BS EN 60393-2:2016

BSI Standards Publication

Potentiometers for use in electronic equipment

Part 2: Sectional specification — Lead-screw actuated and rotary preset potentiometers

bsi.

National foreword

This British Standard is the UK implementation of EN 60393-2:2016. It is identical to IEC 60393-2:2015. It supersedes BS QC 410100:1990 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee EPL/40X, Capacitors and resistors for electronic equipment.

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.

Published by BSI Standards Limited 2016

ISBN 978 0 580 73672 8
ICS 31.040.20

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

This British Standard was published under the authority of the Standards Policy and Strategy Committee on 30 April 2016.

Amendments/corrigenda issued since publication

Date	Text affected

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN 60393-2

April 2016

ICS 31.040.20

English Version

Potentiometers for use in electronic equipment - Part 2: Sectional specification - Lead-screw actuated and rotary preset potentiometers (IEC 60393-2:2015)

Potentiomètres utilisés dans les équipements électroniques - Partie 2 : Spécification intermédiaire - Potentiomètres d'ajustement multitours et rotatifs (IEC 60393-2:2015)

Potentiometer zur Verwendung in Geräten der Elektronik - Teil 2: Rahmenspezifikation - Trimmpotentiometer mit Einstellung durch Gewindespindel oder durch direktes Drehen (IEC 60393-2:2015)

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European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

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

European foreword

The text of document 40/2407/FDIS, future edition 3 of IEC 60393-2, prepared by IEC/TC 40 "Capacitors and resistors for electronic equipment" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 60393-2:2016.

The following dates are fixed:

- latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 2016-10-18
- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2019-01-18

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Endorsement notice

The text of the International Standard IEC 60393-2:2015 was approved by CENELEC as a European Standard without any modification.

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

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.

NOTE 1 When an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

Publication	Year	Title	EN/HD	Year
IEC 60062	-	Marking codes for resistors and capacitors	EN 60062	-
IEC 60068-1	2013	Environmental testing -- Part 1: General and guidance	EN 60068-1	2014
IEC 60068-2-1	2007	Environmental testing -- Part 2-1: Tests - Test A: Cold	EN 60068-2-1	2007
IEC 60068-2-2	2007	Environmental testing -- Part 2-2: Tests - Test B: Dry heat	EN 60068-2-2	2007
IEC 60393-1	2008	Potentiometers for use in electronic equipment -- Part 1: Generic specification	EN 60393-1	2009
IEC 61193-2	2007	Quality assessment systems -- Part 2: Selection and use of sampling plans for inspection of electronic components and packages	EN 61193-2	2007

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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POTENTIOMETERS FOR USE IN ELECTRONIC EQUIPMENT –

Part 2: Sectional specification – Lead-screw actuated and rotary preset potentiometers

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International Standard IEC 60393-2 has been prepared by IEC technical committee 40: Capacitors and resistors for electronic equipment.

This third edition cancels and replaces the second edition published in 1989 and constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) revision of the information on the assessment level EZ and FZ (zero nonconforming);
b) complete editorial revision.

The text of this standard is based on the following documents:

FDIS	Report on voting
40/2407/FDIS	40/2422/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

This International Standard is to be used in conjunction with IEC 60393-1:2008.

A list of all parts in the IEC 60363 series, published under the general title *Potentiometers for use in electronic equipment*, can be found on the IEC website.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

POTENTIOMETERS FOR USE IN ELECTRONIC EQUIPMENT –

Part 2: Sectional specification – Lead-screw actuated and rotary preset potentiometers

1 General

1.1 Scope

This part of IEC 60393 applies to lead-screw actuated and rotary preset potentiometers, wirewound and non-wirewound for use in electronic equipment. These potentiometers are primarily intended for use in circuits for trimming purposes which require infrequent adjustments.

This part of IEC 60393 prescribes preferred ratings and characteristics and selects from IEC 60393-1 the appropriate quality assessment procedures, tests and measuring methods. It provides general performance requirements for this type of potentiometer.

This standard gives the minimum performance requirements and test severities.

1.2 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.

IEC 60062, *Marking codes for resistors and capacitors*

IEC 60068-1:2013, *Environmental testing – Part 1: General and guidance*

IEC 60068-2-1:2007, *Environmental testing – Part 2-1: Tests – Test A: Cold*

IEC 60068-2-2:2007, *Environmental testing – Part 2-2: Tests – Test B: Dry heat*

IEC 60393-1:2008, *Potentiometers for use in electronic equipment – Part 1: Generic specification*

IEC 61193-2:2007, *Quality assessment systems – Part 2: Selection and use of sampling plans for inspection of electronic components and packages*

1.3 Information to be given in a detail specification

1.3.1 General

Detail specifications shall be derived from the relevant blank detail specification.

Detail specifications shall not specify requirements inferior to those of the generic, sectional or blank detail specification. When severer requirements are included, they shall be listed in a subclause of the detail specification and indicated in the test schedules, for example by an asterisk.

The information given in 1.3.2 and 1.3.4 may, for convenience, be presented in tabular form.

The following information shall be given in each detail specification and the values quoted shall preferably be selected from those given in the appropriate clause of this sectional specification.

1.3.2 Outline drawing and dimensions

The detail specification shall incorporate an illustration of the potentiometer being specified. Where space is insufficient to show the detail dimensions required for inspection purposes, such dimensions shall appear on a drawing forming an annex to the detail specification.

All dimensions shall preferably be stated in millimetres, however, when the original dimensions are still given in inches, the converted metric dimensions in millimetres shall be added.

When the potentiometer is not designed for use on printed boards, this shall be clearly indicated in the detail specification.

