BS EN 60393-6:2016

BSI Standards Publication

Potentiometers for use in electronic equipment

Part 6: Sectional specification — Surface mount preset potentiometers

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National foreword

This British Standard is the UK implementation of EN 60393-6:2016. It is identical to IEC 60393-6:2015.

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.

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English Version

Potentiometers for use in electronic equipment - Part 6: Sectional specification - Surface mount preset potentiometers (IEC 60393-6:2015)

Potentiomètres utilises dans les équipements électroniques - Partie 6 : Spécification intermédiaire - Potentiomètres d'ajustement pour montage en surface (IEC 60393-6:2015)

Potentiometer zur Verwendung in Geräten der Elektronik - Teil 6: Rahmenspezifikation - Trimmpotentiometer für die Oberflächenmontage (IEC 60393-6:2015)

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European foreword

The text of document 40/2409/FDIS, future edition 2 of IEC 60393-6, 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 60393-6:2016.

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- latest date by which the national standards conflicting with the document have to be withdrawn (dow) 2019-01-18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 60393-6:2015 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 60068-2-58	2004	Environmental testing -- Part 2-58: Tests - Test Td: Test methods for solderability, resistance to dissolution of metallization and to soldering heat of surface mounting devices (SMD)	EN 60068-2-58	2004
-	-		+ corrigendum Dec.	2004
IEC 60286-3	-	Packaging of components for automatic handling -- Part 3: Packaging of surface mount components on continuous tapes	EN 60286-3	-
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

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

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POTENTIOMETERS FOR USE IN ELECTRONIC EQUIPMENT –

Part 6: Sectional specification – Surface mount preset potentiometers

FOREWORD

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International Standard IEC 60393-6 has been prepared by IEC technical committee 40: Capacitors and resistors for electronic equipment.

This second edition cancels and replaces the first edition published in 2003 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 (zero nonconforming);
b) complete editorial revision.

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

FDIS	Report on voting
40/2409/FDIS	40/2424/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 6: Sectional specification – Surface mount preset potentiometers

1 General

1.1 Scope

This part of IEC 60393 applies to surface mount preset potentiometers for use in electronic equipment.

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, and it gives general performance requirements for this type of potentiometers.

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 code 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 60068-2-58:2004, *Environmental testing – Part 2-58: Tests – Test Td: Test methods for solderability, resistance to dissolution of metallization and to soldering heat of surface mounting devices (SMD)*

IEC 60286-3, *Packaging of components for automatic handling – Part 3: Packaging of surface mount components on continuous tapes*

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 more severe 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 surface mount preset potentiometer as aid to easy recognition and for comparison of the surface mount potentiometer with others.

Dimensions and their associated tolerances, which affect interchangeability and mounting, shall be given in the detail specification. All dimensions shall be stated in millimetres.

Normally the numerical values shall be given for the length, width and thickness of the body.

Where space is insufficient to show the detail dimensions required for inspection purposes, such dimensions shall appear on the drawing forming an annex to the detail specification.

Recommended land patterns shall be given in the detail specification.

When the outline drawing is other than described above, the detail specification shall state such dimensional information as will adequately describe the surface mount potentiometer.

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 bump or 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 voltage proof and the insulation resistance tests and for application of the vibration and shock tests. For the latter tests the mounting shall be such that there shall be no parasitic vibration.

Mounting for test and measurement purpose (when required) shall be in accordance with IEC 60393-1:2008, 4.47.

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 specification together with the following:

1.3.6.2 Nominal total resistance range

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.

1.3.6.3 Particular characteristics

Additional characteristics may be listed, when they are considered necessary to specify adequately the component for design and application purposes.

1.3.6.4 Soldering

The detail specification shall prescribe the test methods, severity and requirements applicable for the solderability and the resistance to soldering heat tests.

1.3.7 Marking

The detail specification shall specify the content of the marking on the surface mount preset potentiometer and on the package. Deviation from 1.4 shall be specifically stated.

