Fusible, Non-Flammable Resistors

A homogenous film of metal alloy is deposited on a high grade ceramic body. After a helical groove has been cut in the resistive layer, tinned connecting wires of electrolytic copper are welded to the end-caps. The resistors are coated with a grey, flame retardant lacquer which provides electrical, mechanical, and climatic protection. The encapsulation is resistant to all cleaning solvents in accordance with "MIL-STD-202E, method 215", and "IEC 60068-2-45".

FEATURES

- Overload protection without risk of fire
- Wide range of overload currents (refer Fusing Characteristics graphs)
- Lead (Pb)-free solder contacts
- Pure tin plating provides compatibility with lead (Pb)-free and lead containing soldering processes
- Compatible with "Restriction of the use of Hazardous Substances" (RoHS) directive 2002/95/EC (issue 2004)

APPLICATIONS

- Audio
- Video

TECHNICAL SPECIFICATIONS

DESCRIPTION	VALUE	
	NFR25	NFR25H
Resistance Range (1)	0.22 Ω to 15 kΩ	
Resistance Tolerance and Series	± 5 %; E24 series	
Maximum Dissipation at T_{amb} = 70 °C	0.33 W	0.5 W
Thermal Resistance R_{th}	240 K/W	150 K/W
Temperature Coefficient:		
0.22 Ω ≤ R ≤ 4.7 Ω	≤ ± 200 x 10^{-6}/K	≤ ± 200 x 10^{-6}/K
4.7 Ω < R ≤ 15 Ω	≤ ± 200 x 10^{-6}/K	≤ ± 100 x 10^{-6}/K
15 Ω < R ≤ 15 kΩ	≤ ± 100 x 10^{-6}/K	≤ ± 100 x 10^{-6}/K
Maximum Permissible Voltage (DC or RMS)	250 V	350 V
Basic Specifications	IEC 60115-1 and 60115-2	
Climatic Category (IEC 60068)	55/155/56	
Stability After:		
Load	ΔR max.: ± (1 % R + 0.05 Ω)	
Climatic Tests	ΔR max.: ± (1 % R + 0.05 Ω)	
Soldering	ΔR max.: ± (0.25 % R + 0.05 Ω)	

Notes:

(1) Ohmic values (other than resistance range) are available on request

- R value is measured with probe distance of 24 ± 1 mm using 4-terminal method

12NC INFORMATION

- The resistors have a 12-digit numeric code starting with 23
- The subsequent 7 digits indicate the resistor type and packaging
- The remaining 3 digits indicate the resistance values:
  - The first 2 digits indicate the resistance value
  - The last digit indicates the resistance decade

Last Digit of 12NC Indicating Resistance Decade

RESISTANCE DECADE	LAST DIGIT
0.22 to 0.91 Ω	7
1 to 9.1 Ω	8
10 to 91 Ω	9
100 to 910 Ω	1
1 to 9.1 kΩ	2
10 to 15 kΩ	3

12NC Example

The 12NC for a NFR25 resistor with value 750 Ω, supplied on a bandolier of 1000 units in ammopack is: 2322 205 13751.

12NC - resistor type and packaging

TYPE	ORDERING CODE 23..			
	BANDOLIER IN AMMOPACK			BANDOLIER ON REEL
	RADIAL TAPED	STRAIGHT LEADS		STRAIGHT LEADS
	4000 UNITS	1000 UNITS	5000 UNITS	5000 UNITS
NFR25	06 204 03...	22 205 13...	22 205 33...	22 205 23...
NFR25H	06 207 03...	22 207 13...	22 207 33...	22 207 23...

PART NUMBER AND PRODUCT DESCRIPTION

PART NUMBER: NFR2500002207JA100

N	F	R	2	5	0	0	0	0	2	2	0	7	J	A	1	0	0

MODEL/SIZE	SPECIAL CHARACTER	TCR/MATERIAL	VALUE	TOLERANCE	PACKAGING (1)	SPECIAL
NFR2500 **NFR25H0**	**0** = Neutral **Z** = Value overflow (Special)	**0** = Standard	**3 digit value** **1 digit multiplier** MULTIPLIER **7** = $*10^{-3}$ **8** = $*10^{-2}$ **9** = $*10^{-1}$ **0** = $*10^{0}$ **1** = $*10^{1}$ **2** = $*10^{2}$	**J** = ± 5 %	**N4** **A5** **A1** **R5**	The 2 digits are used for all special parts. **00** = Standard

