INTERNATIONAL STANDARD

ISO 5867-1

First edition
1996-02-01

Aircraft — Electromagnetic relays and contactors —

Part 1:
General requirements

Aéronefs — Relais et contacteurs électromagnétiques —

Partie 1. Exigences générales

Reference number
ISO 5867-1:1996(E)

Contents

International Organization for Standardization
Case Postale 56 • CH-1211 Genève 20 • Switzerland

Printed in Switzerland

Annexes

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 5867-1 was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 1, *Aerospace electrical requirements*.

ISO 5867 consists of the following parts, under the general title *Aircraft — Electromagnetic relays and contactors*:

— *Part 1: General requirements*

Annexes A and B of this part of ISO 5867 are for information only.

Aircraft — Electromagnetic relays and contactors —

Part 1:
General requirements

1 Scope

This part of ISO 5867 specifies the performance requirements for electromagnetic relays and contactors for use in nominal 28 V d.c. or 115 V/200 V 3-phase, 400 Hz, a.c. systems having the characteristics specified in ISO 1540.

This part of ISO 5867 specifies the performance requirements for relays and contactors having nominal contact ratings of 5 A a.c., 5 A d c. or greater. Auxiliary contacts, where applicable, may be rated at lower currents. Three temperature classes and three classes of sealing are specified.

This part of ISO 5867 is applicable to single-pole and multi-pole relays and contactors, electromagnetically operated and magnetically held, or electromagnetically operated and mechanically or magnetically latched, controlled by a voltage of 28 V d.c. or 115 V, 400 Hz, a.c.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 5867. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 5867 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 1540:1984, *Aerospace — Characteristics of aircraft electrical systems.*

ISO 7137:1995, *Aircraft — Environmental conditions and test procedures for airborne equipment.*

IEC 50 (446):1990, *International Electrotechnical Vocabulary — Chapter 446· Electrical relays.*

IEC 68-2-17:1994, *Basic environmental testing procedures — Part 2. Tests — Test Q· Sealing*

IEC 158-2:1982, *Low-voltage controlgear — Part 2 Semiconductor contacters (solid state contactors)*

3 Definitions

For the purposes of this part of ISO 5867, the definitions given in IEC 50 (446) and IEC 158-2 apply

4 General requirements

4.1 Detail specification sheets

The individual item requirements shall be as specified in this part of ISO 5867 and in accordance with the detail specification sheets related to this part of ISO 5867. In the event of any conflict between requirements of this part of ISO 5867 and the detail specification sheets, the latter shall govern.

The manufacturer shall prepare an individual specification sheet for each type of device produced. The individual specification sheet shall define the values for parameters given in annex A.

4.2 Temperature class

The temperature classes which define the maximum and minimum temperatures for use shall be as follows:

Class A: – 65 °C to + 125 °C
Class B: – 55 °C to + 85 °C
Class C: – 55 °C to + 70 °C

4.3 Sealing

Enclosure design shall be classified as follows:

Class 1: Hermetically sealed
Class 2: Environmentally sealed
Class 3: Ventilated enclosed

4.4 Altitudes

Class 1 and 2 sealed relays and contactors shall be suitable for use up to an altitude of 25 000 m.

Class 3 contactors shall be suitable for use up to an altitude of 15 000 m.

4.5 Dimensions

Relay and contactor dimensions shall be as defined in the detail specification sheet (see 4.1).

4.6 Design requirements

The relays and contactors shall operate satisfactorily when mounted in any attitude. The size and mass shall be the minimum compatible with the required performance, reliability and strength.

The relays and contactors shall be of the single-pole or multi-pole (main contacts) type, with or without auxiliary contacts.

The auxiliary contacts shall be mechanically linked to the main contacts and shall indicate the position of the main contacts.

Suitable barriers shall be placed between the terminals of the contactors in order to prevent an accidental short-circuit. These barriers shall be sufficient to prevent the short-circuiting of all the terminals through the presence of a flat conducting part.

The coil of the relay or contactor shall operate from either, but not both, a 28 V d.c. or 115 V a.c., 400 Hz system having the characteristics specified in ISO 1540.

The contacts of relays or contactors shall be capable of switching 28 V d.c. and/or 115 V/200 V a.c., 400 Hz having a system characteristic specified in ISO 1540.

4.7 Sealing enclosures

Sealing enclosures shall be of sufficient mechanical strength to withstand the normal abuse incurred in handling, transit, storage and installation without causing malfunction or distortion of parts. The case shall not be a part of the contact or coil electrical circuits.

NOTE 1 The case may be a part of the magnetic circuit

4.7.1 Hermetically sealed enclosures

Hermetically sealed enclosures shall be constructed as a gastight enclosure that has been completely sealed by fusion of glass or ceramic to metal, or bonding of metal to metal. Hermetically sealed relays and contactors shall be purged of all air. Relays shall be filled with a suitable inert gas. The fill gas shall have a dew point of at least 5 °C below the lowest temperature rating of the device.

NOTE 2 Contactors may be filled with air or with inert gas

4.7.2 Environmentally sealed enclosures

Environmentally sealed enclosures shall be constructed by any means other than that defined in 4.7.1 to achieve the degree of seal specified in the detail specification (see 4.1). Environmentally sealed relays and contactors shall be purged of all air. Relays shall be filled with a suitable inert gas. The fill gas shall have a dew point of at least 5 °C below the lowest temperature rating of the device.

NOTE 3 Contactors may be filled with air or with inert gas

4.7.3 Ventilated enclosures

Ventilated contactors shall be totally enclosed for mechanical and dust protection and shall be explosion-proof. The enclosure shall be so designed that when the cover is removed, the contactor shall be capable of operating without adjustment. The enclosure design shall be such that pressure differentials cannot exist between the inside and outside to aggravate the moisture accumulation problem The cover shall be rugged in design, constructed of high impact materials, and securely mounted to the contactor.

4.8 Installation clearances

Adequate clearance shall be provided for installation of terminals and mounting hardware. Clearance for standard socket wrenches shall be provided. Special installation tools shall be avoided where possible.

4.9 Grounding

The mounting shall provide an effective electrical contact to ground when the relay or contactor is mounted.

Table 1 — Strength of threaded terminals (static value of pull and torque)

Thread size	Force		Torque	
	N	lbf	N m	in lbf
No 4-40 UNC	22,2	5	0,497	4,4
No 6-32 UNC	133	30	1,13	10
No. 8-32 UNC	156	35	2,26	20
No 10-32 UNC	180	40	3,615	32
No 10-24 UNC	180	40	3,954	35
1/4-28 UNC	222	50	8,474	75
5/16-24 UNF	311	70	11,298	100
3/8-24 UNF	445	100	16,948	150
7/16-20 UNF	445	100	16,948	150
1/2-20 UNF	445	100	16,948	150

4.10 Terminals

Metal covers shall be provided with a means for grounding. Relays and contactors shall have electrical terminals as specified in the detail specification (see 4 1).

No rotation or other loosening of a terminal shall occur throughout the relay or contactor life.

4.10.1 Terminal type

Power terminals of greater than 25 A rating shall be of the threaded stud type. Terminals rated at 25 A or less may be plug-in, solder hook, stud or screw terminals.

4.10.1.1 Threaded terminals and mounting studs

Stud terminals shall accept connections using crimped type lugs made of copper or aluminium, or copper bars. A flat washer having a diameter at least equal to that of the base of the terminal, and a self-locking nut or standard nut with suitable locking washer shall be used on each terminal.

No rotation or other loosening of a terminal, or any fixed portion of a terminal, shall be caused by any mechanical forces specified in table 1 involved in the connection or disconnection, throughout the life of the relay or contactor.

These are maximum values which shall not be exceeded.

NOTE 4 For installation torque values, see the detail specification (4 1)

Each terminal shall have a terminal seat that shall provide the normal current-conducting path. The diameter of the seat shall not be less than the area necessary to ensure that the current density does not exceed $1,55 \times 10^6$ A/m² $(1\ 000$ A/in²$)$.

NOTE 5 The seat does not include the cross-sectional area of the stud

Stud terminals shall be capable of accommodating two lugs with hardware as specified. A minimum of one and a half threads shall remain above the nut with all parts tightened in place.

4.10.1.2 Solder hook or straight terminals

Solder terminals shall be tin plated. The terminal design shall allow for at least two wires of relay rating to be connected (see 4.1).

4.10.1.3 Plug-in terminals

Plug-in terminals shall conform to the arrangement and dimensions necessary for proper mating with the associated socket or connector.

For plug-in relays, the mounting arrangement of the relay and its corresponding socket shall be designed such that the entire weight of the relay shall be suspended and the stability of its mounting shall be provided by an auxiliary mounting means other than the electrical terminals of the socket. Relays with plug-in terminals shall have the electrical and environmental tests performed with the specified socket assembled to the unit. Plug-in terminals shall be gold plated

4.10.1.4 Screw terminals

Screw terminals shall be supplied with hardware as specified in the detail specification (see 4.1). The diameter of the seat shall be equal to, or greater than, the diameter across the corresponding lug designed for the particular current. It shall not be less than the area necessary to ensure that the current density does not exceed 1,55 × 10^6 A/m^2 (1 000 A/in^2).

NOTE 6 The seat area does not include the cross-sectional area of the stud.

4.10.2 Terminal marking

Terminal identification shall be durably and legibly marked as specified in tables 2 to 4. For dual coil relays, the relationship between coil and contacts shall be as specified in table 5. The positive end of the coil (XI) shall be designated on the header by use of a contrast bead.

Table 2 — Contact arrangements, symbols and terminal marking

	Single throw		Double throw	
	Form "A"	Form "B"	Form "C"	Form "K"
	normally open	normally closed	(two position)	three position centre off
Single break	A1 A2 B1 B2 C1 C2	A3 A2 B3 B2 C3 C2	A3 A1 A2 B3 B1 B2 C3 C1 C2	A1 A3 A2 B1 B3 B2 C1 C3 C2
	Form "X"	Form "Y"	Form "Z"	Form "KK"
Double break	A1 A2 B1 B2 C1 C2	A3 A4 B3 B4 C3 C4	A3 A4 A1 A2 B3 B4 B1 B2 C3 C4 C1 C2	A1 A2 A3 A4 B1 B2 B3 B4 C1 C2 C3 C4
NOTE — Contacts are shown with coil(s) de-energized				

Table 3 — Auxiliary terminals

Single throw		Double throw
Normally open	Normally closed	Change over
11 12 21 22 31 32	13 12 23 22 33 32	13 11 12 23 21 22 33 31 32
11 12 21 22 31 32	13 14 23 24 33 34	13 14 11 12 23 24 21 22 33 34 31 32

Table 4 — Symbols and marking for terminals

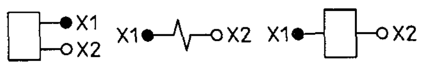
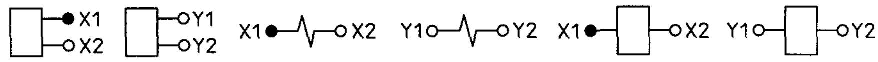
Single coil terminals	Dual coil terminals
	

Table 5 — Dual coil markings

Coil energized	Contacts closed	
	Load	Auxiliary
X1-X2	A1-A2 B1-B2 C1-C2	11-12 21-22 31-32
Y1-Y2	A3-A2 (or A3-A4) B3-B2 (or B3-B4) C3-C2 (or C3-C4)	13-12 23-22 33-32

4.10.3 Terminal covers and barriers

Relays and contactors with stud or screw terminals shall be provided with adequate covering, or separation, of terminal parts to provide protection against inadvertent shorting, grounding, or contact by personnel.

Terminal covers and barriers shall be designed to meet performance requirements applicable to the relay or contactor. The enclosure(s) shall be so designed that when the cover is removed, the relay or contactor shall be capable of operating without adjustment. The cover design shall be such that pressure differentials cannot exist between the inside and outside.

NOTE 7 Barriers may be removable, or may be integral with removable covers

4.11 Contact symbols

Contact arrangements, symbols and terminals marking shall be in accordance with tables 2 to 4.

4.12 Materials

The materials shall conform to requirements specified in 4.12.1 and 4.12.2 as applicable. When a definite material is not specified, the selection of material shall be at the discretion of the manufacturer. Materials selected shall be such that the relays or contactors meet the performance requirements and product characteristics specified in this part of ISO 5867.

4.12.1 Metals

Metals shall be of corrosion-resistant type and shall be plated or treated to resist corrosion. Zinc plating, cadmium plating or unfused pure tin plating shall not be used on internal parts of hermetically sealed relays and contactors.

Unless otherwise specified in the detail specification (see 4.1), the use of dissimilar metals shall conform to table 6.

4.12.2 Non-metals

Non-metals, including protective finishes, shall.

a) be moisture-resistant;

b) be non-toxic;

c) be arc-resistant;

d) be flame-resistant;

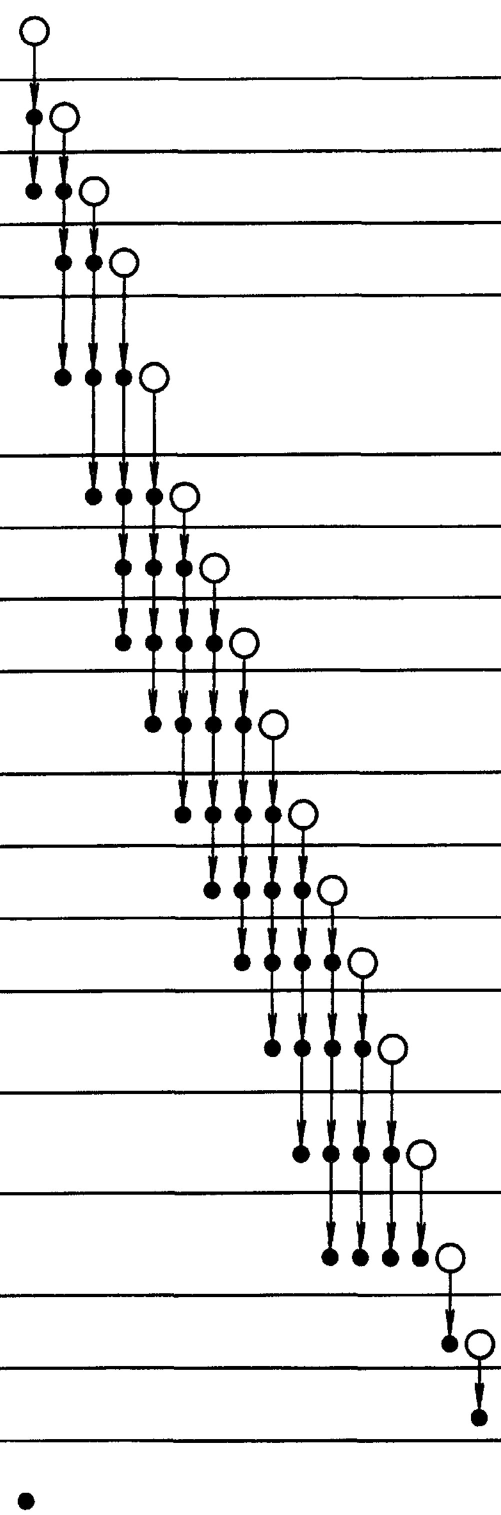
e) be self-extinguishing;

f) not support fungus growth.

They shall not be adversely affected by loss of characteristics of composition in aircraft fluids at the temperatures specified in 4.2.

Materials in hermetically sealed envelopes are not required to meet the moisture- and fungus-resistance requirements.

Table 6 — Dissimilar metals

Group No.	Metallurgical category	EMF V	Anodic index 0,01 V	Compatible couples[1)]
1	Gold, solid and plated; gold-platinum alloys; wrought platinum (most cathodic)	+ 0,15	0	
2	Rhodium plated on silver-plated copper	+ 0,05	10	
3	Silver, solid or plated; high silver alloys	0	15	
4	Nickel, solid or plated; Monel metal, high nickel-copper alloys	– 0,15	30	
5	Copper, solid or plated; low brasses or bronzes; silver sider; German silver; high copper-nickel alloys; nickel-chromium alloys; austenitic corrosion-resistant steels	– 0,20	35	
6	Commercial yellow brasses and bronzes	– 0,25	40	
7	High brasses and bronzes; naval brass; Muntz metal	– 0,30	45	
8	18 % chromium type corrosion-resistant steels	– 0,35	50	
9	Chromium, plated; tin, plated; 12 % chromium type corrosion-resistant steels	– 0,45	60	
10	Tin-plate; terne-plate; tin-lead solder	– 0,50	65	
11	Lead, solid or plated; high lead alloys	– 0,55	70	
12	Aluminium, wrought alloys of the Duralumin type	– 0,60	75	
13	Iron, wrought, gray, or malleable; plain carbon and low alloy steels, armco iron	– 0,70	85	
14	Aluminium, wrought alloys other than duralumin type; aluminium, cast alloys of the silicon type	– 0,75	90	
15	Aluminium, cast alloys other than silicon type; cadmium, plated and chromated	– 0,80	95	
16	Hot-dip-zinc plate; galvanized steel	– 1,05	120	
17	Zinc, wrought; zinc-base die-casting alloys; zinc, plated	– 1,10	125	
18	Magnesium and magnesium-base alloys, cast or wrought (most anodic)	– 1,60	175	

1) Compatible couples: potential difference of 0,25 V max. between groups.

4.12.2.1 Plastic material

Plastic material shall conform to 4.12.2. In addition, when subjected to any of the tests in this part of ISO 5867, the plastic material shall not:

a) support combustion;

b) give off noxious gases in harmful quantities;

c) give off any gases in quantities sufficient to cause explosion of a sealed housing;

d) give off any gases in a sealed housing that will·

1) cause contamination of the contacts or other parts of the component,

2) form current-carrying tracks when subjected to arcing conditions.

4.12.2.2 Ceramic

Ceramic insulating material shall conform to the detail specification (see 4.1 and 4.12 2). External ceramic surfaces shall be glazed.