Surface mount preset potentiometers are generally not marked on the body. If some marking can be applied, the surface mount preset potentiometer shall be clearly marked with the nominal total resistance and many of the remaining items in IEC 60393-1:2008, 2.4.

All items shall be marked on the package.

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 resistanc;

b) 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 on the detail specification.

1.3.10 Packaging

If taping is applied, taping shall be in accordance with IEC 60286-3.

1.4 Marking

1.4.1 General

When coding is used for nominal total 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 position in the list:

a) nominal total resistance;
b) tolerance on nominal total resistance;
c) detail specification and style reference;
d) year and month (or week) of manufacture;
e) manufacturer's name and/or trademark;
f) manufacture’s type designation.

1.4.2 Marking for potentiometers

The potentiometer shall be clearly marked 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 applied in such a way 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 surface mount preset 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 surface mount preset 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 surface mount preset potentiometer shall be chosen for this severity.

2.1.3 Temperature coefficients and temperature characteristics of resistance

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

Each line in the table gives the preferred temperature coefficient and corresponding temperature characteristics for 20 °C to 70 °C and limits of change in resistance for the 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.

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 change)** %							
		Reference temperature/ lower category temperature [b] °C				**Reference temperature/ upper category temperature** [b] °C			
20 °C / 70 °C		+20/–65	+20/–55	+20/–40	+20/–25	+20/+85[a]	+20/+100	+20/+125	+20/+155
±1 000	±5	±8,5	±7,5	±6	±4,5	±6,5	±8	±10,5	±13,5
±750	±3,75	±6,4	±5,63	±4,5	±3,38	±4,88	±6	±7,88	±10,13
±500	±2,5	±4,3	±3,75	±3	±2,25	±3,25	±4	±5,25	±6,75
±250	±1,25	±2,15	±1,88	±1,5	±1,13	±1,62	±2	±2,62	±3,38
±150	±0,75	±1,3	±1,15	±0,9	±0,68	±0,98	±1,2	±1,6	±2,05
±100	±0,5	±0,85	±0,75	±0,6	±0,45	±0,65	±0,8	±1,05	±1,35
±50	±0,25	±0,43	±0,375	±0,3	±0,23	±0,325	±0,4	±0,525	±0,675
±25	±0,125	±0,215	±0,188	±0,15	±0,113	±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.

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

2.1.4 Limits for change in resistance or output voltage ratio

For each stability class the preferred 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	4.48 Shear (adhesion) 4.49 Substrate bending test 4.51 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 [b]			ΔR between terminals a and b [b]	$\Delta \frac{U_{ab}}{U_{ac}}$ [a]	
10	±(10 % R +0,5 Ω)	±(5 % R +0,1 Ω)	±(5 % R +0,1 Ω)	±(15 %+0,5 Ω)	±5 %	±7,5 %
5	±(5 % R +0,1 Ω)	±(3 % R +0,1 Ω)	±(2 % R +0,1 Ω)	±(7,5 %+0,1 Ω)	±2 %	±3 %
3	±(3 % R +0,1 Ω)	±(2 % R +0,1 Ω)	±(1 % R +0,05 Ω)	±(5 %+0,1 Ω)	±1 %	±2 %
2	±(2 % R +0,1 Ω)	±(2 % R +0,1 Ω)	±(1 % R +0,05 Ω)	±(3 %+0,1 Ω)	±1 %	±2 %

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

[a] 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.

[b] ΔR indicates the value of change in resistance.

2.1.5 Total mechanical travel

The preferred values shall be:

a) for single turn rotary surface mount preset potentiometers:
the angle shall be specified in the detail specification,

b) for lead screw actuated surface mount preset potentiometers:
2 to 22 turns.

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 % and ±10 %.

2.2.4 Rated dissipation (in the mounted state)

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 detail specification shall specify the conditions under which the rated dissipation applies.

