

## 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 <sup>(1)</sup>	0.22 $\Omega$ to 15 k $\Omega$	
Resistance Tolerance and Series	$\pm 5\%$ ; E24 series	
Maximum Dissipation at $T_{amb} = 70\text{ }^{\circ}\text{C}$	0.33 W	0.5 W
Thermal Resistance $R_{th}$	240 K/W	150 K/W
Temperature Coefficient:		
0.22 $\Omega \leq R \leq 4.7\text{ } \Omega$	$\leq \pm 200 \times 10^{-6}/\text{K}$	$\leq \pm 200 \times 10^{-6}/\text{K}$
4.7 $\Omega < R \leq 15\text{ } \Omega$	$\leq \pm 200 \times 10^{-6}/\text{K}$	$\leq \pm 100 \times 10^{-6}/\text{K}$
15 $\Omega < R \leq 15\text{ k}\Omega$	$\leq \pm 100 \times 10^{-6}/\text{K}$	$\leq \pm 100 \times 10^{-6}/\text{K}$
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	$\Delta R \text{ max.}: \pm (1\% R + 0.05\text{ } \Omega)$	
Climatic Tests	$\Delta R \text{ max.}: \pm (1\% R + 0.05\text{ } \Omega)$	
Soldering	$\Delta R \text{ max.}: \pm (0.25\% R + 0.05\text{ } \Omega)$	

#### Notes:

- <sup>(1)</sup> Ohmic values (other than resistance range) are available on request
- $R$  value is measured with probe distance of  $24 \pm 1\text{ mm}$  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 $\Omega$	7
1 to 9.1 $\Omega$	8
10 to 91 $\Omega$	9
100 to 910 $\Omega$	1
1 to 9.1 k $\Omega$	2
10 to 15 k $\Omega$	3

### 12NC Example

The 12NC for a NFR25 resistor with value 750  $\Omega$ , supplied on a bandolier of 1000 units in ammpack 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	0	0	2	2	0
7	J	A	1	0	0	
MODEL/SIZE	SPECIAL CHARACTER	TCR/MATERIAL	VALUE	TOLERANCE	PACKAGING <sup>(1)</sup>	SPECIAL
NFR2500 NFR25H0	0 = Neutral Z = Value overflow (Special)	0 = Standard	3 digit value 1 digit multiplier MULTIPLIER 7 = *10 <sup>-3</sup> 8 = *10 <sup>-2</sup> 9 = *10 <sup>-1</sup> 0 = *10 <sup>0</sup> 1 = *10 <sup>1</sup> 2 = *10 <sup>2</sup>	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 <sup>(1)</sup>	RESISTANCE VALUE			
NFR25 NFR25H	± 5 %	N4 A5 A1 R5	1K0 = 1 kΩ 4R7 = 4.7 Ω			

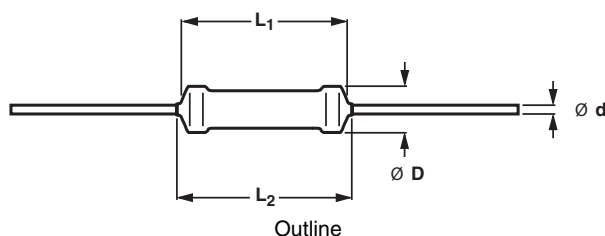
Notes:

<sup>(1)</sup> 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 ammpack radial taped	NFR25, NFR25H
A5	5000	Bandolier in ammpack straight leads	
A1	1000	Bandolier in ammpack straight leads	
R5	5000	Bandolier on reel straight leads	

## DIMENSIONS



### DIMENSIONS - resistor types and relevant physical dimensions

TYPE	Ø D <sub>max.</sub>	L <sub>1</sub> max.	L <sub>2</sub> 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

## OUTLINES

The length of the body (L<sub>1</sub>) 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").

