

INTERNATIONAL STANDARD

IEC
60115-9

First edition
2003-10

Fixed resistors for use in electronic equipment –

Part 9:

Sectional specification:

**Fixed surface mount resistor networks
with individually measurable resistors**

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FIXED RESISTORS FOR USE IN ELECTRONIC EQUIPMENT –

**Part 9: Sectional specification:
Fixed surface mount resistor networks
with individually measurable resistors**

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International Standard IEC 60115-9 has been prepared by IEC technical committee 40: Capacitors and resistors for electronic equipment.

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

| FDIS | Report on voting |
|--------------|------------------|
| 40/1344/FDIS | 40/1366/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 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 2008. At this date, the publication will be

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- withdrawn;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

A bilingual edition of this standard may be issued at a later date.

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FIXED RESISTORS FOR USE IN ELECTRONIC EQUIPMENT –

Part 9: Sectional specification: Fixed surface mount resistor networks with individually measurable resistors

1 General

1.1 Scope

This part of IEC 60115 is applicable to fixed surface mount resistor networks with individually measurable resistors for use in electronic equipment.

1.2 Object

The object of this standard is to prescribe preferred ratings and characteristics and to select from IEC 60115-1, the appropriate Quality Assessment procedures, tests and measuring methods and to give general performance requirements for this type of resistor.

Test severities and requirements prescribed in detail specifications referring to this sectional specification must be of equal or higher performance level, because lower performance levels are not permitted.

1.3 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60063:1963, *Preferred number series for resistors and capacitors*
Amendment 1 (1967)
Amendment 2 (1977)

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

IEC 60068-2-1: *Environmental testing – Part 2: Tests. Tests A: Cold*

IEC 60068-2-2: *Environmental testing – Part 2: Tests. Tests B: Dry heat*

IEC 60115-1:1999, *Fixed resistors for use in electronic equipment – Part 1: Generic specification*

1.4 Information to be given in a detail specification

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

Detail specifications shall not specify requirements inferior to those of the generic, sectional specification or blank detail specification.

When more severe requirements are included, they shall be listed in 1.8 of the detail specification and indicated in the test schedules, for example by an asterisk.

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.

1.4.1 Outline drawing and dimensions

There shall be an illustration of the surface mount resistor network as an aid to easy recognition and for comparison of the surface mount resistor network 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.

Schematic diagrams and pin identifications shall be given in the detail specification. Those are prescribed in Annex A.

Configurations of terminations shall be given in the detail specification. Those are prescribed in Annex B.

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

1.4.2 Mounting

The detail specification shall give guidance on methods of mounting for normal use. Mounting for test and measurement purposes (when required) shall be in accordance with 4.31 of IEC 60115-1.

1.4.3 Style (2.2.2 of IEC 60115-1)

The styles given in Table 1 are preferred. All dimensions are in mm.

Table 1 – Style and outline dimensions

Dimensions in mm

| Code | Length L | Width W | Thickness T | Diagram ^{a)} | Construction of terminals ^{a)} |
|---|----------------|---------------|-----------------|-----------------------|---|
| 1005X2 | $1 \pm 0,1$ | $1 \pm 0,1$ | $0,35 \pm 0,1$ | A | Convex |
| 1005X4 | $2 \pm 0,1$ | $1 \pm 0,1$ | $0,4 \pm 0,15$ | A | Convex Concave |
| 1608X2 | $1,6 \pm 0,2$ | $1,6 \pm 0,2$ | $0,55 \pm 0,15$ | A | Convex Concave |
| 1608X4 | $3,2 \pm 0,2$ | $1,6 \pm 0,2$ | $0,55 \pm 0,15$ | A | Convex Concave |
| 3216X4 | $5,08 \pm 0,2$ | $3,1 \pm 0,2$ | $0,55 \pm 0,15$ | A | Convex Concave |
| 3216 | $3,2 \pm 0,2$ | $1,6 \pm 0,2$ | $0,5 \pm 0,15$ | B, C | Convex |
| 4021 | $4 \pm 0,2$ | $2,1 \pm 0,2$ | $0,6 \pm 0,15$ | D | Concave |
| 6431 | $6,4 \pm 0,2$ | $3,1 \pm 0,2$ | $0,6 \pm 0,15$ | B, C | Convex Concave |
| ^{a)} Diagrams are shown in Annex A. Constructions of terminals are shown in Annex B. | | | | | |

