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Entwurf

Luft- und Raumfahrt – Schutzschalter, dreipolig, temperaturkompensiert, Nennströme von 1 A bis 25 A – Teil 001: Technische Lieferbedingungen; Englische Fassung prEN 2996-001:2020

Aerospace series –
Circuit breakers, three-pole, temperature compensated, rated currents 1 A to 25 A –
Part 001: Technical specification;
English version prEN 2996-001:2020

Série aérospatiale –
Disjoncteurs tripolaires compensés en température, intensités nominales 1 A à 25 A –
Partie 001: Spécification technique;
Version anglaise prEN 2996-001:2020

Anwendungswarnvermerk

Dieser Norm-Entwurf mit Erscheinungsdatum 2020-09-25 wird der Öffentlichkeit zur Prüfung und Stellungnahme vorgelegt.

Weil die beabsichtigte Norm von der vorliegenden Fassung abweichen kann, ist die Anwendung dieses Entwurfs besonders zu vereinbaren.

Stellungnahmen werden erbeten

- vorzugsweise online im Norm-Entwurfs-Portal von DIN unter www.din.de/go/entwuerfe bzw. für Norm-Entwürfe der DKE auch im Norm-Entwurfs-Portal der DKE unter www.entwuerfe.normenbibliothek.de, sofern dort wiedergegeben;
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- oder in Papierform an den DIN-Normenausschuss Luft- und Raumfahrt (NL), 10772 Berlin oder Saatwinkler Damm 42/43, 13627 Berlin.

Die Empfänger dieses Norm-Entwurfs werden gebeten, mit ihren Kommentaren jegliche relevanten Patentrechte, die sie kennen, mitzuteilen und unterstützende Dokumentationen zur Verfügung zu stellen.

Gesamtumfang 25 Seiten

DIN-Normenausschuss Luft- und Raumfahrt (NL)

Nationales Vorwort

Der Verband der Europäischen Luft-, Raumfahrt- und Verteidigungsindustrie – Normung (ASD-STAN) ist vom Europäischen Komitee für Normung (CEN) für zuständig erklärt worden, Europäische Normen (EN) für das Gebiet der Luft- und Raumfahrt auszuarbeiten. Durch die Vereinbarung vom 3. Oktober 1986 wurde ASD Assoziierte Organisation (ASB) des CEN.

Das vorliegende Dokument (prEN 2996-001:2020) wurde von ASD-STAN, Fachbereich Elektrotechnik, unter Mitwirkung deutscher Experten des DIN-Normenausschusses Luft- und Raumfahrt (NL) erarbeitet.

Das zuständige deutsche Normungsgremium ist der Arbeitsausschuss NA 131-04-05 AA „Schalter, Relais und Schutzgeräte“ im DIN-Normenausschuss Luft- und Raumfahrt (NL).

Der vorliegende Norm-Entwurf enthält zur technischen Kommentierung einen Europäischen Norm-Entwurf (prEN) ausschließlich in Englischer Fassung aus der CEN-Umfrage.

Ein zweiter Norm-Entwurf wird nur die Deutsche Fassung der veröffentlichten ASD-STAN prEN enthalten. Es wird darauf hingewiesen, dass auf Grund der Verfahrensweise zur Normenerstellung bei ASD-STAN der zweite Norm-Entwurf ausschließlich der redaktionellen Prüfung der deutschen Sprachfassung dienen wird.

Entsprechend Beschluss 57/9 des Technischen Ausschusses des Beirats des DIN-Normenausschusses Luft- und Raumfahrt (NL) sind die europäischen Luft- und Raumfahrt-Normungsergebnisse zweisprachig, in Deutsch und Englisch, in das Deutsche Normenwerk zu überführen. Aus diesem Grund wird die Norm beide Sprachfassungen enthalten.

Aktuelle Informationen zu diesem Dokument können über die Internetseiten von DIN (www.din.de) durch eine Suche nach der Dokumentennummer aufgerufen werden.

Änderungen

Gegenüber DIN EN 2996-001:2008-01 wurden folgende Änderungen vorgenommen:

a) Aktualisierung der normativen Verweisungen;

b) Literaturverzeichnis hinzugefügt;

c) Dokument wurde redaktionell überarbeitet.

– Entwurf –

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

DRAFT
prEN 2996-001

September 2020

ICS

Will supersede EN 2996-001:2006

English Version

Aerospace series - Circuit breakers, three-pole, temperature compensated, rated currents 1 A to 25 A - Part 001: Technical specification

Série aérospatiale - Disjoncteurs tripolaires compensés en température, intensités nominales 1 A à 25 A - Partie 001 : Spécification technique

Luft- und Raumfahrt - Schutzschalter, dreipolig, Temperaturkompensiert, Nennströme von 1 A bis 25 A - Teil 001: Technische Lieferbedingungen

This draft European Standard is submitted to CEN members for enquiry. It has been drawn up by the Technical Committee ASD-STAN.

If this draft becomes a European Standard, CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

This draft European Standard was established by CEN in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

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Recipients of this draft are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

Ref. No. prEN 2996-001:2020 E

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European foreword

This document (prEN 2996-001:2020) has been prepared by the Aerospace and Defence Industries Association of Europe — Standardization (ASD-STAN).