4.12.2.3 Magnet wire

Magnet wire shall conform to the detail specification (see 4 1 and 4.12.2).

4.12.2.4 Rubber

Rubber shall conform to the detail specification (see 4 1 and 4.12.2)

4.12.2.5 Semiconductors

Semiconductors shall conform to the detail specification (see 4.1).

4.13 Qualification

Relays and contactors supplied in accordance with this part of ISO 5867 shall be products that have been tested and which have satisfied the qualification inspection specified in 7.2. The qualification inspection shall be performed on units produced from parts made by production tools.

NOTE 8 Relays and contactors supplied in accordance with this part of ISO 5867 may be qualified by similarity to other relays or contactors in their generic family The qualifying activity may require additional testing

5 Performance detail requirements

5.1 Examination of product

When relays or contactors are examined and tested in accordance with 6.1, they shall conform to requirements for materials, design, construction, physical dimension, weight, item marking and workmanship as specified in this part of ISO 5867 and in the detail specification (see 4 1).

5.1.1 Dimensions

Dimensions shall be in accordance with 4.5.

5.1.2 Header glass of hermetically sealed enclosures

Header glass or ceramic of relays and contactors shall be visually inspected for workmanship and finish using microscopic examination with × 10 magnification. All relays shall meet the applicable seal requirements, regardless of the acceptability of the header glass

NOTE 9 In case of dispute, the relay may be subjected to the applicable seal requirement or any test deemed appropriate in order to determine its integrity (see 6 1 2)

Header glass may have small irregularities, such as bubbles, chips, cracks, etc. The acceptability of these defects is based on the following (see figure 1)

a) broken or open blisters having sharp edges are not acceptable;

b) blisters whose diameters exceed one-third of the radial distance between the terminal and the corresponding header metal (for a cluster of blisters the combined diameters apply) are not acceptable;

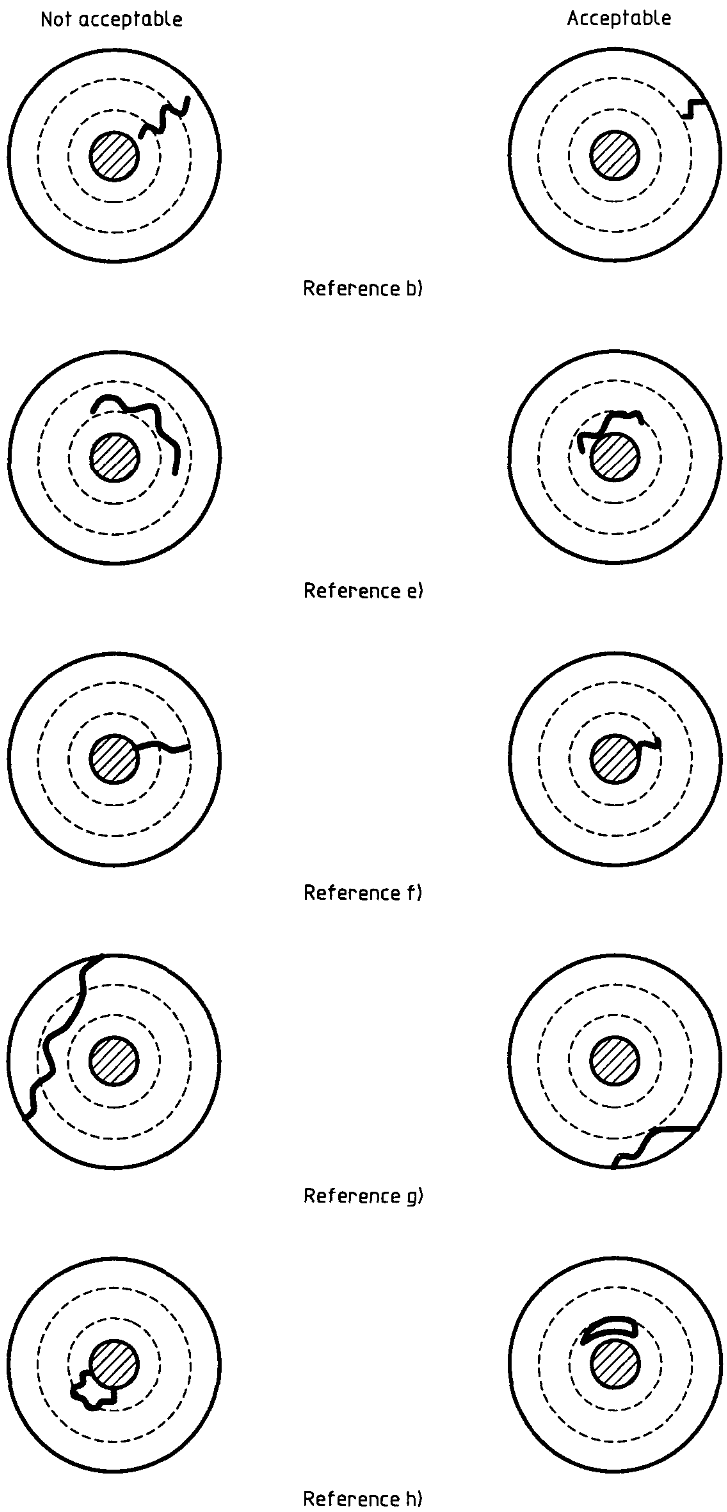
c) foreign material in or on the surface of the glass is not acceptable,

d) dark spots (pigment concentrations) whose diameters exceed one-third of the radial distance between terminal and the corresponding header metal are not acceptable,

e) circumferential cracks which extend more than 90° are not acceptable;

f) radial cracks whose lengths exceed one-third of the distance between the terminal and corresponding header metal are not acceptable,

g) tangential cracks that are not confined to a single zone are not acceptable;



NOTE — Dashed lines indicate radial distance between terminal and header metal, dividing the glass into three equal parts (zones)

Figure 1 — Inspection aid

h) surface chips whose lengths or widths exceed one-third the distance between the terminal and corresponding header metal are not acceptable;

i) chipped menisci are acceptable to the extent that they do not extend below the surface of the glass, and conform to h);

j) menisci that extend up the terminal greater than 0,51 mm (0,020 in) or one-third of the terminal diameter whichever is greater, are not acceptable;

k) peripheral cracks at the boundary of the glass and surrounding header metal are not acceptable;

l) any terminals which appear to be separated from the glass are not acceptable.

5.1.3 Operating voltage

5.1.3.1 Pickup voltage

When relays or contactors are tested in accordance with 6.1.3.1, each set of contacts shall make positive contact or open, as applicable, in the energized position when a potential voltage not in excess of the specified pickup voltage is applied to the relay or contactor coil. All normally open switching circuits shall close with positive contact and all normally closed circuits, if applicable, shall open. Once the device has picked up, the contacts shall not change state (break and remake) when the coil voltage is increased from the point of pickup to the maximum coil voltage, excluding normal contact bounce. For qualification inspection, the pickup voltage shall fall within the maximum specified when the relay or contactor is mounted in each of three mutually perpendicular planes.

5.1.3.2 Dropout voltage

This subclause is not applicable to latching relays.

When relays or contactors are tested in accordance with 6 1.3.2, each set of normally open contacts shall open, and each set of normally closed contacts shall close, as applicable, when the applied coil voltage is in the specified dropout voltage range. Excluding normal contact bounce, once the relay has dropped out, the contacts shall not change state when the voltage is reduced from the point of dropout to 0 V. For qualification inspection, the dropout voltage shall be measured with the device in each of three mutually perpendicular planes.

5.1.4 Hold voltage

When relays or contactors are tested in accordance with 6.1.4, there shall be no change in contact state (neither an opening of contacts that are closed, nor closure of contacts that are opened) until the coil voltage is less than the hold voltage specified in the detail specification (see 4.1).

5.1.5 Coil resistance

When relays or contactors are tested in accordance with 6.1.5, the d.c. coil resistance (or the maximum coil current) shall be as specified in the detail specification (see 4.1). If protective circuitry is involved d.c. coil resistance shall be substituted by coil current (see 5.1.6).

5.1.6 Maximum coil current

When relays or contactors are tested in accordance with 6.1.6, the maximum coil current shall not exceed the value specified in the detail specification (see 4.1).

5.1.7 Contact circuit voltage drop and contact resistance

When relays or contactors are tested in accordance with 6.1.7, the voltage drop values measured at the appropriate terminal with rated resistive current shall not exceed the values given in table 7.

For relays or contactors with auxiliary contacts rated 2 A or less, the contact resistance value shall be not greater than 0,05 Ω prior to the load endurance (life) cycling test and 0,15 Ω after the load endurance (life) cycling test.

5.1.8 Contact bounce, operating and release time

Release time is not applicable to latching relays

Photographic records of contact operating and release times, and contact bounce at nominal coil voltage shall be taken for qualification test approval.

When relays or contactors are tested in accordance with 6.1.8, the contact bounce, operating and release times shall be within limits specified in the detail specification (see 4.1). The operating and release times shall not include the contact bounce time The operating time and release time of each pole of a multipole relay shall be within 1 ms of each other pole of that relay for relays with contact ratings of 15 A or less, and within 2 ms for relays and contactors with contact ratings greater than 15 A. Synchronized switching control parameters for auxiliary contacts relative to main and each other shall be specified in the detail specification (see 4.1). Unless make-before-break action is specified in the detail specification (see 4.1), double-throw relays or contactors shall show no evidence of any normally open contacts closing before all normally closed contacts open; any normally closed contacts shall not make before all normally open contacts break. Contact break bounce on release of normally open contacts when specified in the detail specification (see 4.1) shall be less than 100 µs.

5.1.9 Dielectric strength and leakage current

When relays or contactors are tested in accordance with 6.1.9, the insulation of the relays and contactors shall be capable of withstanding, without damage, the values specified in table 8, or in the relevant detail specification (see 4.1).

All a.c. voltages stated are r.m.s. voltages. The testing shall be carried out under standard sea level conditions.

Leakage current shall not exceed 1 mA and the rate of applied test voltage shall not exceed 250 V/s.

The 1 min test is mandatory for qualification test only. The 5 s to 10 s test may be used for production acceptance testing.

5.1.10 Insulation resistance

When relays or contactors are tested in accordance with 6.1.10, the insulation resistance shall be measured at a potential of (500 ± 25) V d.c. between all mutually insulated terminals and between terminals and case. The required value shall be reached within 2 min after applying the test potential.

Insulation resistance shall be a minimum value of 100 MΩ except after climatic tests when it shall be a minimum value of 50 MΩ.

5.1.11 Low level run-in

Relays and auxiliary contacts shall be tested in accordance with 6.1.11 or 6.2.15.6 as appropriate. One operation exceeding 100 Ω dynamic contact circuit resistance shall constitute failure.

5.1.12 Sealing test

5.1.12.1 Class 1 relays and contactors

When class 1 relays and contactors are tested in accordance with 6.1.12, the leakage rate shall not exceed $6{,}2 \times 10^{-3}$ Pa·cm^3/s per cubic centimetre (1×10^{-6} atm·cm^3/s per cubic inch) of net sealed volume, except for relays of 32,8 cm^3 (2 in^3) net sealed volume or less, in which case the leakage rate shall not exceed $6{,}2 \times 10^{-5}$ Pa·cm^3/s per cubic centimetre (1×10^{-8} atm·cm^3/s per cubic inch) of net sealed volume.

Table 7 — Contact circuit voltage drop

Readings in volts

Class	Before load cycling		After load cycling	
	Average reading	Maximum individual reading	Average reading	Maximum individual reading
1	0,125	0,150	0,150	0,175
2 and 3	0,150	0,175	0,175	0,200

Table 8 — Minimum values for high voltage tests

Rated voltage	Test voltage	Duration
28 V d.c.	500 V, 50 Hz to 60 Hz	1 min
115/200 V a c.	1 250 V, 50 Hz to 60 Hz	1 min
28 V a c	600 V, 50 Hz to 60 Hz	5 s to 10 s
115/200 V a.c.	1 500 V, 50 Hz to 60 Hz	5 s to 10 s

5.1.12.2 Class 2 relays and contactors

When class 2 relays and contactors are tested in accordance with 6.1.12, the leakage rate shall be as specified in the detail specification (see 4.1).

5.1.13 Marking

In addition to the reference marking of the terminals (see 4.10.2), each relay or contactor shall be clearly and indelibly marked with the following information:

a) a reference to this part of ISO 5867;

b) manufacturer's name or identification;

c) manufacturer's type number;

d) the nominal operating coil voltage;

e) the rated voltage and resistive current,

f) circuit diagram (de-energized);

g) date code (year/week).

5.2 Environmental electrical and mechanical requirements

5.2.1 High temperature operation

When relays or contactors are tested in accordance with 6.2.1, the requirements for pickup voltage and dropout voltage shall conform to the detail specifications (see 4.1)

5.2.2 Low temperature operation

When relays or contactors are tested in accordance with 6.2.2, there shall be no damage such as loosening of terminals, cracking or flaking of glass insulation (other than crazing or chipping of the glass meniscus) or of the hermetic seal. Following the test and at the specified low temperature, the pickup voltage, dropout voltage, and contact voltage drop shall conform to the detail specification (see 4.1). Devices which contain permanent magnets in the magnetic circuit shall, in addition to the above test, be subjected to the demagnetizing effect of a sudden application of maximum coil voltage for one operation at the beginning of the second 24 h period when the high temperature pickup voltage shall conform to detail specification (see 4.1).

5.2.3 Electromagnetic interference

5.2.3.1 Exported spikes

If applicable, when tested in accordance with 6.1.14.1, the relays and contactors shall not generate exported spikes (back EMF) in excess of the figures specified in the detailed specification (see 4 1).

5.2.3.2 Imported spikes

When tested in accordance with 6.1 14.2, the relays and contactors shall accept imported spikes of ± 600 V peak over sine wave width of 5 µs without any damage to the relay or contactor coil or coil suppression device.

Following this test, the relays or contactors shall conform to 5.1.3 1, 5.1.3.2, 5.1.5 and 5.2 3.1

5.2.3.3 Compass-safe distance

When relays or contactors are tested in accordance with 6.2.3, they shall satisfy the compass-safe distance as specified in the detail specification (see 4.1). There shall be not more than 1° deflection of the compass when either the relay or contactor is tested in both energized and de-energized condition.

5.2.4 Strength of terminals

When relay or contactor terminals are tested in accordance with 6.2 4, they shall conform to 4.10 and table 1.

5.2.5 Thermal shock

When relays or contactors are tested in accordance with 6.2 5, there shall be no damage to the relay, loosening of terminals, or cracking or flaking of the glass insulation (other than cracking or chipping of the glass meniscus).

5.2.6 Sand and dust

This subclause is only applicable to class 3 relays or contactors.

When relays or contactors are tested in accordance with 6.2.6, there shall be no evidence of damage sufficient to impair the operation of the device

5.2.7 Continuous current

When relays or contactors are tested in accordance with 6.2.7, there shall be no damage such as loosening of terminals or loss of seal, or any deterioration of performance beyond the limits specified in the detail specification (see 4.1). The terminal temperature rise shall not exceed 75 °C.

5.2.8 Shock

When relays or contactors are tested in accordance with 6.2.8, there shall be no closing of open contacts in excess of 1 µs, nor opening of closed contacts for a total time in excess of 10 µs. Following the shock test there shall be no structural failure, loss of seal or other damage that might impair the operation of the device. Latching type devices shall remain in each latched position with no voltage applied to the coil.

5.2.9 Vibration

5.2.9.1 Sinusoidal

When relays or contactors are tested in accordance with 6.2.9.2, there shall be no contact opening in excess of 10 µs and the contact closing shall not exceed 1 µs, unless otherwise specified in the detail specification (see 4.1). The high temperature shall be the maximum specified in the detail specification (see 4.1). Following the resonance endurance and cycling endurance tests, there shall be no structural failure, loss of seal or other damage that impairs the operation of the device. Latching type devices shall remain in each latched position with no voltage applied to the coils.

5.2.9.2 Random

When relays or contactors are tested in accordance with 6.2.9.3, there shall be no contact opening in excess of 10 µs and the contact closing shall not exceed 1 µs, unless otherwise specified in the detail specification (see 4.1). The high temperature shall be the maximum specified in the detail specification (see 4.1). Following the endurance tests, there shall be no structural failure, loss of seal or other damage that impairs the operation of the device. Latching type devices shall remain in each latched position with no voltage applied to the coils.

5.2.10 Acoustical noise

This test is applicable only if specified in the detail specification (see 4.1).

When relays or contactors are tested in accordance with 6.2.10, there shall be no contact opening in excess of 10 µs and the contact closing shall not exceed 1 µs. There shall be no deterioration of device performance or physical damage.

5.2.11 Salt spray (corrosion)

When tested in accordance with 6.2.11, the relay or contactor shall show no evidence of corrosion sufficient to impair the operation of the device.

5.2.12 Ozone

When relays or contactors are tested in accordance with 6.2.12, the device shall exhibit no cracking of materials or other damage which will adversely affect subsequent performance of the device.

5.2.13 Acceleration

When relays or contactors are tested in accordance with 6.2.13, the contacts of the device shall remain in the de-energized conditions with no voltage across the coil and in the energized position when the coil voltage is reduced to 50 % of the nominal system voltage. There shall be no closing of open contacts in excess of 1 µs. Latching devices shall remain in each latched position with no voltage applied to the coils. Following the test there shall be no structural failure, loss of seal or other damage that impairs the operation of the device.

5.2.14 Explosion-proofing

This test is applicable to unsealed contactors.

When contactors are tested in accordance with 6.2.14, any explosion internal to the contactor shall not rupture the case or ignite the external fuel mixture in the test chamber.

5.2.15 Load and life (endurance)

5.2.15.1 Overloads

Monitoring of terminal temperature rise where appropriate is required only during qualification testing.

5.2.15.1.1 Overload a.c. or d.c.

When relays or contactors are tested in accordance with 6.2.15.1, there shall be no electrical failure, such as contact sticking, welding or failure to make or break the specified overload current. Blowing the fuse connected between case and load system ground or neutral shall constitute failure. The terminal temperature rise shall not exceed 75 °C.

