to the appropriate specifications. The order of priority for marking small relays shall be specified.

The marking shall, as a minimum, consist of

- The trade mark or manufacturer's name
- Rated input and output values
- Terminal or circuit diagram
- Coded date of manufacture, in accordance with ISO 8601
- Relay type and variant code
- CECC Mark of Conformity

SECTION 3 - TERMS AND DEFINITIONS

The following paragraphs contain specific additional terminology applicable to solid state relays and shall be included in each national harmonized specification

3.1 Construction

3.1.1 Enclosure types

Relays having one of the following types of enclosure :-

(1) Unenclosed
(2) Enclosed or dust protected
(3) Encapsulated
(4) Hermetically sealed

3.1.2 Pattern

Relays of one enclosure type having a switching capacity of up to 100 A.

3.1.3 Style

Relays of one enclosure type and pattern having, for example one of the following terminations:

(1) Solderable
(2) Plug-in
(3) Screw
(4) Push-on

3.2 Types of Relays

3.2.1 Electrical relay (IEC 50-446)

A device designed to produce sudden, predetermined changes in one or more electrical output circuits after the appearance of certain conditions in the electrical input circuits controlling the device.

3.2.2 Solid State Relay (SSR) (Static relay)

A relay with isolated input and output whose functions are achieved by means of electronic, electromagnetic and/or electro-optic components and without the use of moving parts.

3.2.3 **Zero-voltage turn-on relay** (a.c. only)

A relay with isolated input and output in which added control circuitry delays the output turn-on until a zero voltage transition of the a.c. sine wave is detected.

3.2.4 **Zero-current turn-off relay** (a.c. only)

A relay with isolated input and output in which added control circuitry delays the output turn-off until a zero current transition of the a.c. sine wave is detected.

3.2.5. **Instantaneous turn-on relay**

A relay with isolated input and output which turns on when the control circuit is energised.

3.3 **General terms**

3.3.1 **Rated isolation voltage** (IEC 255-5)

The value of voltage which conventionally designates a relay circuit and to which dielectric tests, clearances and creepage distances are referred. (Normally measured between inputs and outputs, input and case output and case, and output and output when applicable).

3.3.2 **Thyristor** (IEV 521-04-38)

A bistable semiconductor device comprising three or more junctions which can be switched from the off-state to the on-state or vice versa.

3.3.3 **Bidirectional triode thyristor (triac)** (IEV 521-04-44)

A three-terminal thyristor having substantially the same switching behaviour in the first and third quadrants of the current voltage characteristics.

3.3.4 **Derate**

To reduce the rating of a relay due to change in operating conditions, such as reducing output current due to elevated ambient temperature.

3.3.5 Heat sink

A device which is used to dissipate the heat generated within a component by transferring heat to the surrounding ambient by means of conduction, convection and radiation. The heat sink is usually metallic and may be an auxiliary device or an integral part of the component.

3.3.6 Power loss

The loss that occurs within the relay primarily due to the on-state condition losses.

3.3.7 Surge current

A short duration increase of current to a magnitude substantially higher than its normal steady-state value.

3.3.8 Thermal resistance

The resistance of a material to the flow of heat, expressed in Kelvin per watt (K/W). The thermal resisitance between two points in a relay is the ratio of the temperature difference between the two points to the power dissipation producing the heat flow.

3.3.9 Input

That portion of a relay to which a control signal is applied in order to achieve the switching function.

3.3.10 Output

That portion of the relay which performs the switching function required.

3.3.11 Commutating

The action of a thyristor in switching from the on-state to the off-state.

3.3.12 Off-State

The high impedance state of the relay output where only leakage current is flowing through the output circuit.

3.3.13 On-State

The low impedance state of the relay output.

3.4 Prefixes for the values applicable to relays

Values may be defined as rated, actual ("just"), test ("must") or characteristic value and identified as such by using one of these words as a prefix.

3.4.1 Rated value

Value of a quantity assigned generally by a manufacturer, for a specified operating condition of a relay.

3.4.2 Actual ("just") value

Value of a quantity determined by measurement on a single relay, when it just performs a specified function.

3.4.3 Test ("must") value

Value of a quantity with which, during tests, the relay is required to perform or not to perform a specified function.

3.4.4 Characteristic value

Value of a quantity with which, throughout its lifetime or a specified number of cycles, the relay is required to comply with a specified requirement

3.5 Control signal values

3.5.1 Control signal

An electrical quantity such as voltage, which when applied to the input of the relay under specified conditions enables it to fulfil its purpose.

3.5.2 Control voltage value

The voltage of the control signal.

3.5.3 Control current value

The current of the control signal.

3.5.4 Operative range of a control signal

The range of values of a control signal for which the relay under specified conditions is able to perform its intended function according to the specified requirements.

3.5.5 Non-operate value

Value of the control signal at which a relay does not switch from the off-state to the on-state.

3.5.6 Operate value

Value of the control signal at which a relay switches from the off-state to the on-state.

3.5.7 Non-release value

Value of the control signal at which a relay does not switch from the on-state to the off-state.

3.5.8 Release value

Value of the control signal at which a relay switches from the on-state to the off-state.

3.6 Output values

3.6.1 Off-State voltage

The voltage across the output when the relay is in the off-state.

3.6.2 Off-State current

The current that flows in the output circuit when the relay is in the off-state and a voltage is applied.

3.6.3 Off-State dv/dt

The rate of change of voltage across the output with respect to time expressed in volts/microseconds. (V/µs).

3.6.4 Post commutation dv/dt (a.c. only)

The rate of change of voltage that can be re-applied across a relay immediately following commutation and not cause the relay to return to the on-state. Commutation dv/dt is expressed in volts/ microseconds (V/µs) usually only relevant to SSRs with triac power switches.

3.6.5 Zero turn-on voltage (a.c. only)

The specified voltage range about zero within which the relay is able to switch to its on-state.

3.6.6 Zero turn-off current (a.c. only)

The specified current range about zero within which the relay is required to switch to its off-state.

3.6.7 On-State voltage

The voltage present across the relay output when the relay is in the on-state.

3.6.8 Minimum On-State current

The amount of output current reqired to keep the relay in the on-state.

3.6.9 di/dt

The rate of change of current with respect to time expressed in amperes/microsecond (A/µs). For a solid state relay this is the rate of change of output current that can be accomodated on turn-on without causing damage to the output.

3.7 Terms relating to times

3.7.1 Operate time

The time interval between the application of control voltage to a relay and the changing of the relay output from the off-state to the on-state.

3.7.2 Release time

The time interval between the removal of the control voltage from a relay and the changing of the relay output from the on-state to the off-state.

SECTION 4 - QUALITY ASSESSMENT PROCEDURES

4.1 Primary stage of manufacture

The primary stage of manufacture shall be defined in each sectional specification.

4.2 Structurally similar components

The sectional specification shall define those relays within its scope which may be considered as structurally similar.

4.3 Qualification approval requirements
(see CECC 00 107)

The manufacturer shall comply with : -

4.3.1 The general requirements of the basic rules governing qualification approval.

and

4.3.2 The requirements for the primary stage of manufacture contained in 4.1.

In addition, the manufacturer shall comply with the requirements given in sectional and detail specifications.

4.4 Quality conformance inspection
(see CECC 00 107)

The sectional specification shall prescribe the test schedule which shall be included in each blank detail specification for those relays covered by the scope of the sectional specification.

This schedule shall also specify the division into subgroups for the purpose of lot-by-lot and periodic inspection.

A sectional specification may specify more than one schedule which can be applied to differing categories or levels.

4.5 Division into groups

The blank detail specification shall show the order in which the tests or conditions in the subgroup shall be carried out where this order may affect the test results. The blank detail specification shall also indicate wherever any particular order of testing in any subgroup is to be observed.
Where a subgroup contains a destructive test, this shall either be stated in full or the symbol "D" shall be placed alongside of the title of the subgroup in the schedule of inspection requirements in the detail specification.

4.5.1 Division into subgroups

Division is made according to the relative importance of the feature to the overall function of the relay.

4.6 Resubmission of rejected lots

No requirements at present.

4.7 Certified test records

The procedure given in CECC 00 109 shall apply, and these certified test records shall then contain the relevant information prescribed in the blank detail specification.

Unless otherwise stated, certified test records should give attributes information for tests in the subgroups covered by periodic inspection, without references to the parameter for which the failure occured.

4.8 Delivery of relays subjected to destructive tests or non-destructive tests

Relays subjected to destructive tests shall not be included in the lot for delivery. Relays subjected to non-destructive tests may be delivered provided they are re-tested to Group A requirements and satisfy them.

4.9 Delayed delivery

Relays which have been held by the manufacturer for a period exceeding 12 months following acceptance inspection, shall be re-inspected as prescribed in the detail specification, unless another period is specified therein.

If this has been done for the complete lot, no further retesting before delivery is needed for another period of one year or as otherwise specified in the detail specification.

4.10 Supplementary procedure for deliveries

When this has been nationally recognised, manufacturers may, at their discretion, supply relays that have met a higher assessment level against orders for a lower assessment level.

4.11 Unchecked parameters

When, in detail specifications, suplementary information is given, this shall not be the subject of inspection.

4.12 Release for delivery before the completion of Group B tests

When the conditions of IEC 410 for reduced inspection have been satisfied for all Group B tests, the manufacturer is permitted to release the relays before the completion of such tests.

SECTION 5 - TEST AND MEASUREMENT PROCEDURES

5.1 General

The sectional or blank detail specification shall contain tables showing the tests to be made, which measurements are to be made before and after each test or subgroup of tests, and the sequence in which they shall be carried out.

Note :- National committees may insert here a warning from dangers which might occur during tests, as requested by their national legislation.

5.2 Alternative methods

Measurements shall preferably be carried out by using the methods specified. Any other method giving equivalent results may be used except in case of dispute.

Note :- By "equivalent" is meant that the value of the characteristic established by such other method falls within the specified limits when measured by the specified methods.

5.3 Precision of measurement

The limits quoted in detail specifications are mandatory values. Measurement inaccuracies shall be taken into account when evaluating the results. The usual precautions should be taken to reduce measurement errors to a minimum.

5.4 Requirements in detail specifications

If the requirements of the generic specification relative to inspection are not entirely suitable (either for technical reasons or because of a special application), the detail specification shall set out clearly the revised requirements.

5.5 Standard conditions for testing

5.5.1 Unless otherwise specified, all tests shall be carried out under the standard atmospheric conditions for tesing as specified in Clause 5.3 of IEC 68-1 :-

Temperature	15°C	to	35°C
Relative humidity	45%	to	75%
Air pressure	86 kPa (860	to to	106 kPa 1060 mbar)

In case of dispute, the referee conditions are :

Temperature	23°C	±	1°C
Relative humidity	48%	to	52%
Air pressure	86 kPa (860	to to	106 kPa 1060 mbar)

(See Sub-clause 5.2 of IEC 68-1)

Before testing, the relays shall be subjected to the standard atmospheric conditions for a time sufficient to allow them to reach thermal equilibrium.

5.5.2 Unless otherwise specified, the terms a.c. voltage and current indicates r.m.s. values throughout this specification.