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

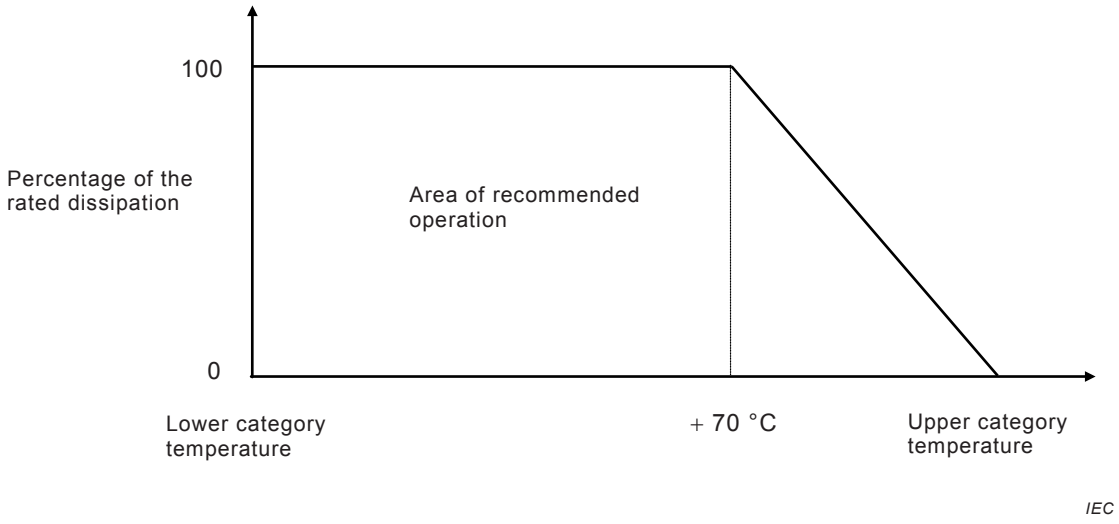

Figure 1 – Rated dissipation curve

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 temperatures other than 70 °C. All break points on the curve shall be verified by test.

An example of a derating curve having a smaller area of operation is given in Figure 2.

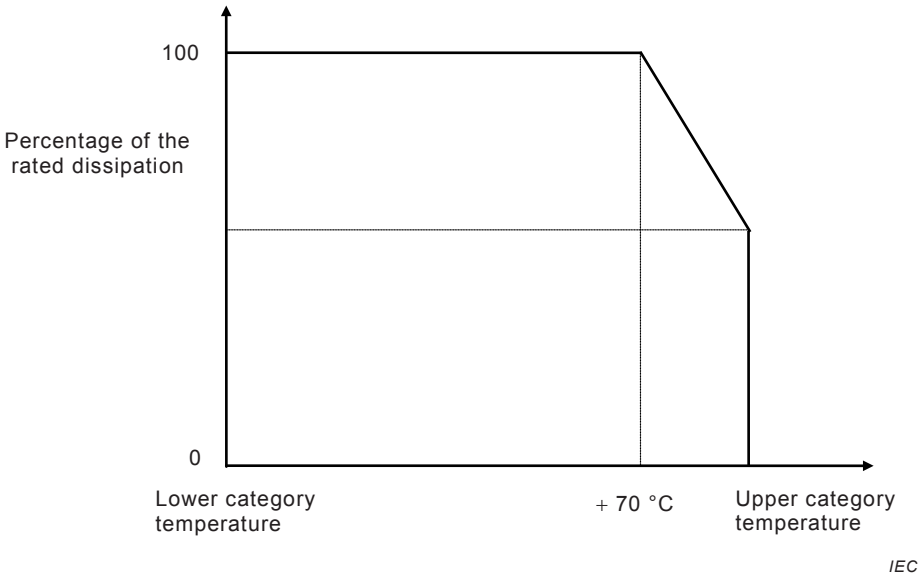

Figure 2 – Rated dissipation curve with smaller area of operation

2.2.5 Limiting element voltage

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

15 V, 30 V, 50 V, 75 V, 100 V, 125 V, 150 V, 200 V, 250 V and 300 V.

2.2.6 Insulation voltage (for insulated styles)

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 (for insulated styles)

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

Procedure 1 of IEC 60393-1:2008, 4.3, 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.