## 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.

## 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".

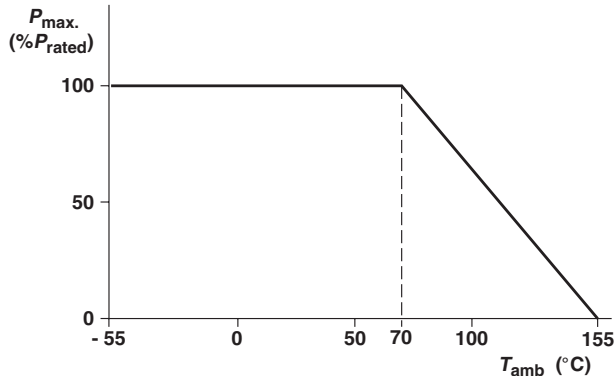
### LIMITING VALUES

TYPE	LIMITING VOLTAGE <sup>(1)</sup> (V)	LIMITING POWER (W)
NFR25	250	0.33
NFR25H	350	0.5

#### Note:

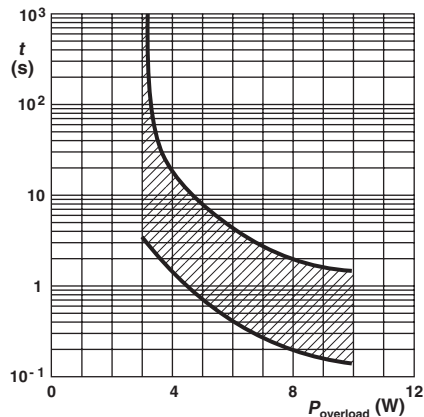
<sup>(1)</sup> The maximum voltage that may be continuously applied to the resistor element, see "IEC publication 60115-1".  
The maximum permissible hot-spot temperature is 155 °C.

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

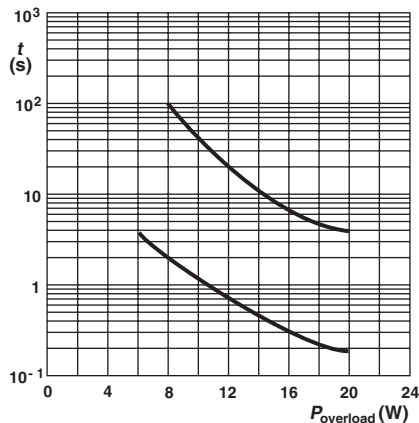


Maximum dissipation ( $P_{max}$ ) in percentage of rated power as a function of the ambient temperature ( $T_{amb}$ )

## Derating



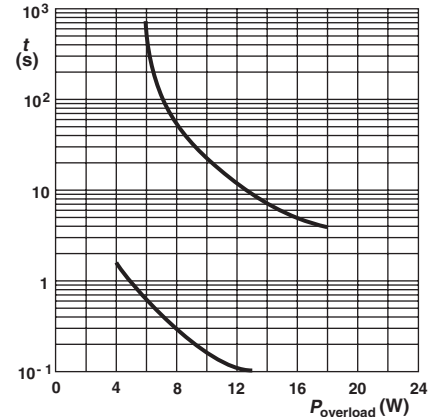
**NFR25** This graph is based on measured data which may deviate according to the application.  
Fusing Characteristics:  $1 \Omega \leq R \leq 15 \Omega$



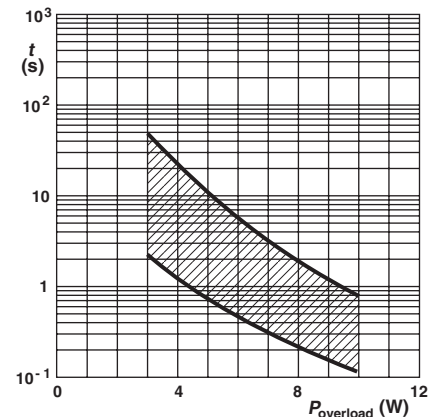
**NFR25H** This graph is based on measured data which may deviate according to the application.  
Fusing Characteristics:  $\leq 1 \Omega$

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.

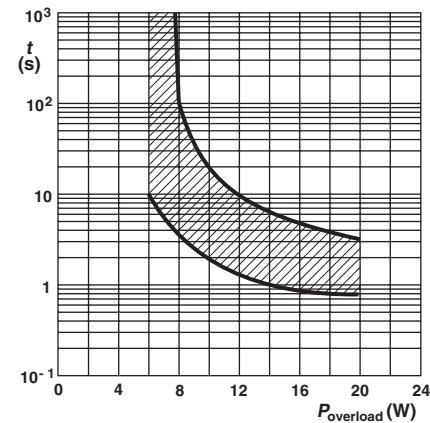
The fusing characteristic is measured under constant voltage.