1.4.4 Ratings and characteristics

The ratings and characteristics shall be in accordance with the relevant clauses of this specification together with the following:

Rated resistance range

See 2.2.1. The preferred values are those of the E-series of IEC 60063.

NOTE When products approved 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 qualified products list".

1.4.5 Marking

The detail specification shall specify the content of the marking on the surface mount resistor network and on the package.

Surface mount resistor networks are generally not marked on the body. If some marking can be applied, the surface mount resistor network shall be clearly marked with the rated resistance and as many of the remaining items in 2.4 of IEC 60115-1 as possible.

All items shall be marked on the package. Deviations from the above mentioned requirements shall be specifically stated.

2 Preferred ratings, characteristics and test severities

2.1 Preferred ratings and characteristics

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

2.1.1 Preferred climatic categories

The surface mount resistor networks covered by this specification are classified into climatic categories according to the general rules given in IEC 60068-1.

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

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

Upper category temperature: +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 resistor networks these temperatures will occur between two of the preferred temperatures given in IEC 60068-2-1 and IEC 60068-2-2. In this event, the nearest preferred temperature within the actual temperature range of the surface mount resistor network shall be chosen for this severity.

2.1.2 Temperature coefficients and temperature characteristics of resistance

The preferred limits of change in resistance for the temperature characteristics of resistance test are given in Table 2.

Each line in the table gives the preferred temperature coefficient and corresponding temperature characteristic for 20 °C to 70 °C and limits of change in resistance for the measurement of the temperature characteristic of resistance (see 4.8 of IEC 60115-1) on the basis of category temperature ranges of 2.1.1 of this sectional specification.

Table 2 – Temperature coefficients and temperature characteristics of resistance

| Temperature coefficient | Temperature characteristic 20/70 °C | Temperature characteristic of resistance (limits of percentage change in resistance) | | | | | | | |
|-------------------------|-------------------------------------|--|---------|---------|---------|---|----------|----------|----------|
| | | Reference temperature /lower category temperature | | | | Reference temperature /upper category temperature | | | |
| $10^{-6}/K$ | % | +20/-55 | +20/-40 | +20/-25 | +20/-10 | +20/+85 | +20/+100 | +20/+125 | +20/+155 |
| ±500 | ±2,5 | ±3,75 | ±3 | ±2,25 | 1,500 | ±3,25 | ±4 | ±5,25 | ±6,75 |
| ±250 | ±1,25 | ±1,88 | ±1,5 | ±1,13 | 0,750 | ±1,62 | ±2 | ±2,62 | ±3,38 |
| ±100 | ±0,5 | ±0,75 | ±0,6 | ±0,45 | 0,300 | ±0,65 | ±0,8 | ±1,05 | ±1,35 |
| ±50 | ±0,25 | ±0,375 | ±0,3 | ±0,23 | 0,150 | ±0,325 | ±0,4 | ±0,525 | ±0,675 |
| ±25 | ±0,125 | ±0,188 | ±0,15 | ±0,113 | 0,075 | ±0,162 | ±0,2 | ±0,262 | ±0,338 |
| ±15 | ±0,075 | ±0,113 | ±0,09 | ±0,068 | 0,045 | ±0,098 | ±0,12 | ±0,158 | ±0,203 |
| ±10 | ±0,05 | ±0,075 | ±0,06 | ±0,045 | 0,030 | ±0,065 | ±0,08 | ±0,105 | ±0,135 |

NOTE 1 Resistors having an upper category temperature of +85 °C need not be measured between 20 °C and 70 °C.