2.3.7 Mounting

See IEC 60393-1:2008, 4.47.

2.3.8 Solderability

See IEC 60393-1:2008, 4.50, with following details:

The solderability test shall be preceded by accelerated aging. Unless specified otherwise in the relevant detail specification, 4 h at 155 °C dry heat shall be used. After accelerated aging, the specimen shall be subjected to standard atmospheric conditions for not less than 2 h and not more than 24 h.

Unless otherwise specified in the relevant detail specification, solderability testing is required for both soldering processes (SnPb solder and lead-free solder).

a) Solderability with SnPb solder shall be tested according to IEC 60068-2-58:2004, 8.2.1, solder bath method with following severity.
   - Solder alloy: Sn60Pb40 or Sn63Pb37
   - Bath temperature: 235 °C ± 5 °C
   - Immersion time: 2 s ± 0,2 s

b) Lead free solder alloys are grouped in IEC 60068-2-58:2004, Clause 4, according to their typical process temperature. The most popular solder alloys SnAg, SnAgCu and SnAgBi are contained in group 3, medium-high temperature.

   Solderability with lead free solder shall be tested according to IEC 60068-2-58:2004, 8.1.1, solder bath method with the following representative severity for group 3:
   - Solder alloy: Sn96,5Ag3,0Cu0,5
   - Bath temperature: 245 °C ± 5 °C

– Immersion time: 3 s ± 0,3 s

2.3.9 Resistance to soldering heat

See IEC 60393-1:2008, 4.51, with following details:

Unless otherwise specified in the relevant detail specification, resistance to soldering heat testing is required for both processes (SnPb solder and lead-free solder).

– Test method: Solder bath method
– Solder alloy: all alloy SnPb or SnAgCu
– Bath temperature: 260 °C ± 5 °C
– Immersion time: 10 s ± 1 s
– Test cycles: 1

2.3.10 Component solvent resistance

See IEC 60393-1:2008, 4.44.

– Solvent temperature: 23 °C ± 5 °C

2.3.11 Solvent resistance of the marking

See IEC 60393-1:2008, 4.45.

– Solvent temperature: 23 °C ± 5 °C.

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 surface mount 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 processes the greatest change in polymerization of the binder.

3.2.2 Structurally similar components

Surface mount preset potentiometers are considered as being structurally similar if they are produced with the same or similar processes and materials, and have the same nominal dimensions but that may have different resistance values and temperature characteristics (or temperature coefficients) of resistance.

3.2.3 Assessment level EZ (zero nonconforming)

Assessment level EZ meets the requirements of “zero nonconforming” approach. It has 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.

Assessment level EZ shall be applied for quality assessment of surface mount preset potentiometers in the detail specification referring to this sectional specification.

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 shall 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 manufacturer's 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 assumes 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 surface mount preset 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 nonconforming 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 part of the tests of the 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 subgroup and total number of permissible nonconformances.