5.2.15.1.2 Rupture

When relays or contactors are tested in accordance with 6.2.15.1.2, there shall be no electrical failure, such as contact sticking, welding or failure to make or break the specified rupture current. Blowing of the fuse connected between case and load system ground or neutral shall constitute failure. The terminal temperature rise shall not exceed 75 °C.

5.2.15.1.3 Circuit breaker compatibility

This test is applicable only if specified in the detail specification (see 4.1).

When relays or contactors are tested in accordance with 6.2.15.1.3, there shall be no evidence of contact welding or sticking and the contact voltage drop shall conform to 5 1.7 after the test. The terminal temperature rise shall not exceed 75 °C. Blowing of the fuse connected between case and load system ground or neutral shall constitute a failure.

5.2.15.2 Endurance (life)

When tested in accordance with 6.2.15.2, relays or contactors having two or more sets of contacts and which are rated for multiphase (115/200 V a c. three-phase) shall be capable of handling multiphase power on adjacent contacts. Phase-to-phase arcing shall constitute a failure. Relays or contactors shall be tested for endurance at rated contact load in accordance with 6 2.15 2 1 to 6.2.15.2.7. Test duty cycle and calibration of the various contact loads shall conform to table 14. There shall be no mechanical or electrical failure. Welding or sticking of contacts, failure to make, carry or break the load, or blowing of the fuse connected between case and load system ground or neutral shall constitute a failure. The terminal temperature rise shall not exceed 75 °C.

5.2.15.3 Mechanical life (endurance at reduced load)

The relay or contactor shall be capable of operating at 25 % of rated resistive load for four times the minimum operating cycles for relays under 25 A contact rating (resistive) and two times the specified minimum operating cycles for contactors rated 25 A and over. When the devices are tested in accordance with 6.2.15.3, they shall remain mechanically and electrically operative. There shall be no indication of mechanical resonance due to the frequency of energizing voltage.

5.2.15.4 Intermediate current

When relays or contactors are tested in accordance with 6 2.15.4, there shall be no mechanical or electrical failures. The contact voltage drop shall not exceed values specified in table 15.

5.2.15.5 Mixed loads

When specified in the detail specification (see 4.1) and tested in accordance with 6.2.15.5, multipole relays or contactors shall be capable of switching low level and high (or intermediate) level loads on adjacent contacts. The requirements for endurance, intermediate current and low level shall apply to the contacts switching these loads.

5.2.15.6 Low level

When relays are tested in accordance with 6.2.15.6, one miss shall constitute failure Monitoring of temperature rise is not applicable.

5.2.15.7 Load transfer, single or polyphase a.c.

When polyphase load transfer is specified in the detail specification (see 4.1) and the contactors are tested in accordance with 6.2.15.7, there shall be no phase-to-phase arc-over or welding (sticking) of contacts during testing. Blowing of the case-to-ground fuse shall constitute failure.

5.2.16 Contamination

When tested in accordance with 6.2.16, relays or contactors shall show no evidence of attack or corrosion.

5.2.17 Insertion and withdrawal force

When tested in accordance with 6.2.17, sockets and connectors shall conform to the insertion and withdrawal forces specified in the detail specification (see 4.1)

5.2.18 Mechanical/electrical interlock

This test is applicable only if specified in the detail specification (see 4.1).

When contactors provided with a mechanical interlocking feature are tested in accordance with 6.2.18, it shall not be possible to close one set of contacts whenever the second set of contacts are maintained closed.

5.2.19 Seal

When relays and contactors are tested in accordance with 6.2.19, hermetically sealed devices shall conform to the seal design requirements described in 4 7 1.

The gas leakage rate shall not exceed $6{,}2 \times 10^{-3}$ Pa·cm^3/s per cubic centimetre (1×10^{-6} atm·cm^3/s per cubic inch) of net sealed volume, except for relays of 32,8 cm^3 ($2 in^3$) net sealed volume or less where the leakage rate shall not exceed $6,2 \times 10^{-5}$ Pa·cm^3/s per cubic centimetre (1×10^{-8} atm·cm^3/s per cubic inch) of sealed volume.

Relays that fail the seal test (6.2.19.3.4) shall be tagged and separated from the test lot.

6 Tests

6.1 Examination of product

Unless otherwise specified in the detail specification (see 4.1), examine the products by the methods described in 6.1.1 to 6.1.14.

6.1.1 General

Inspect relays and contactors to verify that design, construction, materials, physical dimensions, weight, marking and workmanship conform to this part of ISO 5867 and the detail specification (see 4.1). Perform visual and mechanical inspections with measuring equipment to determine dimensions, masses and surface defects.

6.1.2 Header glass

Examine the header glass visually using the procedure in 5.1.2.

6.1.3 Operating voltage

Test relays and contactors in accordance with 6.1.3.1, 6.1.3.2 and 6.1.4. The pickup and dropout voltages shall be as specified in the detail specification (see 4.1), when checked within the temperature limits for the relay class and mounted in the most unfavourable attitude. Perform the following additional tests during qualification.

a) With the relay or contactor de-energized for 30 min prior to test, check the contacts do not change state (break and remake) when the coil voltage is increased from the point of pickup to the maximum coil voltage.

b) With the device energized for 30 min at maximum coil voltage prior to test (for continuous duty coils only), check that the contacts do not change state (break and remake) when the coil voltage is reduced from the point of dropout to 0 V.

6.1.3.1 Pickup voltage

Test relays and contactors to determine that the energized function is completed when a potential not in excess of the specified pickup voltage is applied to the coil.

6.1.3.1.1 Pickup voltage at room temperature

For relays, apply the pickup voltage by gradually increasing the voltage to the coil. For contactors, apply the pickup voltage either as for relays, or apply it as a step function. Use an indicating device to determine that the contacts operate satisfactorily.

6.1.3.1.2 Pickup voltage at high temperature

Subject the relay or contactor to an operating test at the maximum ambient temperature specified in the detail specification (see 4.1). Apply the maximum specified voltage to the coils for 1 h. During this test, continuously energize the continuous duty coils. Cycle the intermittent duty coils at the rate specified for resistive load. Do not lead the contacts during this test. Within 30 s following this period, and with the device maintained at the test temperature, determine the pickup voltage in accordance with 6 1.3.1.1. Check that the pickup voltage is within the limits specified in the detail specification (see 4.1).

6.1.3.2 Dropout voltage

This subclause is not applicable to latching relays or contactors.

Apply the maximum operating voltage to the coil terminals and then reduce the voltage. Check that the device releases to the de-energized position with the specified limits of dropout voltage. Use an indicating device to determine that the contacts operate satisfactorily.

6.1.4 Hold voltage

Apply the maximum operating voltage to the coil terminals and then reduce to the maximum dropout voltage. Use a device such as indicator lamps or, at the option of the manufacturer, a more sensitive device to determine if there is any change of state of contacts. Check that the device conforms to 5.1 4.

6.1.5 D.C. coil resistance

Measure the d.c. coil resistance. Stabilize the relay or contactor at (23 ± 1) °C for a minimum of 2 h prior to making the measurement. If measurement at 23 °C is impractical, stabilize the relay or contactor at any other ambient temperature for 2 h, measure the resistance and recalculate the resistance to 23 °C using the temperature coefficient of resistance formula for copper magnet wire as follows:

$$R_{23} = \frac{R_T}{1 + K(t - 23)}$$

where

R_T is the resistance at the new ambient temperature;

R_{23} is the resistance at 23 °C;

K is the temperature coefficient (0,003 93 for copper at 23 °C);

t is the new ambient temperature, in degrees Celsius.

6.1.6 Maximum coil current

For relays or contactors with semiconductors or a coil suppression circuit, coil resistance measurements cannot be performed accurately. In this case, measure the maximum coil current. Stabilize the device at (23 ± 1) °C for a minimum of 2 h prior to measuring coil current. At the end of that period, apply the maximum coil voltage to the coil and measure the current within 5 s. If measurement at 23 °C is impractical, use any other temperature and recalculate the coil current to 23 °C following the general procedure described in 6.1.5.

6.1.7 Contact circuit voltage drop

Measure the voltage drop across the relay or contactor terminals connected to the electrical contacts at the points at which external circuits are connected.

Measure normally open and normally closed contacts separately with the relay or contactor energized or de-energized as appropriate. In the energized state, apply the nominal voltage to the operating coil unless otherwise stated in the detail specification (see 4.1).

Take voltage drop measurements on plugin type relays at the relay pins and state an allowance for the receptacle (socket).

Unless otherwise stated in the detail specification (see 4.1) for relays between 5 A and 25 A rating, close the contacts before the test current is applied and open the contents after the test current has been removed (i.e. contacts do not "make" or "break" the test current)

NOTE 10 For relays with ratings greater than 25 A and for contactors, the test current may be made and/or broken by the contacts under test

Record the voltage drop after 1 min.

NOTE 11 Voltage drop values obtained within 0,1 s to 10 s may be used if automatic test equipment is involved

Ensure that the following conditions apply:

a) Check that the test current is in a resistive circuit.

   NOTE 12 Certain power supplies can have inrush currents exceedingly high for the relay or contactors under test.

b) Unless otherwise specified in the detail specification (see 4.1), check that the supply does not exceed 6 v d.c. for relays between 5 A and 25 A rating.

c) Unless otherwise specified in the detail specification (see 4.1), check that the supply is not greater than 28 V d.c. for relays and contactors with ratings greater than 25 A but, in any case, check that it does not exceed the maximum rated value of the contacts under test.

d) For qualification testing, take the contact voltage drop as the average value of ten consecutive measurements made with contacts opened and closed between each measurement. Check that no individual reading exceeds the maximum value stated in 5.1.7.

e) For production testing, take one measurement of contact voltage drop. Check that the value does not exceed the maximum stated in 5.1.7.

The contact resistance for relays or auxiliary contacts rated 5 A or less shall be as specified in 5 1.7

The test current shall be 100 mA except for those contacts rated for low level for which it shall be 10 mA.

The open circuit voltage shall be 6 V d.c maximum or a.c. peak.

6.1.8 Contact bounce, operating and release times

Release time is not applicable to latching relays or contactors.

See figure 2 for suggested circuit.

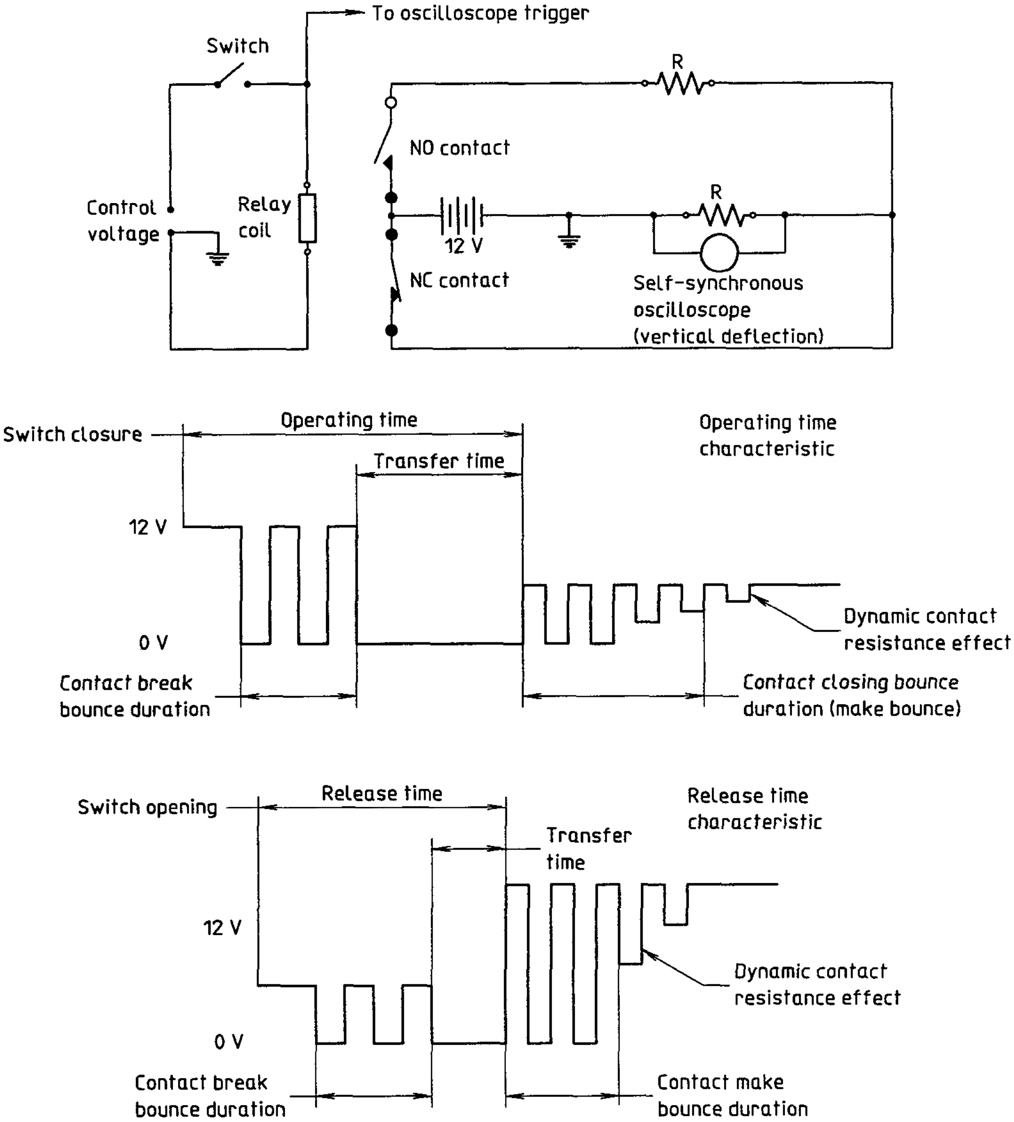


Figure 2 — Contact bounce (typical circuit)

Make photographic records of contact operating and release times and contact bounce at nominal coil voltage for qualification test approval. Apply contact loading, number of activations, and resolution for these measurements as specified in 6.1.8.1, 6.1.8.2 or 6.1.8.3 as applicable. Check contact make bounce on both normally open and normally closed contacts. Check contact break bounce when specified in the detail specification (see 4.1). Check on release of normally open contacts.

NOTE 13 Contact bounce includes both the initial bounce with the contact's first make and any additional bounce Caution should be observed to be sure that the photographic record includes any of the above so-called secondary bounce, if it exists. Contact break bounce occurs when a closed contact initially opens then recloses one or more times before fully opening. Open circuit voltage of 90 % or greater constitutes contact bounce, whereas less than 90 % open circuit voltage is considered to be dynamic contact resistance.

6.1.8.1 The operating conditions for relays with auxiliary contacts rated for low level (see detail specification 4.1) shall be as follows:

a) open circuit voltage — 6 V d.c. max.;

b) contact current — 100 mA max ;

c) number of activations for contact bounce — five min.;

d) resolution — 10 µs.

No measurement shall exceed the time values specified in the detail specification (see 4.1).

6.1.8.2 The operating conditions for relays rated from 5 A to 25 A (see detail specification 4.1) shall be as follows:

a) open circuit voltage — 6 V d.c. (or peak a.c.) max.;

b) contact current — 100 mA max.;

c) number of activations for contact bounce — the average of five consecutive readings;

d) resolution — 10 µs.

No measurement shall exceed the time values specified in the detail specification (see 4.1).

6.1.8.3 The operating conditions for contactors in which the lowest specified load (resistive, inductive, motor, lamp) for the power contact is 25 A or greater (see detail specification 4.1) shall be as follows:

a) open circuit voltage — 28 V d.c. (or peak a.c.);

b) contact current — 100 mA max.;

c) number of activations for contact bounce — the average of five consecutive readings;

d) resolution — 100 µs.

No measurement shall exceed the time values specified in the detail specification (see 4.1).

6.1.9 Dielectric strength

Apply the a.c. test voltage given in table 8 between the following points:

a) between all terminals and ground;

b) between all contact terminals of different polarity;

c) between coil terminals and all contacts;

d) between all unconnected terminals of the same polarity.

Perform these tests with the relay or contactor coil de-energized and energized, with the exception that the coil to enclosure need not be tested in the energized condition. Maintain the relative humidity in the range of 30 % to 50 %, except for the altitude use values specified in the detail specification (see 4.1). It is permissible to perform the dielectric withstanding voltage at humidities above 50 % but, in the event of failure, check the device at 30 % to 50 % relative humidity prior to rejection.

6.1.10 Insulation resistance

Measure the insulation resistance at (500 ± 25) V d c. between the following points:

a) between all terminals and ground;

b) between all contacts terminals of different polarity;

c) between coil terminals and all contacts;

d) between all unconnected terminals of the same polarity.

Perform these tests with the relay or contactor coil de-energized and energized, with the exception that the coil to enclosure need not be tested in the energized condition Maintain the relative humidity in the range of 30 % to 50 %. It is permissible to perform the insulation resistance test at humidities above 50 %, but in the event of failure, check the device at 30 % to 50 % relative humidity prior to rejection

6.1.11 Low level run-in

When specified in the detail specification (see 4.1), test relays for low level run-in in accordance with 6.2.15.6. The number of operations is limited to 5 000.

6.1.12 Sealing

Test relays and contactors for gross and fine leakage in accordance with 6.2.19.

6.1.13 Marking

Examine relays or contactors for marking.

6.1.14 Electromagnetic interference of coil circuit

6.1.14.1 Exported spikes

6.1.14.1.1 A.C. operated relays or contactors

Subject coils of a.c. operated devices to the electromagnetic interference test specified in test procedure ISO 7137 - 3.7.

6.1.14.1.2 D.C. operated relays or contactors

Connect the device as shown in figure 3. Prior to testing, apply maximum operating coil voltage with reverse polarity for more than 2 s to ensure that internal diodes are connected with the correct polarity and that zener diode rating is greater than maximum line voltage.