1.3.3 Mounting

The detail specification shall specify the method of mounting to be applied for the voltage proof and the insulation resistance tests and for the application of the vibration and shock tests. The potentiometers shall be mounted by their normal means, but the design may be such that special mounting fixtures are required. In this case the detail specification shall describe the mounting fixtures and they shall be used for the voltage proof and the insulation resistance tests and for the application of the vibration and shock tests. For the latter tests the mounting shall be such that there shall be no parasitic vibration.

1.3.4 Style

See IEC 60393-1:2008, 2.2.2.

The style shall be presented by a double-letter code, e.g. AB, which is arbitrarily chosen for each detail specification.

The style designation, therefore, has no meaning unless the number of the detail specification is also given.

1.3.5 Resistance law

The resistance law is generally not verified. If required, the detail specification shall prescribe the measuring points and the associated limits for the output ratio and shall specify the position of the corresponding tests in the test schedules.

1.3.6 Ratings and characteristics

1.3.6.1 General

The ratings and characteristics shall be in accordance with the relevant clauses of this standard together with 1.3.6.2.

1.3.6.2 Nominal total resistance

See IEC 60393-1:2008, 2.3.2.

When products approved according to the detail specification have different ranges, the following statement should be added:

“The range of values available in each style is given in the register of approvals, available for example on the website http://www.iecq.org/.

The qualified products list “QPL” style is given in the register of approvals, available, for example, on the website as stated above.

1.3.7 Marking

The detail specification shall specify the content of the marking on the potentiometer and on the package. Deviations from 1.4 of this sectional specification shall be specifically stated.

1.3.8 Ordering information

The detail specification shall indicate that the following information, in clear or in coded form, is required when ordering:

a) nominal total resistance and tolerance on nominal total resistance;

b) resistance law (if other than linear);

c) number and issue reference of the detail specification and style reference.

1.3.9 Additional information (not for inspection purposes)

The detail specification may include information which is not required to be verified by the inspection procedure, such as circuit diagrams, curves, drawings and notes needed for the clarification of the detail specification.

1.4 Marking

1.4.1 General

When coding is used for nominal resistance, tolerance and date of manufacture, the method shall be selected from those given in IEC 60062.

The information given in the marking is normally selected from the following list. The relative importance of each item is indicated by its position in the list:

a) nominal total resistance;

b) tolerance on nominal total resistance;

c) resistance law (if other than linear);

d) detail specification and style reference;

e) year and month (or week) of manufacture;

f) manufacturer's name and/or trademark;

g) manufacturer’s type designation.

1.4.2 Marking for potentiometers

The potentiometer shall be clearly marked with a) and b) of 1.4.1 and with as many of the remaining items as is practicable. Any duplication of information in the marking of the potentiometer should be avoided.

1.4.3 Marking for packaging

The package containing the potentiometer(s) shall be clearly marked with all the information listed in 1.4.1 and below.

a) quantity

b) country origin

1.4.4 Additional marking

Any additional marking shall be so applied that no confusion can arise.

2 Preferred ratings, characteristics and test severities

2.1 Preferred characteristics

2.1.1 General

The values given in the detail specification shall preferably be selected from the following:

2.1.2 Preferred climatic categories

The potentiometers covered by this standard are classified into climatic categories according to the general rules given in IEC 60068-1:2013, Annex A.

The lower and upper category temperature and the duration of the damp heat, steady state test shall be chosen from the following:

Lower category temperature: –65 °C, –55 °C, –40 °C, –25 °C and –10 °C.

Upper category temperature +70 °C, +85 °C, +100 °C, +125 °C and +155 °C.

Duration of the damp heat, steady state test: 4, 10, 21 and 56 days.

The severities for the cold and dry heat tests are the lower and upper category temperatures respectively. Because of the construction of some potentiometers these temperatures will occur between two of the preferred temperatures given in IEC 60068-2-1:2007 and IEC 60068-2-2:2007. In this case the nearest preferred temperature within the actual temperature range of the potentiometer shall be chosen for this severity.

2.1.3 Temperature coefficients and temperature characteristics of resistance

The limits of change in resistance for the preferred temperature characteristics of resistance are given in Table 1.

Each line in the table gives the preferred temperature coefficients and corresponding temperature characteristics for 20 °C to 70 °C and limits of change in resistance for measurement of the temperature characteristics of resistance (see IEC 60393-1:2008, 4.14) on the basis of the category temperature ranges of 2.1.2.

Different portions of the resistance range may be covered by different temperature characteristics (or coefficients) of resistance although they appear in a single detail specification.

If measurements at additional temperatures are required, they shall be specified in the detail specification.