**NFR25** This graph is based on measured data which may deviate according to the application. Fusing Characteristics:  $\leq 1 \Omega$

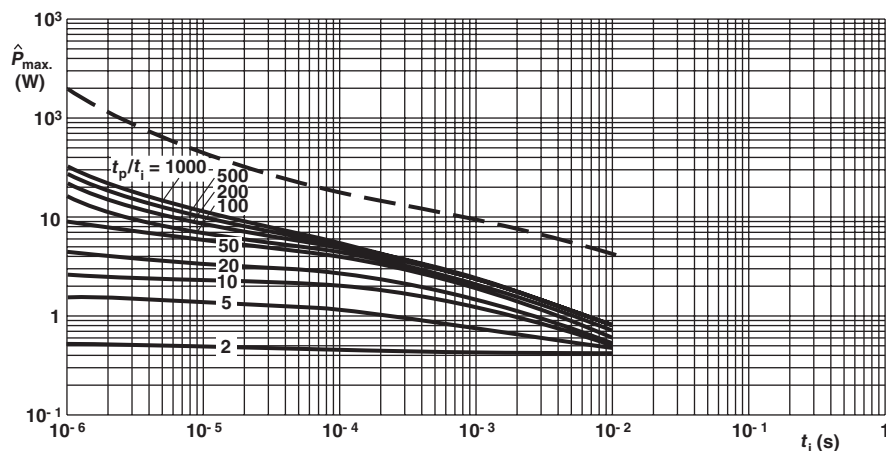


**NFR25** This graph is based on measured data which may deviate according to the application.  
Fusing Characteristics:  $15 \Omega \leq R \leq 15 \text{ k}\Omega$

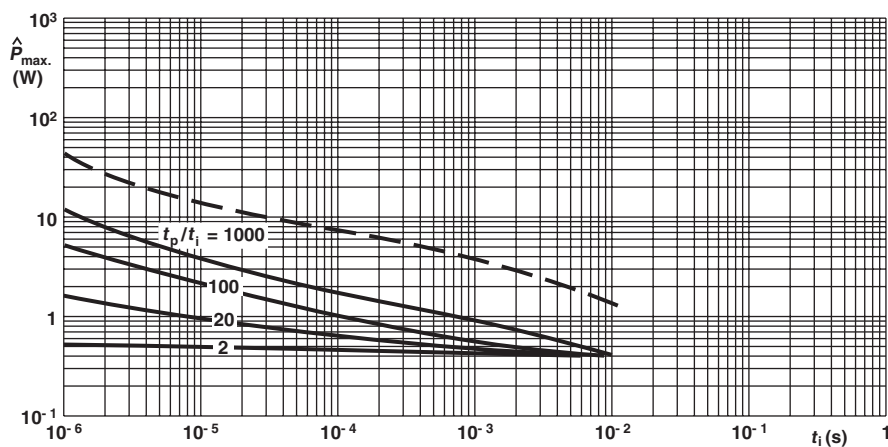


**NFR25H** This graph is based on measured data which may deviate according to the application.  
Fusing Characteristic:  $1 \Omega \leq R \leq 15 \text{ k}\Omega$