NOTE 14 Voltages greater than the maximum specified may damage the coil suppression device

Carry out the following procedure (see figure 3).

Ensure that the switching relay is the same type as the relay or contactor under test. E is the nominal operating voltage for the device under test. The switching relay is operated from a source voltage independent of E. CRO is a cathode-ray oscilloscope with a rise time of 0,020 µs or less. Set the horizontal (time) deflection scale at 5 ms per division (5 ms/cm) and the vertical (voltage) deflection scale at 20 volts per division (20 V/cm). Ensure that both horizontal (time) and vertical (voltage) deflection traces have a calibrated grid spacing (i.e. cm or mm).

The source E is a low impedance source (such as a battery) capable of delivering the nominal coil voltage without a limiting resistor or potentiometer to regulate the line voltage.

NOTE 15 A low source impedance representing a typical application is more important than having the exact nominal voltage

Close the switching relay for a minimum of 5 s allowing the oscilloscope and circuit network to stabilize, then open to obtain the induced voltage deflection trace.

a) Observe the reading in the oscilloscope and record the magnitude of the induced voltage transient.

   NOTE 16 A typical trace is presented in figure 4

b) Record the maximum value of three consecutive readings.

c) Unless otherwise specified in the detail specification (see 4.1), use a test temperature of (25 ± 5) °C.

For final production testing, use only one measurement to verify that the back EMF (coil kick) is within the specified limit.

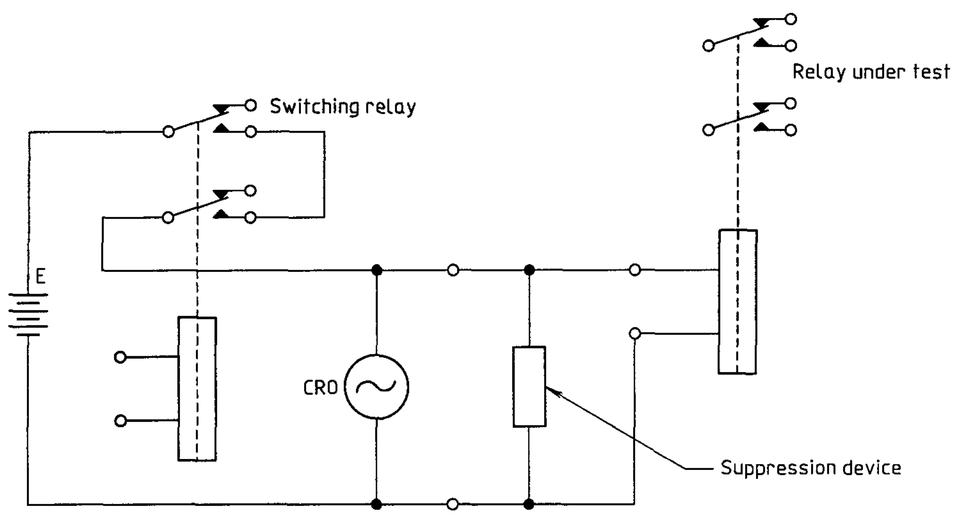
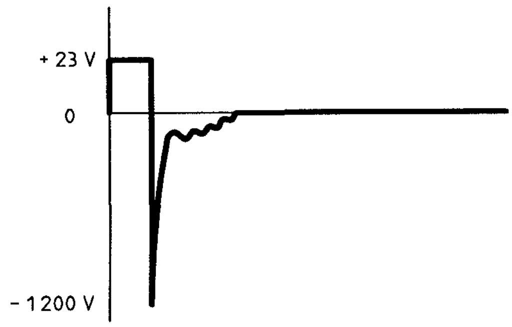
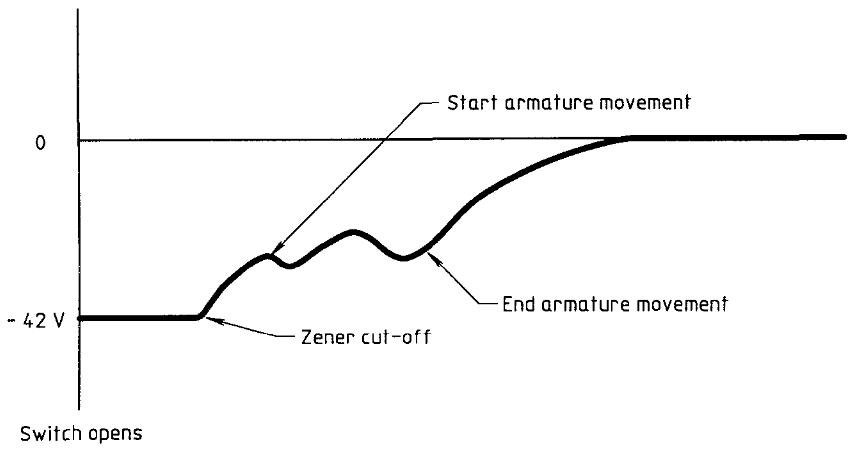


Figure 3 — Electromagnetic interference test circuit



a) Non-suppressed coil circuit



b) Suppressed coil circuit

Figure 4 — Typical transient voltage

6.1.14.2 Imported spikes

Subject the relays or contactors to test procedure ISO 7137 - 3.3 at ambient temperature.

Perform the test on relays or contactors in the energized condition Control the total potential of the spike so that it does not exceed ± 600 V, with a source impedance of 50 Ω.

Apply 10 spikes to the coil.

The switching device shall withstand the interference voltages without damage or malfunction.

6.2 Test methods for electrical and mechanical requirements

6.2.1 High temperature operation

Subject the relay or contactor to an operating test at the maximum ambient temperature specified in the detail specification (see 4.1). Apply the maximum specified voltage to the coils except for latching relays or contactors to which no voltage is applied. Maintain the conditioning for 1 h keeping the relay or contactor coils energized continuously. Do not load the contacts during this test. Within 30 s of the end of the test period, and with the device maintained at the test temperature, measure the pickup and dropout voltage.

6.2.2 Low temperature operation

Perform the tests below in the sequence listed and in the minimum time to prevent significant heating of the coil.

Subject the relay or contactor to the low temperature operation specified in the detail specification (see 4.1) for a period of 48 h in the de-energized condition At the end of this period, and with the device at the low temperature, measure the pickup voltage dropout voltage and contact circuit voltage drop as specified in 6 1.3 1, 6.1.3.2 and 6.1 7 respectively, except that a 20 min preconditioning is not required

Subject relays or contactors that contain permanent magnets in the magnetic circuit, in addition to the above tests, to the demagnetizing effect of the cold coil energized with the maximum voltage specified. During the low temperature test, after approximately 24 h, operate these devices by the sudden application of maximum coil voltages for one operation. Operate latch relays or contactors and centre-off devices containing permanent magnets in both directions with the coil energized, for a period not exceeding 2 s, so that no appreciable heating occurs.

Test all units subjected to this demagnetizing effect in accordance with 6.2.1 at the conclusion of this test.

6.2.3 Compass-safe distance

Test relays or contactors in accordance with test procedure ISO 7137 - 3.1 at ambient temperature.

The deflection of the compass shall be not more than 1° when the device is placed at a distance to the compass as specified in 5.2.3.3.

Perform the test with the relays or contactors in both the energized and de-energized condition. When the relays or contactors are tested in the energized condition, energize the coil to the nominal operating voltage.

6.2.4 Strength of terminals

6.2.4.1 Strength of threaded terminals and mounting studs

Test relays or contactors, having mounting studs or threaded terminals, as follows:

a) Apply the specified pull force both coaxially with the threaded terminal in a direction away from the main body of the device, and again normal to the threaded axis of the terminal in approximately the same plane as the seat for the terminal lug.

b) Apply the appropriate torque specified in table 1 to the terminal lug assembled in correct order.

c) Apply all forces for 1 min.

Test relays or contactors, with stud or threaded terminal assemblies soldered in place, as follows:

a) Stabilize the relay or contactor at 180 °C for a minimum of 2 h.

b) Subject the terminals to the pull and torque test as specified above.

6.2.4.2 Strength of solder terminals less than 1,2 mm (0,047 in) diameter

Twist each terminal (90 ± 10)° clockwise applying the twisting force at the point where connections would be normally made. Following the twist test, apply the appropriate pull force specified in table 9 to each terminal at the point where connections would normally be made. Apply the pull force in any one direction (45 ± 5)° from the normal axis of the terminal for a period of 15 s to 30 s. Return the terminals to their normal position.

Table 9 — Pull force

Terminal diameter		Pull force	
mm	in	N	lbf
0,9 to 1,2	0,035 to 0,047	22 ± 2,2	5 ± 0,5
0,6 to 0,9	0,023 to 0,0349	13 ± 1,3	3 ± 0,3
< 0,6	< 0,023	9 ± 0,9	2 ± 0,2

6.2.4.3 Strength of plug-in terminals less than 1,2 mm (0,047 in) diameter

Bend each terminal 20° to 30° in both directions from the normal axis in a given plane and after returning it to its normal position, bend each terminal 20° to 30° in both directions perpendicular to the previous plane Return the terminals to their normal position Following the bend test, apply the appropriate pull force specified in table 9 to each terminal for a period of 15 s to 30 s.

6.2.4.4 Strength of solder and plug-in terminals greater than 1,2 mm (0,047 in)

Apply a pull force of (44 ± 4,4) N [(10 ± 1) lbf] at (90 ± 10)° to the normal axis of the terminal for a period of 15 s to 30 s. Apply the force to solder terminals at the point where connections would normally be made, or to plug-in terminals in the last quarter of the length.

6.2.4.5 Strength of wire lead terminals

Bend each terminal (90 ± 10)° in any direction from the normal axis of the terminal at (6,4 ± 1,6) mm [(1/4 ± 1/16) in] from the terminal header with the bend radius three to five times the diameter of the wire. Grasp the terminal (12,7 ± 1,6) mm [(1/2 ± 1/16) in] from the bend and twist by rotating the 6,4 mm (1/2 in) length (90 ± 10)° clockwise. Repeat the procedure four times. Following the twist test, apply the appropriate pull force specified in table 9 to each terminal at the point where connections would normally be made. Apply the pull in any one direction (45 ± 5)° from the normal axis of the terminal for a period of 15 s to 30 s

6.2.5 Thermal shock

Test relays and contactors in accordance with test procedure ISO 7137 - 1 2 for the temperature range specified in the detail specification (see 4.1) with the following exceptions to measurements after cycling.

Visually examine the relays and contactors for breaking, cracking, chipping or flaking of the finish, or loosening of the terminals. Measure the insulation resistance, dielectric withstanding voltage, and contact voltage drop.

6.2.6 Sand and dust

This subclause is only applicable to unsealed contactors

Test contactors in accordance with test procedure ISO 7137 - 1 7 with the following exception

Raise and maintain the temperature for 6 h to the maximum specified for the contactor under test. Use a sand and dust velocity through the test chamber of between 30 m/min to 150 m/min.

6.2.7 Continuous current

Perform this test at the maximum temperature and altitude specified in the detail specification (see 4.1) for the class of relay or contactor being tested. Apply also to this test the conditions specified for endurance testing (see 6.2.15). Do not energize the relay or contactor coil for the first 3 h of this test. Load normally closed contacts with the highest rated resistive load. At the end of the 3 h period with no change in the conditions, measure the pickup voltage of the relay or contactor continuously for 97 h and measure the coil voltage Measure the rated resistive current at any convenient voltage for contacts that are in the closed position when the coil is energized. Immediately following the operating period and with the device still at the specified temperature, test the relay or contactor to determine that the energized function is completed when the pickup voltage is applied. Monitor the terminal temperature rise throughout the test.

6.2.8 Shock

Test the relay or contactor in accordance with test procedure ISO 7137 - 2.1 The following details apply.

a) **Mounting.** Rigidly fasten the relay or contactor using its regular mounting to the drop carriage of the shock testing machine. Mount the device in each of its mutually perpendicular axes in turn.

b) **Test conditions.** Subject the relay or contactor to impacts of the intensity and duration specified for the shock characteristics of component being tested in the detail specification (see 4.1) Select the test condition and test procedure accordingly.

c) **Number of impacts.** Apply four shocks (a total of 24 shock pulses), in each direction along each of three mutually perpendicular body axes, one of the axes being in the direction most likely to cause malfunction

d) **Electrical operating conditions.** Perform the shock test with the relay or contactor de-energized (two shocks) then repeat with the relay or contactor energized (two shocks) with the nominal coil voltage or current.

e) **Magnetic latching devices.** Apply two pulses in each direction in the latch position and two pulses in the reset position, with no coil current being applied during these pulses

f) **Measurements during shock.** Monitor contacts for opening or closing (open contacts may be wired in a parallel and closed contacts may be connected in series).

6.2.9 Vibration

Perform vibration tests in accordance with the requirements specified in the detail specification (see 4.1).

NOTE 17 The detail specification (see 4 1) may specify test procedure ISO 7137 - 2 2 as an alternative to this procedure

High temperature is the maximum higher temperature specified for the relay or contactor being tested. Low temperature shall be as specified in the detail specification (see 4.1). When vibrating intermittent duty devices in the energized position, reduce the coil voltage to a level that prevents overheating and subsequent damage to the insulation system.

6.2.9.1 General requirements

6.2.9.1.1 Test installation

Rigidly attach the relay or contactor to the vibrator table either directly, or with an adaptor of sufficient rigidity to be nonresonant in the test frequency range. If necessary, conduct an independent frequency scan on the adapter with a suitable dummy load in lieu of the relay or contactor to determine whether the adapter has resonances in the test frequency range. Ensure that the test configuration does not induce rotational motion of the vibrator table or adaptor bracket due to any unsymmetrical weight or stiffness distribution of the component. Mount the control accelerometer(s) on the test fixture as near as possible to the equipment mounting location.

6.2.9.1.2 Contact disturbance

When relays or contactors are tested for contact disturbance, there shall be no contact opening in excess of 10 µs and the contact closing shall not exceed 1 µs, unless otherwise specified in the detail specification (see 4.1). 6.2.9.1.3 specifies the voltage, current, and instrumentation which should be used to measure the contact disturbance.

Connect multiple open contacts in parallel and multiple closed contacts in series during testing.

NOTE 18 Contact disturbance may be detected by a circuit similar to that shown in figure 2.

6.2.9.1.3 Voltage and current for contact disturbance measurements

Apply a test voltage of between 12 V and 25 V with a series noninductive resistor of suitable resistance to limit the closed circuit current to some value between 5 mA and 10 mA. Use an oscilloscope with high input impedance and a bandwidth of 1 MHz, or greater.

6.2.9.2 Sinusoidal vibration

6.2.9.2.1 Amplitude measurement

Make measurements of vibratory accelerations or amplitudes at the mounting base of the components. Vibratory acceleration increased by its own resonances is not considered as part of the applied vibration. The means of measuring vibratory amplitudes of acceleration is not considered as part of the applied vibration. Select the means of measuring vibratory amplitudes or acceleration to provide a clear distinction between the applied vibration and the response to the vibration of the relay assembly or contactor assembly.

6.2.9.2.2 Frequency measurements

Select equipment capable of measuring frequency to within ± 5 % and amplitude or acceleration to within ± 10 %. Use a vibrator table that provides simple harmonic motion with not more than 10 % distortion. Distortion of the table motion caused by the operation, or response of the component itself, is not considered part of the distortion of the driving motion

6.2.9.2.3 Frequency scan

If ISO 7137 is not specified in the detail specification (see 4.1) the test curves in figure 5 apply. Vibrate the relay or contactor first in the energized and then in the de-energized position along each of three mutually perpendicular axes for resonance under the conditions defined in the detail specification (see 4.1). Conduct the frequency scan slowly and carefully. Divide the frequency range into small convenient intervals, and scan each interval at a constant applied acceleration or amplitude that produces approximately the table amplitude or acceleration. Observe closely during the frequency scans to detect frequencies of minimum table motion that define some of the frequencies at which some components may be in resonance These frequencies are quite sharply tuned and do not necessarily coincide with the frequencies at which maximum component amplitude or noises occur when scanning at constant applied force amplitude When the resonant components are small, the reduction of table motion at resonance may not be discernible, in which case the resonant frequencies may be determined for observation of maximum amplitudes, noises or changes in performance such as contact disturbance In all cases, verify the resonant frequencies, if possible, by checking for minimum table motion.

6.2.9.2.4 Resonance endurances

If ISO 7137 is not specified in the detail specification (see 4.1), the test curves in figure 5 apply After completion of the frequency scanning, conduct resonance endurance tests as specified in the detail specification (see 4 1), modified as follows.

a) Use a test duration of one million cycles or 8 h, whichever occurs first.

b) Perform a separate test for each resonance found in the frequency scan specified in 6 2.9.2 3, do not divide the test time between resonances. Separate resonance endurance tests may be performed on separate relays or contactors, if the resonance is common to more than one sample.

c) Vibrate the specimen for 15 min at the specified minimum temperature. Stabilize the test device at the maximum and minimum temperatures before conducting resonance endurance tests at these temperatures. Continue vibrations at room temperature for the duration of the test.

d) Divide the resonance endurance time equally between vibration with the relay or contactor coil in the energized and the de-energized conditions

e) For intermittent duty devices, energize for 3 min at the end of each temperature level of the cycle.

f) Do not conduct endurance tests at any frequency at which the table amplitude abruptly increases when scanning at constant applied force amplitude. If a change in resonant frequency occurs during testing, or owing to change in test temperature, adjust the frequency of vibration to follow the resonance. However, if large or abrupt resonant frequency shifts occur, examine the item for structural failure or excessive wear.