Table 1 – Temperature coefficients and temperature characteristics of resistance

Temperature coefficients of resistance 10^{-6}/K	Temperature characteristics of resistance %	Temperature characteristics of resistance (limits of resistance change in percentage) %								
		Reference temperature/ Lower category temperature °C					Reference temperature/ Upper category temperature °C			
20 °C / 70 °C		+20/–65	+20/–55	+20/–40	+20/–25	+20/–10	20/85 [a]	20/100	20/125	20/155
–800/ –2 500	–4/ –12,5	+6,8/ +21,3	+6/ +18,75	+4,8/ +15	+3,6/ +11,3	+2,4/ +7,5	–5,2/ – 16,25	–6,4/ –20	–8,4/ – 26,25	–10,8/ – 33,75
–400/ –1 000	–2/ –5	+3,4/ +8,5	+3/ +7,5	+2,4/ +6	+1,8/ +4,5	+1,2/ +3	–2,6/ –6,5	–3,2/ –8	–4,2/ – 10,25	–5,4/ –13,5
–150/ – 600	-0,75/ -3	+1,3/ +5,1	+1,13/ +4,5	+0,9/ +3,6	+0,68/ +2,7	+0,45/ +1,8	–0,98/ –3,9	–1,2/ –4,8	–1,58/ –6,3	–2,02/ –8,2
±1 000	±5	±8,5	±7,5	±6	±4,5	±3	±6,5	±8	±10,5	±13,5
±500	±2,5	±4,3	±3,75	±3	±2,25	±1,5	±3,25	±4	±5,25	±6,75
±250	±1,25	±2,15	±1,88	±1,5	±1,13	±0,75	±1,62	±2	±2,62	±3,38
±150	±0,75	±1,3	±1,15	±0,9	±0,68	±0,45	±0,98	±1,2	±1,6	±2,05
±100	±0,5	±0,85	±0,75	±0,6	±0,45	±0,3	±0,65	±0,8	±1,05	±1,35
±50	±0,25	±0,43	±0,375	±0,3	±0,23	±0,15	±0,325	±0,4	±0,525	±0,675
±25	±0,125	±0,215	±0,188	±0,15	±0,113	±0,075	±0,162	±0,2	±0,262	±0,34

[a] Potentiometers having an upper category temperature of 85 °C need not be measured between 20 °C and 70 °C.

2.1.4 Limits for change in resistance or output voltage ratio

The preferred combinations of limits for change in resistance or output voltage ratio in each of the tests listed in the heading of Table 2 are as indicated in the lines of the table.

Table 2 – Limits for change in resistance or output voltage ratio

Stability class %	4.38 Climatic sequence 4.39 Damp heat, steady state 4.40 Mechanical endurance 4.43.2 Electrical endurance at 70 °C 4.43.3 Electrical endurance at upper category temperature	4.34 Change of temperature	4.30 Robustness of terminals 4.33 Resistance to soldering heat 4,35 Vibration 4.37 Shock	4.43.2 Electrical endurance at 70 °C 4.43.3 Electrical endurance at upper category temperature	4.22 Thrust and pull on shaft 4.34 Change of temperature	4.35 Vibration 4.37 Shock
	ΔR between terminals a and c [c]			ΔR between terminations a and b [a c]	$\Delta \frac{U_{ab}}{U_{ac}}$ [a, b]	$\Delta \frac{U_{ab}}{U_{ac}}$ [a, b]
10	±(10 % R + 0,5 Ω)	±(5 % R + 0,1 Ω)	±(5 % R + 0,1 Ω)	±(15 % R + 0,5 Ω)	±5 %	±7,5 %
5	±(5 % R + 0,1 Ω)	±(3 % R + 0,1 Ω)	±(2 % R + 0,1 Ω)	±(7,5 % R + 0,1 Ω)	±2 %	±3 %
3	±(3 % R + 0,1 Ω)	±(2 % R + 0,1 Ω)	±(1 % R + 0,05 Ω)	±(5 % R + 0,1 Ω)	±1 %	±2 %
2	±(2 % R + 0,1 Ω)	±(2 % R + 0,1 Ω)	±(1 % R + 0,05 Ω)	±(3 % R + 0,1 Ω)	±1 %	±2 %

The clause numbers in the table refer to IEC 60393-1:2008.

[a] For wirewound potentiometers, the value of resolution specified in the detail specification shall be added to the permissible output ratio limits or the permissible change in resistance limits for all tests.

[b] The setting stability change in the output voltage ratio $\Delta \frac{U_{ab}}{U_{ac}}$ shall be expressed in percent of the total applied voltage.

[c] ΔR indicate the value of change in resistance.

2.1.5 Total mechanical travel

The preferred values shall be:

a) for lead-screw actuated preset potentiometers:
   2 to 25 turns;
b) for single-turn rotary preset potentiometers:
   the angle shall be specified in the detail specification.

2.2 Preferred values of ratings

2.2.1 General

The values given in detail specifications shall preferably be selected from the following:

2.2.2 Nominal total resistance

See IEC 60393-1:2008, 2.3.2.

2.2.3 Tolerances on nominal total resistance

The preferred tolerances on nominal total resistance are:

±30 %, ±25 %, ±20 %, ±10 % and ±5 %.

2.2.4 Rated dissipation

The preferred values of rated dissipation at 70 °C are:

0,05 W, 0,063 W, 0,1 W, 0,125 W, 0,15 W, 0,2 W, 0,25 W, 0,3 W, 0,5 W, 0,75 W and 1 W.

The derated values of dissipation at temperatures in excess of 70 °C shall be as indicated by the curve as shown in Figure 1.