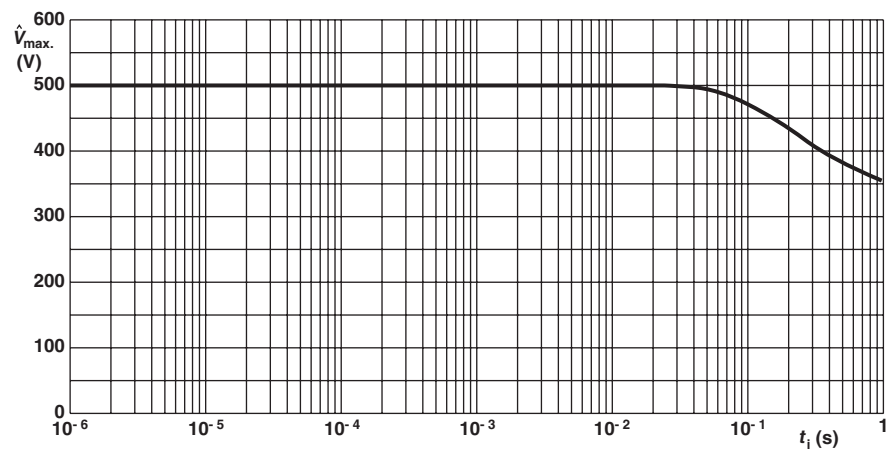
## Fusing Characteristics



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

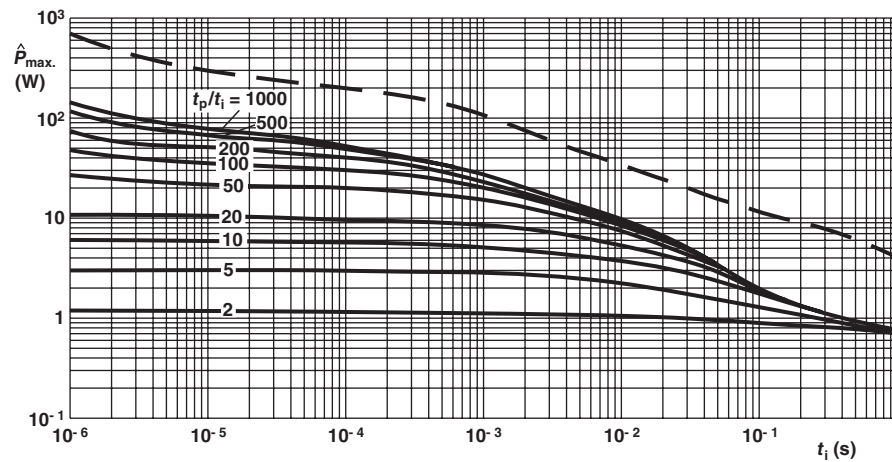


NFR25 Pulse on a regular basis; maximum permissible peak pulse power ( $\hat{P}_{max.}$ ) as a function of pulse duration ( $t_i$ ),  $15 \Omega < R \leq 15 \text{ k}\Omega$

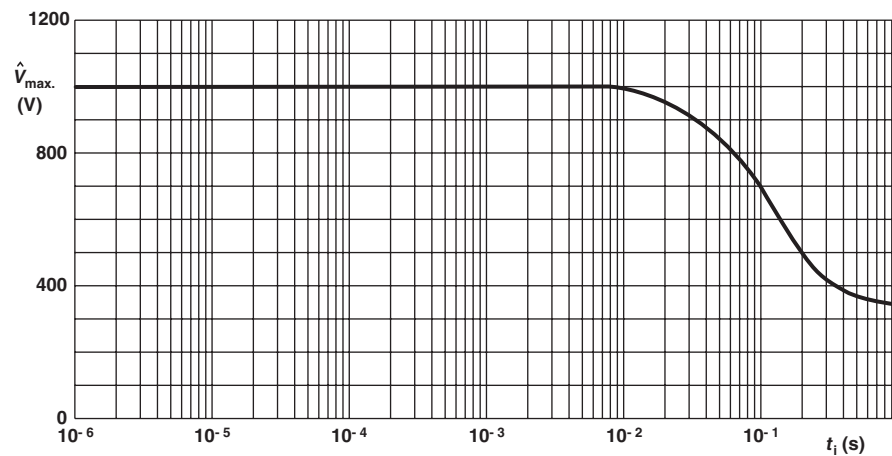


NFR25 Pulse on a regular basis; maximum permissible peak pulse voltage  $\hat{V}_{max.}$  as a function of pulse duration ( $t_i$ )

