BS EN 3773-001:2014

BSI Standards Publication

Aerospace series — Circuit breakers, single-pole, temperature compensated, rated currents 1 A to 25 A

Part 001: Technical specification

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National foreword

This British Standard is the UK implementation of EN 3773-001:2014. It supersedes BS EN 3773-001:1999 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee ACE/6, Aerospace avionic electrical and fibre optic technology.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Compliance with a British Standard cannot confer immunity from legal obligations.

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

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EUROPÄISCHES KOMITEE FÜR NORMUNG

CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

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Foreword

This document (EN 3773-001:2014) 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, prior to its presentation to CEN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by April 2015, and conflicting national standards shall be withdrawn at the latest by April 2015.

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1 Scope

This European Standard specifies the single-pole temperature compensated circuit breakers 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.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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 3841-100, *Aerospace series - Circuit breakers - Test methods - Part 100: General*

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

EN 9133, *Aerospace series - Quality management systems - Qualification procedure for aerospace standard parts*

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

3 Terms and definitions

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

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 assured up to the short-circuit current.

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1) Published as ASD-STAN Technical Report at the date of publication of this standard. http://www.asd-stan.org/

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 micro-organisms action.

Application of any material or protective coating, which might crack, break on 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.

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.

When pulling it, power contacts of the circuit breaker open.

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 Clearances and creepage distances

The clearances, creepage distances and the minimal space to be foreseen between the energized parts and any other part of the circuit breaker made of conductive material, as well as between the energized parts of opposite polarity, shall be sufficient to avoid any default or arcing 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

Designation	Requirements
Assembly	See product standard.
Mass	See product standard.
Operational altitude	See product standard.
Power contact connection	See product standard.
1 input terminal on power supply side (identified by digit 1)	
1 output terminal on distribution side (identified by digit 2)	
Operational ambient temperatures limits	From − 55 °C to 125 °C
Temperature compensation	From − 55 °C to 125 °C See product standard.
Rating marking	On control actuator (indelible white)

6.2 Ratings

See product standard.

6.3 Nominal voltage of operational circuits

See product standard.

6.4 Dimensional characteristics

See product standard.

6.5 Recommended panel mounting dimensions

Panel cut-out: The panel cut-out is in accordance with the designation TR6083C202

Spacing : 20 mm horizontal and 25 mm vertical from the centre of the mounting holes.

Panel thickness : 1 mm to 3 mm

7 Tests

7.1 Mechanical tests

See Table 2.

Table 2 — 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">EN 3841-201</td></tr>
<tr><td colspan="2" rowspan="2">Operational force</td><td colspan="2">Closing force (push)</td><td rowspan="2">EN 3841-502</td><td>3,5 N to 45 N</td></tr>
<tr><td colspan="2">Opening force (pull)</td><td>5 N to 30 N</td></tr>
<tr><td rowspan="8">Mechanical strength</td><td rowspan="4">Actuator</td><td colspan="2">Travel</td><td colspan="2">EN 3841-501
For value, see product standard.</td></tr>
<tr><td colspan="2">Transverse load</td><td rowspan="3">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">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">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>
</table>

7.2 Environmental tests

See Table 3.

Table 3 — Environmental conditions *(1 of 2)*

Tests		Requirements	
Combined tests. Ambient temperature 70 °C and vibrations (see notes).	Sinusoidal (see Figure 1). Duration: — circuit breaker in the "closed" position; — 0,9 I_n load – Seven cycles/axis – 1 octave/min; — no load – Two cycles/axis – 1 octave/min. — circuit breaker in the "opened" position; — two cycles/axis – 1 octave/min.	See EN 3841-506.	5 Hz to 80 Hz – Constant amplitude 2 a = 0,76 mm
			80 Hz to 500 Hz – Constant acceleration = 10 g_n
			500 Hz to 2 000 Hz – Constant acceleration = 5 g_n
	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.		10 Hz to 2 000 Hz – Constant acceleration = 5,8 g_n
	Low frequencies (see Figure 3). Applicability: see product standard. Duration: — circuit breaker in the "closed" position; — 0,9 I_n load – Two cycles/axis; — no load – Two cycles/axis. — circuit breaker in the "opened" position; — two cycles/axis.		10 Hz to 27 Hz to 10 Hz – Constant acceleration = 10 g_n
Combined tests. Ambient temperature 85 °C, cabin max. altitude 4 600 m and vibrations (see notes).	Sinusoidal – Applicability: see product standard. Duration: — circuit breaker in the "closed" position; — 0,9 I_n load – Four cycles/axis – 1 octave/min; — no load – Two cycles/axis – 1 octave/min. — circuit breaker in the "opened" position; — two cycles/axis – 1 octave/min.	See EN 3841-511.	5 Hz to 54 Hz – Constant shift 2 a = 0,5 mm
			54 Hz to 2 000 Hz – Constant acceleration = 3 g_n