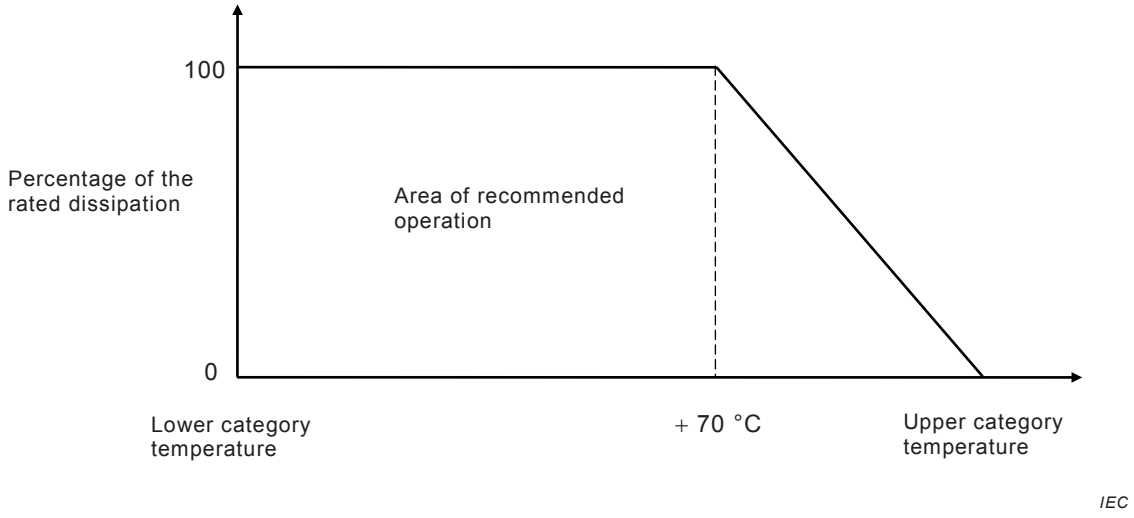
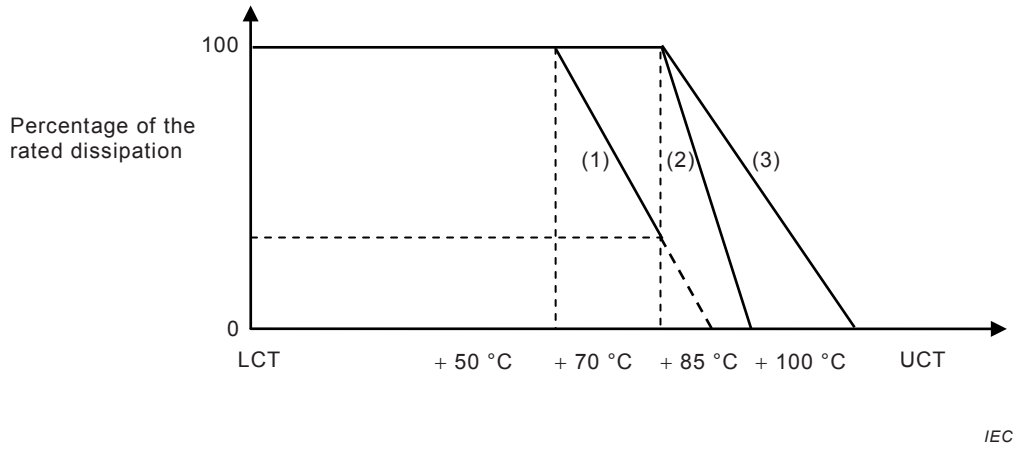


Figure 1 – Rated dissipation curve

A smaller (or larger) area of operation may be given in the detail specification. In this event, the detail specification shall state the maximum allowable dissipation at temperature other than 70 °C. All break points on the curve shall be verified by test.

A derating curve having examples of smaller areas of operation (carbon composition) is given in Figure 2.



The differences between (1), (2) and (3) depend on the substrate, whereby

(1) = Phenolic resin (multi-layer),

(2) = Resin molded and

(3) = Alumina

Key:

LCT = Lower category temperature

UCT = Upper category temperature

Figure 2 – Rated dissipation curve

2.2.5 Limiting element voltage

The preferred values of limiting element voltage d.c. or a.c. (r.m.s.) are:

100 V, 125 V, 150 V, 200 V, 250 V and 300 V.

2.2.6 Insulation voltage

The detail specification shall prescribe the value of the insulation voltage, rounded off to the nearest 10 V. The numerical value of the insulation voltage shall be:

Normal air pressure: ≥1,42 times the limiting element voltage.

Low air pressure (at 8 kPa): ≥two-thirds the value at normal air pressure.

2.2.7 Limits for insulation resistance

Unless otherwise specified in the detail specification the insulation resistance shall be not less than 1 GΩ after dry heat tests and 100 MΩ after humidity tests.

2.3 Preferred test severities

2.3.1 General

Test severities given in the detail specification shall preferably be selected from the following:

2.3.2 Drying

See IEC 60393-1:2008, 4.3, Procedure 1 shall be used.

2.3.3 Vibration

See IEC 60393-1:2008, 4.35, with the following details:

Frequency range:	10 Hz to 55 Hz, or 10 Hz to 500 Hz, or 10 Hz to 2 000 Hz.
Amplitude:	0,75 mm or acceleration 100 m/s^2 (whichever is the less severe)
Sweep endurance:	Total duration: 6 h

The detail specification shall prescribe the mounting method to be used. (See 1.3.3)

2.3.4 Shock

See IEC 60393-1:2008, 4.37, with the following details:

Pulse shape:	Half-sine
Acceleration:	500 m/s^2
Pulse duration:	11 ms
Severity:	3 successive shocks to be applied in each of the three directions (total 3 shocks)

The detail specification shall prescribe the mounting method to be used (see 1.3.3).

2.3.5 Low air pressure

See IEC 60393-1:2008, 4.38.5, with the following details:

Air pressure: 8 kPa.

2.3.6 Change of temperature

See IEC 60393-1:2008, 4.34, with the following details:

The duration of the exposure at the extremes of temperature shall be 30 min.

3 Quality assessment procedures

3.1 General

See IEC 60393-1:2008, Clause H.1.

3.2 Definitions

3.2.1 Primary stage of manufacture

For preset potentiometers, primary stage of the manufacture is:

– For film types: The deposition of the resistive film on the substrate.
– For carbon composition types: The process which produces the greatest change polymerization of the binder.
– For wire-wound types: The winding of the resistance wire on the mandrel insulation or insulated.

3.2.2 Structurally similar components

Preset potentiometers are considered as being structurally similar if they are potentiometers produced with the same or similar processes and materials, and that have the same nominal

dimensions but have different resistance values and temperature characteristics (or coefficients) of resistance.