PRODUCT DESCRIPTION: NFR25 5 % A1 R22

NFR25	5 %	A1	R22
MODEL/SIZE	TOLERANCE	PACKAGING (1)	RESISTANCE VALUE
NFR25 **NFR25H**	± **5** %	**N4** **A5** **A1** **R5**	**1K0** = 1 kΩ **4R7** = 4.7 Ω

Notes:

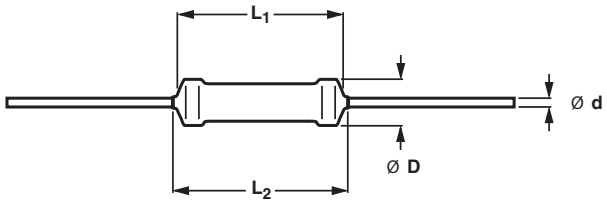
(1) Please refer to table PACKAGING for details.

- The PART NUMBER is shown to facilitate the introduction of a unified part numbering system for ordering products.

PACKAGING

CODE	PIECES	DESCRIPTION	MODEL/SIZE
N4	4000	Bandolier in ammopack radial taped	NFR25, NFR25H
A5	5000	Bandolier in ammopack straight leads	
A1	1000	Bandolier in ammopack straight leads	
R5	5000	Bandolier on reel straight leads	

DIMENSIONS



Outline

DIMENSIONS - resistor types and relevant physical dimensions				
TYPE	**Ø $D_{max.}$**	**$L_{1\ max.}$**	**$L_{2\ max.}$**	**Ø d**
NFR25	2.5	6.5	7.5	0.58 ± 0.05
NFR25H				

MASS PER 100 UNITS	
TYPE	**MASS (g)**
NFR25	20.1
NFR25H	20.1

MARKING

The nominal resistance and tolerance are marked on the resistor using four coloured bands in accordance with IEC publication 60062 “Color codes for fixed resistors”.

For ease of recognition a fifth ring is added, which is violet for type NFR25 and white for type NFR25H.

OUTLINES

The length of the body (L_1) is measured by inserting the leads into holes of two identical gauge plates and moving these plates parallel to each other until the resistor body is clamped without deformation (“IEC publication 60294”).

FUNCTIONAL PERFORMANCE

PRODUCT CHARACTERIZATION

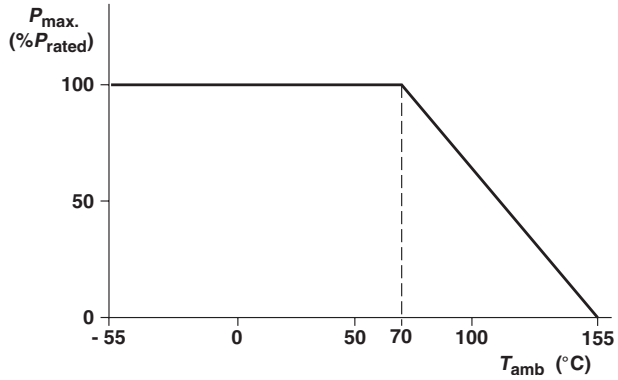
Standard values of nominal resistance are taken from the E24 series for resistors with a tolerance of ± 5 %.
The values of the E24 series are in accordance with “IEC publication 60063”.

LIMITING VALUES		
TYPE	**LIMITING VOLTAGE** [1] **(V)**	**LIMITING POWER (W)**
NFR25	250	0.33
NFR25H	350	0.5

Note:

[1] The maximum voltage that may be continuously applied to the resistor element, see “IEC publication 60115-1”. The maximum permissible hot-spot temperature is 155 °C.

The power that the resistor can dissipate depends on the operating temperature.