5.5.3 Any value to be assigned to quantities as defined in this specification will relate to specified conditions which are within the intended conditions of use of a relay, and different values may apply to steady-state and dynamic operation.

5.5.4 Unless otherwise prescribed, the following shall apply to power supplies and their connections. (See IEC 443).

5.5.4.1 The change in voltage or current shall not exceed 5% for a change in load of half the rated load for the test.

The peak-to-peak periodic and random deviations of the output of a d.c. supply shall not exceed 1%.

The operating error in frequency of an a.c. supply shall not exceed 1%, and the form factor shall lie between 0,95 and 1,25.

5.5.4.2 The following shall be earthed as applicable : the negative side of the d.c. power supply, one side of the single-phase a.c. power supply, or the neutral of the three-phase a.c. power supply.

5.5.4.3 The earthed side of the power supply shall be connected to : one terminal of the input, or one terminal each of one or more inputs of the relay under test, and one terminal of each of the loads connected to the relay under test.

Note : Earthing of the neutral conductor : If the power supply referred to in clauses 5.5.4.2 and 5.5.4.3 is taken from the public supply care should be taken to ensure that the local supply regulations allow the neutral to be earthed. If this is not the case an isolating transformer will be required.

5.5.5 Where mounting is required for a particular test, the relay shall be mounted in accordance with the specified fixing instructions.

5.5.6 **Conditions to be prescribed in the detail specification** :

(1) Atmospheric conditions if other than in 5.5.1
(2) Properties of the power supply, and its connections, if other than in 5.5.4
(3) Fixing instructions
(4) Tests to which these conditions are to be applied, unless applicable to all tests
(5) Steady-state or dynamic operation.

5.6 Visual inspection and check of dimensions

5.6.1 The relays shall be checked for conformity to the outline drawings, including creepage distance and clearances, prescribed in the detail specification.

5.6.2 Unless otherwise prescribed in the detail specification, visual inspection shall be performed under normal factory lighting and visual conditions.

5.6.3 External inspection and check of key dimensions shall be carried out as non-destructive tests.

5.6.4 Visual inspection shall include :

(1) Correctness of marking
(2) Correctness of terminal identification
(3) Correct housing
(4) Absence of physical defects, as prescribed in the detail specification.

5.6.5 The condition, workmanship and finish shall be satisfactory as determined by visual inspection.

5.6.6 Shaking of the relay shall be carried out as an audible inspection to detect loose particles, if prescribed in the detail specification.

5.6.7 **Conditions to be prescribed in the detail specification** :

(1) Dimensions and tolerances, marking and terminals to be checked, if required.
(2) Creepage distance and clearances to be checked, and minimum values.
(3) Particular lighting and/or optical devices, if required.
(4) Shaking of the relay, if required.
(5) Physical properties to be checked, and required results.

5.7 Mass

5.7.1 When prescribed in the detail specification the relay shall be weighed.

5.7.2 **Conditions to be prescribed in the detail specification**

(1) Mass of the relay, and tolerances.

5.8 **Terminal identification**

In the following test procedures terminals 1 and 2 are assigned to the output and terminals 3 and 4 to the input of the solid state relay (SSR).

5.9 **'MUST OPERATE' AND 'MUST RELEASE' CONTROL SIGNAL CURRENT AND VOLTAGE I_{ON}, V_{ON}, V_O**

5.9.1 **Purpose**

To measure the 'must operate' control current and/or voltage and to prove and measure the 'must release' voltage of a SSR under specified conditions.

5.9.2 **Procedure**

The test circuit shown in FIG. 1 shall be used, with the two sources set to zero and the switch S closed. The SSR is inserted into the test circuit and the temperature set to the specified value.

The off-state voltage across the SSR as measured on the voltmeter V_1 is increased to the specified value.

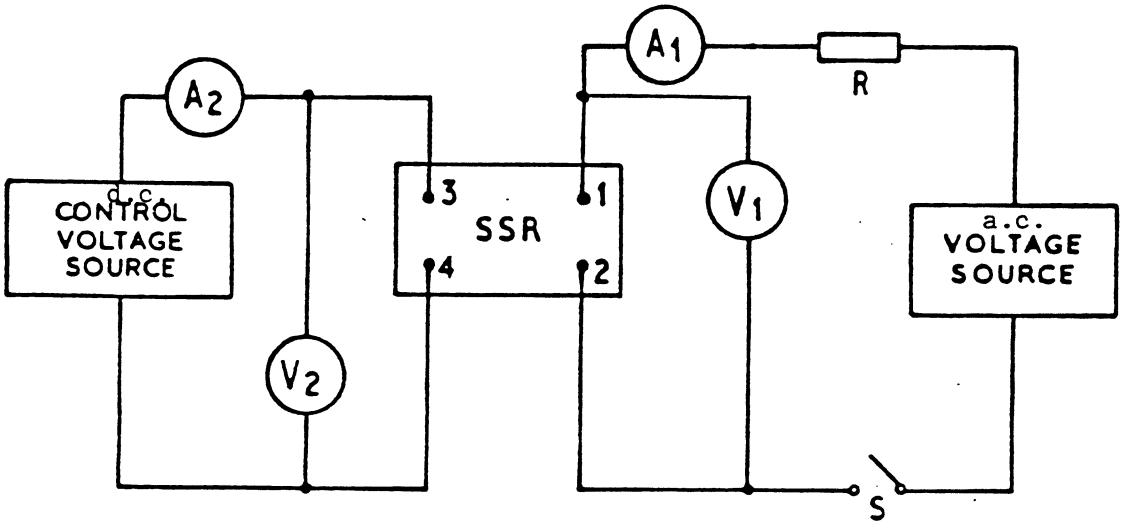


FIG. 1 : Test circuit for 'must operate' and 'must release' control signal current and voltage.

Resistor R is a protective resistor. V_1 is an r.m.s measuring voltmeter.

'Must operate' voltage and current V_{ON}, I_{ON}

The control voltage is gradually increased until the specified 'must operate' voltage is reached. If the SSR turns on the test is proved. Ammeter A_1 indicates the principal current. Switch S is then opened and the control current and voltage are measured on ammeter A_2 and voltmeter V_2 respectively.

'Must release' voltage V_0

To prove the 'must release' voltage the control voltage is gradually decreased from the 'must operate' voltage until the specified 'must release' voltage is reached. If the SSR has turned off, indicated by the principal current ceasing to flow in the ammeter A_1, the test is proved.

To measure the 'must release' voltage the control voltage is gradually increased until the SSR turns on and the principal current flows through the ammeter A_1. The control voltage is then reduced until the principal current indicated on ammeter A_1 ceases to flow. The must release voltage is measured on voltmeter V_2.

5.9.3 Conditions to be prescribed in the Detail Specification

(1) **Off state voltage**
(2) Frequency range of alternating source
(3) **Must release voltage (for proof test only)**
(4) **Ambient, case or reference point temperature**
(5) Value of protective resistor.

5.10 PEAK ON-STATE VOLTAGE

5.10.1 Purpose

To measure the peak on-state voltage of a SSR under specified conditions.

5.10.2 Procedure

The test circuit in FIG. 2 shall be used and the two sources set to zero.

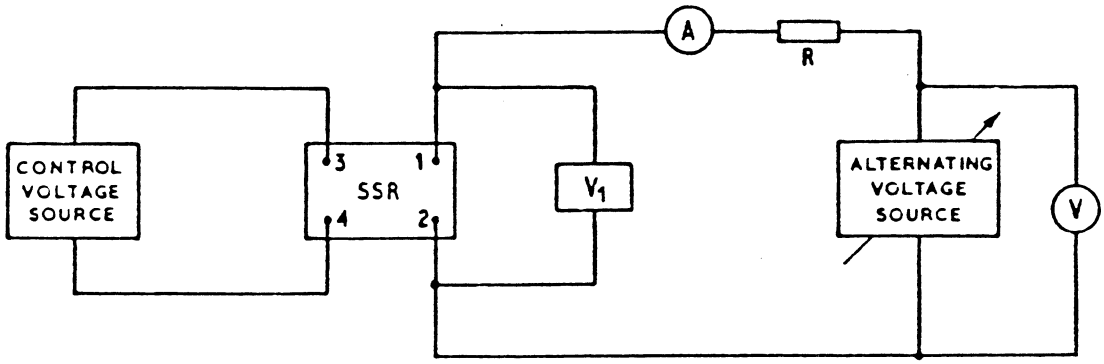


FIG. 2 : Test circuit for peak on-state voltage

R is a protective resistor. Separate voltage and current connections shall be made to teminals 1 and 2. V_1 is a peak reading voltmeter or oscilloscope.

The SSR is inserted into the test circuit and the temperature is set to a specified value. The control voltage source is set to the specified value and the peak on-state current through the SSR as measured on the peak reading instrument 'A' is increased to the specified value.

The peak on-state voltage across the SSR terminals is measured on V_1.

The sources are reduced to zero and the SSR removed from the test circuit.

Note : To avoid problems of waveform distortion caused by the 'zero' voltage switching characteristics, R must be chosen such that the required current is reached with the voltage source measured on V set to between 90% and 100% of the maximum peak voltage rating of the SSR under test.

5.10.3 Conditions to be prescribed in the Detail Specification

(1) RMS on-state current
(2) Control voltage conditions
(3) Frequency range of alternating source
(4) Ambient, case or reference point temperature before test.

5.11 "ZERO" TURN-ON VOLTAGE

(Applicable to 'zero' voltage turn-on relays only)

5.11.1 Purpose

To measure the 'zero' turn-on voltage of a SSR under specified conditions.

5.11.2 Procedure

The test circuit in FIG. 3 shall be used.
The two sources are set to zero and the switch S opened.

The SSR is inserted into the test circuit and the temperature set to the specified value.

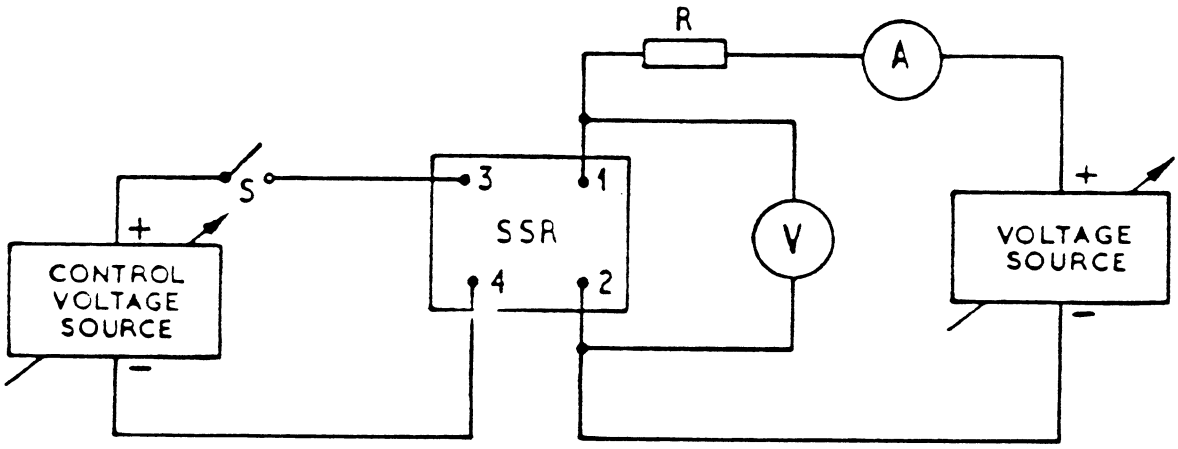


FIG. 3 : Test circuit for 'zero' turn-on voltage

Resistor R is a protective resistor.