6.2.9.2.5 Cycling endurance

If ISO 7137 is not specified in the detail specification (see 4.1), the test curves in figure 5 apply. Cycle the relay or contactor for 30 min at maximum and 30 min at minimum rated ambient temperature. Energize the test device for the first half of each test period During the second half, de-energize the test device. Cycle the frequency for 15 min periods between the frequency limits specified in figure 5 and at the vibration levels specified in figures 6 to 10 for the class of relay or contactor being tested. Ensure that the rate of change of frequency is logarithmic. Where there is no provision for logarithmic cycling, use a linear rate of frequency change. The cycling test may be divided into convenient frequency ranges, provided cycling rates and test times for each range are not changed.

6.2.9.3 Random vibration test procedure

6.2.9.3.1 Critical frequencies survey

Prior to and after random vibration, perform the sinusoidal test procedures of 6.2.9.2.3, except to limit the test to one sweep (minimum to maximum frequency) at appropriate levels in each axis Identify critical frequencies.

Subject the test item, while operating, to vibration along each of three mutually perpendicular axes according to the spectral density envelope indicated by the appropriate category of table 10. Continue vibration and operation for 1 h, or for a longer period if necessary, to complete the test. The difficulty in reading the vibrating display when the total excursion exceeds 0,51 mm is not cause for failing the test

The instantaneous random vibration acceleration peaks may be limited to three times the RMS acceleration level. Ensure that the power spectral density of the test control signal does not deviate from the specified requirements by more than + 3 dB or − 1,5 dB below 500 Hz, and ± 3,0 dB between 500 Hz and 2 000 Hz, except that deviations as large as ± 6,0 dB are permitted over a cumulative bandwidth of 100 Hz, maximum between 500 Hz and 2 000 Hz. These tolerances are increased in rolled-off regions of the spectrum by ± 0,1 dB for every 1 dB down from the maximum level specified

Confirm these tolerances by using an analysis system providing statistical accuracies corresponding to a minimum bandwidth-time constant product, $(BT)_{min} = 50$. Use a specific analyser with the following characteristics:

a) online, contiguous filter, equalization/analysis system having a maximum bandwith, $B_{max} = 50$ Hz;

b) swept frequency analysis systems characterized as follows:

   1) constant bandwidth analyser with

      — filter bandwidths

         $B = 10$ Hz, maximum between 10 Hz to 200 Hz

         $B = 50$ Hz, maximum between 200 Hz to 2 000 Hz

      — analyser averaging time, $T = 2RC =$ 2 s min. where T is the true averaging time and RC is the analyser time constant,

      — analyses sweep rate (linear), $r = B/4RC$ or $B^2/8$ (Hz/s) max, whichever is smaller,

   2) constant percentage bandwidth analyser with·

      — filter bandwidth, $Pf_c =$ one-third octave maximum (0,23 f where P is the percentage and f_c is the analyser centre frequency),

      — analyser averaging time, $T = 50/Pf_c$, expressed in minutes,

— analysis sweep rate (logarithmic),

$$r = \frac{Pf_c}{4RC} \text{ or } \frac{(Pf_c)^2}{8} \text{(Hz/s) max.,}$$

whichever is smaller;

c) digital power spectral density analysis system employing quantitative techniques providing accuracies corresponding to the above approach;

d) the composite G = RMS test level not less than the value given for the applicable category. Mount accelerometer(s) employed for test level control in accordance with 6.2.9.1.1. Where more than one accelerometer is employed for test level control, use the power average of the accelerometer signals as the test level signal control.

6.2.9.4 Severe vibration environment test procedures

Use the applicable test curves specified in the detail specification (see 4.1). The severe vibration test curves are shown in table 11 and figure 10. Sinusoidal or random test procedures, as appropriate, may be used for the robustness test (6.2.9.4.2).

6.2.9.4.1 Vibration response survey (step 1)

The vibration response survey is the same as the sinusoidal test in 6.2.9.2 except that only one sweep per axis of 5 Hz to 2 000 Hz to 5 Hz is required.

6.2.9.4.2 Robustness test (step 2)

Unless otherwise specified in the detail specification (see 4.1), operate the test item during vibration so that performance effects caused by vibration may be evaluated. However, compliance with applicable equipment performance standards is not required during the application of vibration.

Subject the test item to random or sinusoidal vibration according to the appropriate categories specified in the detail specification (see 4.1), or table 11 and figure 10, along one of its three orthogonal axes. Use a vibration duration of 3 h and, if sinusoidal procedures are used, a sine sweep rate not exceeding 1,0 octave/min.

6.2.9.4.3 Vibration response survey (step 3)

Repeat step 1 above and record a comparison of responses that have exceeded $Q = 3$ in either survey Record if the dynamic response or the performance of the equipment has changed significantly

Repeat the procedures specified in 6.2 9.4.1 to 6.2.9.4.3 with the vibratory motion applied along the second major orthogonal axis of the equipment

Repeat the procedures specified in 6.2 9.4 1 to 6.2.9.4.3 with the vibratory motion applied along the third major orthogonal axis of the equipment.

At the conclusion of severe vibration testing, determine compliance with applicable equipment performance standards.

6.2.10 Acoustical noise

This test is applicable only if specified in the detail specification (see 4.1).

Test relays or contactors in accordance with test procedure ISO 7137 - 2.4 to the overall noise level and relative power distribution specified in the detail specification (see 4.1). Subject the relay or contactor to wide-band acoustical noise in the de-energized position and in the energized position with rated voltage applied to the coil. Continuously monitor the contacts.

6.2.11 Salt spray

Test the relays or contactors and, when applicable, the terminal lugs attached in accordance with test procedure ISO 7137 - 1.9. At the completion of the test, clean the relay or contactor by washing in cold running tap water and examine for deterioration Dry the device for approximately 6 h in a circulating air oven at approximately 65 °C.

6.2.12 Ozone

Place the relay or contactor in an enclosure and subject it to an atmosphere with an ozone volume fraction of from 0,010 % to 0,015 % for a period of 2 h at room temperature. At the end of the test period, examine the sample for signs of ozone deterioration

Table 10 — Categorization of standard vibration test requirements by aircraft types and equipment locations

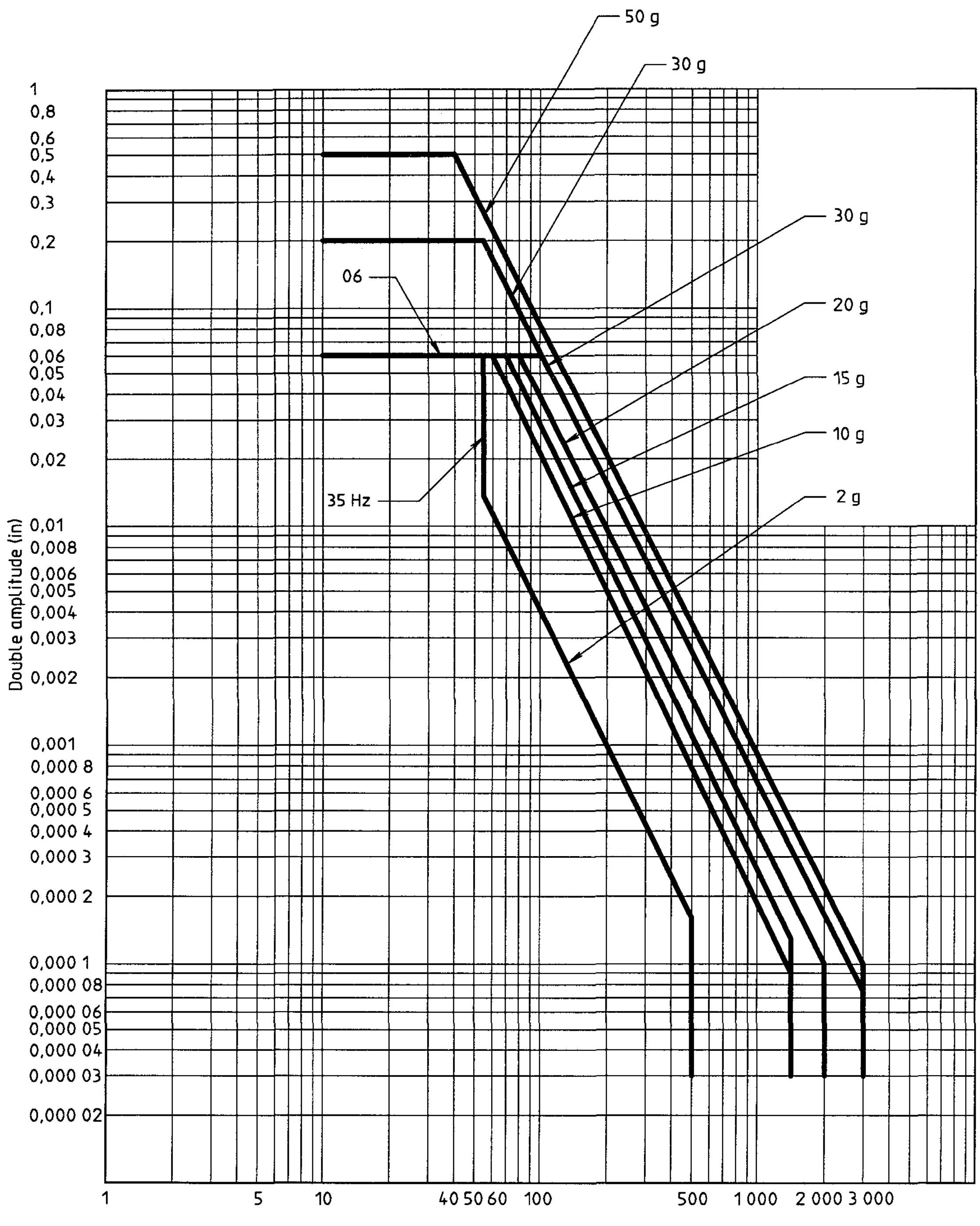
Aircraft type	Fuselage	Vibration test envelope for equipment mounted on:				
		Instrument panel[1)] console[1)] and equipment rack[2)]	Equipment rack, non-vibration-isolated	Nacelle and engine pylon	Engine and gear box	Wing, empennage or wheel well
Helicopters						
Reciprocating engine	Y[3)]	P	N	U	U	V
Turbojet engine	Y[4) 3)]	P	N	W	W	V[4)]
Fixed-wing — Turbojet engine						
Subsonic (including turbofan engine)	J[4)] or C	K or A	O or B	R or D	W	R[4)] or D
Supersonic	J[4)] or C	K or A	O or B	R or D	W	R[4)] or D
Fixed wing — Reciprocating and turbopropeller engines						
Multi-engine, greater than 5 700 kg (12 500 lb)	L	S	M	T	U	T
Multi-engine, less than 5 700 kg (12 500 lb)	M	S	M	L	L	L
Single engine, less than 5 700 kg (12 500 lb)	M	S	M	M	L	M

1) Panel-console vibration and non-vibration-isolated in regard to aircraft structure
2) Rack vibration isolated from aircraft structure
3) Includes equipment mounted in the nose and tail boom areas of helicopter.
4) Does not include equipment mounted on structure directly affected by jet efflux

Table 11 — Categorization of severe vibration test requirements for fixed-wing turbojet engine aircraft and equipment locations

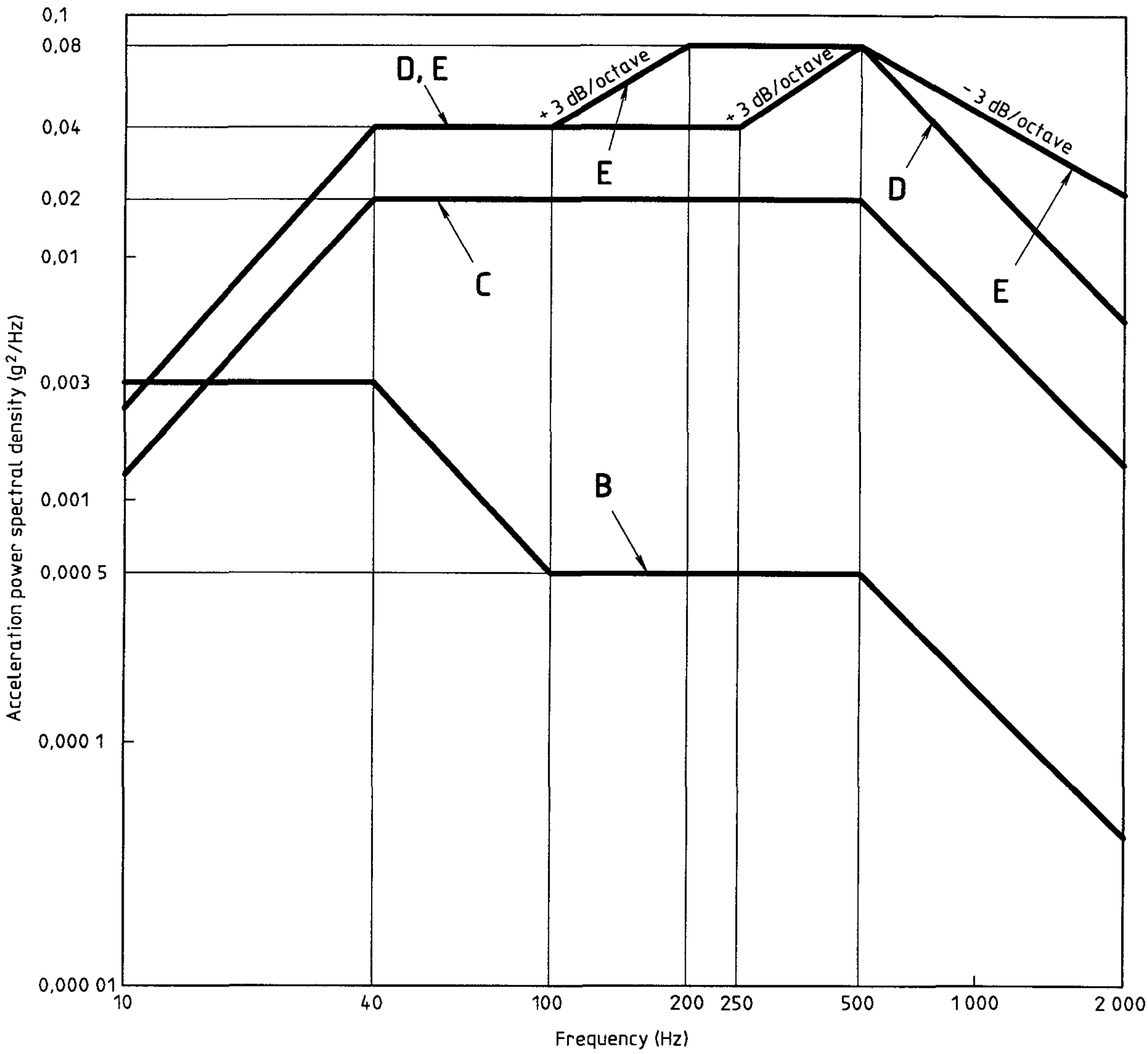
Aircraft type	Fuselage	Vibration test envelope for equipment mounted on:				
		Instrument panel[1)] console[1)] and equipment rack[2)]	Equipment rack, non-vibration-isolated	Nacelle and engine pylon	Engine and gear box	Wing, empennage or wheel well
Fixed-wing — Turbojet engine						
Subsonic (including turbofan engine)	J[3)] or C	K or A	O or B	R or D	W	R[3)] or D
Supersonic	J[3)] or C	K or A	O or B	R or D	W	R[3)] or D

1) Panel-console vibration and non-vibration-isolated in regard to aircraft structure
2) Rack vibration isolated from aircraft structure
3) Does not include equipment mounted on structure directly affected by jet efflux.