After enquiries and votes carried out in accordance with the rules of this Association, this Standard has received the approval of the National Associations and the Official Services of the member countries of ASD-STAN, prior to its presentation to CEN.

This document is currently submitted to the CEN Enquiry.

This document will supersede EN 2996-001:2006.

1 Scope

This document specifies the three-pole temperature compensated circuit breakers with signal contacts, polarized or not, rated from 1 A to 25 A and used in aircraft on-board circuits. It describes specific environmental, electrical and mechanical characteristics and the stringency of tests to be applied according to test methods of EN 3841-100.

These circuit breakers are intended for use in aircraft with electrical supplies in accordance with EN 2282 (all categories).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 2083, *Aerospace series - Copper and copper alloys conductors for electrical cables - Product standard*

EN 2282, *Aerospace series - Characteristics of aircraft electrical supplies*

EN 2825, *Aerospace series - Burning behaviour of non metallic materials under the influence of radiating heat and flames - Determination of smoke density*

EN 2826, *Aerospace series - Burning behaviour of non metallic materials under the influence of radiating heat and flames - Determination of gas components in the smoke*

EN 3841 (series), *Aerospace series — Circuit breakers — Test Methods*

EN 3844-1, *Aerospace series - Flammability of non-metallic materials - Part 1: Small burner test, vertical - Determination of the vertical flame propagation*

TR 6083 [1)], *Aerospace series — Cut-outs for installation of electrical components*

MIL-I-81969/1A [2)], *Installing and removal tools, connector electrical contact, type III, class 2, composition C*

MIL-I-81969/14C [2)], *Installing and removal tools, connector electrical contact, type III, class 2, composition B*

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1) Published as ASD-STAN Technical Report at the date of publication of this document by AeroSpace and Defence industries Association of Europe — Standardization (ASD-STAN), http://www.asd-stan.org/.

2) Published by: Department of Defense (DOD), the Pentagon, Washington D.C. 20301 USA

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 3841-100 apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at http://www.iso.org/obp
- IEC Electropedia: available at http://www.electropedia.org/

4 Description

These circuit breakers are operated by a “push-pull” type single push button (actuator) and with delayed action “trip-free” tripping. Their function is ensured up to the short-circuit current.

5 Design

5.1 Materials

5.1.1 Metallic materials

All metallic parts shall be resistant to corrosion or finished against corrosion. When dissimilar materials are in close contact, an adequate protection against corrosion shall be used so that the electromotive force of the galvanic couple does not exceed 0,25 V.

When bimetals are used, an eventual corrosion shall not affect the good operation of the circuit breaker.

5.1.2 Insulation materials

The insulating parts shall be made of auto-extinguishing or non-flammable materials; they shall not emit damaging or explosive vapours, even in presence of fire or internal electric arc.

They shall be insensitive to moulds and microorganisms action.

Application of any material or protective coating which might crack, break or flake shall be forbidden.

Materials which are not specified, or which are not specially described shall be as light as possible for the requested use.

Materials shall be selected according to security criteria (toxicity, smoke density) as defined in contractual documents.

5.2 Design

5.2.1 Insulating box

The insulating box shall integrate besides the mechanism, the connection and attachment unit.

5.2.2 Free release mechanism

Design of circuit breaker mechanism shall allow free release, i.e. the circuit breaker cuts out in case of overload and remains cut out even if the actuator is kept by force in engaged position.

A new engagement of circuit breaker is only possible after a first total release of the control actuator.

The operation in these conditions shall not affect further performances of the circuit breaker.

5.2.3 Attachment

All visible parts shall be black coloured and non-reflective.

5.2.4 Electrical connection units

They shall be able to receive the lugs (or contacts).

5.2.5 Control actuator

In engaged position, the visible part of the control actuator shall be of the colour stated in the product standard. In disengaged (or opened) position, the control actuator shall show a white strip.

The outer part of this actuator shall be isolated from all undervoltage parts.

The control actuator shall not stay in a transition position or give a false indication about the circuit breaker condition. It shall not be removable.

When pushing it, power contacts of the circuit breaker engage and indicating contact opens.

When pulling it, power contacts of the circuit breaker open and indicating contact closes.

The circuit breaker rating is indicated in indelible white colour on the front part of the control actuator.

The product standard gives the digits positioning.

5.2.6 Rating inviolability

The circuit breaker shall be designed in such a way that the calibration unit cannot be reached without breaking a sealing.

5.2.7 Leakage lines

The leakage lines and the minimal space to be foreseen between the undervoltage parts and any other part of the circuit breaker made of non-insulating material, as well as between the undervoltage parts of opposite polarity, shall be sufficient to avoid any default or arc tracking in all uses and climatic conditions.

5.2.8 Protection against non-release

Electrical overload happening on a circuit breaker locked in its engaged position (sticked contacts or non-operating release mechanism), shall cause the opening of the circuit by circuit breaker destruction without any fire or important smoke release.

6 Characteristics

6.1 General characteristics

See Table 1.