The off-state voltage as measured on voltmeter V is increased to the nominal working voltage.

Switch S is closed and the control voltage increased to the must operate value. The off-state voltage is gradually decreased by reducing the voltage source until the SSR turns on and the ammeter A indicates the flow of current.

The value of the off-state voltage measured on voltmeter V, immediatly prior to the turn-on point, is the 'zero' turn-on voltage.

The sources are reduced to zero and the SSR removed from the test circuit. The test is repeated with connections 1 and 2 reversed.

5.11.3 Conditions to be prescribed in the Detail Specification

(1) Ambient, case or reference point temperature
(2) Nominal working voltage.

5.12 SURGE (NON-REPETITIVE) ON-STATE CURRENT I_{TSM}

5.12.1 Purpose

To prove the surge (non-repetitive) on-state current rating of a SSR under specified conditions.

5.12.2 Procedure

With the voltage and current sources set to zero the SSR is inserted into the test circuit FIG. 4 and the temperature set to the specified value.

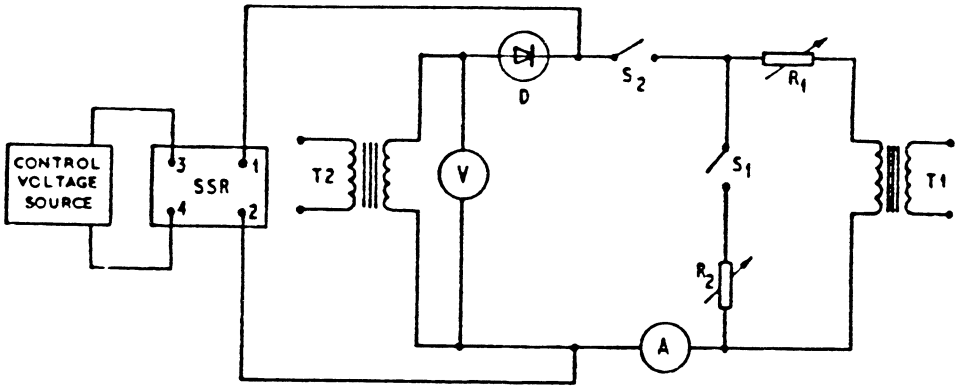


FIG. 4 : Test circuit for surge (non-repetitive) on-state current

A is a peak reading ammeter, V is a peak reading voltmeter.

R_1 is the surge current setting resistor and should be large compared to R_2.

R_2 is the surge current balancing resistor, and should approximately equal the on-state impedance of the SSR under test with the surge current flowing.
S_1 is an electromechanical or electronic switch with a conduction angle of approximately 180° during the reverse half cycle.

S_2 is an electromechanical or electronic switch with a conduction angle of approximately 180° during the forward (surge) half cycle.

T_1 is a transformer of low voltage and high current supplying the surge half cycle. The current wave shape should be essentially a half sine wave of aproximately 10 ms duration with a repetition rate of approximately 50 pulses/s.

T_2 is a transformer of high voltage and low current supplying (through diode D) the reverse half cycle and is fed from a separate source whose phase is the same as that of T_1. The voltage shape shall be essentially a half sine wave.

The control voltage source is arranged such that the SSR is turned on only during a single forward (surge) half cycle.

The control voltage is set such that the SSR will turn on and the peak reverse voltage, measured on voltmeter V, is set to the specified value.

The peak on-state surge current, measured on ammeter A is set to the specified value by adjustment of R_1.

The specified number of cycles of on-state surge current within the period of the surge and peak reverse voltage are applied to the SSR under test.

The voltage and current sources are reduced to zero and the SSR removed from the test circuit.

Proof of the ability of the SSR to meet the on-state surge current rating is obtained from the post test measurement.

5.12.3 Conditions to be prescribed in the Detail Specification

(1) Peak reverse voltage
(2) Peak on-state surge current
(3) Transformer requirements
(4) Period between surges if applicable
(5) Ambient, case or reference point temperature before test
(6) Frequency range of alternating sources
(7) Maximum impedance of the reverse voltage source
(8) The post test end point measurement limits

5.13 SURGE (NON - REPETITIVE) ON-STATE CURRENT I_{TSM}
(with rapid rate of rise of reverse voltage)

5.13.1 Purpose

To prove the surge (non-repetitive) on-state current rating of a SSR under specified conditions.

5.13.2 Procedure

The test circuit in FIG. 5 shall be used with the control voltage source arranged such that the SSR is turned on only during each forward (surge) half cycle.

With the voltage and current sources set at zero the SSR is inserted into the test circuit and the temperature set to the specified value. The control voltage source is set such that the SSR will turn on and peak reverse voltage measured on voltmeter V, is set to the specified value.

The peak-on state surge current measured on ammeter A, is set to the specified value by adjustment of R_1. The specified number of cycles of on-state surge current and peak reverse voltage are applied to the SSR under test.

The voltage and current sources are reduced to zero and the SSR removed from the test circuit.

Proof of the ability of the SSR to meet the on-state surge current rating is obtained from the post test measurements.

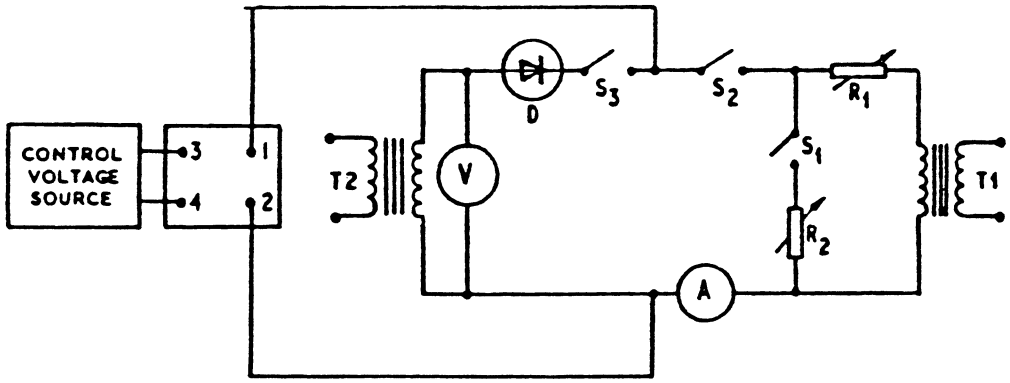


FIG. 5 : Test circuit for surge (non-repetitive) on-state current (with rapid rate of rise of reverse voltage).

Ammeter A and voltmeter V are peak reading instruments.

R_1 is the surge current setting resistor and should be large compared to R_2.

R_2 is the surge current balancing resistor and should approximately equal the forward impedance of the SSR under test.

S_1 is an electromechanical or electronic switch with a conduction angle of approximately 180° during the reverse half cycle.

S_2 is an electromechanical or electronic switch with a conduction angle of approximatley 180° during the forward (surge) half cycle.

S_3 is an electromechanical or electronic switch with a conduction angle between 85° and 90° immediately after the forward (surge) half cycle and during the reverse half cycle.

T_1 is a transformer of low voltage and high current supplying the forward (surge) half cycle. The current wave shape should be essentially a half sine wave with a repetition rate of approximately 50 pulses/s.

T_2 is a transformer of high voltage and low current supplying (through diode D) the reverse half cycle and is fed from a separate source whose phase leads that T_1 by 90° (See FIG. 6).

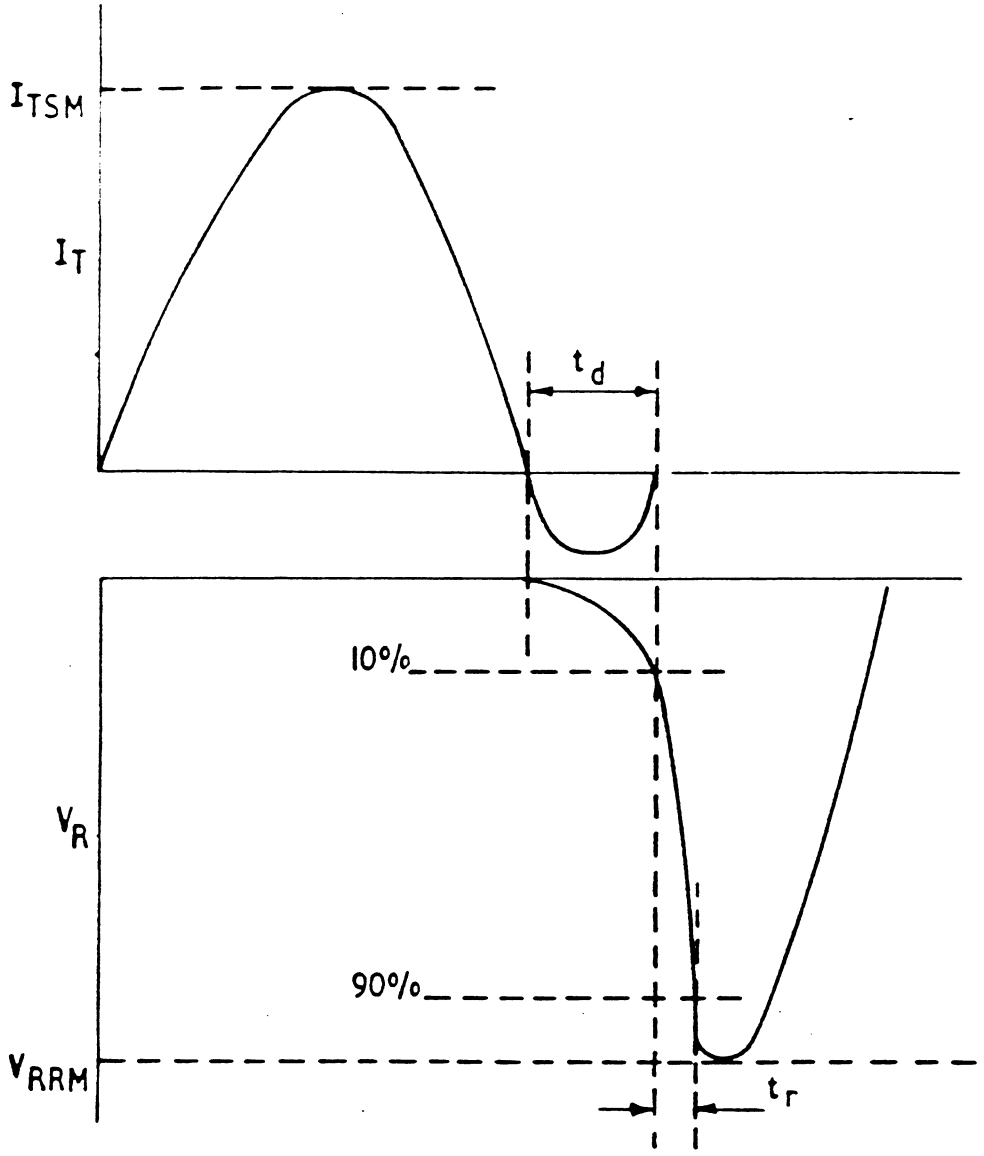


FIG. 6 : Waveforms for surge (non-repetitive) on-state current test

t_r should not be greater than specified

t_d is the circuit recovery time and should be as short as possible.