NOTE — In this figure, Imperial units have been retained because the graph was derived from these units originally

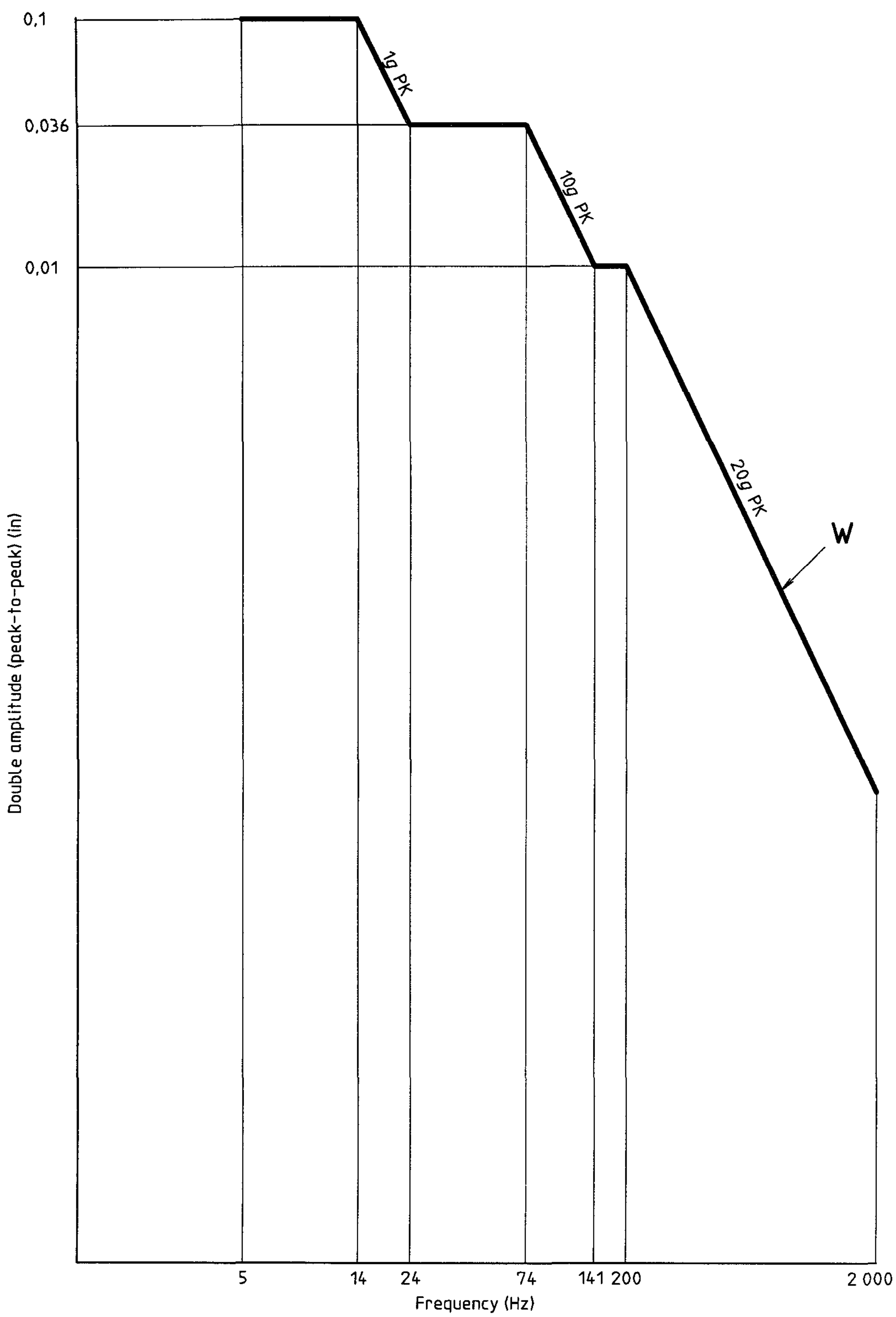
Figure 5 — Range curve for vibration tests



Category	G_{rms}
B	0,7
C	4,12
D	8,9
E	7,93

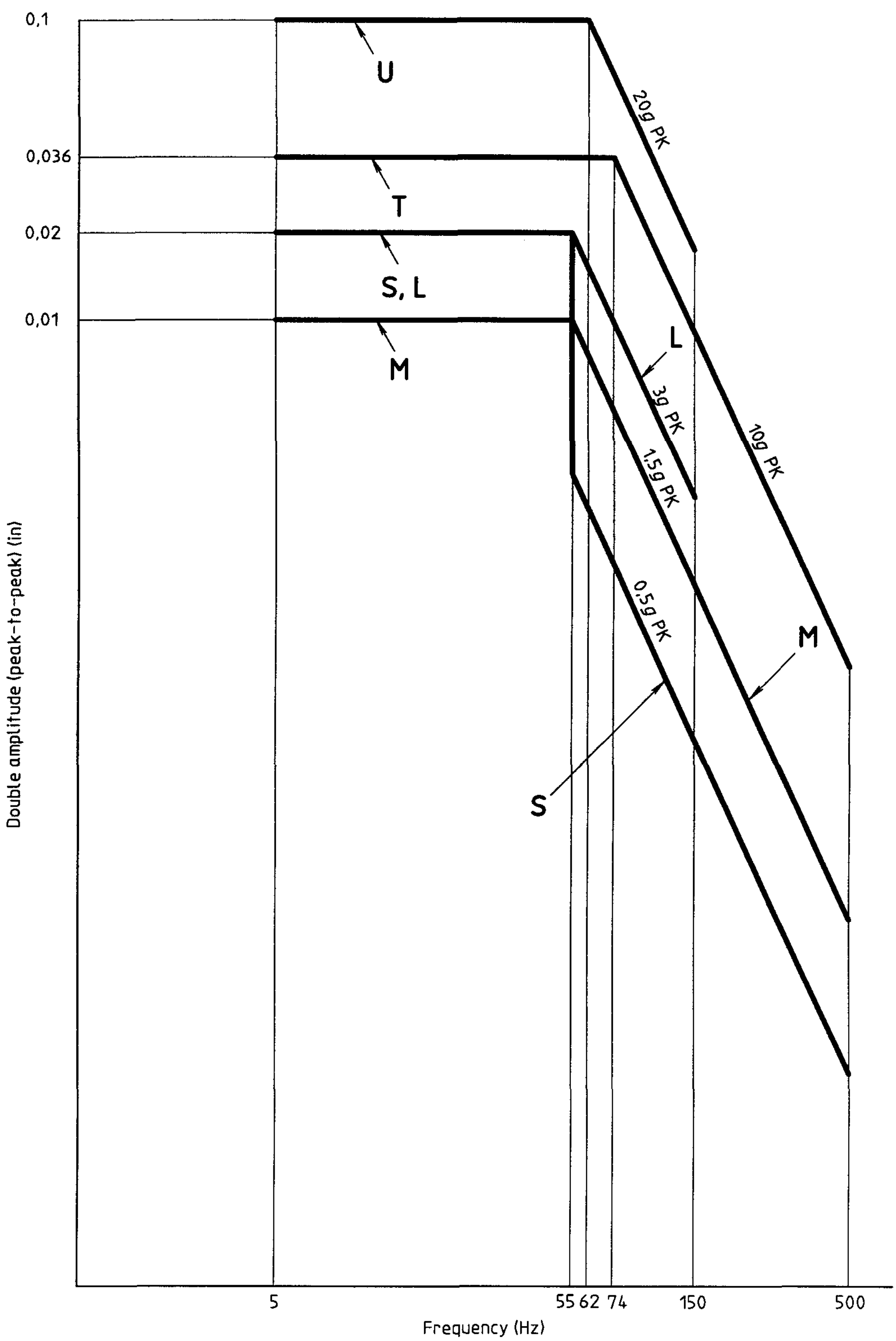
NOTE — All slopes are ± 6 dB/octave except as noted on curves D and E

Figure 6 — Standard random vibration test curves for equipment installed in fixed-wing aircraft with turbojet engines



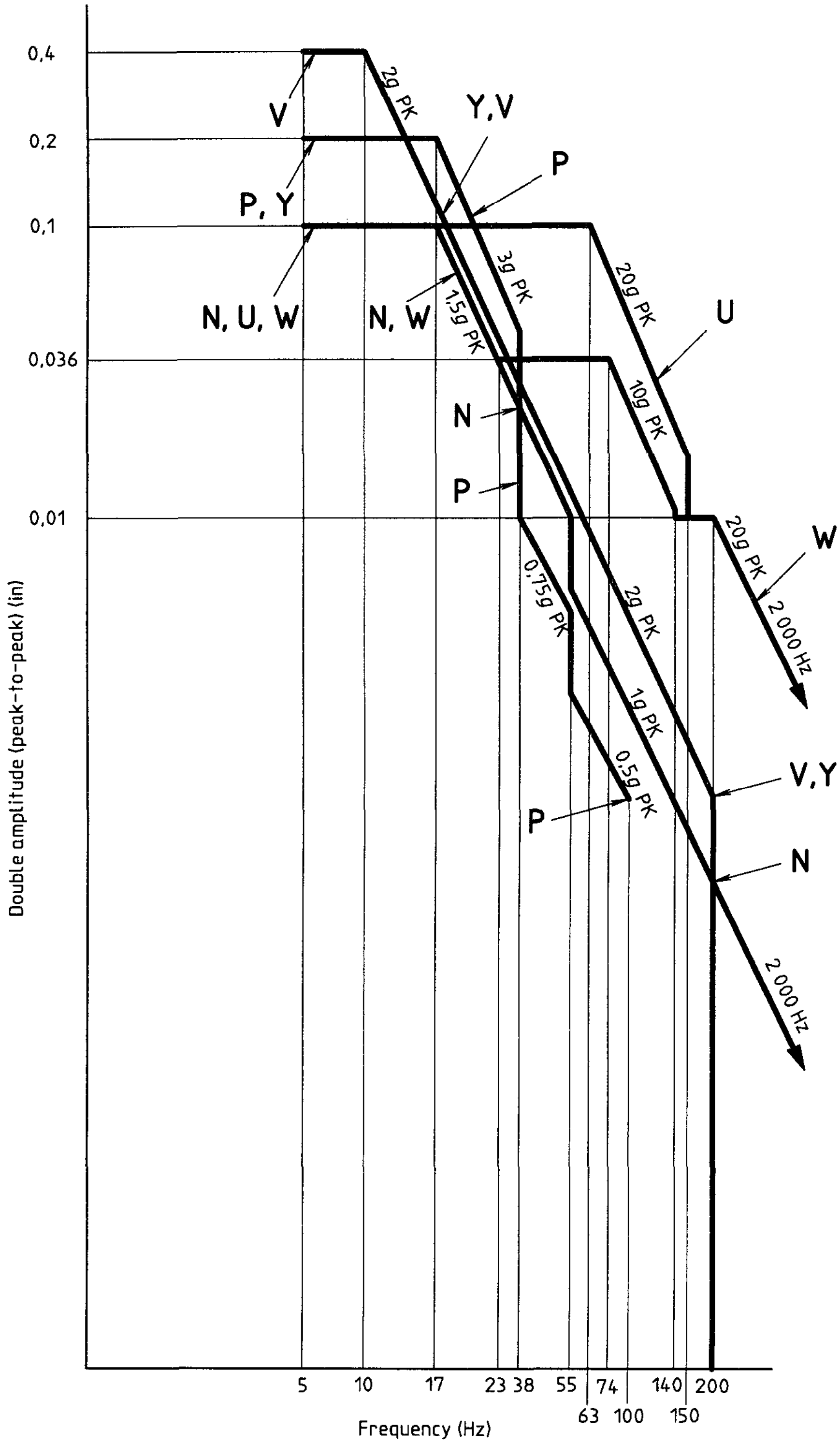
NOTE — In this figure, Imperial units have been retained because the graph was derived from these units originally.

Figure 7 — Standard sinusoidal vibration test curves for equipment installed in fixed-wing aircraft with turbojet engines



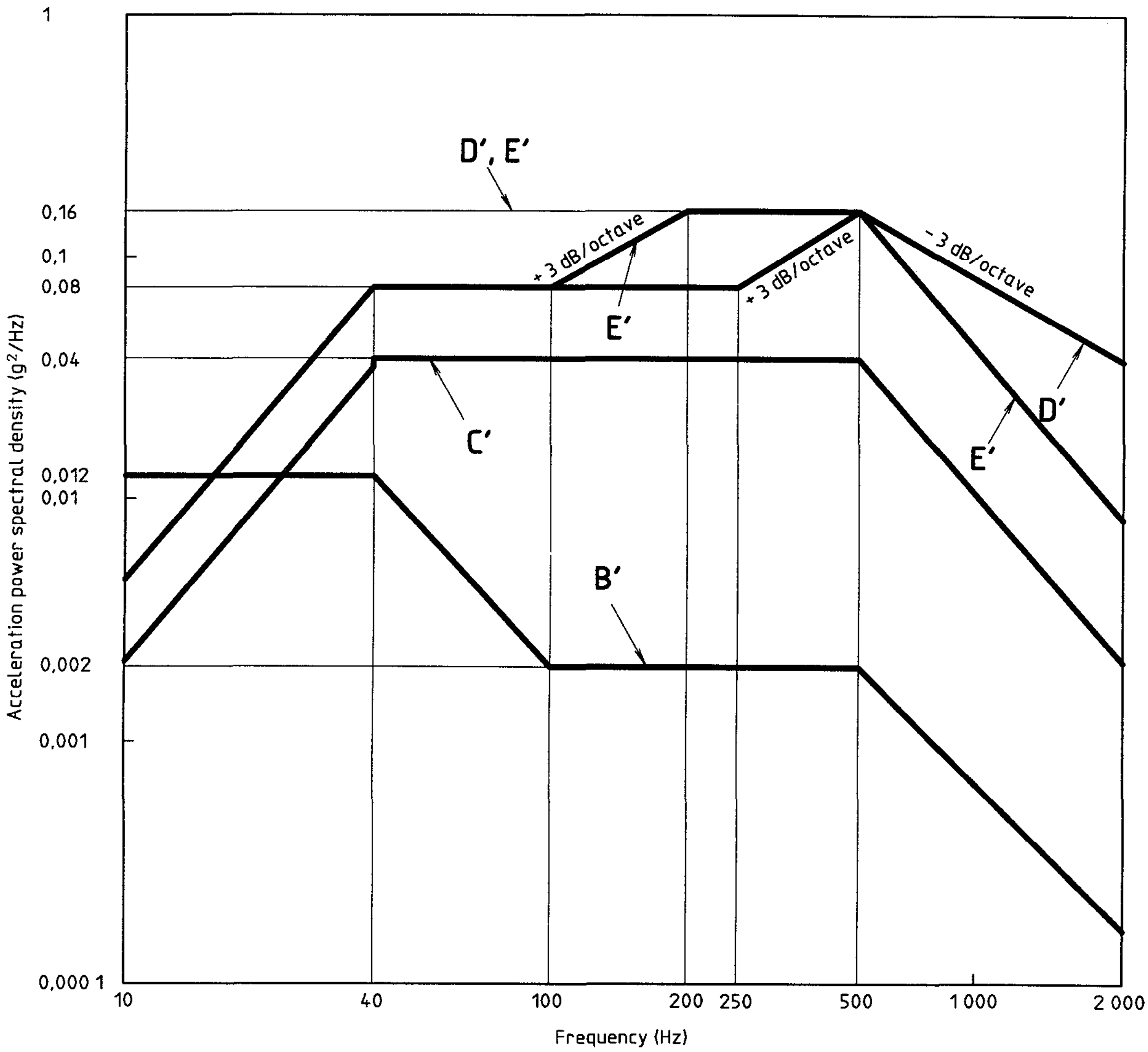
NOTE — In this figure, Imperial units have been retained because the graph was derived from these units originally

Figure 8 — Standard sinusoidal vibration test curves for equipment installed in fixed-wing aircraft with reciprocating or turbopropeller engines



NOTE — In this figure, Imperial units have been retained because the graph was derived from these units originally

Figure 9 — Standard sinusoidal vibration test curves for equipment installed in helicopters



Category	G_{rms}
B′	1,4
C′	6,08
D′	13,3
E′	11,9

NOTE — All slopes are ± 6 dB/octave except as noted on curves D′ and E′

Figure 10 — Robust random vibration test curves for equipment installed in fixed-wing aircraft with turbojet engines

6.2.13 Acceleration

Test the relays or contactors in accordance with test procedure ISO 7137 - 2.3 subject to the following details or exceptions:

a) **Mounting.** Rigidly fasten the relays or contactors using the normal mount in each of three mutually perpendicular positions.

b) **Test condition.** Subject the relays or contactors to test condition A. Apply the acceleration in each direction along three mutually perpendicular axes of the specimen with one of the axes in the direction most likely to cause malfunction. Use the acceleration force specified in the detail specification (see 4.1).

c) **Electrical operating conditions during acceleration.** Perform the acceleration test with the device in the de-energized condition and repeat with the coil energized. Connect an indicating instrument across the contacts while the device is undergoing this test to determine the ability of contacts to remain in the proper position. Wire open contacts in parallel and closed contacts in series.

6.2.14 Explosion-proofing

This test is only applicable to unsealed contactors.

Test contactors in accordance with test procedure ISO 7137 - 4.1 modified as follows:

Maintain the temperature of the ambient explosive mixture and of the equipment at the maximum temperature specified for the contactor in the detail specification (see 4.1). Perform at least five tests for internal explosions at each 0,5 % mixture increment from 3 % to 6 % volume fraction of commercial butane, using dry air in establishing the mixture. The spark may be obtained by operating at rated inductive load. Tests at altitude conditions are not required.

6.2.15 Loads and life (endurance)

Arrange test loads and circuits so that the specific current flows through each pole. During all load or endurance (life) tests, maintain the relay or contactor enclosure at the electrical system ground to neutral through a fuse rated at 5 % of the rated resistive load, but in no event greater than 3 A or less than 100 mA. Blowing of this fuse constitutes a failure. Use line-to-line and line-to-ground voltages specified in the detail specification (see 4.1). Perform the load test cycles in any number of continuous periods, each not less than 3 h. Suspend or mount the relay or contactor in still air, using a thermal insulating material. Test the normally open (NO) and normally closed (NC) contacts of double-throw devices. If the NO and NC contacts are tested separately, provide an additional sample unit for this test. An additional sample unit is required to meet all other tests in the test sequence. If both NO and NC contacts of double-throw devices are being tested at the same time, provide a separate load for each NO and each NC contact. Connect the movable contacts to the power source, except for double break contacts Connect all loads between the contacts and power supply ground or neutral. When testing multipole relays or contactors with three-phase ratings, connect three-phase loads to adjacent contacts. During endurance tests, monitor every operation of each contact for failure to make, carry and break the specified load, any of which constitutes a failure. Check that the minimum sensing period is 10 % of the dwell time in the open or closed position. Select test equipment capable of either locking in the state of failure, or recording the sequence number of the miss. Specify failure to close as a voltage drop across the contacts exceeding 10 % of full load voltage, except for intermediate current tests when the intermediate current voltage drop shall be as specified. A failure on vibration or of the dielectric withstanding voltage after load tests constitutes one failure for the purposes of establishing MCBF.

6.2.15.1 Overloads

6.2.15.1.1 Overload a.c. or d.c.

Force the contacts of the relay or contactor to make and break the overload values for the durations shown in table 12, or as specified in the detail specification (see 4.1), for 50 operations at each of the maximum system voltage (open circuit) ratings. For double-throw devices, perform separate tests for the NO and for the NC contacts.

6.2.15.1.2 Rupture

Force the relay or contactor to make and break its rated rupture current at each of the maximum system voltage (open circuit) ratings, for a minimum of 50 operations using the values of current and cycling time in table 13, or as specified in the detail specification (see 4.1). For double-throw devices, perform separate tests for the NO and NC contacts For those devices with both a.c. and d.c. ratings, perform a c and d c. rupture tests on separate samples at highest system voltage (open circuit), as specified in the detail specification (see 4.1)

Table 12 — Overload values and durations

Relay rating A	Rated resistive %			Duty cycle s	
	28 V d.c.	115 V d c	115/200 V a.c. three-phase	ON ± 0,05	OFF ±1
⩽ 24	400	400	600	0,2	20
⩾ 25	800	800	800	0,2	20

Table 13 — Rupture values and durations

Resistive rating A	Rated resistive load %			Duty cycle s	
	28 V a c.	115 V a c	115/200 V a.c three-phase	ON ± 0,05	OFF ±1
⩽ 10	500	500	800	0,2	30
> 10	1 000	1 000	1 000	0,2	30

6.2.15.1.3 Circuit breaker compatibility

This test is applicable only if specified in the detail specification (see 4.1).