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		106 [f]	0	
4.4.1 Visual examination					As in 4.4.1
4.6 Element resistance					As in 4.6.3
4.4.2 Dimensions (gauging)					As specified in the detail specification
4.7 Terminal resistance		Resistance between a and b Resistance between b and c			$R \leq \ldots\ \Omega$ $R \leq \ldots\ \Omega$
4.4.4 Total mechanical travel		- Lead screw styles: Effective operating turns			 ≥70 % of total mechanical travel
		- Rotary styles:			As specified in the detail specification
4.4.6 Effective electrical travel		- Lead screw styles			≥70 % of the measured total mechanical travel
		- Rotary styles:			As specified in the detail specification
4.5 Continuity [c]					As in 4.5.1 or 4.5.2
4.15 Rotational noise		Method B or Method C			Method B: ≤... % or ... Ω (whichever is greater) Method C: ≤ ... Ω
4.47 Mounting		Substrate material and spacing: see 2.3.8 of this standard			
4.12 Voltage proof (insulated potentiometers only)		Normal air pressure			As in 4.12.5
Spare specimens			5		
GROUP 1	D		20	0	
4.18 Starting torque					See detail specification
4.50 Solderability (not applicable to potentiometers which are not suitable for total immersion)		Aging, if applicable Solder bath method: Temperature and duration: SnPb: (235 ± 5) °C, (2 ± 0,5) s SnAgCu: (245 ± 5) °C, (3 ± 0,3) s			As in 4.50 See detail specification
4.45 Solvent resistance of marking (if applicable)		Solvent: ... Solvent temperature: ... Method 1 Rubbing material: cotton wool			Legible marking
4.14 Temperature characteristic of resistance		Recovery: ... Lower category temperature/20 °C 20 °C/70 °C 20 °C/Upper category temperature			 $\frac{\Delta R}{R} \leq \ldots\ \%$ $\frac{\Delta R}{R} \leq \ldots\ \%$ $\frac{\Delta R}{R} \leq \ldots\ \%$

Table 3 *(2 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*	
4.20 End stop torque		- For types fitted with end stops:			
		As specified in 4.20.1			As in 4.20.1
		Not less than five times the upper limit of the starting torque (unless otherwise stated by the detail specification)			
		- 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 specified in 4.22.3			
		Setting stability (output voltage ratio) (as in 4.17.2.1)			$\Delta \frac{U_{ab}}{U_{ac}} \leq$ ... %
4.40 Mechanical endurance		Number of cycles: ...			See detail specification
		Rate:			
		- Rotary types: 5 to 10 cycles per minute			
		- Lead screw types:			
		Visual examination			As in 4.40.6
		Element resistance			$\Delta R \leq \pm$(... % + ... Ω)
		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	
4.47 Mounting		Substrate:			
		Visual examination			No visible damage
		Element resistance			$\Delta R \leq \pm$(... % + ... Ω)
4.49 Substrate bending test		Element resistance			$\Delta R \leq \pm$(... % + ... Ω)
		Visual examination			No visible damage
4.51 Resistance to soldering heat (not applicable to potentiometers which are not suitable for total immersion)		Terminal resistance: Resistance between a and b Resistance between b and c			 $R \leq$ ... Ω $R \leq$ ... Ω
		Temperature and duration: (260 ± 5) °C, (5 ± 1) s or (10 ± 1) s			

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			See detail specification
		Recovery			
4.31 Sealing (if applicable)		Temperature: 85 °C to 95 °C			As in 4.31.3
			(12 of the sample)	0	
4.47 Mounting		Substrate:			
		Visual examination			No visible damage
		Element resistance			$\Delta R \leq \pm($ ... % + ... $\Omega)$
4.34 Change of temperature [d]		T_A = Lower category temperature T_B = Upper category temperature			
		Visual examination			As in 4.34.5
		Setting stability (output voltage ratio) (as in 4.17.2.1)			$\Delta \frac{U_{ab}}{U_{ac}} \leq$ ... %
		Element resistance			$\Delta R \leq \pm($ ... % + ... $\Omega)$
4.37 Shock [d]		For mounting method see detail specification			
		Pulse shape: half sine			
		Acceleration: 500 m/s^2			
		Pulse duration: 11 ms			
		Visual examination			As in 4.37.3
		Element resistance			$\Delta R \leq \pm($ ... % + ... $\Omega)$
		Setting stability (output voltage ratio) (as in 4.17.2.1)			$\Delta \frac{U_{ab}}{U_{ac}} \leq$ ... %
4.35 Vibration [d]		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:			