5.13.3 Conditions to be prescribed in the Detail Specification

(1) **Peak reverse voltage.**
(2) **Peak on-state surge current.**
(3) Transformer requirements
(4) **Ambient, case or reference point temperature.**
(5) Frequency range of alternating sources
(6) **Maximum impedance of the reverse voltage source.**
(7) **The post test end point measurement limits.**
(8) Rise time t_r.

5.14 CRITICAL RATE OF RISE OF ON-STATE CURRENT dI/dt

5.14.1 Purpose

To prove the dI/dt rating of a SSR under specified conditions.

5.14.2 Procedure

Using the test circuit shown in FIG. 7 the voltage source is set to zero with care being taken to ensure that the capacitor C is fully discharged. The SSR is inserted into the test circuit and the temperature is set to the specified value.

The supply voltage is set to give a peak voltage equal to the specified peak off-state voltage V_{DM} as shown by voltmeter V when the capacitor C is fully charged.

Capacitor C is discharged through L and the SSR under test when the SSR is operated. The repetition rate is controlled by the control voltage source and shall be as specified. The voltage and current sources are reduced to zero and the SSR removed from the test circuit.

Proof of the ability of the SSR to meet the critical rate of rise of on-state current rating is obtained from the post test measurements.

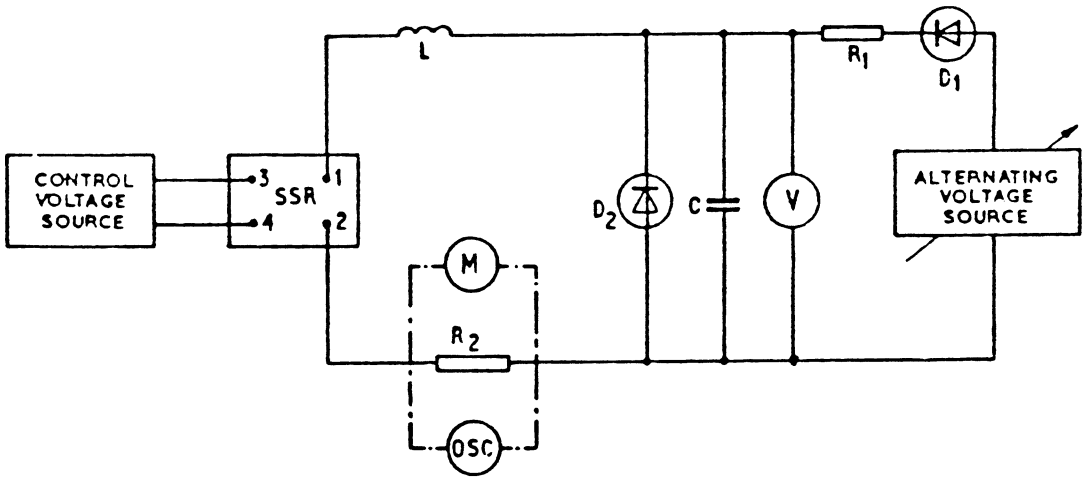


FIG. 7 : Test circuit for the critical rate of rise of on-state current.

V is a high resistance voltmeter.

R_1 and D_1 are chosen so that the capacitor C has time to charge fully between each repeated operation.

R_2 is a non-inductive current sensing resistor.

Meter M is a peak reading instrument.

Diode D_2 protects the SSR under test from excessive reverse voltage which might arise from resonance effects.

To obtain the required rate of rise of on-state current, C and L are chosen so that their values are approximately related to the test voltage, current magnitude and time t_1 as follows :

$$C = 1.9 \frac{t_1 I_{TM}}{V_{DM}} \quad \text{and} \quad L = 1.9 \frac{t_1 V_{DM}}{I_{TM}}$$

where V_{DM} = peak off-state voltage,

then $$\frac{dI}{dt} = 0.5 \frac{I_{TM}}{t_1}$$

where t_1 is the time taken for the current to reach the value $0.5\ I_{TM}$ (see FIG. 8) Final adjustments are made to L and C with the test terminals short-circuited and the source voltage set to the specified V_{DM} to ensure that the peak on-state current measured on meter M and the rate of rise of on-state current dI/dt measured on the oscilloscope are as specified.

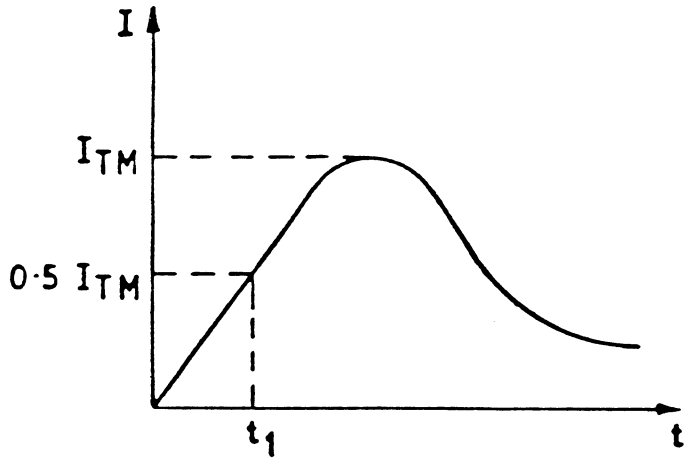


FIG. 8 : Rate of rise of on-state current

5.14.3 Conditions to be prescribed in the Detail Specification

(1) Rated rate of rise of on-state current.
(2) Peak off-state voltage
(3) Peak on-state current
(4) Case or reference point temperature before test
(5) Repetition rate (if required)
(6) Control voltage source characteristics
(7) The post test end point measurement limits

5.15 CRITICAL RATE OF RISE OF COMMUTATING VOLTAGE dv/dt

5.15.1 Purpose

To prove the critical rate of rise of commutating voltage of a SSR under high rate of decay of on-state current.

5.15.2 Procedure

The test circuit in FIG. 9 shall be used and the voltage sources set to zero. The SSR is inserted into the test circuit and the temperature is set to the specified value.

The peak on-state current I_{TM} is set to the specified value by adjustment of voltage V_{ac}. The peak off-state voltage, V_{DM}, is set to the specified value by means of voltage V_2 and when the rise of voltage is to be linear, by means of voltage V_1.

The current waveform through the SSR is examined on the oscilloscope across resistor R4 and the slope, di/dt (see FIG. 10) is checked and adjusted if necessary by means of inductor L_2 to the specified value.

The voltage waveform across the SSR is examined on the oscilloscope and the slope dV/dt (see FIG. 10) is checked and adjusted if necessary by means of capacitor C to the specified value. If the SSR withstands the applied V_{DM} without conducting in this direction, the rating is proved.

The voltage sources are reduced to zero and the SSR removed from the test circuit.

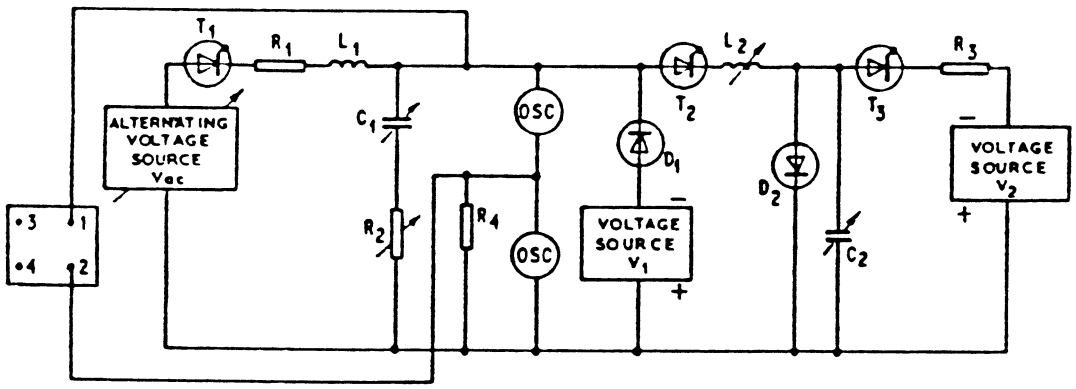


FIG. 9 : Test circuit for the critical rate of rise of commutating voltage

NOTE : Alternative on-state current sources may be used e.g. the alternating voltage sources V_{ac} may be applied by a capacitor charged from a power supply.

The on-state current I_T, measured on the oscilloscope across non-inductive current sensing resistor R_4, is supplied via thyristor T_1, resistor R_1 and inductor L_1 to the SSR under test from the alternating supply V_{ac}. (The inductor L_1 is chosen to ensure that the rated di/dt is not exceeded).

Thyristor T_1 is triggered at the same time as the SSR under test. The off-state voltage V_D is supplied from the voltage built up across the capacitor C_2 due to the triggering of thyristor T_3. Voltage V_D is applied to the SSR under test via inductor L_2 when thyristor T_2 is triggered. The on-state current is set by adjusting V_{ac}.

The rate of decay of on-state current, di/dt and the duration of the off-state voltage are dependant on the values of inductor L_2 and capacitor C_1, resistor R_2 and voltage V_2.

When a linear dV/dt is specified voltage V_1 clamps the peak off-state voltage V_{DM} to the specified value. Refer to FIG. 10 for the specification of the required linearity.

When an exponential dV/dt is specified voltage V_1 and diode D_1 shall be omitted and voltage V_2 set to the specified peak off-state voltage V_{DM}. Refer to FIG. 11 for specification of wave shape.

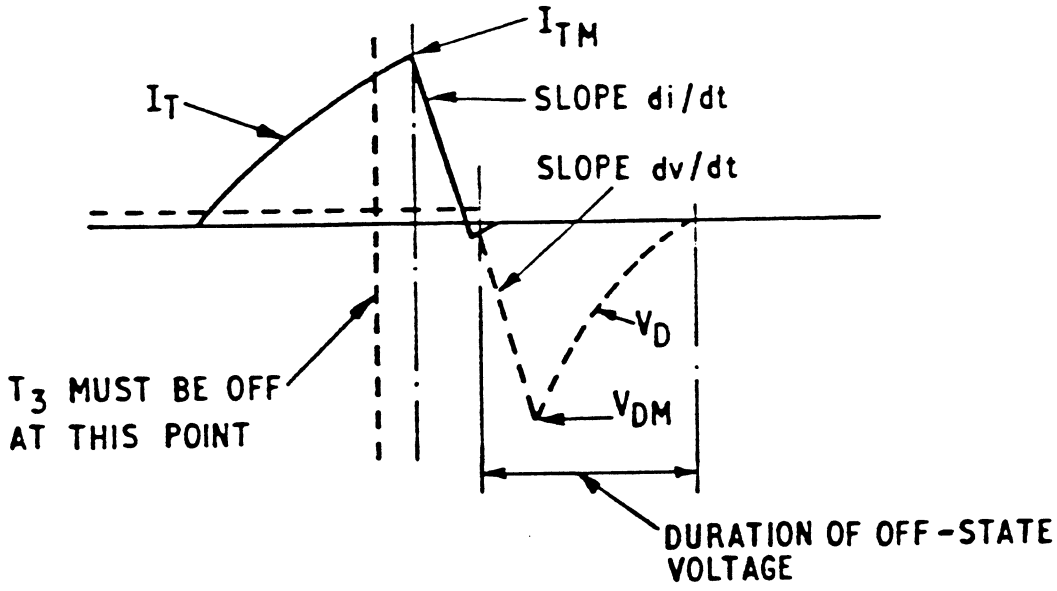


FIG. 10

5.15.2.1 **Precautions**

Care shall be taken to ensure that stray capacitance to earth due to heat sinks, etc. does not affect the validity of the test.