Subject each relay or contactor to five applications (make and carry only) of power concurrently on adjacent poles at each of the current levels and for the associated time specified in the detail specification (see 4.1). Test relays or contactors at 28 V d.c. and 115/200 V a.c., 400 Hz, three-phase with a resistive load. Allow cooling time of 30 min between successive applications of current. Perform tests at room conditions on both the NO and NC contacts.

6.2.15.2 Endurance (life)

Perform endurance load cycling tests as specified in the detail specification (see 4.1), and this subclause. Use a duty cycle conforming to table 14. Conduct the endurance test with 50 % of the required operating cycles at the maximum temperature and altitude for the class of relay being tested. Make provision for continuous monitoring of contact operation. Interrupt the life test every 5 000 operations and record the contact circuit voltage drop. Check that the readings do not exceed the values specified in the detail specification (see 4.1).

NOTE 19 The altitude requirement for hermetically sealed relays or contactors may be waived provided that the ambient temperature is increased by 10 % of that specified for the class of device being tested

Unless otherwise specified during all endurance tests, apply the control and contact voltages using the d.c. or a.c. (open circuit) system voltages specified in the detail specification (see 4.1). Use a minimum of 100 000 cycles at each contact load rating unless otherwise specified in the detail specification (see 4.1).

6.2.15.2.1 Inductive load, d.c.

Subject the relay or contactor to the minimum number of operating cycles with inductive loads of time constant $\tau = L/R = (5 \pm 0,5)$ ms (see 4.1), using the duty cycle of table 14.

6.2.15.2.2 Motor load, d.c.

Subject the relay or contactor to the minimum number of operating cycles for making six times the rated motor load at rated system voltage, and for breaking the normal rated motor load.

Use a specified inrush current duration of (0,07 ± 0,02) s. After this period, reduce the current to its rated motor load for the remainder of the "ON" period.

6.2.15.2.3 Resistive load, d.c.

Subject the relay or contactor to the minimum number of operating cycles in a noninductive resistive circuit, the current being the maximum rated resistive loads specified in the detail specification (see 4.1), at each rated system voltage.

Use resistors for loads that have an L/R ratio not exceeding 1×10^{-4} s.

Table 14 — Duty cycle

Time in seconds

Relay or contactor	Inductive (a c or d c)		Motor (a c or d c)		Resistive (a c or d.c)		Lamp (28 V d c)	
	ON	OFF1)	ON	OFF1)	ON	OFF1)	ON	OFF1)
Classes 1, 2 and 3	0,5 ± 0,05	3,0 ± 0,1	0,35 ± 0,09 2)	2 ± 0,1	1,5 ± 0,1	1,5 ± 0,1	2 ± 0,05	7 ± 2
Intermittent duty coils	0,5 ± 0,05	3,0 ± 0,1	0,35 ± 0,09 2)	10 ± 0,1	1,5 ± 0,05	2,5 ± 0,1	2 ± 0,05	7 ± 2

1) "OFF" time may be decreased at the manufacturer's discretion

2) The duration of specified inrush current shall be (0,07 ± 0,02) s, after which it shall be reduced to its rated motor load for the remainder of the ON period

6.2.15.2.4 Lamp load

Unless otherwise specified in the detail specification (see 4.1), perform the lamp load with a 28 V d.c. power supply. Subject relays or contactors to the minimum operating cycles specified in the detail specification (see 4.1), making 12 times the rated lamp load and breaking the rated lamp load. Use a duration for the 12 times inrush current of 0,015 s to 0,020 s. Except for single-throw devices, test one NC contact. Test multipole devices with the loads on two separate adjacent poles.

6.2.15.2.5 Inductive load, a.c.

Subject the relay or contactor to the minimum operating cycles with inductive loads for the rated current and voltage using the duty cycle of table 11. Use inductive load circuits with inductive and resistive load elements connected in series. Use circuit parameters of rated inductive current, voltage and frequency, and a (0,7 ± 0,05) lagging power factor.

6.2.15.2.6 Motor load, a.c.

Use the procedure specified in 6.2.15.2.2 for the a.c. motor load test with the a.c. inrush current five times rated motor load current, or as specified in the detail specification (see 4.1).

6.2.15.2.7 Resistive load, a.c.

Use the procedure specified in 6.2.15.2.3 with the a.c. load equal to the resistive current specified in the detail specification (see 4.1).

6.2.15.3 Mechanical life (endurance at reduced load)

With rated coil voltage, cycle the relay or contactor at 25 % of rated resistive load for four times the specified minimum operating cycles for relays under 25 A contact rating (resistive), and twice the specified minimum operating cycles for contactors of 25 A and over. Use the cycling rate specified for resistive loads. Load each relay circuit (NO and NC contacts of all poles) including interlock circuits if they exist, at 25 % of rated resistive load current (steady-state) at 28 V d.c. or rated a.c. voltage Provide each load with a circuit that will detect failure of the contacts to open and close. Specify failure to close as a voltage drop across the contacts exceeding 10 % of full load voltage. During the test, ensure that each set of contacts opens and closes its individual circuit in proper sequence.

6.2.15.4 Intermediate current

Subject the relay or contactor to 50 000 cycles as follows. Test NO and NC contacts. Perform tests on NO and NC contacts of double-throw relays and contactors concurrently. Use a test voltage of (28 ± 1) V d.c. During each cycle, energize the coil for (29 ± 3) s and de-energize for (1,5 ± 0,5) s During each cycle, ensure that the contacts under test make, carry and interrupt the test current specified in the applicable clause below. While the contacts are carrying the test current, measure the contact voltage drop at the start of the test and ensure that it does not exceed the value shown in table 15. Monitor to provide either a continuous record of contact voltage drop, or to cause cessation of the test if the values of table 15 are exceeded. Perform tests on main and auxiliary contacts concurrently. Carry out the test at the maximum ambient temperature specified in the detail specification (see 4.1) and at sea level conditions. Where a relay or contactor is required to be cycled for more than 50 000 cycles, cycling in excess of 50 000 may be accomplished at the rate specified in table 15. Relays or contactors with intermittent duty coils are exempt from this test.

Use an inductance conforming to figures 11 and 12 and record compliance.

Table 15 — Contact voltage drop

Contact ratings (rated resistive load) A	Maximum initial voltage drop (see 5.1 7) mv	Calculated initial allowable resistance Ω	Maximum allowable voltage drop after test begins[1) 2)]			
			0,5 A resistive load mV	0,3 A resistive load mV	0,1 A resistive load mV	Rated resistive load mV
2 (auxiliary contacts)	150	0,075	63	38	13	175
5	150	0,030	40	24	8	175
10	150	0,015	32	20	7	175
15	150	0,010	30	18	6	175
20	150	0,010	30	18	6	175

1) Determine maximum allowable contact voltage drop for ratings not listed by adding 0,05 Ω to the calculated initial allowable resistance based on initial allowable contact voltage drop with a maximum of 200 mV. Check that the voltage drop at rated current does not exceed the limits of contact voltage drop specified in 5 1.7.

For contactors rated above 20 A and with an intermediate current of 10 % of rated resistive load, calculate E_{max}, in millivolts, from the following equation, or use 200 mV, whichever is less

$$E_{max} = \left[I_i \times \left(\frac{0,150}{I_r} \right) + 0,05 \right] \times 1\ 000$$

where

I_i is the intermediate current,

I_r is the rated resistive load

2) Where the lower specified load (resistive, motor, inductive, lamp) of a contactor's power contacts is ⩾ 25 A the following apply:

a) 2 % of the specified operations may exceed the voltage drop listed, but no more than three operations may exceed 1 000 mV drop,
b) use a cycle rate of 20 s on and 10 s off

Connect each NO and NC contact to loads in accordance with table 16.

Table 16

Circuit No. Pole No.	Loads
1	0,5 A resistive load
2	0,3 A resistive load
3	0,1 A resistive load
4	rated resistive load

If the relay or contactor has more than two poles, repeat the above loads in the sequence listed. Omit rated load for single-pole, single-throw devices. For single-pole, double-throw devices, test each sample unit with rated load on the normally open contact, and specified intermediate current on the closed contact.

For two- and three-pole devices, load one pole with rated current, and load the other poles with intermediate currents. Test sufficient samples to cover all combinations.

6.2.15.5 Mixed loads

This test is applicable only if specified in the detail specification (see 4.1).

Load the NO and NC contacts of one pole of a multipole relay with the low level load specified in the detail specification (see 4.1). Load all the NO and NC contacts of the remaining poles with the following loads specified in the detail specification (see 4.1).

a) inductive load (d.c.);
b) inductive load (a.c.);
c) resistive load (d.c.);
d) resistive load (a.c.);
e) lamp load;
f) motor load (d.c.);
g) motor load (a.c.).

Provide one relay for each of the above loads (e.g. one sample will switch low level and (d.c.) inductive, one will switch low level and (a.c.) inductive, etc).

Wire relays of three or more poles so that the contact switching the low level load is in between the poles switching the high level loads. Use a cycle rate and number of cycles of operation as required for each of the applicable high level loads. Ensure all other testing requirements (including monitoring) conform to loads specified in 6.2.15.

6.2.15.6 Low level

Test relays for low level requirements. The following details apply, unless otherwise specified in the detail specification (see 4.1).

a) Contact load: 10 μA to 50 μA at 10 mV to 50 mV (d.c. or peak a.c.).

b) Cycling rate: Use a minimum cycling rate of 60 operations per minute. Use a maximum cycling rate 10 times the sum of the maximum specified operate and release times for the relay under test.

c) Total cycles: 100 000.

d) Coil voltage: Nominal.

e) Miss detection monitoring level· 100 Ω

f) Sticking of contacts constitutes a failure.

6.2.15.7 Load transfer, single or polyphase a.c.

Connect the relay or contactor contacts to 2 separate and independent four-wire, three-phase (Y-connected) power supply systems in accordance with figure 11. Use a systems (generator) voltage and load currents as specified in the detail specification (see 4 1) Maintain the frequency of generator number one within 1 % of specified rating. Maintain the frequency of generator number two at 2 % to 10 % below the frequency specified in the detail specification (see 4.1).

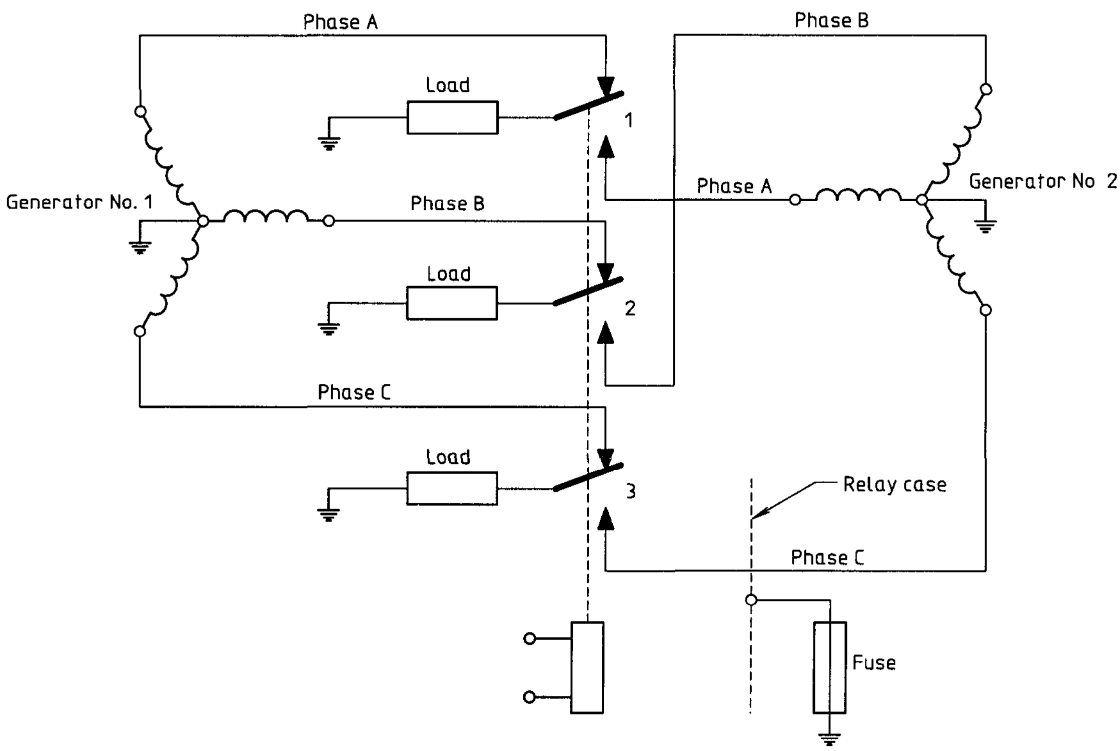


Figure 11 — Test circuit, three-phase load transfer

As an alternative, use a single power supply system in which the load can be switched between phases and in which the system voltage can be raised to 133 V/230 V r.m.s., three-phase a.c. (e.g. by use of a variable auto-transformer), or in which a transformer is used as shown in figure 12. Ensure that the transformer continuous duty rating is at least as great as the loads to be switched. Ensure that voltage regulation at the load does not exceed 2,5 % when the line current of one or more phases is 10 times the specified load current.

With rated coil voltage and current, subject the relay or contactor to 10 000 cycles of operation at a duty cycle of (5 ± 1) s ON and (5 ± 1) s OFF. Use inductive a.c. loads (see 6.2.15.4) and current and voltage values as specified in the detail specification (see 4.1). Monitor each phase of the power supply system, and each movable contact of the relay or contactor continuously to determine phase-to-phase arc-over, and contact sticking and welding. Single- and two-pole devices may be tested in the same manner by omitting inapplicable contacts and loads. The test circuitry may be modified for testing interlock contactors and devices with double break contacts. Energize interlock contacts alternately by use of SPDT transfer switch device.

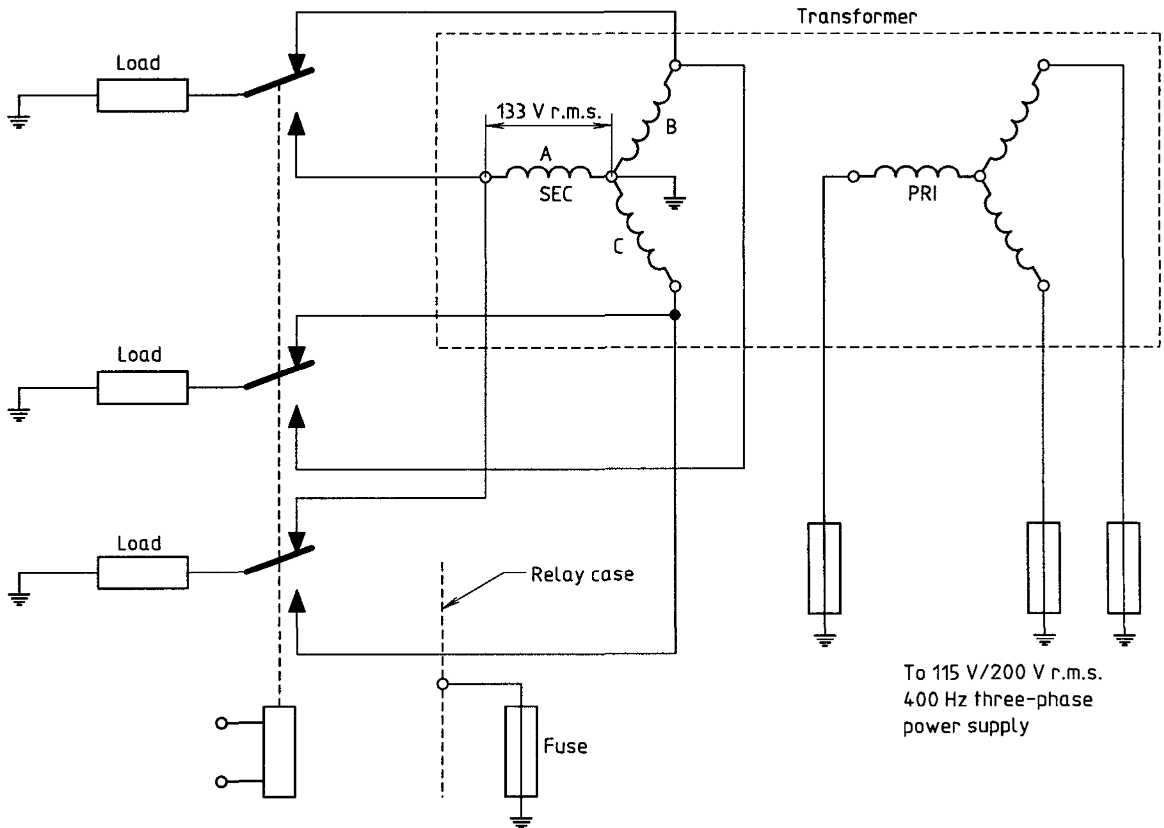


Figure 12 — Alternative test circuit, three-phase load transfer

6.2.16 Contamination

Subject each device to the contamination test cycle specified in 6.2.16.1 to 6.2.16.3. Use the contaminants specified in the detail specification (see 4.1) selected from the groups in table 17.

Table 17 — Contaminant test temperatures

Types of contaminant	Temperature °C
1) Fuels	50
2) Hydraulic fluids — mineral oil based — synthetic	 85 120
3) Lubricants — mineral oil based — synthetic	 120 120
4) Cleaning fluids	25
5) De-icing fluids	50
6) Fire extinguishing agents (at 0,1 MPa overpressure)	15
7) Coolants	50
8) Greases	70

6.2.16.1 First phase

6.2.16.1.1 Immersion in liquids

Raise the temperature of the test sample and contaminants to the temperature specified in table 17 without exceeding the temperature limits of the test sample.