3.2.3 Assessment levels EZ and FZ (zero nonconforming)

Assessment levels EZ and FZ meet the requirements of “zero nonconforming” approach. They have been introduced to align the assessment procedures and levels with current industry practices by prescribing the permitted number of nonconforming items (acceptance number) c as zero.

Therefore the sample size for lot-by-lot testing is determined by IEC 61193-2:2007, Table 1.

3.3 Qualification approval

3.3.1 General

The procedures for qualification approval testing are given in IEC 60393-1:2008, Clause H.5.

The schedule to be used for qualification approval testing on the basis of lot-by-lot and periodic test is given in 3.4.

The procedure using a fixed sample size schedule is given in 3.3.2 and 3.3.3 below.

3.3.2 Qualification approval on the basis of the fixed sample size procedure

Sampling

The fixed sample size procedure is described in IEC 60393-1:2008, H.5.3 b). The sample shall be representative of the range of values for which approval is sought. This may or may not be the complete range covered by the detail specification.

The sample shall consist of specimens having the highest and lowest resistance values for which approval is being sought. It should also include the specimens having the critical resistance value, if this is within the range being submitted. When approval is being sought for more than one temperature coefficient (or characteristics) of resistance, the sample shall contain specimens representative of the different temperature coefficients (or characteristics) of resistance. In a similar manner, the sample should contain a proportion of specimens of the different resistance values having the closest tolerance for which approval is being sought. The proportion of specimens having the different characteristics shall be proposed by the manufacturers chief inspector and shall be to the satisfaction of a certification body (for example IECQ CB).

Spare specimens are permitted as follows:

a) One per resistance value and one per each temperature coefficient or temperature characteristic value which may be used to replace the permitted nonconforming items in Group 0.

b) One per resistance value and one per each temperature coefficient or temperature characteristic value which may be used to replace specimens which are nonconforming because of incidents not attributable to the manufacturer. The number given in Group 0 assume that all groups are applicable.

When additional groups are introduced into the qualification approval test schedule, the number of specimens required for Group 0 shall be increased by the same number as that required for the additional groups.

3.3.3 Tests

The complete series of tests specified in Table 3 are required for the approval of potentiometers covered by one detail specification. The tests of each group shall be carried out in the given order.

The whole sample shall be subjected to the tests of Group 0 and then divided for the other groups.

Specimens found non-conforming during the test of Group 0 shall not be used for the other groups.

"One nonconforming item" is counted when a potentiometer has not satisfied the whole or a part of the tests of a group.

The approval is granted when the number of nonconforming items does not exceed the specified number of permissible nonconforming items for each group or sub-group and the total number of permissible non-conformances.

In Table 3 the fixed sample size test schedule is given. It includes details of sampling and permissible nonconforming items for different tests for groups of tests and gives, together with the details of the test contained in IEC 60393-1:2008, Clause 4, and Clause 2 of this standard, a complete summary of test conditions and performance requirements.

It is indicated in Table 3, where, for the test methods, test conditions and/or performance requirements, a choice shall be made in the detail specification.

The conditions of test and the performance requirements for the fixed sample size test schedule shall be identical to those prescribed in the detail specification for quality conformance inspection.

Table 3 – Fixed sample size test schedule for qualification approval *(1 of 7)*

Subclause number and test [a]	D or ND [b]	Conditions of test [a]	Sample size and criterion of acceptability [b]		Performance requirements [a]
			n	*c*	
GROUP 0	ND		114 [g]	0	
4.4.1 Visual examination					As in 4.4.1 Legible marking and as specified in the detail specification
4.6 Element resistance					As in 4.6.3
4.4.2 Dimensions (gauging)					See detail specification
4.7 Terminal resistance		Resistance between a and b			$R \leq \ldots\ \Omega$
		Resistance between b and c			$R \leq \ldots\ \Omega$
4.4.4 Total mechanical travel		- Lead screw styles Effective operating turns...			≥70 % of total mechanical travel
		- Rotary styles			See detail specification
4.4.6 Effective electrical travel		- Lead screw styles			≥70 % of the measured total mechanical travel
		- Rotary styles			See detail specification
4.5 Continuity [c]					As in 4.5.1 or 4.5.2
4.15 Rotational noise		Method B or Method C			≤ ... % or ... Ω
4.12 Voltage proof (Insulated potentiometers only) [h]		Normal air pressure			As in 4.12.5
Spare specimens			5		
GROUP 1	D		20	0	
4.18 Starting torque					See detail specification
4.32 Solderability		Solder bath method Temperature and duration: SnPb: (235 ± 5) °C, (2 ± 0,5) s SnAgCu: (245 ± 5) °C, (3 ± 0,3) s			Good tinning as evidenced by free flowing of the solder with wetting of the terminals.
4.45 Solvent resistance of the marking (if applicable)		Solvent: Solvent temperature: ... Method 1 Rubbing material: cotton wool			See detail specification
		Recovery: ...			Legible marking
4.14 Temperature characteristic of resistance		Lower category temperature/20 °C			$\Delta R/R \leq \ldots$ %
		20 °C / 70 °C			$\Delta R/R \leq \ldots$ %
		20 °C / Upper category temperature			$\Delta R/R \leq \ldots$ %
4.21 Locking torque (if applicable)		Output voltage ratio			$\Delta \frac{U_{ab}}{U_{ac}} \leq \ldots$ %
		Visual examination			As in 4.21.2