## Pulse Loading Capabilities

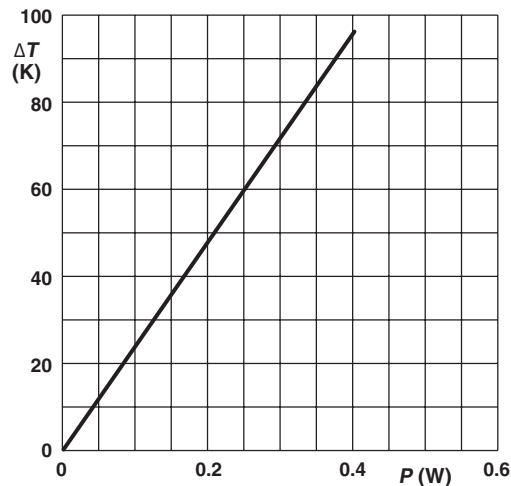


**NFR25H** Pulse on a regular basis; maximum permissible peak pulse power ( $\hat{P}_{max}$ ) as a function of pulse duration ( $t_i$ )



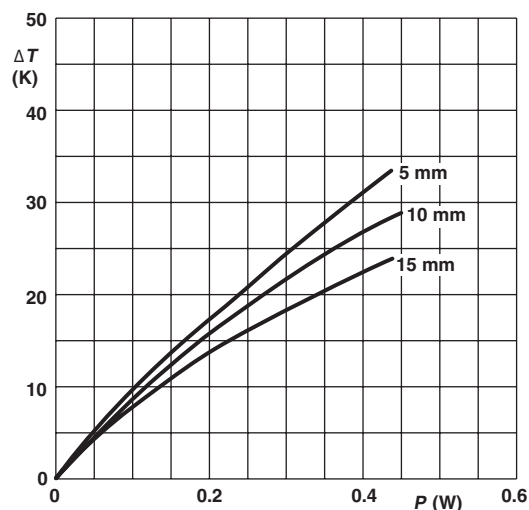
**NFR25H** Pulse on a regular basis; maximum permissible peak pulse voltage ( $\hat{V}_{max}$ ) as a function of pulse duration ( $t_i$ )

### Pulse Loading Capabilities



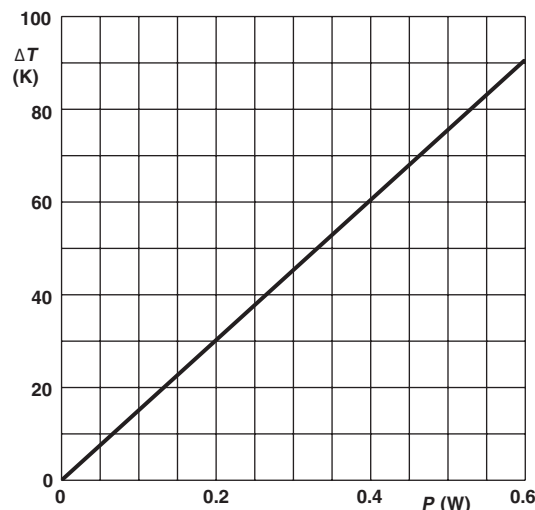
**NFR25** Hot-spot temperature rise ( $\Delta T$ ) as a function of dissipated power

### Application Information

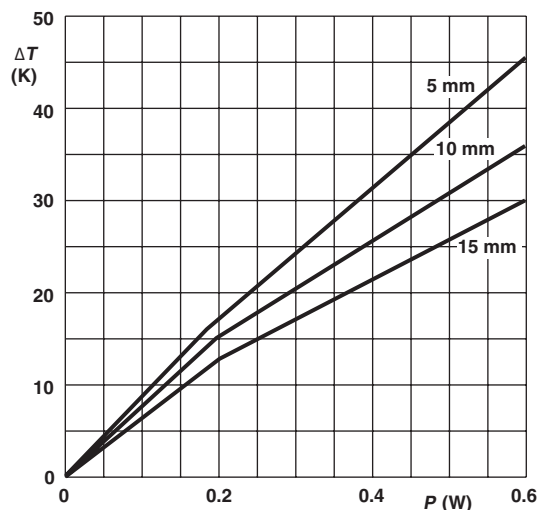


Minimum distance from resistor body to PCB = 1 mm

**NFR25** Temperature rise ( $\Delta T$ ) at the lead end (soldering point) as a function of dissipated power at various lead lengths after mounting