Table 3 — Environmental conditions *(2 of 2)*

Tests	Requirements
Mechanical shocks (see notes)	50 g_n – 11 ms – Half sine wave. See EN 3841-507.
Constant accelerations	See product standard.
Sand and dust	See product standard.
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 3844-1, code B.
Smoke density	See test EN 2825, code A or code B.
Toxicity	See test EN 2826, code B.
Overvoltage caused by lightning only on main contacts	See EN 3841-308. Requirement: no tripping.

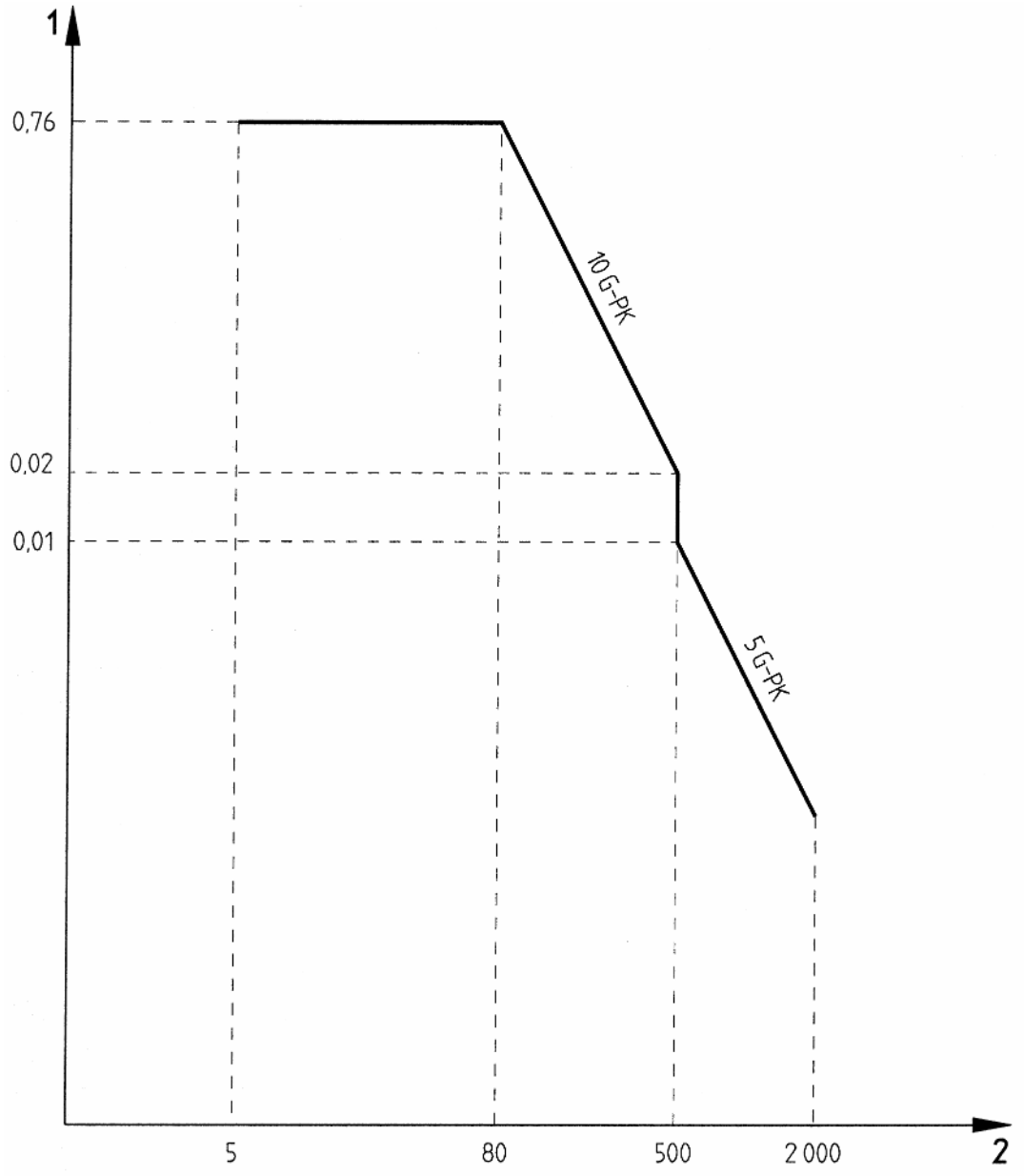
NOTE 1 Vibration tests performed on circuit breakers in closed position without load and in opened position, are carried out in order to detect contact opening and closure.