Table 3 *(2 of 7)*

Subclause number and test [a]	D or N D [b]	Conditions of test [a]	Sample size and criterion of acceptability [b]		Performance requirements [a]
			n	*c*	
4.20 End stop torque		- For types fitted with end stops: As specified in 4.20.1 Not less than five times the upper limit of the starting torque (Unless otherwise stated by the detail specification)			As in 4.20.1
		- For types fitted with slipping clutches: As specified in 4.20.2			As in 4.20.2
4.22 Thrust and pull on shaft		Only the thrust shall be applied. The pull is not applicable			
		- Half of the specimens			
		As specified in 4.22.2			As in 4.22.2
		Continuity			
		- Remaining specimens			As in 4.22.3
		As specified in 4.22.3			
		Setting stability (output voltage ratio) (as in 4.17.2.1)			$\Delta \frac{U_{ab}}{U_{ac}} \leq \ldots$ %
4.40 Mechanical endurance (potentiometers)		Number of cycles: 200 Rate:			
		- Rotary types: 5 to 10 cycles per minute			
		- Lead screw types:.			
		Visual examination			As in 4.40.6
		Element resistance			$\Delta R \leq \pm(\ldots\ \% + \ldots\ \Omega)$
		Starting torque			… mN·m to … mN·m
		Rotational noise, Method B or Method C			Method B: ≤ … % or … Ω (whichever is greater) Method C: ≤ … Ω
GROUP 2	D		24	0	
			(12 of the sample)	0	
4.30 Robustness of terminals		The test appropriate to the type of terminal			
		Visual examination			As in 4.30.8
		Element resistance			$\Delta R \leq \pm(\ldots\ \% + \ldots\ \Omega)$
4.33 Resistance to soldering heat		- For potentiometers designed for printed board applications: Method 1			As in4.33.2 a)
		- For other potentiometers: Method 2			As in 4.33.2 b)
		Element resistance			$\Delta R \leq \pm(\ldots\ \% + \ldots\ \Omega)$
		Terminal resistance:			≤ … Ω
		Resistance a to b			≤ … Ω
		Resistance b to c			

Table 3 *(3 of 7)*

Subclause number and test [a]	D or ND [b]	Conditions of test [a]	Sample size and criterion of acceptability [b]		Performance requirements [a]
			n	*c*	
4.44 Component solvent resistance (if applicable)		Solvent:... Solvent temperature: ... Method 2 Recovery:...			See detail specification
4.31 Sealing (if applicable)		Temperature: 85 °C to 90 °C			As in 4.31.3
			(Other 12 of the sample)	0	
4.34 Change of temperature [d]		T_A = Lower category temperature T_B = Upper category temperature Visual examination Setting stability (output voltage ratio) (as in 4.17.2.1)			As in 4.34.5 $\Delta \frac{U_{ab}}{U_{ac}} \leq \ldots$ %
4.37 Shock		Element resistance For mounting method see detail specification Pulse shape: half sine Acceleration: 500 m/s^2 Pulse duration:11 ms Visual examination Element resistance Setting stability (output voltage ratio) (as in 4.17.2.1)			$\Delta R \leq \pm(\ldots\ \% + \ldots\ \Omega)$ As in 4.37.3 $\Delta R \leq \pm(\ldots\ \% + \ldots\ \Omega)$ $\Delta \frac{U_{ab}}{U_{ac}} \leq \ldots$ %
4.35 Vibration [d, e]		For mounting method see detail specification Frequency range: ... Hz to... Hz Amplitude: 0,75 mm or acceleration 100 m/s^2 (whichever is the less severe) Sweep endurance: Total duration: 6 h [d]			
- Measurements during test		Electrical continuity (as specified in 4.35.4)			There shall be no discontinuity >100 μs
- Final measurements		Visual examination			As in 4.35.5

Table 3 *(4 of 7)*

Subclause number and test [a]	D or ND [b]	Conditions of test [a]	Sample size and criterion of acceptability [b]		Performance requirements [a]
			n	*c*	
		Setting stability (output voltage ratio) (as in 4.17.2.1)			$\Delta \frac{U_{ab}}{U_{ac}} \leq \ldots$ %
		Element resistance			$\Delta R \leq \pm(\ldots \% + \ldots \Omega)$
			24	0	
4.38 Climatic sequence					
- Dry heat		Visual examination			As in 4.38.2.2
- Damp heat, cyclic, Test Db, first cycle					
- Cold		Starting torque			... mN·m to ... mN·m
- Low air pressure		8 kPa			
		Voltage proof (insulated potentiometers only) [h]			As in 4.38.5.3
- Damp heat, cyclic, Test Db, remaining cycle					
- DC load [f]					As in 4.38.7
- Insulation voltage [f]					As in 4.38.8
- Final measurements		Visual examination			As in 4.38.10.1
		Element resistance			$\Delta R \leq \pm(\ldots \% + \ldots \Omega)$
		Insulation resistance (insulated potentiometers only) [h]			≥100 MΩ
		Switch contact resistance (if applicable)			$\leq \ldots \Omega$
		Continuity			As in 4.5.1 or 4.5.2
		Starting torque			... mN·m to ... mN·m
		Voltage proof (insulated potentiometers only) [h]			As in 4.38.10.7
GROUP 3	D		20	0	
4.43.2 Electrical endurance at 70 °C		Duration: 1 000 h			
		- Loaded between a and c:	(10)		
		Examination at 48 h, 500 h and 1 000 h:			
		Visual examination			As in 4.43.2.6 a)
		Element resistance			$\Delta R \leq \pm(\ldots \% + \ldots \Omega)$
		- Loaded between a and b:	(10)		
		Examination at 48 h, 500 h and 1 000 h:			
		Visual examination			As in 4.43.2.6 a)
		Resistance between a and b:			$\Delta R \leq \pm(\ldots \% + \ldots \Omega)$
		Element resistance			$\Delta R \leq \pm(\ldots \% + \ldots \Omega)$