Test relays with plug-socket holders separately. Immerse the test sample in the liquid for a period of (15 ± 5) min.

6.2.16.1.2 Application of greases

Raise the temperature of the test sample and the grease to the temperature specified in table 17. Apply the grease thinly using a brush. Place the test sample in a warming cupboard and store for 15 min to 20 min. Ensure that relays with plug-socket holders are plugged in for this test.

6.2.16.2 Second phase

6.2.16.2.1 Liquids

Remove the test sample from the liquid and store for (7 ± 0,5) h under normal ambient conditions

6.2.16.2.2 Greases

Store the test samples under normal ambient conditions for (7 ± 0,5) h.

6.2.16.3 Third phase

Subject the test sample to the maximum temperature specified in the detail specification (see 4 1) in a chamber with circulating, clean air for (16 ± 0,5) h.

If a drying temperature is not specified in the detail specification, use a temperature not below + 65 °C.

Repeat this cycle four times (total of five cycles). Ensure that relays with plug-socket holders are plugged in for this test.

6.2.17 Insertion and withdrawal force

6.2.17.1 Preparation

Use new and previously unused contacts for this test.

Wire up all contacts as specified in the detail specification (see 4.1) and place in the insert, with the exception of those to be used for the test

6.2.17.2 Procedure

6.2.17.2.1 Number of contacts to be tested per contact size

Table 18 gives the number of contacts to be tested per contact size.

Table 18

Number of contacts per contact size, N	Minimum number of contacts to be tested %
$N \leqslant 5$	100
$5 < N < 60$	50

Where the number of contacts in the test sample is odd, round up the number of contacts to be tested.

The test equipment consists of:

— a suitable insertion and extractor tool;

— a holder for test sample; and

— a unit for measurement of forces.

If the number of contacts to be tested is greater than five, repeat the insertion and the withdrawal 10 times for contact.

Measure the forces for the first insertion and last withdrawal.

6.2.17.2.2 Insertion force

Insert the contact using the tool specified in the detail specification (see 4.1) and check for full engagement.

Measure the force required in the axial direction to insert the contact with the measuring equipment.

6.2.17.2.3 Withdrawal force

Withdraw the contact using the tool specified in the detail specification (see 4.1).

Measure the force required to withdraw the contact with the measuring equipment.

6.2.17.2.4 Test characteristics

Test characteristics are given in table 19.

Table 19

Socket size AWG	Wire size AWG	Maximum insertion force N	Maximum release force N
16/16 and 16/20	16	66	45
20/20	16	66	45
12/12	12	66	45

Check that the seal is not damaged.

6.2.17.3 Flexibility and resistance to elongation

6.2.17.3.1 Preparation

Insert the contact sockets to be tested, with or without wiring, in the contact insert of the test sample. Secure firmly to prevent twisting during the test.

Other devices may be used to hold the contact sockets, but these must simulate the contact insert of the test sample.

6.2.17.3.2 Procedure

Table 18 gives the number of contacts to be tested per contact size.

6.2.18 Mechanical/electrical interlock

Subject relays or contactors incorporating a mechanical interlocking feature to the following tests. With one set of contacts held in the closed position as specified below, apply maximum operating voltage to the actuating coil of the opposing set of contacts for 200 cycles. The operational cycle consists of 0,5 s ON and 2,5 s OFF. Apply the 200 cycles of operation under each of the following conditions:

a) The first set of contacts held in the closed position by the application of maximum operating voltage to the actuating coil.

b) The second set of contacts held in the closed position by the application of maximum operating voltage to the actuating coil

c) The first set of contacts held in the closed position by mechanical means. The manufacturer may submit an opened sample unit of a sealed device for this test.

d) The second set of contacts held in the closed position by mechanical means. The manufacturer may submit an opened sample unit of a sealed device for this test.

Use an indicating device to determine conformance of the relay or contactor.

6.2.19 Seal test

Test hermetically sealed and environmentally sealed relays and contactors for gross and fine leaks. Test contactors larger than 32,8 cm^3 (2 in^3) with leakage rate requirements of $6{,}2 \times 10^{-3}$ $Pa{\cdot}cm^3/s$ per cubic centimetre (1×10^{-6} $atm{\cdot}cm^3/s$ per cubic inch) of net sealed gas volume in accordance with standard test methods given in IEC 68-2-17 using helium as a tracer gas, or the radioisotope procedure (see 6.2.19.1). Test relays equal to or less than 32,8 cm^3 (2 in^3) with gas leakage rate requirements of 6,2 × 10^{-5} Pa·cm^3/s per cubic centimetre (1 × 10^{-8} atm·cm^3/s per cubic inch) of net sealed gas volume with the radioisotope method (see 6.2.19.1).

NOTES

20 Leakage rates are air equivalent values.

21 Relays may be tested using other methods but, in the event of a dispute the radioisotope method is to be used

6.2.19.1 Radioisotope procedure (preferred)

Examine relay or contactor for physical damage to seal.

If necessary, wash device to eliminate any foreign contaminant.

6.2.19.2 Radioisotope dry gross leak test

6.2.19.2.1 General

Use this test only for devices that contain internally a krypton-85 absorbing medium, such as electrical insulation, organic or molecular sieve material. This test is permitted only if the following requirements are met:

a) Make a 5 mm to 10 mm diameter hole in a representative sample of the device to be tested.

   NOTE 22 This is a one-time test that remains in effect until a design change is made in the relay or contactor internal construction.

b) Subject the representative sample to the tests defined in 6.2.19.2.2 and 6.2.19.2.3. If the sample device exhibits a hard failure, the test may be used for those devices of the type represented by the sample. If the sample device does not fail, the dry gross leak test shall not be used to test devices of the type represented by the sample.

6.2.19.2.2 Apparatus and reagent

The following apparatus and reagent are required for this test:

a) **radioactive tracer gas activation console,** containing krypton-85/dry nitrogen gas mixture;

b) **counting station,** with sufficient sensitivity to determine the radiation level of krypton-85 tracer gas inside the device;

c) **tracer gas mixture,** consisting of krypton-85/dry nitrogen with a minimum allowable specific activity of 100 µCi/atm·cm^3. The specific activity of the mixture shall be a known value and determined on a once-a-month basis as a minimum.

6.2.19.2.3 Procedure

Place the device in a radioactive tracer gas activation tank and evacuate to a pressure not exceeding 66,661 Pa (0,5 torr). Subject the device to a minimum pressure of 3,325 N/m^2 (10 psig) of the krypton-85/dry nitrogen gas mixture for 30 s. The gas mixture exists in the activation tank. Backfill the activation tank with air (air wash). Remove the device from the activation tank and leak test within 2 h after gas exposure using a scintillation-crystal-equipped counting station. Devices indicating 1 000 counts per minute (CPM) or greater above the ambient background of the counting station shall be considered a gross leak failure.

6.2.19.3 Radioisotope fine leak test

6.2.19.3.1 Apparatus and reagent

The following apparatus and reagent are required for this test:

a) **Radioactive tracer gas activation console,**

b) **counting station,** of sufficient sensitivity to determine through the device wall the radiation level of krypton-85 tracer gas present within the device The counting station requires a minimum detectability of 500 CPM above ambient background;

c) **tracer gas mixture,** consisting of krypton-85/dry nitrogen with a minimum allowable specific activity of 100 µCi/atm·cm^3. The specific activity of the mixture shall be a known value and determined on a once-a-month basis as a minimum

6.2.19.3.2 Activation parameters

Determine the activation pressure, $\overline{P}$, and soak time, T, in hours, for which the devices are to be activated in accordance with the following equation:

$$Qs = \frac{R}{3\,600skTP} \quad \ldots (1)$$

where

Qs is the maximum leak rate allowable, in Pa·cm^3/s (atm·cm^3/s), for the device to be tested (conversion factor from krypton to air is 1,712);

R is the reject count above the background of both the counting equipment and the component if it has been through prior radioactive leak tests and is 1 000 CPM above the ambient background after activation if the device leak rate is exactly equal to Q;

s is the specific activity, in µCi/Pa·cm^3 (µCi/atm·cm^3), of the krypton-85 tracer gas in the activation system;

k is the overall counting efficiency of the scintillation crystal, in CPM per microcurie of krypton-85 in the internal void of the specific component being evaluated. This factor depends upon component configuration and dimensions of the scintillation crystal;

NOTE 23 The k-factors of the relays or contactors in regular use have already been determined and accepted throughout industry If unavailable for a particular package, consult the test equipment manufacturer.

with

$$\overline{P} = P_e - P_i$$

where

P_e is the activation pressure, in pascals (atmospheres absolute);

P_i is the original internal pressure of the devices, in pascals (atmospheres absolute).

NOTE 24 The activation pressure (P_e) may be established by specification, or if a convenient soak time (T) has been established, the activation pressure (P_e) can be adjusted to satisfy equation (1)

6.2.19.3.3 Evaluation of surface absorption

Evaluate all device encapsulations except those of glass, metal and ceramic including coatings and external sealants (or combinations of these), for surface absorption of krypton-85 before establishing the leak test parameters. Subject representative samples of the devices to the predetermined pressure and time conditions established for the device. Check the devices for surface absorption of krypton-85 gas using a surface beta detector. This type of surface detector will provide over 200 times the detectability obtained with a scintillation crystal when measuring surface gas. Take a reading every 10 min until the surface is shown to be free of krypton-85. At that time, take a final reading using the scintillation crystal for rejection of leaking devices.

6.2.19.3.4 Seal testing procedure

Place the devices in a radioactive tracer gas activation tank and evacuate the tank to 66,661 Pa (0,5 torr). Subject the devices to a pressure limit and a time determined from equation (1). Evacuate the krypton-85/dry nitrogen mixture to storage until 66,661 Pa (0,5 torr) exists in the activation tank. Complete this evacuation in 5 min maximum. Backfill the activation tank with air (air wash). Remove the devices from the activation tank and leak test immediately using a scintillation-crystal counting station Test devices that show surface absorption in the scintillation-crystal after the surface measurements indicate that externally absorbed krypton-85 has dissipated. Calculate the actual leak rate, Q, in Pa·cm^3/s (atm·cm^3/s) of the component from the following equation:

$$Q = \frac{n \times Qs}{R}$$

where

n is the readout, in counts per minute; and

Qs and R are as defined in 6.2.19.3.2.

Unless otherwise specified in the detail specification (see 4.1), devices that exhibit a leak rate equal to or greater than $1{,}712 \times 10^{-8}$ atm·cm^3/s of krypton-85 are considered a failure

7 Qualification

7.1 Production acceptance tests

Production acceptance shall conform to the tests shown in table 20. If the manufacturer performs more stringent tests than required by table 20 as the final step of his production process, table 20 tests may be waived for other type testing. Actual measured values shall be shown for final acceptance testing.

7.2 Qualification inspection

Qualification inspection shall be performed at a laboratory acceptable to national authority Relays or contactors shall be tested to the requirements of this part of ISO 5867 and shall be qualified to the applicable national standard.

Qualification inspection shall conform to the tests shown in table 21. The number of test samples shall be sufficient to cover all required tests. Devices that have completed the applicable environmental tests shall continue to satisfy the basic electrical characteristics.

NOTE 25 A typical test sequence for motorload testing is outlined in table 21.

7.3 Retention of qualification

The manufacturer shall show that he maintains qualification to the applicable ISO standard or national standard.

Table 20 — Production acceptance tests

Inspection	Requirement subclause	Test method subclause
Dimensions	5 1 1	6 1 1
Visual inspection	5 1 2	6 1 2
Operate voltage	5 1 3 and 5 1 4	6 1 3
Coil resistance or current	5 1 6	6.1.5 and 6 1.6
Contact voltage drop	5 1 7	6.1.7
Operate, release and bounce time	5 1 8	6.1.8
Dielectric strength	5 1.9	6.1 9
Insulation resistance	5 1 10	6 1 10
Low level[1)]	5 1 11	6 1 11
Sealing	5 1.12	6 1 12
Marking	5.1 13	6 1 13
Exported spikes[1)]	5 2 3 1	6 1 14 1
1) If applicable		

Table 21 — Qualification inspection

	Detail performance requirement	Methods for examination test	Test sequence per sample																
	subclause	subclause	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Examination of product	5.1	6.1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Dimensions	5.1.1	6.1.1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Visual inspection	5.1.2	6.1.2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	
Pickup voltage	5.1.3.1	6.1.3.1	4	4, 13	4, 14	4, 13, 18	4, 13, 22	4, 13, 22	4	4	4	4, 16	4, 12	4, 13	4	4	4	4	
Dropout voltage	5.1.3.2	6.1.3.2	5	5, 14	5, 15	5, 14, 19	5, 14, 23	5, 14, 19	5	5	5	5, 17	5, 13	5, 14	5	5	5	5	
Hold voltage	5.1.4	6.1.4	6	6, 15	6, 16	6, 15, 20	6, 15	6, 15, 20	6	6	6	6	6, 14	6, 15	6	6	6	6	6
Contact bounce, operate and release time	5.1.8	6.1.8	7	7	7, 17	7	7	7, 21	7	7	7	7, 18	7, 15	7, 16	7	7	7	7	
Insulation resistance	5.1.9	6.1.9	8	8, 16	8, 19	8, 21, 25	8, 16	8, 22	8, 12	8, 12	8, 13	8, 13	8, 16	8, 17	8, 12	8, 12	8, 12	8, 12	
Dielectric strength	5.1.10	6.1.10	9	9, 17	9, 20	9, 22, 26	9, 17	9, 23	9, 13	9, 13	9, 14	9, 14	9, 17	9, 18	9, 13	9, 13	9, 13	9, 13	
Contact voltage drop	5.1.7	6.1.7	10	10, 18	10, 21	10, 16, 27	10, 18, 24	10, 16, 24	10, 14	10, 14	10, 15	10, 15	10, 18	10, 19	10, 14	10, 14	10, 14	10, 14	
High temperature operation	5.2.1	6.2.1				17	11	11											
Low temperature operation	5.2.2	6.2.2				12													
EMI	5.2.3	6.2.3	11	11															
Strength of terminals	5.2.4	6.2.4			11														
Thermal shock	5.2.5	6.2.5				11													
Sand and dust	5.2.6	6.2.6						12											
Continuous current	5.2.7	6.2.7						17											
Shock	5.2.8	6.2.8			12														
Acoustical noise	5.2.10	6.2.10												11					
Salt spray	5.2.11	6.2.11					12												
Ozone	5.2.12	6.2.12					19												
Acceleration	5.2.13	6.2.13			13														

	Detail performance requirement subclause	Methods for examination test subclause	Test sequence per sample 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Explosion-proofing	5.2.14	6.2.14		19															
Overload a.c. or d.c.	5.2.15.1.1	6.2.15.1.1				23	20				11	11							
Rupture	5.2.15.1.2	6.2.15.1.2	13											11					
Circuit breaker compatibility	5.2.15.1.3	6.2.15.1.3													11				
Mechanical life	5.2.15.3	6.2.15.3		12										11					
Intermediate current	5.2.15.4	6.2.15.4	12					28											
Mixed loads	5.2.15.5	6.2.15.5																	
Load transfer	5.2.15.7	6.2.15.7														11			
Inductive load, d.c.	5.2.15.2	6.2.15.4								11									
Motor load, d.c.	5.2.15.2	6.2.15.4									12								
Resistive load, d.c.	5.2.15.2	6.2.15.4					21												
Lamp load, d.c.	5.2.15.2	6.2.15.4							11										
Inductive load, a.c.	5.2.15.2	6.2.15.4			18														
Motor load, a.c.	5.2.15.2	6.2.15.4									12								
Resistive load, a.c.	5.2.15.2	6.2.15.4										12							
Seal test	5.2.19	6.2.19	14	20	22	28	25	29	16	15	16	19	19	20					
Marking	5.1.13	6.1.13	17				26	21											3
Vibration sinusoidal	5.2.9.1	6.2.9.1						27											
Vibration random	5.2.9.2	6.2.9.2						28	15										
Electrical mechanical interlock	5.2.18	6.2.18	15																
Contamination	5.2.16	6.2.16	16	21	23			30	17	16	17	20	20	21					
Insertion and withdrawal test	5.2.17	6.2.17																	4
Coil resistance	5.1.5	6.1.5						25											
Coil current	5.1.6	6.1.6						26											

Annex A
(informative)

Example of an individual specification sheet

Manufacturer: ....

Type or part No.: ....

Nominal on-load voltage: ....

Open circuit voltage: ....

Overload voltage: ....

Environmental requirements

Acceleration: ....

Rapid decompression: ....

Vibration: ....

Mould growth: ....

Free fall. ....

Fluid contamination: ....

Bump: ....

Max. ambient temperature (T_H): ....

Min. ambient temperature (T_L): ... .

Weight (kg): ....

Outline and interface dimensions

Side elevation

End elevation

Plan view

Interface details

Terminations: ....

Drawing (if necessary)

Markings

Drawing of label

Degree of seal: ....
Installation torque values (N·m): ....
Dissimilar metals, exceptions (if any): ....
Magnet wire, type/size: ....
Rubber, type/grade: ....
Ceramic insulator material: ....
Semiconductors: ....
D.C. coil resistance (Ω): ....
Maximum coil current (A): ....
Operating and release time limits: ....
Contact bounce time: ....
Dielectric strength: .... Insulation resistance (Ω): ....
Leakage rate: ....
Pickup voltage (V): .... Dropout voltage (V): ....
Compass-safe distance: ....
Acoustical noise limits (if applicable): ....
Circuit breaker compatibility: ....
Mixed-load levels (if applicable): ....
Polyphase load transfer: ....
Insertion and withdrawal forces (N): ....
Mechanical/electrical interlock (if applicable): ....
....
Minimum number of operating cycles: ....
Maximum number of operating cycles: ....

Annex B
(informative)

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1) To be published

ICS 49.060

Descriptors: aircraft industry, aircraft, aircraft equipment, electromagnetic equipment, contactors (switches), electric relays, specifications, performance, tests, performance tests, acceptance testing, qualification

Price based on 47 pages