Table 1 — General characteristics

<table>
<tr><th colspan="2">Designation</th><th colspan="2">Requirements</th></tr>
<tr><td colspan="2">Assembly</td><td colspan="2">See product standard.</td></tr>
<tr><td colspan="2">Mass</td><td colspan="2">See product standard.</td></tr>
<tr><td colspan="2">Operational altitude</td><td colspan="2">See product standard.</td></tr>
<tr><td colspan="2">Power contact connection</td><td colspan="2" rowspan="3">See product standard.</td></tr>
<tr><td colspan="2">3 (three) input terminals on power supply side
(identified by digit A1, B1, C1)</td></tr>
<tr><td colspan="2">3 (three) output terminals on distribution side
(identified by digit A2, B2, C2)</td></tr>
<tr><td colspan="2">Signal contact connection, circuit closed
when circuit breaker is released</td><td colspan="2">Crimp contacts size 20
See product standard.</td></tr>
<tr><td colspan="2">Operational ambient temperatures limits</td><td colspan="2">From −55 °C to 125 °C</td></tr>
<tr><td rowspan="2">Temperature
compensation</td><td>Rating 1 A to 15 A</td><td>From −55 °C to 125 °C</td><td rowspan="2">See product standard.</td></tr>
<tr><td>Rating 20 A and 25 A</td><td>From −55 °C to 90 °C</td></tr>
<tr><td colspan="2">Rating marking</td><td colspan="2">On control actuator (indelible white)</td></tr>
</table>

6.2 Ratings

See product standard.

6.3 Nominal voltage of main contacts

See product standard.

6.4 Signal contact performances

See Table 2.

Table 2 — Signal contact performances

Signal contact	Type of load	28 V d.c.	5 V d.c.	5 V a.c. [a]	28 V d.c.
	Resistive	≤ 0,5 A	≥ 3 mA	Not used	≥ 3 mA
	Lamp	≤ 0,2 A	Not used	0,23 A	Not used
[a] Applicable on version without diode only.					

The circuit breaker status signalling function, open or closed shall be guaranteed after all the tests described in this specification.

NOTE In order to avoid any deterioration of the signalization circuit (contact and diode), the reception electrical test could be performed without exceeding the value recommended of 60 mW max. at 28 V d.c. max. (resistive load).

6.5 Dimensional characteristics

See product standard.

6.6 Recommended panel mounting dimensions

Panel cut-out:	The panel cut-out is in accordance with the designation TR 6083, C202.
Spacing:	50 mm horizontal and 40 mm vertical from the centres of the mounting holes.
Panel thickness:	1 mm to 3 mm.

7 Tests

7.1 Mechanical tests

See Table 3.

Table 3 — Mechanical tests

<table>
<tr><th colspan="4">Tests</th><th colspan="2">Requirements</th></tr>
<tr><td colspan="4">Visual check</td><td colspan="2">See EN 3841-201.</td></tr>
<tr><td colspan="3" rowspan="2">Operational force</td><td>Closing force (push)</td><td rowspan="2">See EN 3841-502.</td><td>8 N to 80 N</td></tr>
<tr><td>Opening force (pull)</td><td>5 N to 30 N</td></tr>
<tr><td rowspan="12">Mechanical strength</td><td rowspan="4">Actuator</td><td colspan="2">Travel</td><td colspan="2">See EN 3841-501.
For value, see product standard.</td></tr>
<tr><td colspan="2">Transverse load</td><td rowspan="3">See EN 3841-503.</td><td>≥ 110 N</td></tr>
<tr><td rowspan="2">Longitudinal load</td><td>Push</td><td>≥ 110 N</td></tr>
<tr><td>Pull</td><td>≥ 110 N</td></tr>
<tr><td rowspan="2">Attachment nut</td><td colspan="2">Tightening torque</td><td rowspan="2">See EN 3841-504.</td><td>≥ 5 N.m</td></tr>
<tr><td colspan="2">Rotation torque</td><td>≥ 3 N.m</td></tr>
<tr><td rowspan="3">Main contact connection</td><td colspan="2">Screw tightening torque</td><td rowspan="3">See EN 3841-505.</td><td>≥ 2 N.m</td></tr>
<tr><td colspan="2">Tensile force as per F_1
(see Figure 1 in product standard).</td><td>≥ 110 N</td></tr>
<tr><td colspan="2">Pressure force as per F_2
(see Figure 1 in product standard).</td><td>≥ 55 N</td></tr>
<tr><td rowspan="5">Signal contact connection (size 20)</td><td colspan="4">See product standard.</td></tr>
<tr><td colspan="2">Insertion force
Insertion possible without tools</td><td rowspan="2">See EN 3841-509.</td><td>≤ 6 N</td></tr>
<tr><td colspan="2">Extraction force</td><td>≤ 15 N</td></tr>
<tr><td colspan="2">Contact retention force
(pre-load 13,5 N)</td><td>See EN 3841-510.</td><td>≥ 67 N
shift ≤ 0,3 mm</td></tr>
<tr><td colspan="2">Radial load</td><td>See EN 3841-510.</td><td>≥ 30 N</td></tr>
<tr><td colspan="2">Recommended tools:
- plastic: MIL-I-81969/14–11
- metallic: MIL-I-81969/1–02</td><td colspan="2">See MIL-I-81969/1A and
MIL-I-81969/14C.</td></tr>
</table>

7.2 Environmental tests

See Table 4.