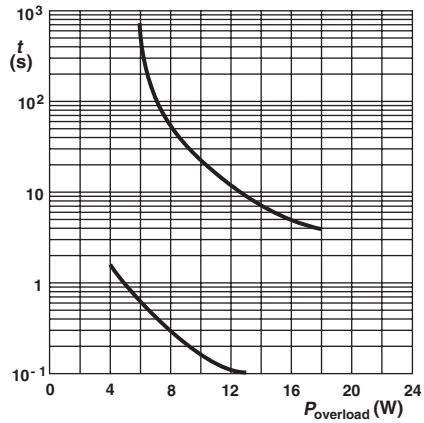


Maximum dissipation ($P_{max.}$) in percentage of rated power as a function of the ambient temperature (T_{amb})

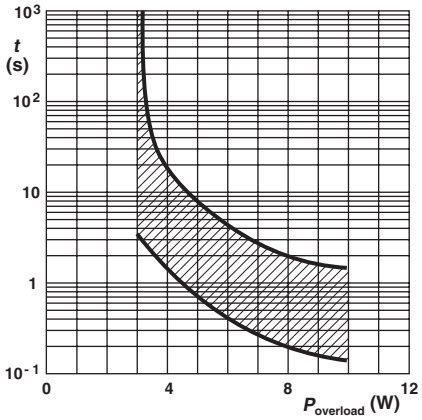
Derating

The resistors will fuse without the risk of fire and within an indicated range of overload. Fusing means that the resistive value of the resistor increases at least 100 times.

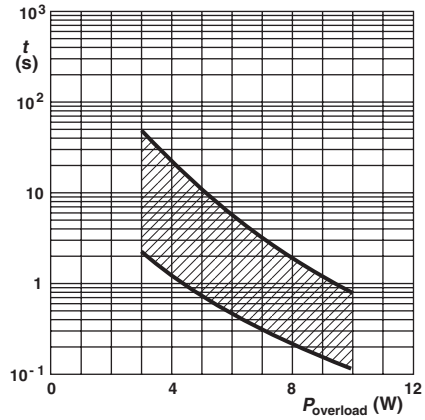
The fusing characteristic is measured under constant voltage.



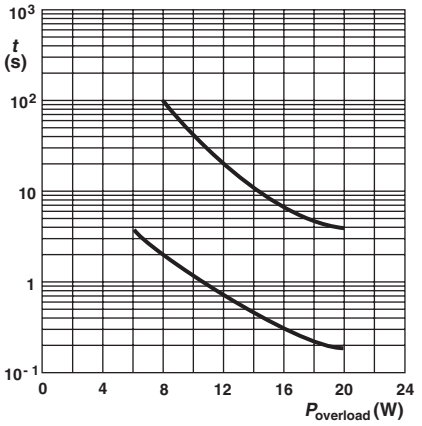
NFR25 This graph is based on measured data which may deviate according to the application. Fusing Characteristics: ≤ 1 Ω



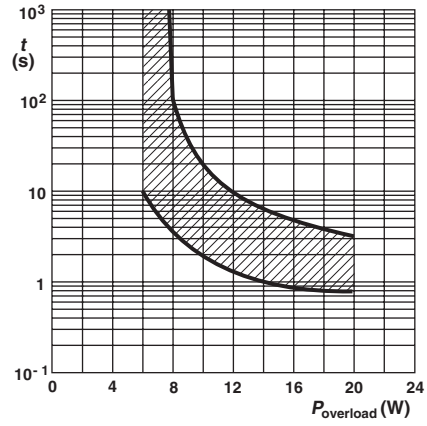
NFR25 This graph is based on measured data which may deviate according to the application. Fusing Characteristics: 1 Ω ≤ *R* ≤ 15 Ω



NFR25 This graph is based on measured data which may deviate according to the application. Fusing Characteristics: 15 Ω ≤ *R* ≤ 15 kΩ