NOTE 2 If measurements are required at additional temperatures, these shall be specified in the detail specification.

2.1.3 Limits for change in resistance

For each stability class the preferred limits for change in resistance for each of the tests listed in the heading of Table 3 are as indicated.

Table 3 – Limits for change in resistance

| Stability class in % | Long-term tests | | Short-term tests | |
|----------------------|-----------------|---|------------------|------------------------------|
| | Clause | Description | Clause | Description |
| 5 | 4.23 | Climatic sequence | 4.13 | Overload |
| | 4.24 | Damp heat, steady state | 4.18 | Resistance to soldering heat |
| | 4.25.1 | Endurance at 70 °C | 4.19 | Rapid change of temperature |
| | 4.25.3 | Endurance at upper category temperature | 4.32 | Shear |
| 3 | | | 4.33 | Substrate bending test |
| | | | | |
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| 2 | | | | |
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| 0,1 | | | | |
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| | | | | |

NOTE The clause numbers in the heading refer to IEC 60115-1.

2.2 Preferred values of ratings

2.2.1 Rated resistance

See 2.2.6 of IEC 60115-1.

2.2.2 Tolerances on rated resistance

The preferred tolerances on rated resistance are:

$\pm 5\%$; $\pm 2\%$; $\pm 1\%$; $\pm 0,5\%$; $\pm 0,25\%$ and $\pm 0,1\%$.

2.2.3 Rated dissipation (in the mounted state)

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

For the network: 0,125 W; 0,25 W and 0,5 W.

For the resistor element: 0,03 W; 0,05 W; 0,063 W; 0,1 W and 0,125 W.

The detail specification shall prescribe the applicable value of rated dissipation for each resistor element in the network and also the maximum allowable total dissipation for the network.

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

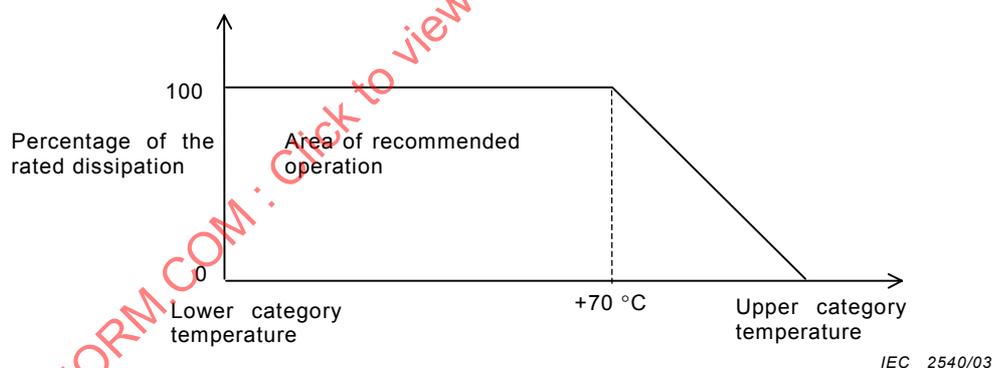


Figure 1 – Rated dissipation curve

A larger area of operation may be given in the detail specification, provided it includes all of the area given above. 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.

2.2.4 Limiting element voltage

The preferred values of limiting element voltage are:

25 V; 50 V; 100 V and 200 V DC or AC r.m.s.

2.2.5 Insulation resistance (if applicable)

The insulation resistance shall be not less than 1 G Ω after dry heat tests.

2.2.6 Insulation resistance between individual resistors (if applicable)

The preferred minimum limit for insulation resistance between individual resistors shall be 100 M Ω unless otherwise prescribed in the detail specification.

2.2.7 Insulation voltage against conducting mounting surface

The maximum DC or AC r.m.s. voltage which can be applied under continuous operating conditions between the resistor network terminations and any conducting mounting surface shall be prescribed in the relevant detail specification.