The duration of the on-state current and the repetition frequency should be low enough to ensure that the rise of junction temperature of the SSR under test is insignificant.

The duration of off-state voltage and on-state current should not be so short that the critical rate of rise of commutating voltage capability of the SSR under the test is influenced.

5.15.3 **Conditions to be prescribed in the Detail Specification**

(1) Critical rate of rise of commutating voltage.
(2) Peak on-state current.
(3) Rate of decay of on-state current.
(4) Peak off-state voltage
(5) Control circuit conditions (during rise of commutating voltage).
(6) Linear or exponential rise of commutating voltage.
(7) Ambient or reference point temperature.

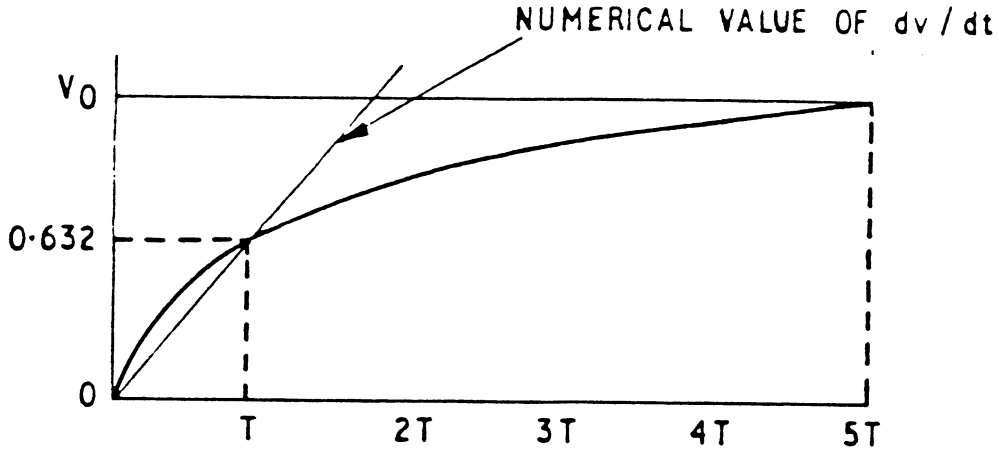


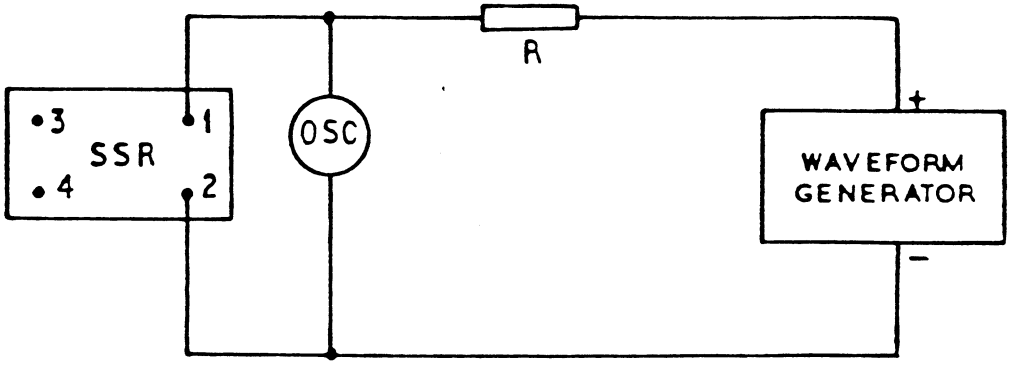
FIG. 11

5.16 CRITICAL RATE OF RISE OF OFF-STATE VOLTAGE dV/dt

5.16.1 Purpose

To prove the maximum rate of rise of off-state voltage rating under specified conditions.

5.16.2 Procedure



R. is a protective resistor.

FIG. 12 : Test circuit for the rate of rise of off-state voltage.

Method 1 (Linear Method)

The test circuit in FIG 12 shall be used with a linear voltage waveform generator to generate a repetitive voltage pulse as shown in FIG. 13 and the following conditions shall be met :

The instantaneous test voltage between 10% and 90% V_o shall not vary by more than 10% from the straight line connecting the 10% and 90% V_o points.

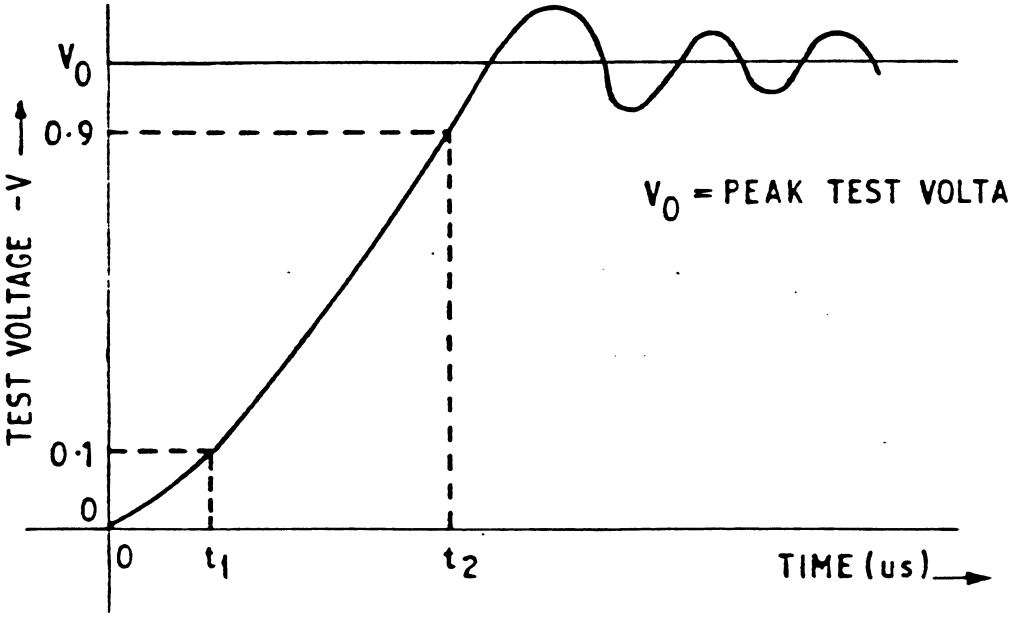


FIG. 13

The instantaneous slope of the test voltage between 10% and 90% V_o, shall not vary by more than $\pm$ 100% from the slope of the line connecting the 10% and 90% V_o points.

The slope of the straight line connecting the 5% and 10% V_o points shall not be less than 75% of the slope of the straight line connecting the 10% and 90% V_o points.

The peak of the test voltage overshoot shall not exceed 10% of V_o

The pulse width shall be at least five times the total pulse rise time.

With the voltage generator set to zero the SSR is inserted into the test circuit and the temperature set to the specified value.

The rate of rise of the voltage from the linear waveform generator is adjusted to the specified value.

The amplitude of the voltage from the linear waveform generator is increased to the specified value.

The voltage waveform across the SSR is examined on the oscilloscope. If the SSR remains in the off-state the rating is proven.

The voltage is reduced to zero and the SSR removed from the test circuit.

The test is repeated with connections 1 and 2 reversed.

Method 2 (Exponential method)

The test circuit in FIG. 12 shall be used with an exponential voltage waveform generator. The actual voltage across the SSR at the 0.1 T and 2.0 T points in FIG. 14 shall not differ from the theoretical values by more than 5% of the peak off-state voltage. The rate of rise of off-state voltage is :-

$$\frac{dV}{dt} = \frac{V_o}{T} \times 0.632 \text{ V/µs}$$

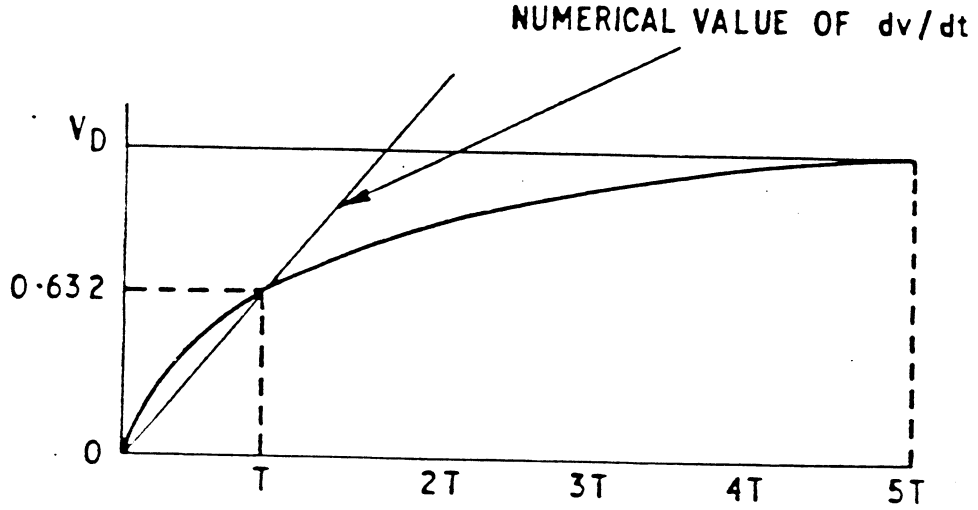


FIG. 14

With the voltage generator set to zero the SSR is inserted into the test circuit and the temperature set to the specified value.

The rate of rise control on the exponential waveform generator is adjusted for minimum rate of rise.

The amplitude of the exponential waveform generator output is adjusted to the specified value.

The voltage waveform across the SSR is examined on the oscilloscope and the rate of rise control is adjusted so that the measured value of dV/dt is equal to the specified value. If the SSR remains in the off-state the rating is proven.

The voltage is reduced to zero and the SSR removed from the test circuits. The test is then repeated with connections 1 and 2 reversed.

5.16.3 **Conditions to be prescribed in the Detail Specification**

(1) Method
(2) Rated rate of rise of voltage dV/dt
(3) Peak off-state voltage
(4) Ambient, case or reference point temperature before test.

5.17 OFF-STATE CURRENT I_D

5.17.1 Purpose

To measure the off-state leakage current of a SSR under specified conditions.

5.17.2 Procedure

The test circuit in FIG. 15 shall be be used and the voltage source set to zero.