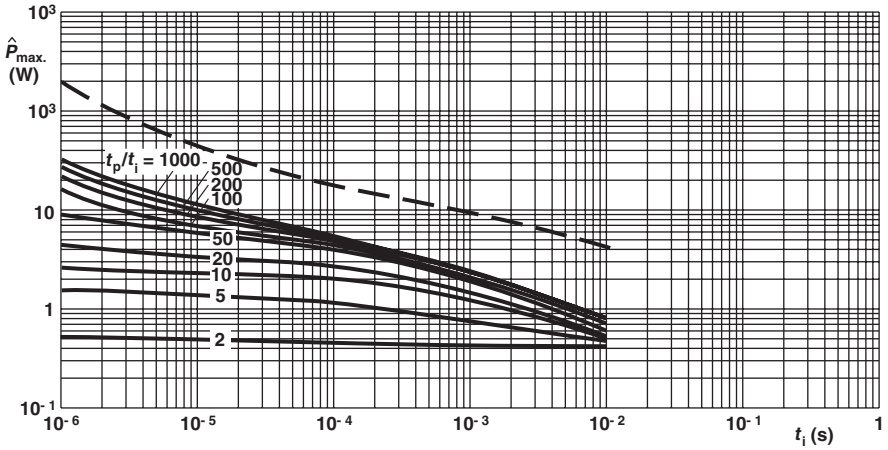


NFR25H This graph is based on measured data which may deviate according to the application. Fusing Characteristics: ≤ 1 Ω

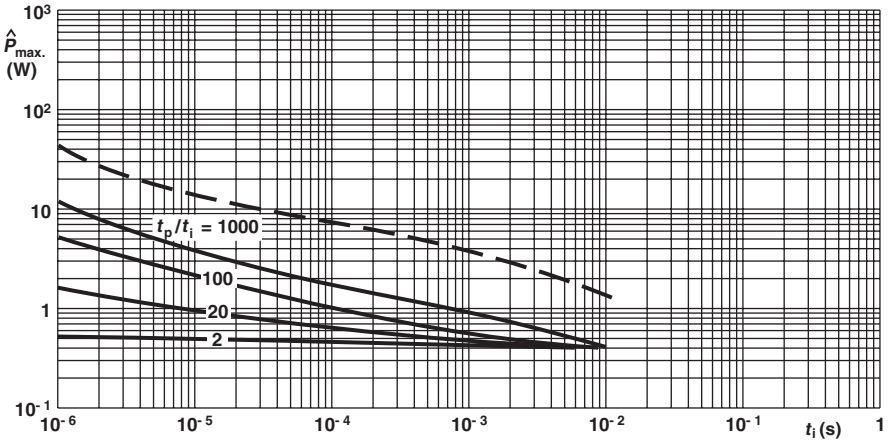


NFR25H This graph is based on measured data which may deviate according to the application. Fusing Characteristic: 1 Ω ≤ *R* ≤ 15 kΩ

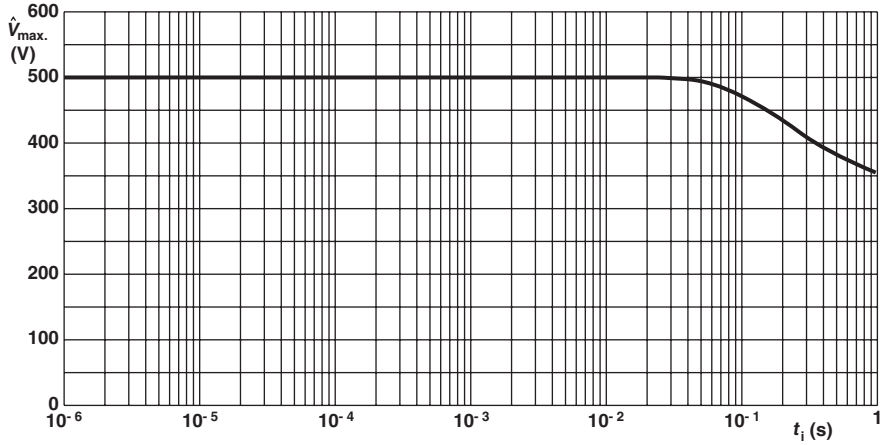
Fusing Characteristics



NFR25 Pulse on a regular basis; maximum permissible peak pulse power ($\hat{P}_{max.}$) as a function of pulse duration (t_i), 0.22 Ω ≤ R < 15 Ω