2.2.8 Insulation voltage between neighbouring individual resistors

The maximum DC or AC r.m.s. voltage which can be applied under continuous operating conditions between each individual resistor element as one pole, and all other individual resistors connected together as the other pole shall be prescribed in the relevant detail specification.

2.3 Preferred test severities

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

2.3.1 Drying

Procedure I of 4.3 of IEC 60115-1 shall be used.

2.3.2 Overload (in the mounted state)

4.13 of IEC 60115-1, with the following details:

Applied voltage: 2,5 times the rated voltage or twice the limiting element voltage, whichever is the less.

Duration: the DC test voltage shall be applied for 2 s to each resistor in the network, one at a time.

Substrate material: epoxy glass laminate as specified in the detail specification.

The distance between surface mount resistor networks shall not be less than the largest dimension of the surface mount resistor network. The detail specification shall specify any further details as necessary (see 2.2.3).

3 Quality assessment procedures

3.1 Structurally similar components

Surface mount resistor networks are considered as being structurally similar if they are produced with similar processes and materials, and have the same nominal dimensions but different resistance values and temperature characteristics.

3.2 Qualification approval

The procedures for Qualification Approval testing are given in 3.5 of IEC 60115-1.

The schedule to be used for Qualification Approval testing on the basis of lot-by-lot and periodic testing is given in 3.3 of this specification. The procedure using a fixed sample size schedule is given in 3.2.1 and 3.2.2.

3.2.1 Qualification Approval on the basis of the fixed sample size procedure

Sampling

The fixed sample size procedure is described in 3.5.3 b) of IEC 60115-1. When according to these procedures approval is desired for one specific network with fixed resistance values, the number of specimens shall be specified in Table 4.

When qualification approval is desired for a range of resistance values in the network, the sample shall consist of specimens containing the highest and lowest resistance values for which approval is being sought. It should also include specimens having the critical resistance values, if this is within the range being submitted. For each value submitted, the number of specimens shall be as specified in Table 3. When approval is being sought for more than one temperature coefficient of resistance, the sample shall contain specimens representative of the different temperature coefficients. In a similar manner, the sample shall contain a proportion of specimens at 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 the National Supervising Inspectorate (N.S.I.).

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 defectives in Group 0A and Group 0B.
- b) One per resistance value and one per each temperature coefficient or temperature characteristic value which may be used to replace specimens which are defective because of incidents not attributable to the manufacturer.

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

3.2.2 Tests

The complete series of tests specified in Table 4 is required for the approval of surface mount resistor networks 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 0A and Group 0B, and then divided for the other groups.

Specimens found defective during the tests of Group 0A or Group 0B shall not be used for the other groups.

"One defective" is counted when a surface mount resistor network has not satisfied the whole or a part of the tests of a group.

The approval is granted when the number of defectives does not exceed the specified number of permissible defectives for each group or subgroup and the total number of permissible defectives.

NOTE In Table 4 the fixed sample size test schedule is given. It includes details of sampling and permissible defectives for different tests or groups of tests and gives, together with the details of tests contained in Clause 4 of IEC 60115-1 and Clause 2 of this specification, a complete summary of test conditions and performance requirements.

It is indicated in Table 4 where, for the test methods, test conditions and/or performance requirements, a choice has to 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 4 – Fixed sample size test schedule for qualification approval Assessment level EZ