Table 3 *(5 of 7)*

Subclause number and test [a]	D or ND [b]	Conditions of test [a]	Sample size and criterion of acceptability [b]		Performance requirements [a]
			n	*c*	
		All specimens Examination at 1 000 h: Insulation resistance (insulated potentiometers only) [h] Rotational noise, Method B or Method C			 ≥1 GΩ Method B: ≤ ... % or ... Ω (whichever is greater) Method C: ≤ ... Ω
GROUP 4 4.4.3 Dimensions (detail)	N D		10	0	As specified in the detail specification
GROUP 5 4.39 Damp heat, steady state	D	1) As in 4.39.2.1 1st group: 4 specimens 2nd group: 8 specimens 3rd group: 8 specimens 2) As in 4.39.2.2 1st group: 10 specimens 2nd group: 10 specimens DC load [f] Insulation voltage [f, h]	20	0	 As in 4.39.3 As in 4.39.4
- Final measurements		Visual examination Element resistance Insulation resistance (insulated potentiometers only) [h] Continuity Starting torque Rotational noise, Method B or Method C Voltage proof (insulated potentiometers only) [h]			As in 4.39.6.1 $\Delta R \leq \pm(... \% + ... \Omega)$ >100 MΩ As in 4.5.1 or 4.5.2 ... mN·m to ... mN·m Method B: ≤ ... % or ... Ω (whichever is greater) Method C: ≤ ... Ω As in 4.39.6.8
GROUP 6 4.43.3 Electrical endurance at upper category temperature	D	Duration: 1 000 h - Loaded between a and c: Examination at 48 h, 500 h and 1 000 h: Visual examination Element resistance - Loaded between a and b: Examination at 48 h, 500 h and 1 000 h:	20 (10) (10)	0	 As in 4.43.3.7 a) $\Delta R \leq \pm(... \% + ... \Omega)$

Table 3 *(6 of 7)*

Subclause number and test [a]	D or N D [b]	Conditions of test [a]	Sample size and criterion of acceptability [b]		Performance requirements [a]
			n	*c*	
		Visual examination			As in 4.43.3.7 a)
		Resistance between a and b			$\Delta R \leq \pm(\ldots\ \% + \ldots\ \Omega)$
		Element resistance			$\Delta R \leq \pm(\ldots\ \% + \ldots\ \Omega)$
		All specimens			
		Examination at 1 000 h: Insulation resistance (insulated potentiometers only) [h]			≥1 GΩ
GROUP 7	D		20	0	
4.43 Electrical endurance at temperatures other than 70 °C (if applicable)		(This group is only applicable if a derating curve other than those shown in 2.2.3 of this specification is claimed in the detail specification)			
		Duration: 1 000 h			
		- Loaded between a and c: Examination at 48 h, 500 h and 1 000 h:	(10)		
		Visual examination			As in 4.43.1.6 a)
		Element resistance			$\Delta R \leq \pm(\ldots\ \% + \ldots\ \Omega)$ (as for Group 3)
		- Loaded between a and b: Examination at 48 h, 500 h and 1 000 h:	(10)		
		Visual examination			As in 4.43.1.6 a)
		Resistance between a and b			$\Delta R \leq \pm(\ldots\ \% + \ldots\ \Omega)$ (as for Group 3)
		Element resistance			$\Delta R \leq \pm(\ldots\ \% + \ldots\ \Omega)$
		All specimens			
		Examination at 1 000 h: Insulation resistance (insulated potentiometers only) [h]			≥1 GΩ

Table 3 *(7 of 7)*

[a] Subclause numbers of test and performance requirements refer to IEC 60393-1:2008, except for some severities for environmental tests and limits of change in resistance or output ratio, which have to be taken from the relevant clauses of this sectional specification.

[b] In this Table:

n = the sample size
c = the group acceptance criterion (permitted number of defectives per group).
D = destructive

ND = non-destructive

[c] The continuity test may be performed whilst the effective electrical travel is being checked.

[d] The requirements for preset potentiometers in the test method shall apply.

[e] This test is only applicable to potentiometers of climatic category 25/-/-, 40/-/-, 55/-/- and 65/-/-.

[f] The d.c. load test and the insulation voltage test are considered as alternatives. The detail specification shall indicate which test applies.

[g] The sample size in Group 0 shall be increased by 20 specimens when Group 7 is applicable.

[h] For method of mounting see 4.12 or 4.13, as appropriate, of IEC 60393-1:2008, with the following details:

1) Components designed as "mounted by body" shall be mounted as in 4.12.1.
2) Components designed as "mounted by terminals" shall be tested whilst mounted by their terminals on a printed board, irrespective of whether any holes exist which could permit mounting by the body.

3.4 Quality conformance inspection

3.4.1 Formation of inspection lots

An inspection lot shall consist of structurally similar potentiometers. (See 3.2.2). In addition, the following details are applicable:

a) Groups A and B: These tests shall be carried out on a lot-by-lot basis and resistance values shall be representative of production.
b) Group C
   1) The sample shall be collected over 13 weeks.
   2) The sample shall be representative of the range of resistance values produced during this period.
c) Group D: As Group C, except that the sample shall be collected over the last 13 weeks of the inspection period.

There shall be satisfactory balance between high, low and critical resistance values in the samples taken.

3.4.2 Test schedule

The schedule for the lot-by-lot and periodic tests for quality conformance inspection is given in Table 2 of the blank detail specification.

3.4.3 Assessment levels

The assessment level(s) given in the blank detail specification shall preferably be selected from Table 4 and Table 5.