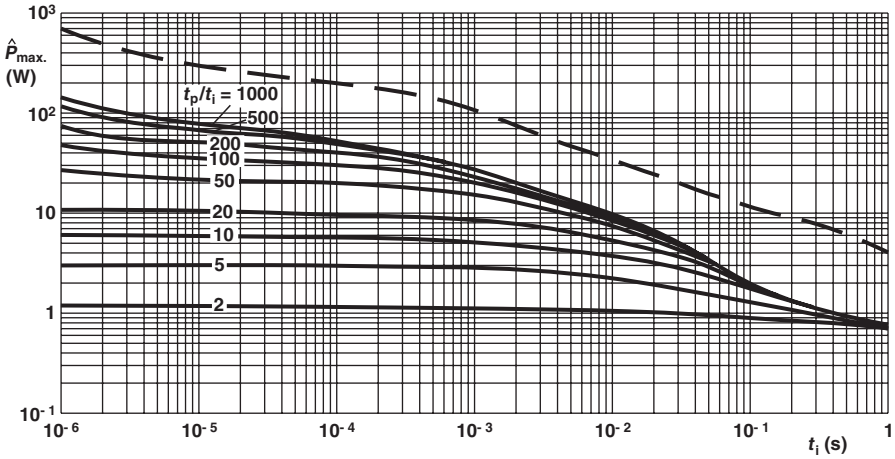


NFR25 Pulse on a regular basis; maximum permissible peak pulse power ($\hat{P}_{max.}$) as a function of pulse duration (t_i), 15 Ω < R ≤ 15 kΩ

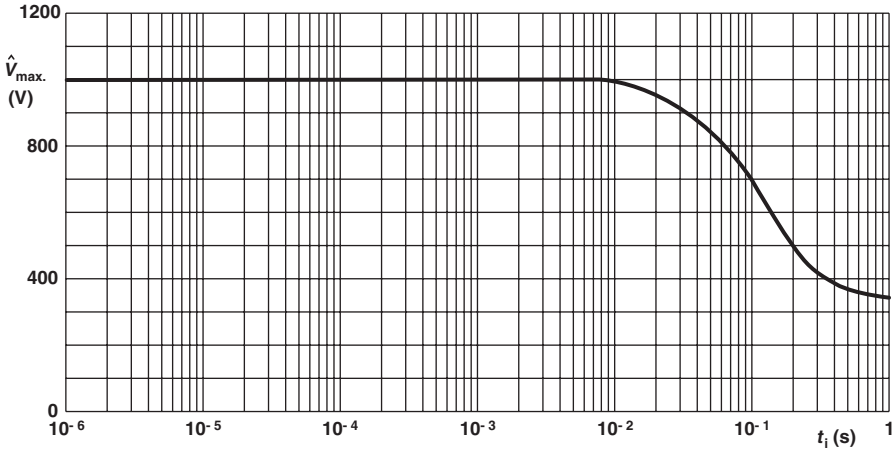


NFR25 Pulse on a regular basis; maximum permissible peak pulse voltage $\hat{V}_{max.}$ as a function of pulse duration (t_i)

Pulse Loading Capabilities

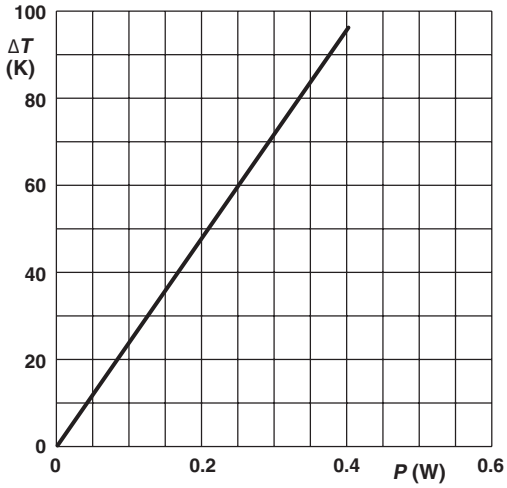


NFR25H Pulse on a regular basis; maximum permissible peak pulse power ($\hat{P}_{max.}$) as a function of pulse duration (t_i)



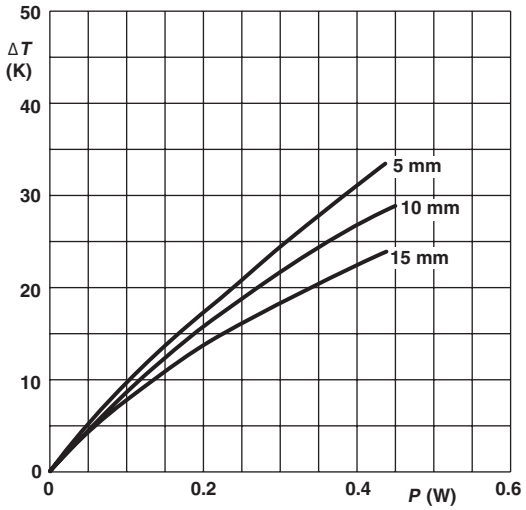
NFR25H Pulse on a regular basis; maximum permissible peak pulse voltage ($\hat{V}_{max.}$) as a function of pulse duration (t_i)