The SSR is inserted into the test circuit and the temperature is set to the specified value.

With switch S closed the off-state voltage across the SSR as measured on voltmeter V is increased to the specified value.

With switch S open the off-state current through the SSR under test is measured on ammeter A.

The voltage source is reduced to zero and the SSR removed from the test circuit.

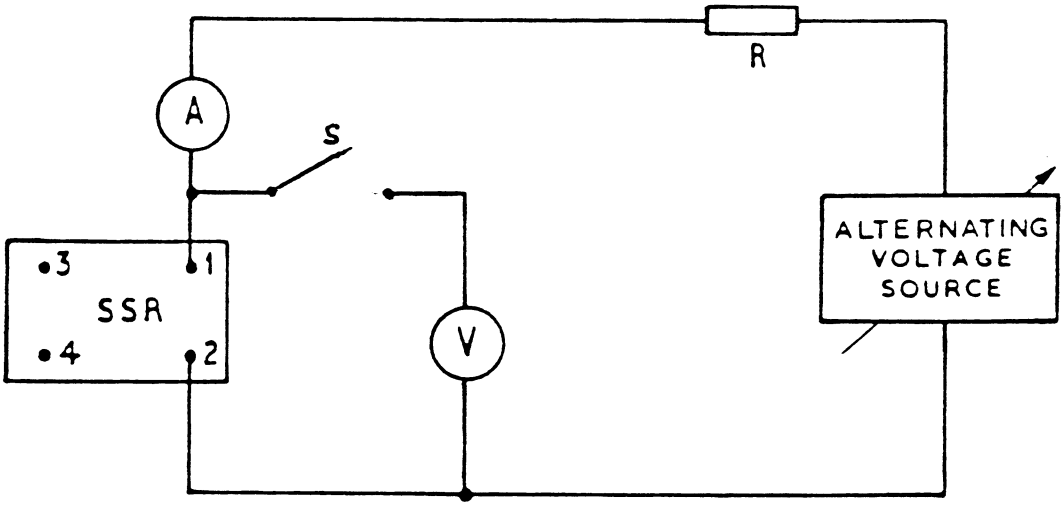


FIG. 15 : Test circuit for off-state current

Resistor R is a protective resistor. Ammeter A and voltmeter V for a.c. relays are r.m.s reading instruments.

5.17.3 Conditions to be prescribed in the Detail Specification :-

(1) Off-state voltage r.m.s.
(2) Frequency range of alternating voltage
(3) Ambient, case or reference point temperature before test.

5.18 REPETITIVE PEAK OFF-STATE VOLTAGE V_{DRM}

5.18.1 Purpose

To prove the repetitive peak off-state voltage rating of a SSR under specified conditions.

5.18.2 Procedure

The test circuit in FIG. 16 shall be used and the alternating voltage source set to zero.

The SSR is inserted into the test circuit and the temperature is set to the specified value.

The switch S is opened and the peak off-state voltage, measured on voltmeter V, is increased to the specified value.

The specified repetitive peak off-state voltage is applied to the SSR under test by closing switch S for not less than 3 s and not more than 5 s.

If the SSR remains in the off-state, the rating is proven.

The peak off-state voltage is reduced to zero and the SSR removed from the test circuit.

The test is repeated with connections 1 and 2 reversed.

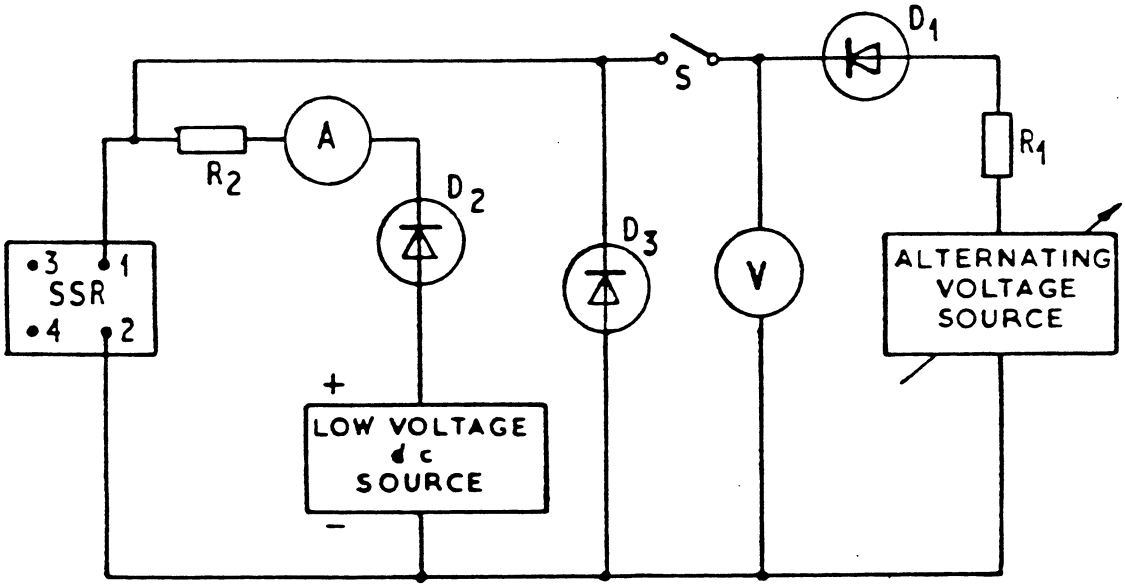


FIG. 16 : Test circuit for repetitive peak off-state voltage

Voltmeter V is a peak reading voltmeter or oscilloscope.

Resistors R_1 and R_2 are limiting resistors.

Switch S is an electromechanical or electronic switch which closes during the reverse half cycle and applies the off-state voltage to the SSR under test in such a way that the critical rate of rise of off-state voltage is not exceeded.

The low voltage d.c. source, limiting resistor R_2, ammeter A and diode D_2 are used to verify that the breakover point has not been reached and the SSR is not in the on-state condition.

Diode D_1 is to ensure the correct polarity to the SSR.
Diode D_2 is used to block the low voltage d.c. source.

Diode D_3 is used to prevent reverse voltage being applied to the SSR under test.

5.18.3 **Conditions to be prescribed in the Detail Specification**

(1) Repetitive peak off-state voltage
(2) Ambient, case or reference point temperature before test
(3) Frequency range of alternating source
(4) Maximum impedance of alternating source.

5.19 NON-REPETITIVE PEAK OFF-STATE VOLTAGE V_{DSM}

5.19.1 Purpose

To prove non-repetitive peak off-state voltage rating of a SSR under specified conditions.

5.19.2 Procedure

The test circuit in FIG. 17 shall be used and the alternating voltage source set to zero.

The SSR is inserted into the test circuit and the temperature is set to the specified value.

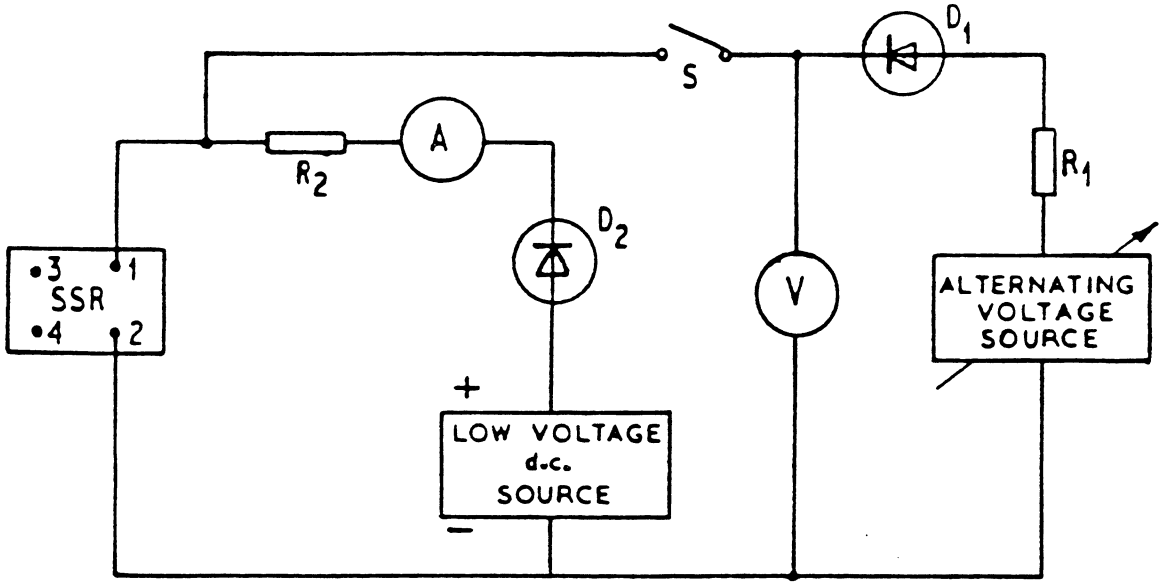
The switch S is opened and the peak off-state voltage measured on voltmeter V, is increased to the specified value.

The specified non-repetitive peak off-state voltage is applied to the SSR under test by closing switch S for approximately 180° during a forward half cycle.

If the SSR remains in the off-state, the rating is proven.

The peak off-state voltage is reduced to zero and the SSR removed from the test circuit.

The test is repeated with connections 1 and 2 reversed.



Voltmeter V is a peak reading voltmeter or oscilloscope.

Resistors R_1 and R_2 are limiting resistors.

Switch S is an electromechanical or electronic switch with a conduction angle of approximately 180°, which applies the a.c. source voltage to the SSR under test for one half cycle in the off-state direction.

The low voltage d.c. source limiting resistor R_2, ammeter A and diode D_2 are used to verify that the breakdown point has not been reached and the SSR is not in the on-state condition.
Diode D_1 is to ensure the correct polarity to the SSR.
Diode D_2 is used to block the low voltage d.c. source.

5.19.3 **Conditions to be prescribed in the Detail Specification**

(1) Non-repetitive peak off-state voltage
(2) Ambient, case or reference point temperature before test
(3) Frequency of alternating source.

5.20 INPUT CIRCUIT RESISTANCE

5.20.1 **Purpose**

To ensure that the input circuit resistance is within the specified limits.
This test is mainly required for those types of solid state relay using a coil in the input circuit.

5.20.2 **Procedure**

The temperature shall be set to the specified value for a specified period of time. The output of the SSR shall remain open circuit during these tests. If other components, e.g. a diode are connected internally in the input circuit, full details including any modification to the test procedure shall be given in the detail specification. The input circuit resistance shall then be measured.

5.20.3 **Conditions to be prescribed in the Detail Specification :-**

(1) Input circuit resistance limits
(2) Test voltage
(3) Ambient, case or reference temperature before test
(4) Time at prescribed temperature before measurements are made.
(5) Type and polarity of any components in series with the input coil together with any modification necessary to the above procedure.

5.21 DIELECTRIC TEST

5.21.1 Procedure

The input terminals shall be electrically connected and similarly the output terminals shall be electrically connected. The test shall be carried out in accordance with the dielectric test of IEC 255-5 (Clause 6) except that the test voltages shall be as prescribed in the detail specification.
The test voltage shall be applied between :

- the input and output terminals
- the input terminals connected together and all other specified exposed conducting parts
- The output terminals connected together and all other specified exposed conducting parts.