Table 4 – Quality conformance inspection: Lot-by-lot inspection

Assessment level EZ				Assessment level FZ			
Inspection subgroup [d]	IL [a]	n [a]	c [a]	**Inspection subgroup** [d]	IL [a]	n [a]	c [a]
A0 4.6 Element resistance	100 % [b]			**A0** 4.6 Element resistance	100 % [b]		
A1 4.4.1 Visual examination	II	[c]	0	**A1** 4.4.1 Visual examination	S-3	[c]	0
A2 4.4.2 Dimensions [e] (gauging)	S-2	[c]	0	**A2** 4.5 Continuity	S-3	[c]	0
A3 4.7 Terminal resistance 4.5 Continuity 4.15 Rotational noise 4.12 Voltage proof	S-3	[c]	0				
B1 4.18 Starting torque 4.31 Sealing (if applicable)	S-2	[c]	0	**B1** 4.12 Voltage proof 4.32 Solderability 4.45 Solvent resistance of the marking (if applicable)	S-2	[c]	0
B2 4.32 Solderability 4.45 Solvent resistance of the marking (if applicable)	S-2	[c]	0				

[a] IL = the inspection level
n = the sample size
c = the permissible number of nonconforming items

[b] This inspection shall be performed after removal of nonconforming items by 100 % testing during the manufacturing process. Whether the lot was accepted or not, all of samples for sampling inspection shall be inspected in order to monitor outgoing quality level by nonconforming items per million ($\times 10^{-6}$). The sampling level shall be established by the manufacturer, preferably according to IEC 61193-2:2007, Annex A.

In case one or more nonconforming items occur in a sample, this lot shall be rejected but all nonconforming items shall be counted for the calculation of quality level values.

If applicable, outgoing quality level by nonconforming items per million ($\times 10^{-6}$) values shall be calculated by accumulating inspection data according to the method given in IEC 61193-2:2007, 6.2.

[c] Number to be tested: Sample size shall be determined according to IEC 61193-2:2007, 4.3.2.

[d] The content of the inspection subgroups is described in Clause 2 of the relevant blank detail specification.

[e] This test may be replaced by in-production testing if the manufacturer installs statistical process control (SPC) on dimensional measurements or other mechanisms to avoid part exceeding the dimensional limits.

Table 5 – Quality conformance inspection: Periodic testing *(1 of 2)*

Assessment level EZ				Assessment level FZ			
Inspection subgroup [b]	p [a]	n [a]	c [a,c]	**Inspection subgroup** [b]	p [a]	n [a]	c [a,c]
C1 4.14 Temperature characteristic of resistance 4.21 Locking torque (if applicable) 4.20 End stop torque 4.22 Thrust and pull on shaft 4.4.4 Total mechanical travel 4.4.6 Effective electrical travel	3	20	0	**C1** 4.4.2 Dimensions (gauging) 4.4.4 Total mechanical travel 4.4.6 Effective electrical travel	3	12	0
C2	3	24	0	**C2** 4.30 Robustness of terminals 4.15 Rotational noise	3	12	0
C2A (Part of sample) 4.30 Robustness of terminals 4.33 Resistance to soldering heat 4.44 Component solvent resistance (if applicable) 4.31 Sealing (if applicable)	3	12	0				
C2B (Part of sample) 4.34 Change of temperature 4.37 Shock 4.35 Vibration	3	12	0				
C2 (Combined sample C2A and C2B) 4.38 Climatic sequence	3	24	0				
C3 4.43.2 Electrical endurance at 70 °C	6	20	0	**C3** 4.43.2 Electrical endurance at 70 °C	6	12	0
C4 4.40 Mechanical endurance (potentiometers)	6	20	0				
D1 4.39 Damp heat, steady state	12	20	0	**D1** 4.39 Damp heat, steady state	12	12	0
D2 4.43.3 Electrical endurance at upper category temperature	36	20	0	**D2** 4.40 Mechanical endurance (potentiometers)	12	12	0

Table 5 *(2 of 2)*

Assessment level EZ				Assessment level FZ			
Inspection subgroup [b]	p [a]	n [a]	c [a]	**Inspection subgroup** [b]	p [a]	n [a]	c [a]
D3 4.4.3 Dimensions (detail)	36	10	0	**D3** 4.18 Starting torque 4.20 End stop torque 4.21 Locking torque (when applicable) 4.7 Terminal resistance 4.22 Thrust and pull on shaft	12	6	0
D4 4.43 Electrical endurance at temperature other than 70 °C (if applicable)	36	20	0	**D4**	24	12	0
				D4A (Part of sample) 4.33 Resistance to soldering heat 4.44 Component solvent resistance (if applicable)	24	6	0
				D4B (Part of sample) 4.34 Change of temperature 4.35 Vibration	24	6	0
				D4 (Combined sample D4A and D4B) 4.38 Climatic sequence	24	12	0
				D5 4.14 Temperature characteristic of resistance 4.4.3 Dimensions (detail)	24	12	0

[a] In this table:

p = the periodicity in months
n = the sample size
c = permissible number of nonconforming items

[b] The content of the inspection subgroups in Clause 2 of the relevant blank detail specification.

[c] If one nonconforming item is obtained, all the tests of subgroup shall be repeated on a new sample and then no further nonconforming items are permitted. Release of product may continue during repeat testing.

3.5 Delayed delivery

The provisions of IEC 60393-1:2008, Clause H.10, shall apply, except that the inspection level shall be reduced to S-2 and (except for carbon composition potentiometers) the period shall be extended to two years. The period for carbon composition potentiometers shall remain at one year.

Bibliography

IEC 60410:1973, *Sampling plans and procedures for inspection by attributes*

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