Table 4 — Environmental conditions

<table>
<tr><th colspan="2">Tests</th><th colspan="2">Requirements</th></tr>
<tr><td rowspan="5">Combined tests
Ambient temperature 70 °C and vibrations (see notes).</td><td rowspan="2">Sinusoidal (see Figure 1).
Duration:
– circuit breaker in the “closed” position;
- 0,9 I_n load – 7 (seven) cycles/axis – 1 octave/min;
- no load – 2 (two) cycles/axis - 1 octave/min.
– circuit breaker in the “opened” position;
- 2 (two) cycles/axis – 1 octave/min.</td><td rowspan="5">See EN 3841-506.</td><td>5 Hz to 80 Hz - Constant amplitude 2 a = 0,76 mm</td></tr>
<tr><td>80 Hz to 500 Hz - Constant acceleration = 10 g-PK</td></tr>
<tr><td>Random (see Figure 2).
Duration:
– circuit breaker in the “closed” position;
- 0,9 I_n load – 15 min/axis;
- no load – 15 min/axis.
– circuit breaker in the “opened” position;
- 15 min/axis.</td><td>500 Hz to 2 000 Hz - Constant acceleration = 5 g-PK

10 Hz to 2 000 Hz - Overall acceleration = 5,8 Grms</td></tr>
<tr><td rowspan="2">Low frequencies (see Figure 3).
Applicability: see product standard.
Duration:
– circuit breaker in the “closed” position;
- 0,9 I_n load – 2 (two) cycles/axis;
- no load – 2 (two) cycles/axis.
– circuit breaker in the “opened” position;
- 2 (two) cycles/axis.</td><td>10 Hz to 27 Hz to 10 Hz - Constant acceleration = 10 g-PK</td></tr>
<tr><td>10 Hz to 5 Hz - Constant acceleration = 3,5 g-PK</td></tr>
<tr><td rowspan="2">Combined tests
Ambient temperature 85 °C, cabin max. altitude 4 600 m and vibrations (see notes).</td><td rowspan="2">Sinusoidal - Applicability: see product standard.
Duration:
– circuit breaker in the “closed” position;
- 0,9 I_n load – 4 (four) cycles/axis - 1 octave/min;
- no load – 2 (two) cycles/axis - 1 octave/min.
– circuit breaker in the “opened” position;
- 2 (two) cycles/axis - 1 octave/min.</td><td rowspan="2">See EN 3841-511.</td><td>5 Hz to 54 Hz - Constant shift 2 a = 0,5 mm</td></tr>
<tr><td>54 Hz to 2 000 Hz - Constant acceleration = 3 g-PK</td></tr>
<tr><td colspan="2">Mechanical shocks (see notes)</td><td colspan="2">50 g-PK – 11 ms - half sine wave. See EN 3841-507.</td></tr>
<tr><td colspan="2">Constant accelerations</td><td colspan="2">See product standard.</td></tr>
<tr><td colspan="2">Sand and dust</td><td colspan="2">See product standard.</td></tr>
</table>

Tests	Requirements
Corrosion (salt spray)	See EN 3841-402 category S.
Humidity	See EN 3841-403 category A.
Explosion-proofing	See product standard.
Contaminating liquids	Cleaning and extinguishing products. See EN 3841-405.
Flammability (glow wire test)	See EN 3841-406.
Inflammability	See test EN 3844-1B.
Smoke density	See test EN 2825 A or B.
Toxicity	See test EN 2826 B.
Overvoltage caused by lightning only on main contacts	See EN 3841-308. Requirement: no tripping.