| Subclause number and test (see NOTE 1) | D or ND | Conditions of test (see NOTE 1) | Sample size and criterion of acceptability (see NOTE 2) | | Performance requirements (see NOTE 1) |
|--|---------|---|--|----------|--|
| | | | <i>n</i> | <i>c</i> | |
| Group 0A | ND | | 165 | 0 | |
| 4.4.1 Visual examination | | | | | As in 4.4.1 |
| Group 0B | ND | | 165 | 0 | |
| 4.4.2 Dimensions (gauging) | | | | | As specified in the detail specification |
| 4.5 Resistance | | | | | As in 4.5.2 |
| Group 1A | D | | 20 | 0 | |
| 4.18 Resistance to soldering heat | | Visual examination Resistance | | | As in 4.18.3 $\Delta R \leq \pm(\dots \%R + \dots \Omega)$ |
| 4.29 Component solvent resistance | | Solvent: ... Solvent temperature: ... Method 2 Recovery: ... | | | See detail specification |
| Group 1B | D | | 20 | 0 | |
| 4.17 Solderability | | Aging, if applicable | | | As in 4.17.5 |
| 4.7 Voltage proof (insulated resistors only) | | Method: ... Insulation voltage: ...V | | | As in 4.7.3 |
| Voltage proof between neighbouring resistors | | Voltage: ... V | | | As in 4.7.3 |
| 4.31 Mounting | | Substrate material and spacing, see 2.3.2 of this specification | | | |
| 4.6 Insulation resistance (insulated resistors only) | | Method: ... Insulation voltage: ...V | | | $\geq 100 \text{ M}\Omega$ |
| 4.13 Overload (in the mounted state) | | The applied voltage shall be 2,5 times the rated voltage or twice the limiting element voltage, whichever is the less severe Duration: 2 s Visual examination Resistance | | | No visible damage $\Delta R \leq \pm(\dots \%R + \dots \Omega)$ |
| 4.30 Solvent resistance of the marking (if applicable) | | Solvent: ... Solvent temperature: ... Method 1 Rubbing material: cotton wool Recovery: ... | | | Legible marking |

| Subclause number and test (see NOTE 1) | D or ND | Conditions of test (see NOTE 1) | Sample size and criterion of acceptability (see NOTE 2) | | Performance requirements (see NOTE 1) |
|--|---------|--|--|---|---|
| | | | n | c | |
| Group 2 4.33 Substrate bending test 4.33.6 Final inspection | D | Resistance Visual examination | 20 | 0 | $\Delta R \leq \pm(\dots \%R + \dots \Omega)$ No visible damage |
| Group 3 4.31 Mounting | D | Substrate material: ... Visual examination Resistance | 100 | 0 | No visible damage $\Delta R \leq \pm(\dots \%R + \dots \Omega)$ |
| Group 3.1 4.32 Shear 4.19 Rapid change of temperature 4.23 Climatic sequence - Dry heat - Damp heat, cyclic, Test Db, first cycle - Cold - Damp heat, cyclic, Test Db, remaining cycles - DC load | D | Visual examination T_A : Lower category temperature T_B : Upper category temperature Visual examination Resistance Visual examination Resistance | 20 | 0 | No visible damage No visible damage $\Delta R \leq \pm(\dots \%R + \dots \Omega)$ No visible damage $\Delta R \leq \pm(\dots \%R + \dots \Omega)$ |
| Group 3.2 4.24 Damp heat, steady state | D | Without polarizing voltage Visual examination Resistance | 20 | 0 | No visible damage Legible marking $\Delta R \leq \pm(\dots \%R + \dots \Omega)$ |
| Group 3.3 4.25.1 Endurance at 70 °C | D | Spacing as in 2.3.2 of this specification Duration: 1 000 h Examination at 48 h, 500 h and 1 000 h: Visual examination Resistance | 20 | 0 | No visible damage $\Delta R \leq \pm(\dots \%R + \dots \Omega)$ |