5.21.2 Conditions to be prescribed in the Detail Specification :

(1) Voltage between input and output
(2) Voltage between input and output and specified conductive parts
(3) Duration of test 1 s or 1 min
(4) Maximum leakage current

5.22 INSULATION RESISTANCE

5.22.1 Procedure

This test shall be carried out in accordance with the insulation resistance measurement procedure of IEC 255-5 (Clause 7) execpt that the terminals concerned, and the time to steady-state reading, if required, shall be those prescribed in the detail specification, and that the measurment voltage shall be 500 V unless otherwise prescribed in the detail specification.

5.22.2 Conditions to be prescribed in the Detail Specification

(1) Measurement voltage (if other than 50 V)
(2) Minimum value of insulation resistance
(3) Conductive parts

5.23 CLIMATIC SEQUENCE

5.23.1 Purpose

To determine the ability of the solid state relay to withstand a sequence of climatic test conditions.

5.23.2 **Procedure**

The sequence shall be performed in the order of the following tests and shall not have an interval of more than 3 days between any of these tests, except between damp heat, cyclic, first cycle and dry cold.

5.23.3 Dry Heat

5.23.3.1 This test shall be carried out in accordance with Test Ba test duration 16 h or, if in relation to the test facilities the relay is to be considered as an appreciably heat dissipating specimen, Test Bc of IEC 68-2-2.

5.23.4 **Damp Heat, Cyclic, First Cycle**

5.23.4.1 This test shall be carried out when prescribed in the detail specification.

5.23.4.2 This test shall be carried out in accordance with Test Db variant 2 of IEC 68-2-30 for one cycle of 24 h, with the exception that the periodic variation in temperature shall be omitted.

5.23.4.3 Upon completion of the cycle, the relay shall be removed from the chamber, and exposed to the recovery conditions prescribed in the detail specification.

5.23.4.4 After recovery, the relay shall be immediately subjected to the cold test.

5.23.5 **Cold**

5.23.5.1 This test shall be carried out :

- for sealed relays : in accordance with Test Aa
- for unsealed relays : in accordance with Test Ab

of IEC Publication 68-2-1. The test duration shall be 2 h.

5.23.6 **Low Air Pressure**

5.23.6.1 This test shall be carried out in accordance with Test M of IEC 68-2-13, and if prescribed in the detail specification.

5.23.6.2 At the end of the test period, and while still under low pressure, a dielectric test voltage as prescribed in the detail specification shall be applied between :

(1) The input and output terminals
(2) All specified conducting parts

5.23.6.3 During the dielectric test, there shall be no flashover or breakdown of the insulation of the relay.

5.23.7 **Damp Heat, Cyclic, all or Remaining Cycles**

5.23.7.1 This test shall be carried out when prescribed in the detail specification.

5.23.7.2 This test shall be carried out in accordance with Test Db variant 2 of IEC 68-2-30 with the exception that the periodic variation of temperature shall be omitted. The number of cycles shall be in accordance with the detail specification.

5.23.7.3 Upon completion of the cycles, the relay shall be removed from the chamber and exposed to the recovery conditions prescribed in the detail specification.

5.23.8 **Intermediate Measurements**

Intermediate measurements, if required, shall be made as prescribed in the detail specification.

5.23.9 **Final Measurement**

5.23.9.1 After recovery of not less than one hour and not more than two hours, the relay shall be visually examined in accordance with 5.6. There shall be no evidence of corrosion, peeling or chipping, or of mechanical deterioration that could impair operation.

5.23.9.2 Insulation resistance shall be measured in accordance with 5.22. Degradation shall be permitted to the extent prescribed by the detail specification.

5.23.9.3 Other final measurements, if required, as prescribed in the detail specification.

5.23.9.4 **Conditions to be prescribed in the detail specification**

(1) Degree of severity of the climatic conditions and recovery conditions.
(2) Specification of the functional test after dry heat exposure.
(3) Whether or not the test damp heat, cyclic, first cycle is required.
(4) For the cold test whether method Aa or Ab.
(5) Whether or not the low pressure exposure is required
(6) Value of the test voltage during low pressure exposure
(7) Whether or not test damp heat, cyclic, all remaining cycles is required.
(8) Permitted degradation in insulation resistance
(9) Mechanical deterioration to be checked
(10) Other final measurements, if required

5.24 **DAMP HEAT, STEADY STATE**

5.24.1 **Purpose**

To assess the suitablity of the relay use and/or storage under conditions of high relative humidity.

Procedure

This test shall be carried out in accordance with Test Ca of IEC 68-2-3 using the appropriate degree of severity as prescribed by the detail specification.

5.24.2 **Conditions to be prescribed in the Detail Specification :**

(1) Duration of the exposure and recovery conditions
(2) Loading during conditioning
(3) Final measurements

- Visual inspection as specified in 5.6. There shall be no evidence of corrosion, peeling or chipping or of mechanical deterioration that could impair operation.
- Insulation resistance as specified in 5.22, and the extent of degradation permitted.
- Dielectric voltage as specified in 5.21
- Permissible changes in functional characteristics
- Other final measurements, if required.

5.25 **RAPID CHANGE OF TEMPERATURE**

5.25.1 **Purpose**

To determine the ability of the relay to withstand rapid changes of air temperature.

5.25.2 **Procedure**

Method 1 The test shall be carried out in accordance with Test Na of IEC 68-2-14.

Method 2 The test shall be carried out in accordance with Test Nc of IEC 68-2-14.

5.25.3 **Conditions to be prescribed in the Detail Specification :**

(1) Method 1 or 2
(2) Temperature extremes and duration
(3) Final measurements
- Visual inspection as specified in 5.6
  There shall be no evidence of corrosion, peeling and chipping nor of mechanical deterioration that could impair operation.
- Insulation resistance as specified in 5.22
- Other final measurements, if required.

5.26 ACCELERATED THERMAL CYCLING

5.26.1 **Purpose**

To assess the effect of thermally induced stresses due to heating and cooling of the SSR.

5.26.2 Procedure

The temperature of the SSR shall be raised so that its chip is at its maximum working temperature by the self heating effect of the specified load current. The heating time shall be 10 minutes unless otherwise specified in the detail specifiction.

The load conditions shall then be removed and the SSR cooled to a temperature less than 40°C which may be acheived by forced cooling if required. The cooling time shall be 20 minutes unless otherwise specified in the detail specification.

When the low temperature has been reached the SSR is again put under load and the cycle repeated.

The number of temperature cycles shall be a minimum of 1000 unless otherwise specified in the detail specification.

The SSR shall be monitored at intervals throughout the test and after the final cycle for short circuit, open circuit and V_{DRM}

5.26. **Conditions to be prescribed in the detail specification**

(1) Load voltage and current
(2) Maximum working temperature
(3) Minimum temperature
(4) Heating and cooling times
(5) Number of cycles

5.27 ENCLOSURE

5.27.1 Purpose

To determine the effectiveness of relay enclosure. It may determine the effectiveness of either the sealing or the protection against sand and dust.

5.27.2 Sealing

5.27.2.1 Procedure

Method 1 This test shall be carried out in accordance with the procedures of Test Qc, method 2, of IEC 68-2-17.

Method 2 This test shall be carried out in accordance with the procedures of Test Qk of IEC 68-2-17. Where method 2 is used, it shall be preceded and followed by method 1 if so prescribed in the detail specification.

If the time interval between sealing and testing has been more than 48 h the relay shall be exposed to an atmosphere of helium at high pressure.

The difference pressure and the duration of exposure shall be as prescribed in the detail specification.

After the exposure, the absorbed helium shall be cleaned from the surface as prescribed in the detail specification.

Method 3 For relay capsules a krypton detection method is acceptable (see IEC 147-5).

Method 4 This test shall be carried out in accordance with the procedures of Test Qf of IEC 68-2-17.

5.27.2.2 Conditions to be prescribed in the Detail Specification

(1) Method or sequence of methods
(2) Method 2 : Permitted leakage rate, chosen from one of the following :

10^{-6}, 10^{-7}, or 10^{-8} mbar. l/s

(3) Pressurizing and cleaning procedures
(4) Method 3 : Details of method and limits
(5) Method 4 : Pressure difference and duration
(6) Free volume inside relay

5.27.3 **Sand and Dust**

5.27.3.1 **Procedure**

This test, which applies only to enclosed relays and non-hermetically sealed relays, shall be carried out in accordance with IEC 144.

5.27.3.2 **Condition to be prescribed in the detail specification.**

(1) First characteristic, numeral, to be chosen from 1 to 4.

5.28 **CORROSIVE ATMOSPHERES**

5.28.1 **Salt Mist**

5.28.1.1 This test is only applicable to those relays to which the Methods 2 and 3 of 5.27.2 are applicable.

5.28.1.2 **Purpose**

To assess the suitability of the relay for use and/or storage in a salt-laden atmosphere.

5.28.1.3 **Procedure**

The test shall be carried out in accordance with Test Ka of IEC 68-2-11. Upon completion of the exposure period, the relay shall be removed from the chamber and exposed to the recovery conditions prescribed in the detail specification.

5.28.2 **Other Corrosive Atmospheres**

No requirements at present.

5.29 **MOULD GROWTH**

5.29.1 **Purpose**

To assess the extent of mould growth on a relay, or the effect of mould growth on the function of a relay.

5.29.2 **Procedures**

The test shall be carried out in accordance with Test J of IEC 68-2-10, and - regarding test duration, initial measurements and final examination - as prescribed in the detail specification.

5.29.3 **Conditions to be prescribed in the Detail Specification :**

(1) All details following letters 'a' to 'g' of Clause 8 of IEC 68-2-10

5.30 ROBUSTNESS OF TERMINALS

5.30.1 Purpose

To determine the ability of terminals to withstand direct axial pulls, bending or twisting, and nuts and threaded terminals to withstand torques likely to be experienced during normal assembly operations.

5.30.2 **Procedure**

Terminals shall be subjected to test Ua_1, Ua_2, Uc or Ud of IEC 68-2-21 as appropriate.

5.30.3 **Conditions to be prescribed in the Detail Specification :**

(1) Tests Ua_1, Ua_2, Uc or Ud and corresponding loads
(2) Final Measurements :

- Visual inspection as specified in 5.6
- Input circuit resistance, as specified in 5.20
- Output circuit
- Other final measurements if required

5.31 SOLDERING

5.31.1 This test is only applicable to relays with solder terminals.

5.31.2 **Purpose**

To determine the ability of relay terminals to wet easily with solder, and/or the ability of the relay to withstand soldering heat.

5.31.3 **Procedure**

Prior to the tests, printed wiring terminals shall be fitted with a 1,5 $\pm$ 0,5 mm thick thermal screen, and shall be immersed no further than the underside of that screen.

Test 1 : Solderability. The test shall be conducted in accordance with the procedures for solderability described in method 1, 2, or 3 of Test Ta of IEC 68-2-20, as prescribed in the detail specification.