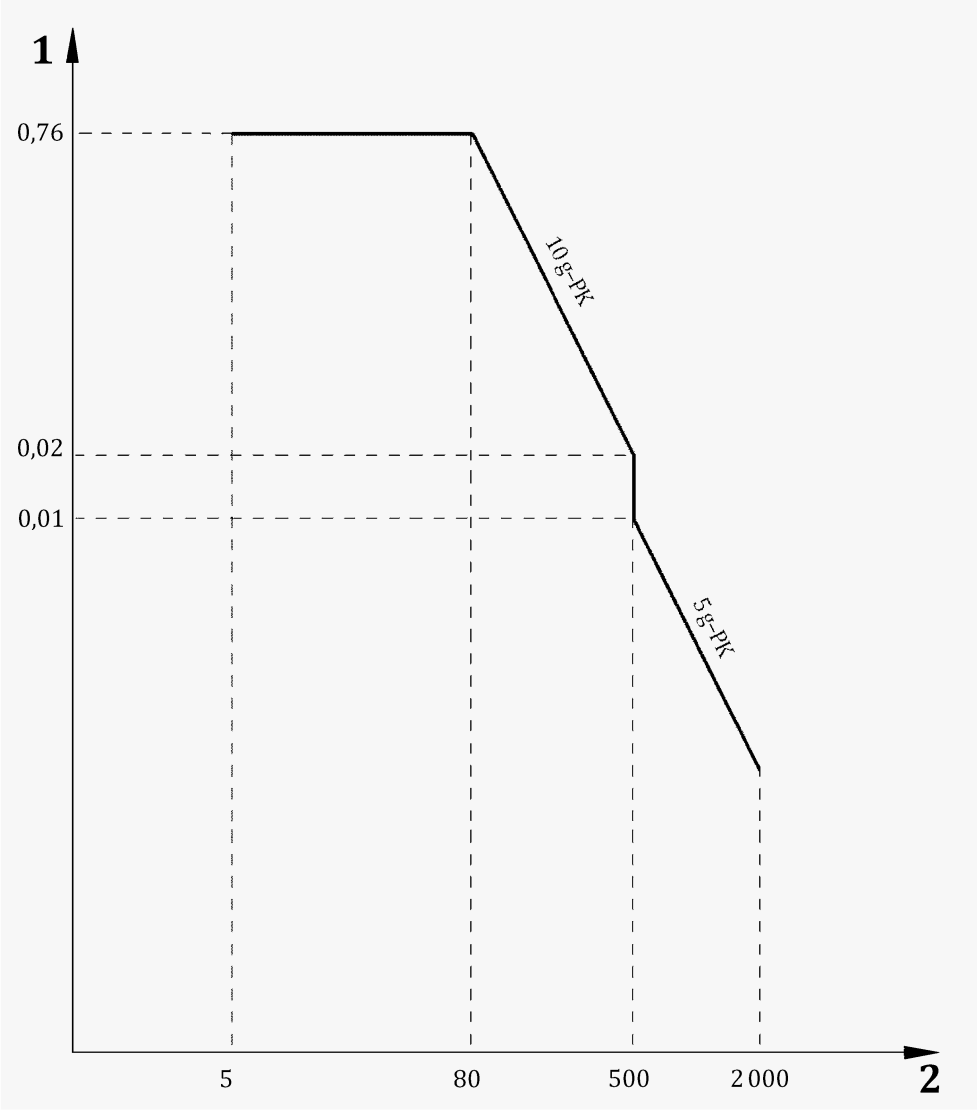
NOTE 1 Vibration tests performed on circuit breakers in closed position without load and in opened position, are carried out in order to detect contact opening and closure.

NOTE 2 For vibration and shock tests, the contact-opening or contact-closure shall be less than or equal to 10 µs on the power and the signal contacts.

NOTE 3 Shock tests are performed one on each way for each of the 3 (three) directions (i.e. 6 (six) shocks in all).

NOTE 4 Circuit breaker in the closed position = main contacts closed and auxiliary contacts opened. Circuit breaker in the opened position = main contacts opened and auxiliary contacts closed.

NOTE 5 Any additional vibration testing (e.g. Sustained Engine Imbalance) shall be contractually agreed between users and manufacturers.