Pulse Loading Capabilities



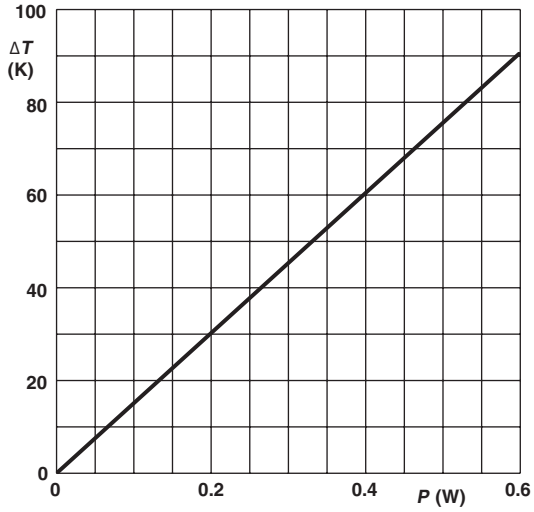
NFR25 Hot-spot temperature rise (ΔT) as a function of dissipated power

Application Information

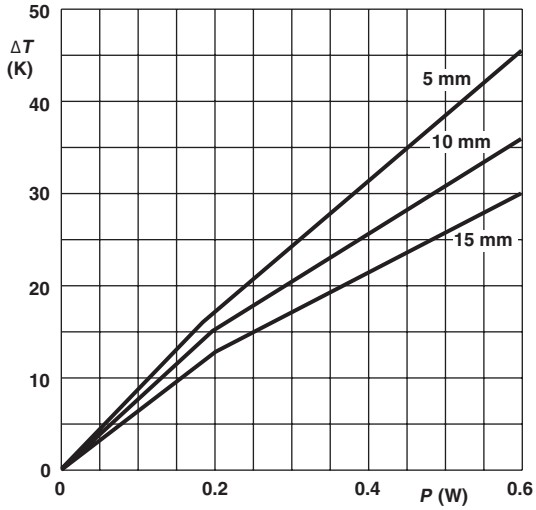


Minimum distance from resistor body to PCB = 1 mm

NFR25 Temperature rise (ΔT) at the lead end (soldering point) as a function of dissipated power at various lead lengths after mounting



NFR25H Hot-spot temperature rise (ΔT) as a function of dissipated power.



Minimum distance from resistor body to PCB = 1 mm

NFR25H Temperature rise (ΔT) at the lead end (soldering point) as a function of dissipated power at various lead lengths after mounting

Application Information

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of "IEC publication 60115-1", category LCT/UCT/56 (rated temperature range: Lower Category Temperature, Upper Category Temperature; damp heat, long term, 56 days). The testing also covers the requirements specified by EIA and EIAJ.

The tests are carried out in accordance with IEC publication 60068-2, "Recommended basic climatic and mechanical robustness testing procedure for electronic components" and under standard atmospheric conditions according to "IEC 60068-1", subclause 5.3.

In the Test Procedures and Requirements table the tests and requirements are listed with reference to the relevant clauses of "IEC publications 60115-1 and 60068-2"; a short description of the test procedure is also given. In some instances deviations from the IEC recommendations were necessary for our method of specifying. For inflammability requirements reference is made to "IEC 60115-1" and to "EN 140000, appendix D".

All soldering tests are performed with mildly activated flux.