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*	
		Total duration: 6 h			
- 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
		Setting stability (output voltage ratio) (as in 4.17.2.1)			$\Delta \frac{U_{ab}}{U_{ac}} \leq$ ... %
		Element resistance			$\Delta R \leq \pm$(... % + ... Ω)
4.48 Shear (if applicable)		Mounting: see 4.47			
		Force: 5 N, 10 s ± 1 s			
		Visual examination			As in 4.48
			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) [g] (as in 4.38.7)			As in 4.38.5.3
- Damp heat, cyclic, Test Db, remaining cycles					
- DC load [e]					
- Insulation voltage [e]					As in 4.38.8
- Final measurements		Visual examination			As in 4.38.10.1
		Element resistance			$\Delta R \leq \pm$(... % + ... Ω)
		Insulation resistance (insulated potentiometers only) [g]			≥100 MΩ
		Continuity			As in 4.5.1 or 4.5.2
		Starting torque			... mN·m to ... mN·m
		Voltage proof (insulated potentiometers only) [g]			As in 4.38.10.7

Table 3 *(5 of 7)*

Subclause number and test [a]	D or ND [b]	Conditions of test [a]	Sample size & criterion of acceptability [b]		Performance requirements [a]
			n	*c*	
GROUP 3	D	Duration: 500 h or 1 000 h	20	0	
4.43.2 Electrical endurance at 70 °C		- Loaded between a and c:	(10)	0	
		Examination at 48 h, 500 h and 1 000 h			
		Visual examination			As in 4.43.2.6 a)
		Element resistance			$\Delta R \leq \pm($ … % + … Ω$)$
		- Loaded between a and b:	(10)	0	
		Examination at 48 h, 500 h and 1 000 h			
		Visual examination			As in 4.43.2.6 a)
		Resistance between a and b:			$\Delta R \leq \pm($ … % + … Ω$)$
		Element resistance			$\Delta R \leq \pm($ … % + … Ω$)$
		All specimens			
		Examination at 500 h or 1 000 h			
		Insulation resistance (insulated potentiometers only) [g]			≥1 GΩ
		Rotational noise, Method B or Method C			≤ … % or … Ω
GROUP 4	ND		10	0	
4.4.3 Dimensions (detail)					As specified in the detail specification
GROUP 5	D		12	0	
4.39 Damp heat, steady state		As in 4.39.2.2			
		1st group: 6 specimens			
		2nd group: 6 specimens			
		DC load [e]			
		Insulation voltage [e,g]			As in 4.39.4
- Final measurements		Visual examination			As in 4.39.6.1
		Element resistance			$\Delta R \leq \pm($ … % + … Ω$)$
		Insulation resistance (insulated potentiometers only) [g]			≥100 MΩ
		Continuity			As in 4.5.1 or 4.5.2
		Starting torque			… mN·m to … mN·m
		Rotational noise Method B or Method C			Method B: ≤ … % or … Ω (whichever is greater)
					Method C: ≤ … Ω
		Voltage proof (insulated potentiometers only) [g]			As in 4.39.6.8