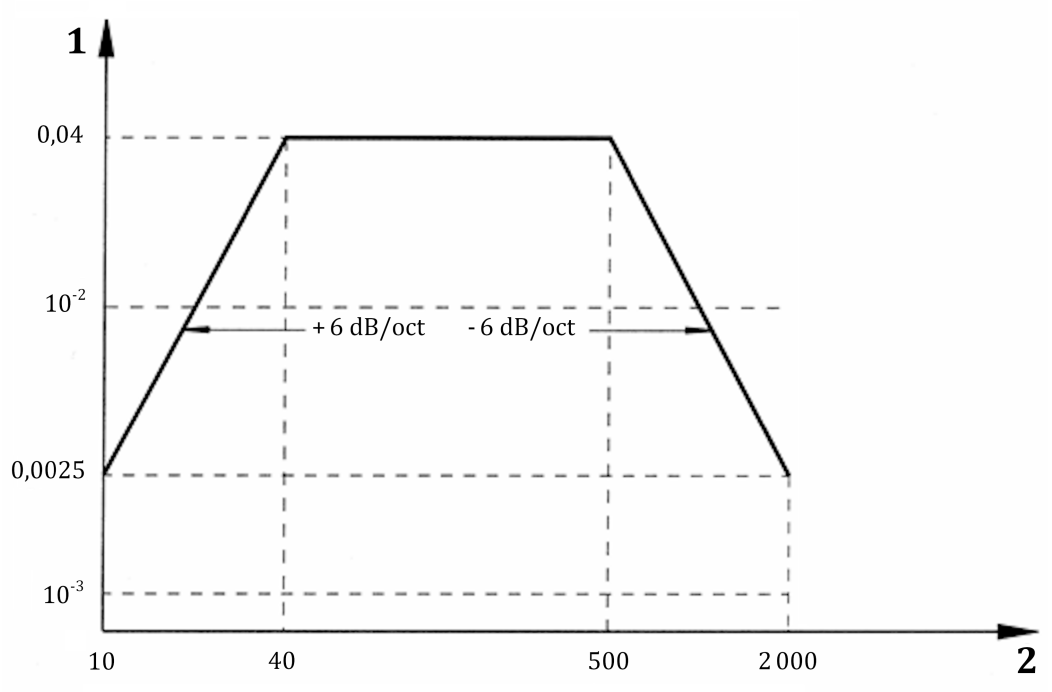


Key

1 Peak to peak amplitude (mm)

2 Frequency (Hz)

Figure 1 — Sinusoidal vibrations



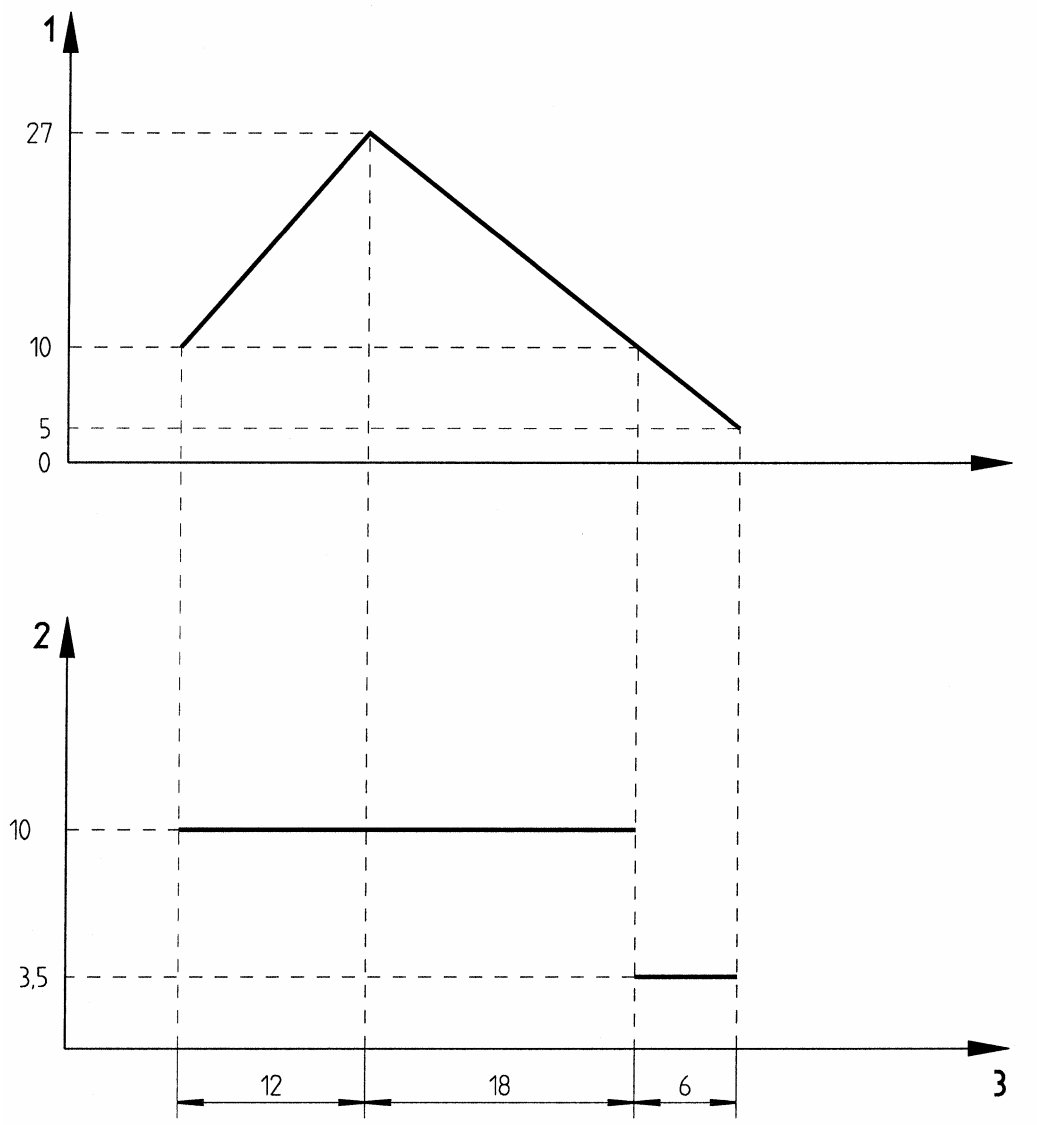
Key

1 Acceleration Spectral Density (ASD) (g^2/Hz)

2 Frequency (Hz)

Characteristics		
Test	PSD/ASD	Overall Grms
A	0,04	5,82

Figure 2 — Random vibrations



Key

1 Frequency (Hz)

2 Acceleration level (*g*-PK)

3 Time (s)

The unit shall operate during application of a vibration on all 3 (three) axes. The evolution of this vibration is given on the following figures with respect to time.

Figure 3 — Low frequencies vibrations

7.3 Electrical tests

See Table 5, Table 6 and Table 7.

Table 5 — Electrical characteristics

Tests	Requirements
Voltage drop of main contacts at I_n	See product standard and EN 3841-301:2004, 3.1.
Voltage drop of main contacts at low current under 28 V d.c.	I = 100 mA See product standard and EN 3841-301.
Voltage drop of signal contacts at minimum current.	For voltage and current values refer to Table 2 and EN 3841-301. Measuring points on pin contacts.
Dielectric strength (in V a.c. – 50 Hz) Measurement points and voltage values: see product standard.	See EN 3841-303. Leakage current ≤ 1 mA No breakdown or deterioration.
Insulation resistance [a] (on main and signal contacts)	See EN 3841-302. ≥ 100 MΩ
Trip threshold check	See product standard and EN 3841-304.
Overload trips	See product standard and EN 3841-304.
“Trip free” tripping at 2 I_n, ambient temperature (23 ± 5) °C	See EN 3841-304. Trip time: 2 s to 20 s
Short-circuit resistance	See Table 6. See product standard and EN 3841-305.
No-load and load endurance The endurance test on each circuit breaker tested shall be always performed by, first, the no-load test followed then by one of the load tests at I_n given in the product standard. Test sampling should be sufficient to perform all possible combinations. Only the test for a low current will not be preceded by the no-load test.	See product standard and EN 3841-306. Measure and note every (1 000) operations (no-load and load) the voltage drops.
Check of behaviour of circuit breakers in case of non-release Test at 10 I_n and at short-circuit maximum current.	See Table 7 and EN 3841-307.