**NFR25H** Hot-spot temperature rise ( $\Delta T$ ) as a function of dissipated power.



Minimum distance from resistor body to PCB = 1 mm

**NFR25H** Temperature rise ( $\Delta T$ ) 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 $10 \Omega \leq R < 100 \Omega$ : 0.3 V $100 \Omega \leq R < 1 \text{ k}\Omega$ : 1 V $1 \text{ k}\Omega \leq R < 10 \text{ k}\Omega$ : 3 V $10 \text{ k}\Omega \leq R \leq 15 \text{ k}\Omega$ : 10 V	$R - R_{\text{nom}}$ : max. $\pm 5 \%$	
4.18	20 (Tb)	resistance to soldering heat	thermal shock: 3 s; 350 °C; 3 mm from body	$\Delta R$ max.: $\pm (0.25 \% R + 0.05 \Omega)$	
4.29	45 (Xa)	component solvent resistance	isopropyl alcohol or H <sub>2</sub> O 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	$U_{\text{RMS}} = 500 V_{\text{RMS}}$ during 1 min; metal block method	no breakdown or flashover	
4.16	21 (U)	robustness of terminations:	load 10 N; 10 s  load 5 N; 4 x 90°  3 x 360° in opposite directions	number of failures < 10 x 10 <sup>-6</sup>	
4.16.2	21 (Ua1)	tensile all samples		number of failures < 10 x 10 <sup>-6</sup>	
4.16.3	21 (Ub)	bending half number of samples		no damage	
4.16.4	21 (Uc)	torsion other half of samples		$\Delta R$ max.: $\pm (0.25 \% R + 0.05 \Omega)$	
4.20	29 (Eb)	bump	3 x 1500 bumps in 3 directions; 40 g	no damage $\Delta R$ max.: $\pm (0.25 \% R + 0.05 \Omega)$	
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 $\Delta R$ max.: $\pm (0.25 \% R + 0.05 \Omega)$	
4.19	14 (Na)	rapid change of temperature	30 min at LCT and 30 min at UCT; 5 cycles	no visual damage $\Delta R$ max.: $\pm (0.25 \% + 0.05 \Omega)$	
4.23	30 (Db)	climatic sequence:	6 days; 55 °C; 95 % to 98 % RH	$R_{\text{ins}}$ min.: 10 <sup>3</sup> MW $\Delta R$ max.: $\pm (1 \% R + 0.05 \Omega)$	
4.23.3		damp heat (accelerated) 1 <sup>st</sup> cycle			
4.23.6	30 (Db)	damp heat (accelerated) remaining cycles			
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)	$R_{\text{ins}}$ max.: 1000 MΩ $\Delta R$ max.: $\pm (1 \% R + 0.05 \Omega)$	
4.25.1		endurance (at 70 °C)	1000 h; loaded with Pn or $V_{\text{max}}$ ; 1.5 h ON and 0.5 h OFF	$\Delta R$ max.: $\pm (1 \% R + 0.05 \Omega)$	
4.25.3		endurance at upper category temperature	1000 h; no load	$\Delta R$ max.: $\pm (1 \% R + 0.05 \Omega)$	
4.8.4.2		temperature coefficient	at 20/LCT/20 °C and 20/UCT/20 °C (TCR x 10 <sup>-6</sup> /K): $0.22 \Omega \leq R \leq 4.7 \Omega$ $4.7 \Omega < R \leq 15 \Omega$ $15 \Omega < R \leq 15 \text{ k}\Omega$	$\leq \pm 200 \times 10^{-6}/\text{K}$ $\leq \pm 200 \times 10^{-6}/\text{K}$ $\leq \pm 100 \times 10^{-6}/\text{K}$	$\leq \pm 200 \times 10^{-6}/\text{K}$ $\leq \pm 100 \times 10^{-6}/\text{K}$ $\leq \pm 100 \times 10^{-6}/\text{K}$
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 $U_{\text{max}}$ . DC = 500 V after 1 min; metal block method	$R_{\text{ins}}$ min.: 10 <sup>4</sup> MΩ	
see 2 <sup>nd</sup> amendment to "IEC 60115-1", Jan.'87		pulse load		see the Pulse Loading Capabilities graphs	





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