Table 3 *(6 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 6	D	Duration: 500 h or 1 000 h	20	0	
4.43.3 Electrical endurance at upper category temperature		- Loaded between a and c:	(10)	0	
		Examination at 48 h, 500 h and 1 000 h:			
		Visual examination			As in 4.43.3.7 a)
		Element resistance			$\Delta R \leq \pm($ ... % + ... $\Omega)$
		- Loaded between a and b:	(10)	0	
		Examination at 48 h, 500 h and 1 000 h:			
		Visual examination			As in 4.43.3.7 a)
		Resistance between a and b			$\Delta R \leq \pm($ ... % + ... $\Omega)$
		Element resistance			$\Delta R \leq \pm($ ... % + ... $\Omega)$
		All specimens	20	0	
		Examination at 500 h or 1 000 h:			
		Insulation resistance (insulated potentiometers only) [g]			≥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 2.2.4 of this standard is claimed in the detail specification)			
		Duration: 500 h or 1 000 h			
		- Loaded between a and c:	(10)	0	
		Examination at 48 h, 500 h and 1 000 h:			
		Visual examination			As in 4.43.1.6 a)
		Element resistance			$\Delta R \leq \pm($ ... % + ... $\Omega)$ (as for Group 3)
		- Loaded between a and b:	(10)	0	
		Examination at 48 h, 500 h and 1 000 h:			
		Visual examination			As in 4.43.1.6 a)
		Resistance between a and b			$\Delta R \leq \pm($ ... % + ... $\Omega)$ (as for Group 3)
		Element resistance			$\Delta R \leq \pm($ ... % + ... $\Omega)$
		All specimens			
		Examination at 500 h or 1 000 h:			
		Insulation resistance (insulated potentiometers only) [g]			≥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 shall be selected from Table 1 and Table 2 of this standard, as appropriate.
[b]	In this table: n = sample size c = 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 as described in IEC 60393-1:2008, 4.34.3 and 4.34.6 for "change of temperature" and in IEC 60393-1:2008,4.35.2 for "vibration" apply.
[e]	The d.c. load test and the insulation voltage test are considered as alternatives. The detail specification shall indicate which test applies.
[f]	The sample size in Group 0 shall be increased by 20 specimens when Group 7 is applicable.
[g]	For the method of mounting, see IEC 60393-1:2008, 4.47.

3.4 Quality conformance inspection

3.4.1 Formation of inspection lots

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

a) Groups A and B: These tests shall be carried on 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 be in accordance with Table 4 and Table 5.

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

Assessment level EZ			
Inspection subgroup [d]	**IL** [a]	***n*** [a]	***c*** [a]
A0 4.6 Element resistance	100 % [b]		
A1 4.4.1 Visual examination	II	[c]	0
A2 4.4.2 Dimensions [e] (gauging)	S-2	[c]	0
A3 4.7 Terminal resistance 4.5 Continuity 4.15 Rotational noise 4.12 Voltage proof (insulated potentiometers only)	S-3	[c]	0
B1 4.18 Starting torque 4.31 Sealing (if applicable)	S-2	[c]	0
B2 4.50 Solderability 4.45 Solvent resistance of the marking (if applicable)	S-2	[c]	0

[a] IL = inspection level;
n = sample size
c = 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 the 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 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 that any parts exceed the dimensional limits.

Table 5 – Quality conformance inspection: Periodic testing

Assessment level EZ				
Inspection subgroup [b]		p [a]	n [a]	c [a]
	C1	3	20	0
4.14	Temperature characteristic of resistance			
4.20	End stop torque			
4.22	Thrust and pull on shaft			
4.4.4	Total mechanical travel			
4.4.6	Effective electrical travel			
	C2	3	24	0
C2A	(Part of the sample)	3	12	0
4.47	Mounting			
4.49	Substrate bending test			
4.51	Resistance to soldering heat			
4.44	Components solvent resistance			
4.31	Sealing (if applicable)			
C2B	(Part of the sample)	3	12	0
4.47	Mounting			
4.48	Shear			
4.34	Change of temperature			
4.37	Shock			
4.35	Vibration			
	C2	3	24	0
(Combined sample of C2A and C2B)				
4.38	Climatic sequence			
	C3	6	20	0
4.43.2	Electrical endurance at 70 °C			
	C4	6	20	0
4.40	Mechanical endurance (potentiometers)			
	D1	12	20	0
4.39	Damp heat, steady state			
	D2	36	20	0
4.43.3	Electrical endurance at upper category temperature			
	D3	36	10	0
4.4.3	Dimensions (detail)			
	D4	36	20	0
4.43	Electrical endurance at other than 70 °C (if applicable)			

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

[a] p = periodicity in months
n = sample size
c = permissible number of nonconforming items.

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

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 be one year.

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