[a] Test points identical to those used for dielectric strength test.

Table 6 — Short-circuit performance

Nominal voltage	115/200 V a.c. (360 Hz – 800 Hz)
No-load voltage	(120/208 ± 5) V a.c.
Minimum r.m.s. voltage at maximum short-circuit current (see NOTE 1)	20 V a.c.
Current rise time (t)	0,7 ms ≥ t ≥ 0,3 ms (depending on frequency)
Return time to nominal voltage from the starting of circuit opening by circuit breaker (before overvoltage appearance)	2,8 ms ≥ t ≥ 1,25 ms
Maximum overvoltage	255 V peak between phase and neutral conductor
Maximum durability of overvoltage	55 ms
Circuit breaker rating	1 A to 25 A
Prospective current (see NOTE 2)	See product standard.
Number of operations	
Test altitudes	

NOTE 1 Voltage values on the terminals of the generator when the short-circuit current is established.

NOTE 2 Test on 1 (one) pole: for each sample, 1 (one) pole is submitted to interrupting capacity, others are charged under I_n. Each of the three poles is checked on all the samples planned for this test.

Test on 3 (three) poles: the 3 (three) poles are symmetrically loaded with the short-circuit current. Use an additional sample.

The test is intended to estimate the stringency of the consequences of trip failure in the case of a short-circuit at 10 I_n and at maximum r.m.s. prospective short-circuit current given in product standard.

Therefore, the mechanism shall be locked in order to simulate a sticking of one phase with no direct action on the bimetal (the other phases are not loaded).

The circuit breakers shall be placed in an oven at (90 ± 5) °C for 2 h.

The test shall be performed within 5 min after removing the circuit breakers from the oven.

Table 7 — Overload test with mechanism locked

Nominal voltage		115 V a.c. at 360 Hz – 800 Hz						
Ratings A		1 to 3	5	7,5	10	15	20	25
Cable conductor sizes according to EN 2083		010	010	012	012	020	030	050
Maximum opening time by destruction of circuit breaker (in second)	At 10 I_n	30	20	20	10	8	8	8
	At I r.m.s. max., prospective (see product standard).	1						
Requirement: Circuit opening by destruction of circuit breakers shall be without bursting, flaming or thick smoke.								

8 Qualification tests

8.1 Sampling

Table 8 of this document specifies the tests sequence and the number of circuit breakers to be tested as well as the checking tests (see Table 9) to be done at the end of each qualification test if necessary.

Tests shall be run on circuit breakers sampled from the production line, and therefore on circuit breakers manufactured under normal production line conditions.

The 112 circuit breakers to be tested shall be distributed as indicated in Table 8.

Other circuit breakers can be supplied, if requested by the approval authority, to repeat or complete certain tests.

For each process defined in the product standard, a rated current value is chosen, representing each one.

Table 8 — Qualification tests

Group No.	Number of samples per process			Tests to be run	Inspection test according to Table 9	No. of standard	
	All rated current	Repre-sentative rated current	Number of circuit breakers for rated current			EN 2996-001 subclause	EN 3841-
1	[a]	–	–	Visual inspection	–	7.1	201
				Voltage drop at I_n	–	7.3	301
				Insulating resistance	–	7.3	302
				Dielectric rigidity at ground level	–	7.3	303
				Operating force	–	7.1	502
				Overload at 2 I_n - 23 °C ground level	–	7.3	304
2	–	3 rated current	2	Dimensions	–	6.5	202
				Strength of attachment	A + E + F + C + D	7.1	504
				Strength of connection	A + C + D	7.1	505
3	–	3 rated current	2	Dielectric altitude	–	7.3	303
				Strength of control element	A + E + F + C + D	7.1	503
				Maximum insertion force	–	7.1	509
				Maximum extraction force	–	7.1	509
				Contact retention force	–	7.1	510

Group No.	Number of samples per process			Tests to be run	Inspection test according to Table 9	No. of standard	
	All rated current	Repre-sentative rated current	Number of circuit breakers for rated current			EN 2996-00 1 subclause	EN 3841-
4	[a]	–	1	Mass	–	6.1	202
				Voltage drop at 100 mA	–	7.3	301
				Minimum and maximum threshold at ambient temperature	–	7.3	304
				Trip free at 23 °C	–	7.3	304
				Minimum tripping threshold at altitude	–	7.3	304
				Overload tripping at temperature	–	7.3	304
				Lightning	–	7.2	308
5	[a]	–	1	Sinus vibration	A + D + G + C	7.2	506
				Random vibration	A + D + G + C	7.2	506
				Combined vibration/ temperature/altitude	A + D + G + C	7.2	506
				Low frequency vibration	A + D + G + C	7.2	506
				Mechanical shocks	A + C + D	7.2	507
				Centrifugal acceleration	–	[b]	508
6 [c]	[a]	–	1	Resistance to short-circuit on the ground a.c. current	C + D + G + A	7.3	305
7 [c]	[a]	–	1	Resistance to short-circuit maximum altitude a.c. current	C + D + G + A	7.3	305
8	[a]	–	1	Resistance to short-circuit on the ground d.c. current	C + D + G + A	[b]	305
9	[a]	–	1	Resistance to short-circuit maximum altitude d.c. current	C + D + G + A	[b]	305
10	–	3 rated current	1	Low current voltage drop	C + D + G + A	[b]	301
				Low current endurance		[b]	306
11	–	3 rated current	1	No load endurance (mechanical)	C + E + D + A	[b]	306
				Nominal current endurance, d.c., resistive load	C + E + A + D + G	[b]	306