Test 2 : Resistance to soldering heat. The test shall be conducted in accordance with one of the procedures for resistance to soldering heat of Test Tb of IEC 68-2-20, as prescribed in the detail specification.

5.31.4 **Conditions to be prescribed in the Detail Specification** :

(1) Test 1 or 2 (or both), and methods in either of them
(2) Test 1 : Ageing procedures if required
(3) Final measurements :
- Visual inspection as specified in 5.6 for Test 1 extended by examination of the solder wetting
- Input circuit resistance as specified in 5.20
- Other final measurements, if required

5.32 SHOCK

5.32.1 Purpose

To prove the capability of the relay to function during and/or after non-repetitive shocks, encountered in service or during transportation.

5.32.2 Procedure

The test shall be conducted in accordance with Test Ea of IEC 68-2-27.

5.32.2.1 **Method 1** Capability to function during shocks. During this test, the relay shall be subjected to one series of shocks while being in its operate condition and one further series whilst being in its release condition. Both series of tests shall be performed in both directions of each of the three mutually prependicular axes.

During the test, there shall be no false operating or releasing of the relay.

5.32.2.2 **Method 2** Capability to function after shocks. During this test, the relay shall be subjected to a series of shocks in both directions of each of the three mutually perpendicular axes. The relay shall not be energized, or monitored.

5.32.2.3 Immediately following the shock test (Method 1 or 2), the relay shall be operated ten times with the rated control signal and output values applied to the input and output terminals.

5.32.3 **Conditions to be prescribed in the Detail Specification :**

(1) Method 1 or 2
(2) Pulse shape and peak acceleration
(3) Method of mounting
(4) Final measurements :
- Visual inspection as specified in 5.6
- Permissible changes in functional characteristics
- Other final measurements, if required

5.33 **BUMP**

5.33.1 **Purpose**

To prove the capability of the relay to function during and/or after repetitive bumps encountered in service or during transportation.

5.33.2 **Procedure**

The test shall be conducted in accordance with Test Eb of IEC 68-2-29, at a peak acceleration as stated in the detail specification.

5.33.2.1 **Method 1** Capability to function during bumps. During this test, the relay shall be subjected to one half of the total number of bumps while being in its operate condition and the other half of the total number of bumps while being in its release condition. Both series of tests shall be performed in both directions of each of the three mutually perpendicular axes.

During this test, there shall be no false operating or releasing of the relay.

5.33.2.2 **Method 2** Capability to function after bumps. During this test, the relay shall be subjected to the required number of bumps in each direction of the mutually perpendicular axes. The relay shall not be energized, or monitored.

5.33.2.3 Immediately following the bump test (Method 1 or 2), the relay shall be operated ten times with the rated control signal and output values applied to the input and output terminals.

5.33.3 **Conditions to be prescribed in the Detail Specification :**

(1) Method 1 or 2
(2) Peak acceleration and number of bumps
(3) Method of mounting
(4) Final measurements :
- Visual inspection as specified in 5.6
- Permissible changes in functional characteristics
- Other final measurements, if required

5.34 VIBRATION

5.34.1 Purpose

To prove the capability of the relay to withstand conditions of vibration.

5.34.2 Procedure

This test shall be carried out in accordance with Procedure A of Test Fc of IEC 68-2-6, unless another procedure of IEC 68 is prescribed in the detail specification.

During vibration the relay shall be alternatley in its operate condition and in its release condition, the change in condition being synchronized with the completion of each vibration sweep cycle.

During this test, care shall be taken to make sure that the stray field of the vibration generator does not affect the relay.

During the vibration test there shall be no false operating or releasing of the relay.

The relay shall be subjected to vibration in each of three mutually perpendicular axes unless otherwise prescribed in the detail specification.

Immediately following the vibration test, the relay shall be operated ten times with the rated control signal and output values applied to the input and output terminals.

5.34.3 Conditions to be prescribed in the Detail Specification :

(1) Amplitude or acceleration level, duration and frequency range.
(2) Method of mounting.
(3) Final measurements :
- Visual inspection, as specified in 5.6
- Insulation resistance as specified in 5.22
- Permissible changes in functional characteristics.
- Other final measurements, if required

(4) Procedure, if other than Test Fc of IEC 68, and required details.

5.35 ACCELERATION

5.35.1 Purpose

To prove the capability of the relay to function during and/or after being subjected to forces produced by steady acceleration environments (such as moving vehicles, aircraft and projectiles).

5.35.2 **Procedure**

This test shall be carried out in accordance with Test Ga of IEC 68-2-7.

5.35.2.1 **Method 1** Capability to function during acceleration. During this test the relay shall be in its operate condition for 50% of the time of exposure. During the remaining 50% of exposure, the relay shall be in its release condition. Both exposures shall be performed in both directions of each of the three mutually perpendicular axes.

5.35.2.3 Immediately following the acceleration test (Method 1 or 2), the relay shall be operated ten times with the rated control signal and output values applied to the input and output terminals.

5.35.3 **Conditions to be prescribed in the Detail Specification :**

(1) Method 1 or 2
(2) Acceleration and if required, duration
(3) Method of mounting
(4) Final measurements :
- Visual inspection as specificed 5.6
- Permissible changes in function characteristics
- Other final measurements, if required

5.36 **ELECTRICAL ENDURANCE**

5.36.1 **Purpose**

To check the electrical endurance of a SSR under specified conditions

5.36.2 **Procedure**

Pre-tests

The SSR shall be functionally tested as prescribed in the detail specification.

Endurance Test

The test circuit in FIG. 18 shall be used and the two sources set to zero. The SSR is inserted into the test circuit and the temperature set to the specified value. The control voltage and then the supply voltage source are set to the specified values for setting up the endurance test levels.

The control voltage is then energised as prescribed in the detail specification for the specified period of time. At the end of this period the sources are reduced to zero and the SSR removed.

Post Tests

The SSR shall be functionally tested as prescribed in the detail specification.

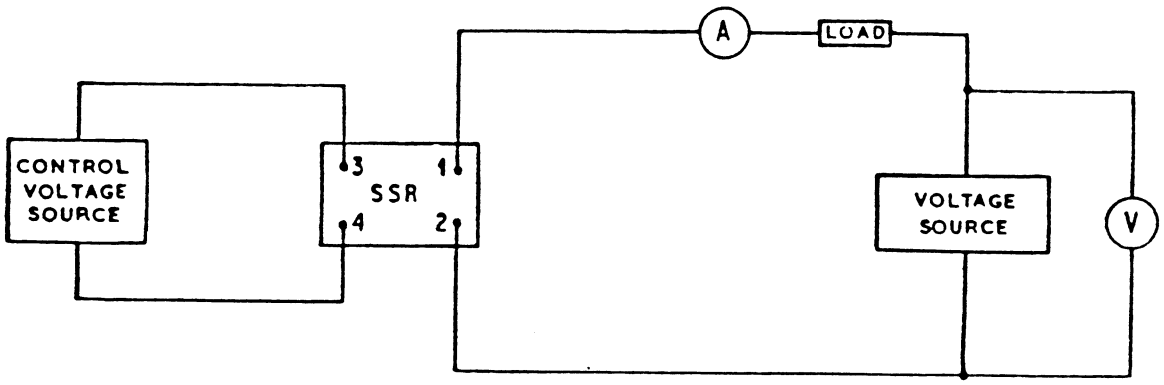


FIG. 18 : Test circuit for electrical endurance

Ammeter A and voltmeter V for a.c. relays are r.m.s reading instruments.

5.36.3 **Conditions to be prescribed in the Detail Specification** :

(1) Pre and Post tests and maximum permissible changes in values.
(2) Endurance test specified temperature value
(3) Control voltage value for setting up test levels
(4) Control voltage during endurance test including duty cycle and frequency if applicable.
(5) Supply voltage source value, and frequency when a.c. for setting up the endurance test.
(6) Length of endurance test in time or number of operations.
(7) Load value if other than rated load.

5.37 **THERMAL ENDURANCE**

5.37.1 **Purpose**

To assess the effect of high temperature conditions on the relay when energized.

5.37.2 **Procedure**

The test shall be carried out at the upper value of the operating temperature range with the relay energized as prescribed in the detail specification.

Method 1 For long term endurance the duration period shall be 1000 h.

Method 2 For short term endurance the duration period shall be a minimum of 24 h or as otherwise prescribed in the detail specification.

5.37.3 **Conditions to be prescribed in the Detail Specification :**

(1) Method 1 or 2
(2) Method of mounting
(3) Thermal resistance of heat sink if applicable
(4) Duration
(5) Ambient temperature
(6) Load current
(7) Final measurements :
- Insulation resistance as specified in 5.22
- Functional tests as required
- Other final measurements

5.38 VOLTAGE BLOCKING

5.38.1 **Purpose**

To prove the voltage blocking rating of the SSR under specified conditions.

5.38.2 **Procedure**

With the control circuit open circuit the maximum load voltage is applied to the output terminals of the SSR with a monitoring device connected in series which will indicate if the on-state is reached.

The temperature of the device shall be raised to 80°C and maintained for 1000 h.

Failure of the SSR is indicated by the monitoring device if the SSR switches to the on-state.

5.38.3 **Conditions to be prescribed in the detail specification**

1) Maximum load voltage
2) Ambient, case or reference point temperature
3) Frequency of the alternating source

5.39 **RESISTANCE TO SOLVENTS**

5.39.1 **Purpose**

To ensure that the relay is suitable for use and that its markings remain legible when immersed in solvents.

5.39.2 **Procedure**

The test shall be conducted in accordance with Method 1 or 2 of Test XA of IEC 68-2-45. The relay shall be immersed in a solvent at a stated temperature as specified in the detail specification.

One or both of the following solvents may be used.

(1) A mixture of 1,1,2-trichlorotrifluoroethane, 70 ± 5% by weight and 2-propanol (isopropylalcohol), 30 ± 5% by weight.
(2) Demineralized or distilled water with 2% by weight of an industrial use detergent added.

The solvent shall not be agitated during the test.

5.39.3 **Conditions to be prescribed in the Detail Speification :-**

(1) Solvent(s) to be used
(2) Solvent temperature :
for mixture a) : 23 ± 5°C or 48.6°C to 50.5°C
for mixture b) : 55 ± 5°C
(3) Method 1 or 2, and rubbing material for Method 1
(4) Recovery time before final measurements, if required
(5) Final measurements :
- Visual inspection of the marking as specified in 5.6
- Insulation resistance as specified in 5.22
- Functional tests as required.

5.40 **FIRE HAZARD**

5.40.1 **Purpose**

To ensure that the relay will not cause propagation of fire and spread of flame within determined limits when overloaded or subjected to external ignition.

5.40.2 **Procedure**

The test shall be conducted in accordance with IEC 695-2-1 or 695-2-2. The conditions of the test and the criteria of failure shall be as specified in the detail specification.

5.40.3 **Conditions to be prescribed in the Detail Specification :**

(1) Test from IEC 695-2-1 or from IEC 695-2-2.
(2) All conditions following letters a) to h) of these publications.
(3) Final measurements : As required.

5.41 **RADIO FREQUENCY INTERFERENCE**

under consideration (incoming and outgoing)

Publication(s) referred to

See national foreword.

Issue 2, October 1997

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