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 three directions (i.e. six shocks in all).

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

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



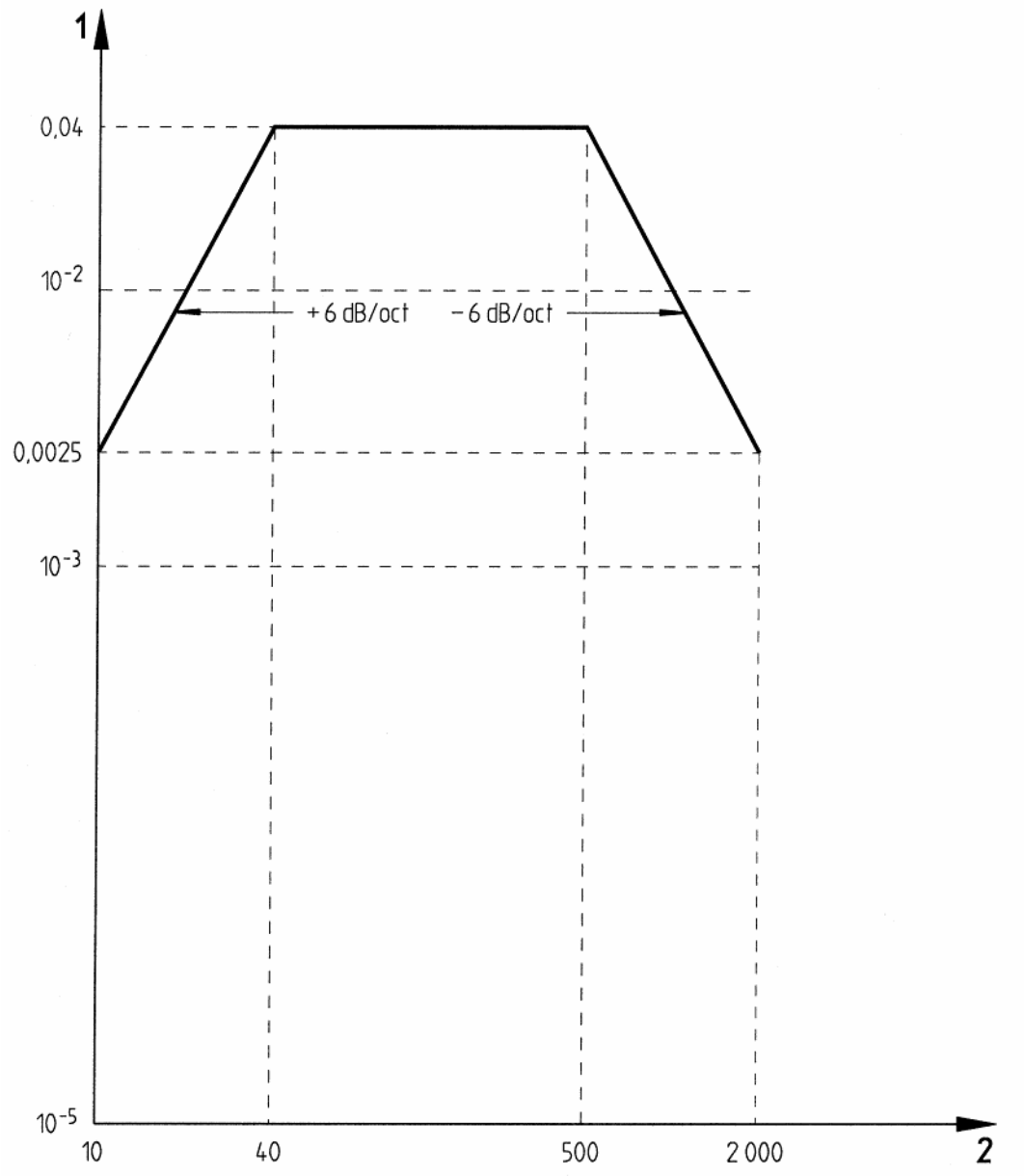
Key

1 Peak to peak amplitude (mm)

2 Frequency (Hz)

NOTE The identification G-PK corresponds to peak g_n