| Subclause number and test (see NOTE 1) | D or ND | Conditions of test (see NOTE 1) | Sample size and criterion of acceptability (see NOTE 2) | | Performance requirements (see NOTE 1) |
|---|---------|---|--|----------|--|
| | | | <i>n</i> | <i>c</i> | |
| Group 3.4 4.25.3 Endurance at upper category temperature | D | Spacing as in 2.3.2 of this specification Duration: 1 000 h Examination at 48 h, 500 h and 1 000 h: Visual examination Resistance | 20 | 0 | No visible damage $\Delta R \leq \pm(\dots \% R + \dots \Omega)$ |
| Group 3.5 4.8 Variation of resistance with temperature | ND | Lower category temperature /20 °C 20 °C/upper category temperature | 20 | 0 | $\frac{\Delta R}{R} \leq \dots \%$ or $\alpha: \dots 10^{-6}/K$ $\frac{\Delta R}{R} \leq \dots \%$ or $\alpha: \dots 10^{-6}/K$ |
| NOTE 1 Subclause numbers of test and performance requirements refer to the Generic specification, IEC 60115-1, except for resistance change requirements, which shall be selected from Table 1 and Table 2 of this specification, as appropriate. | | | | | |
| NOTE 2 In this table: <i>n</i> = sample size <i>c</i> = group acceptance criterion (permitted number of defectives per group or subgroup) D = destructive ND = non-destructive | | | | | |

3.3 Quality conformance inspection

3.3.1 Formation of inspection lots

An inspection lot shall consist of structurally similar surface mount resistor networks (see 3.1) of the same style. It shall be representative of those extremes of the resistance range produced during the inspection period. Styles having different temperature characteristics of resistance which are produced during the period may be aggregated, except for the purposes of subgroups which contain a test for temperature characteristics of resistance. The low and high extreme values, or any critical value of the ranges of resistance and temperature characteristics of resistance, for which qualification approval has been granted shall be inspected during a period which is approved by the National Supervising Inspectorate (see NOTE).

The samples for Group C and Group D shall be collected over the last 13 weeks of the inspection period.

NOTE "Low" extreme values should be between 0 % and 50 % of the current lowest approved resistance value (or lowest value produced within the approval range); "high" extreme values should be between -30 % and 0 % of the current highest approved resistance value (or highest value produced within the approval range); "critical" values should be between -20 % and 0 % of the calculated value.

3.3.2 Test schedule

The schedule for the lot-by-lot and periodic tests for quality conformance Inspection is given in Clause 2, Table 2 of the blank detail specification, i.e. IEC 60115-9-1.

3.3.3 Assessment levels

The assessment level given in the blank detail specification shall be in accordance with Table 5 and Table 6.

Table 5 – Quality conformance inspection for lot-by-lot inspection

| Inspection subgroup ^{d)} | Assessment level | | | |
|-----------------------------------|-------------------------|------------------------|------------------------|--|
| | EZ | | | |
| | <i>IL</i> ^{a)} | <i>n</i> ^{a)} | <i>c</i> ^{a)} | |
| A0 | 100 % ^{b)} | | | |
| A1 | S-4 | c) | 0 | |
| B1 | S-3 | c) | 0 | |
| B2 | S-3 | c) | 0 | |
| B3 | S-3 | c) | 0 | |

a) *IL* is the inspection level
n is the sample size
c is the permissible number of non-conforming items

b) 100 % testing shall be followed by re-inspection by sampling in order to monitor outgoing quality level by non-conforming items per million (ppm). The sampling level shall be established by the manufacturer. For the calculation of ppm values, any parametric failure shall be counted as a non-conforming item. In case one or more non-conforming items occur in a sample, this lot shall be rejected.

c) Number to be tested: sample size as directly allotted to the code letter for *IL* in Table IIA of IEC 60410 (Single sampling plan for normal inspection).

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

Table 6 – Quality conformance inspection for periodic testing

| Inspection subgroup ^{b)} | Assessment level | | | |
|-----------------------------------|------------------------|------------------------|---------------------------|--|
| | EZ | | | |
| | <i>p</i> ^{a)} | <i>n</i> ^{a)} | <i>c</i> ^{a) c)} | |
| C1 | 3 | 20 | 0 | |
| C2 | 3 | 20 | 0 | |
| C3 | 3 | 20 | 0 | |
| C4 | 3 | 20 | 0 | |
| C5 | 3 | 20 | 0 | |
| D1 | 12 | 20 | 0 | |
| D2 | 36 | 20 | 0 | |

a) *p* is the periodicity in months
n is the sample size
c is the permissible number of non-conforming items

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

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