TEST PROCEDURES AND REQUIREMENTS

IEC 60115-1 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS	
				NFR25	NFR25H
TESTS IN ACCORDANCE WITH THE SCHEDULE OF IEC PUBLICATION 60115-8					
4.4.1		visual examination		no holes; clean surface; no damage	
4.4.2		dimensions (outline)	gauge (mm)	see Dimensions Table	
4.5		resistance (refer note on first page for measuring distance)	applied voltage (+ 0/- 10 %): $R < 10\ \Omega$: 0.1 V $10\ \Omega \le R < 100\ \Omega$: 0.3 V $100\ \Omega \le R < 1\ k\Omega$: 1 V $1\ k\Omega \le R < 10\ k\Omega$: 3 V $10\ k\Omega \le R \le 15\ k\Omega$: 10 V	$R - R_{nom}$: max. ± 5 %	
4.18	20 (Tb)	resistance to soldering heat	thermal shock: 3 s; 350 °C; 3 mm from body	ΔR max.: ± (0.25 % R + 0.05 Ω)	
4.29	45 (Xa)	component solvent resistance	isopropyl alcohol or H_2O followed by brushing in accordance with *"MIL 202 F"*	no visual damage	
4.17	20 (Ta)	solderability	2 s; 235 °C	good tinning; no damage	
4.7		voltage proof on insulation	U_{RMS} = 500 V_{RMS} during 1 min; metal block method	no breakdown or flashover	
4.16	21 (U)	robustness of terminations:			
4.16.2	21 (Ua1)	tensile all samples	load 10 N; 10 s	number of failures < 10 x 10^{-6}	
4.16.3	21 (Ub)	bending half number of samples	load 5 N; 4 x 90°	number of failures < 10 x 10^{-6}	
4.16.4	21 (Uc)	torsion other half of samples	3 x 360° in opposite directions	no damage ΔR max.: ± (0.25 % R + 0.05 Ω)	
4.20	29 (Eb)	bump	3 x 1500 bumps in 3 directions; 40 g	no damage ΔR max.: ± (0.25 % R + 0.05 Ω)	
4.22	6 (Fc)	vibration	frequency 10 Hz to 500 Hz; displacement 1.5 mm or acceleration 10 g; 3 directions; total 6 h (3 x 2 h)	no damage ΔR max.: ± (0.25 % R + 0.05 Ω)	
4.19	14 (Na)	rapid change of temperature	30 min at LCT and 30 min at UCT; 5 cycles	no visual damage ΔR max.: ± (0.25 % + 0.05 Ω)	
4.23		climatic sequence:			
4.23.3	30 (Db)	damp heat (accelerated) 1st cycle			
4.23.6	30 (Db)	damp heat (accelerated) remaining cycles	6 days; 55 °C; 95 % to 98 % RH	R_{ins} min.: 10^3 MW ΔR max.: ± (1 % R + 0.05 Ω)	
4.24.2	3 (Ca)	damp heat (steady state) (IEC)	56 days; 40 °C; 90 % to 95 % RH; loaded with 0.01 Pn (IEC steps: 4 to 100 V)	R_{ins} max.: 1000 MΩ ΔR max.: ± (1 % R + 0.05 Ω)	
4.25.1		endurance (at 70 °C)	1000 h; loaded with Pn or $V_{max.}$; 1.5 h ON and 0.5 h OFF	ΔR max.: ± (1 % R + 0.05 Ω)	
4.25.3		endurance at upper category temperature	1000 h; no load	ΔR max.: ± (1 % R + 0.05 Ω)	
4.8.4.2		temperature coefficient	at 20/LCT/20 °C and 20/UCT/20 °C (TCR x 10^{-6}/K): $0.22\ \Omega \le R \le 4.7\ \Omega$ $4.7\ \Omega < R \le 15\ \Omega$ $15\ \Omega < R \le 15\ k\Omega$	 ≤ ± 200 x 10^{-6}/K ≤ ± 200 x 10^{-6}/K ≤ ± 100 x 10^{-6}/K	 ≤ ± 200 x 10^{-6}/K ≤ ± 100 x 10^{-6}/K ≤ ± 100 x 10^{-6}/K
4.12		noise	"IEC publication 60195"	< 0.1 µV/V	
4.26		accidental overload	cheese-cloth	nonflammable	
OTHER TESTS IN ACCORDANCE WITH IEC 60115 CLAUSES AND IEC 60068 TEST METHOD					
4.17	20 (Ta)	solderability (after ageing)	8 h steam or 16 h 155 °C; leads immersed 6 mm for 2 ± 0.5 s in a solder bath at 235 ± 5 °C	good tinning (≥ 95 % covered); no damage	
4.6.1.1		insulation resistance	maximum voltage $U_{max.}$ DC = 500 V after 1 min; metal block method	R_{ins} min.: 10^4 MΩ	
see 2nd amendment to "IEC 60115-1", Jan.'87		pulse load		see the Pulse Loading Capabilities graphs	

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