Figure 1 — Sinusoidal vibrations

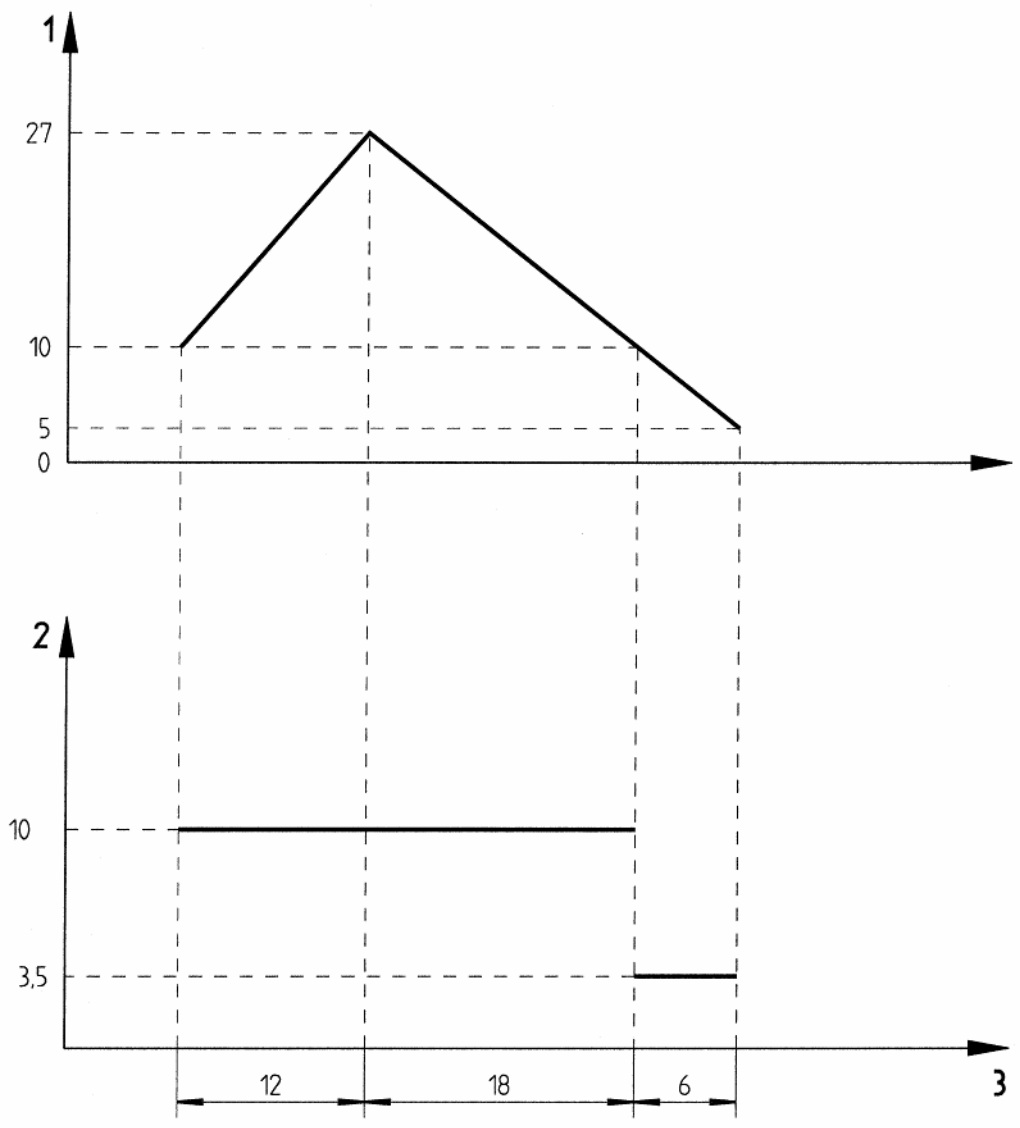


Key

1 Spectral density (g^2/Hz)

2 Frequency (Hz)

Figure 2 — Random vibrations



Key

1 Frequency (Hz)

2 Acceleration level (*g*)

3 Time (s)

NOTE The unit shall operate during application of a vibration on all 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 4, Table 5 and Table 6.