Group No.	Number of samples per process			Tests to be run	Inspection test according to Table 9	No. of standard	
	All rated current	Repre-sentative rated current	Number of circuit breakers for rated current			EN 2996-00 1 subclause	EN 3841-
12	–	3 rated current	1	No load endurance (mechanical)	C + E + D + A	[b]	306
				Nominal current endurance, d.c., inductive load	C + E + A + D + G	[b]	306
13 [c]	–	3 rated current	1	No load endurance (mechanical)	C + E + A + D + G	7.3	306
				Nominal current endurance, a.c., inductive load	C + E + A + D + G	7.3	306
14	–	3 rated current	1	Corrosion	A + D + E + C + G	7.2	402
15	–	3 rated current	1	Humidity	D + F + C + E + G	7.2	403
16	–	3 rated current	1	Sand and dust	–	[b]	401
17	–	3 rated current	1	Overload protection endurance d.c. current	–	[b]	306
				Resistance to fire	–	5.1.2	406
18	–	3 rated current	1	Overload protection endurance a.c. current	–	[b]	308
19	–	3 rated current	1	Explosion proof	–	[b]	404
20	–	4 rated current	2	Contaminating liquids	A + C	7.2	405
21 [c]	[a]	–	1	Non release test at I r.m.s. max.	–	7.3	307
22	[a]	–	1	Non release test at 10 I_n	–	7.3	307
23	[a]	–	1	Spare group	–	–	–

[a] All circuit breakers.

[b] Not applicable.

[c] It shall be demonstrated that requirements were met at any frequency within specified range (see product standard).

Table 9 — Inspection tests

Type	EN 3841-	Definition of test
A	304	Ground protection check at 2 I_n; tolerances increased to 80 % minimum time and 120 % maximum time
B	304	Minimum and maximum tripping threshold check, with tolerances increased to 90 % minimum threshold and 110 % maximum threshold defined in the product standard (at 23 °C on the ground)
C	201	Visual examination (appearance check)
D	303	Dielectric strength check, test voltage shall be reduced to 75 % of the value in the product standard (at given ambient temperature on the ground).
E	502	Control stress check, with ± 10 % tolerance compared to values given in the product standard
F	304	Free tripping check at 5 I_n, with ± 10 % tolerance compared to the time required in the product standard
G	301	Main and signal contacts voltage drop checks at I_n for main contacts and at 3 mA/28 V d.c. for the signal contacts which does not exceed 130 % of the value given in the product standard.

8.2 Material tests

The following tests shall be carried out on the housing material (see Table 10).

Table 10

Inflammability	See test EN 3844-1B.
Smoke density	See test EN 2825 A or B.
Toxicity	See test EN 2826 B.

8.3 Periodic checks for qualification maintenance

The method shall be chosen by agreement between the manufacturer and the purchaser, taking into account the circuit breaker design and the manufacturer quality assurance system.

9 Quality assurance

The qualification procedure for aerospace standard products (e.g. according to EN 9133 or an equivalent aerospace accepted and established qualification procedure) shall be used and documented according to the specified tests if not otherwise agreed between customer and supplier.

10 Marking

See product standard.

11 Delivery conditions

The method shall be chosen by agreement between the manufacturer and the customer, taking into account the circuit breaker's design and the manufacturer's quality assurance system.

12 Packaging

Products shall be individually packed in a rigid box unless otherwise specified by contract.

13 Storage

13.1 Definition

The term “storage” means the duration of the circuit breaker's stay (several weeks or years), in unoperated conditions, and in environmental conditions in accordance with aircraft manufacturer warehouse.

13.2 Storage conditions

Circuit breakers shall be stored:

— main contacts in closed position (push button activated);

— in ambient temperature of 5 °C min. and 40 °C max.;

— in relative humidity 80 % max.;

— protected from ultraviolet rays and dust, but not necessarily in a protected or sealed packaging;

— environmental atmosphere shall not be explosive or corrosive.

13.3 Storage duration

The storage duration under conditions defined in 13.2 shall be 5 (five) years maximum.

After a longer period, the following tests shall be conducted before use:

— voltage drop at I_n;

— tripping time at 2 I_n - Ambient temperature 23 °C.

3 (three) to 5 (five) switchings shall be performed prior to check. If the second voltage drop measurement failed, the circuit breakers have to be scrapped.

Bibliography

[1] EN 9133, *Aerospace series - Quality Management Systems - Qualification Procedure for Aerospace Standard Products*