Table 4 — Electrical characteristics

Tests	Requirements
Voltage drop at I_n	See product standard and EN 3841-301.
Voltage drop of main contact at low current under 28 V d.c.	I = 100 mA See product standard and EN 3841-301.
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 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 5 — Short-circuit performance

Nominal voltage	28 V d.c.	115 V a.c. – (360 – 800) Hz
No-load voltage	(30 ± 2) V d.c.	(120 ± 5) V a.c.
Minimum r.m.s. voltage at maximum short-circuit current (see note).	16 V d.c.	20 V a.c.
Current rise time (t)	≤ 3 ms	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 ms	2,8 ms ≥ t ≥ 1,25 ms
Maximum overvoltage	60 V	255 V peak between phase and neutral conductor
Maximum durability of overvoltage	55 ms	55 ms
Circuit breaker rating	1 A to 25 A	1 A to 25 A
Prospective current	See product standard.	
Number of operations		
Test altitudes		
NOTE Voltage values on the terminals of the generator and of the batteries when the short-circuit current is established.		

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 the power contacts with no direct action on the bimetal.

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 6 — 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 standard		010	010	012	012	020	030	050
Maximum opening time by destruction of circuit breaker (s)	At 10 I_n	30	20	20	10	8	8	8
	At I r.m.s. max., prospective (see product standard).	1	1	1	1	1	1	1
Requirement: Circuit opening by destruction of circuit breakers shall be without bursting, flaming or thick smoke.								

8 Qualification tests

8.1 Sampling

Table 7 of this standard specifies the tests sequence and the number of circuit breakers to be tested as well as the checking tests (see Table 8) 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.

For full range qualificate 131 circuit breakers have to be tested shall be distributed as indicated in Table 7.

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, representating each one.

Table 7 — Qualification tests *(1 of 3)*

Group No.	Number of samples per process			Tests to be run	Inspection test according to Table 9	No. of standard	
	All rated current	Representative rated current	Number of circuit breakers for rated current			EN 3773-001 subclause	EN 3841-
1	a	–	–	Visual examination	–	7.1	201
				Voltage drop at I_n	–	7.3	301
				Insulating resistance			302
				Dielectric rigidity at ground level			303
				Operating force	–	7.1	502
				Overload at 2 I_n - 23 °C ground level	–	7.3	304
2	–	3 rated current	2	Dimensions	–	6.4	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			
				Contact retention force	–	7.1	510

Table 7 — Qualification tests *(2 of 3)*

Group No.	Number of samples per process			Tests to be run	Inspection test according to Table 9	No. of standard	
	All rated current	Representative rated current	Number of circuit breakers for rated current			EN 3773-001 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			
				Minimum tripping threshold at altitude			
				Overload tripping at temperature			
				Lightning	–	7.2	308
5	a	–	1	Sinus vibration	A+D+G+C	7.2	506
				Random vibration			
				Combined vibration/ temperature/altitude			
				Low frequency vibration			
				Mechanical shocks	A+C+D	7.2	507
				Centrifugal acceleration	–	b	508
6	a	–	1	Resistance to short-circuit on the ground a.c. current	C+D+G+A	7.3	305
7	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	7.3	305
9	a	–	1	Resistance to short-circuit maximum altitude d.c. current	C+D+G+A	7.3	305
10	–	3 rated current	1	Low current voltage drop	C+D+G+A	7.3	301
				Low current endurance			306

Table 7 — Qualification tests *(3 of 3)*

Group No.	Number of samples per process			Tests to be run	Inspection test according to Table 9	No. of standard	
	All rated current	Representative rated current	Number of circuit breakers for rated current			EN 3773-001 subclause	EN 3841-
11	–	3 rated current	1	No load endurance (mechanical)	C+E+D+A	7.3	306
				Nominal current endurance, d.c., resistive load	C+E+A+D+G		
12	–	3 rated current	1	No load endurance (mechanical)	C+E+D+A	7.3	306
				Nominal current endurance, d.c., inductive load	C+E+A+D+G		
13	–	3 rated current	1	No load endurance (mechanical)	C+E+A+D+G	7.3	306
				Nominal current endurance, a.c., inductive load			
14	–	3 rated current	1	Corrosion	A+D+E+C	7.2	402
15	–	3 rated current	1	Humidity	D+F+C+E	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	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	Square group	–	–	–

a All circuit breakers.
b Not applicable.

Table 8 — Qualification tests

Type	EN 3841-	Definition of test to be run
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 contacts voltage drop checks at I_n 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 9).

Table 9

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

See EN 9133.

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.

The packaging shall protect the circuit breaker during transportation and storage.

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 three 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.

NOTE Three to five switchings shall be performed prior to check. If the second voltage drop measurement failed, the circuit breakers have to be scrapped.

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