



Fusible, Non-Flammable Metal Film Led Resistors



FEATURES

- Technology: metal film
- 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
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912



RoHS COMPLIANT

DESCRIPTION

A homogeneous 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 gray, flame retardant lacquer which provides electrical, mechanical, and climatic protection. The encapsulant is resistant to all cleaning solvents in accordance with IEC 60068-2-45.

APPLICATIONS

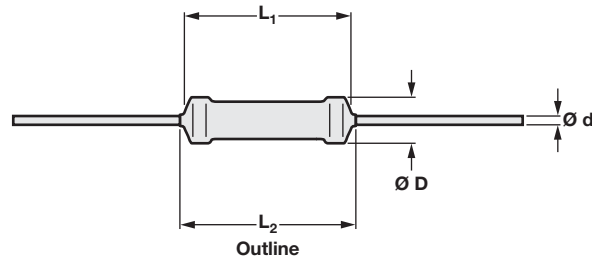
- Audio
- Video

| TECHNICAL SPECIFICATIONS | | |
|---|-----------------------|-----------------------|
| DESCRIPTION | NFR25 | NFR25H |
| Resistance range ⁽¹⁾ | 0.22 Ω to 15 kΩ | 0.22 Ω to 15 kΩ |
| Resistance tolerance | ± 5 % | ± 5 % |
| Resistance series | E24 | E24 |
| Rated dissipation P_{70} | 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 ppm/K | ≤ ± 200 ppm/K |
| 4.7 Ω ≤ R ≤ 15 Ω | ≤ ± 200 ppm/K | ≤ ± 100 ppm/K |
| 15 Ω ≤ R ≤ 15 kΩ | ≤ ± 100 ppm/K | ≤ ± 100 ppm/K |
| Operating voltage, U_{max} . DC or RMS | 250 V | 350 V |
| Basic specifications | IEC 60 115-1 | IEC 60 115-1 |
| Climatic category (IEC 60068-1) | 55/155/56 | 55/155/56 |
| Maximum resistance change for resistance range, ΔR max., after: | | |
| Load (1000 h, P_{70}): | ± (1 % R + 0.05 Ω) | ± (1 % R + 0.05 Ω) |
| Long term damp heat test (56 days): | ± (1 % R + 0.05 Ω) | ± (1 % R + 0.05 Ω) |
| Soldering (260 °C, 10 s): | ± (0.25 % R + 0.05 Ω) | ± (0.25 % R + 0.05 Ω) |

Notes

- R value is measured with probe distance of 24 mm ± 1 mm using 4-terminal method
- ⁽¹⁾ Ohmic values (other than resistance range) are available on request

| PACKAGING | | | | | |
|---------------|--------------|----------|------|--------|------|
| MODEL | TAPING | AMMOPACK | | REEL | |
| | | PIECES | CODE | PIECES | CODE |
| NFR25, NFR25H | Axial, 52 mm | 5000 | A5 | 5000 | R5 |
| | | 1000 | A1 | | |
| NFR25, NFR25H | Radial | 2000 | N2 | - | - |

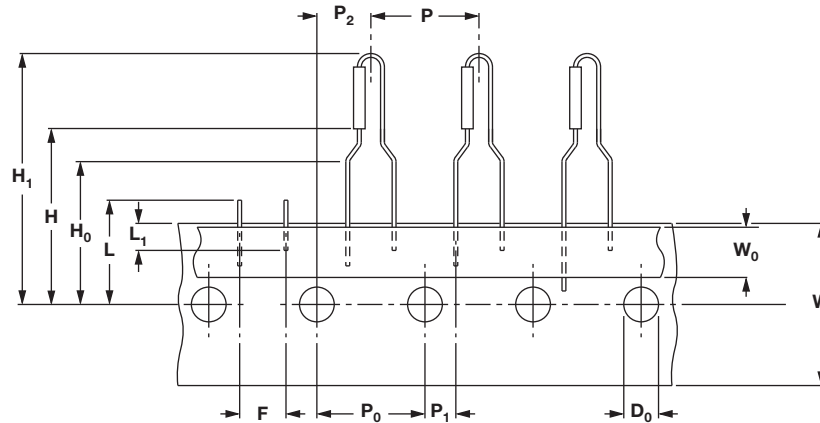
DIMENSIONS


| DIMENSIONS (Resistor types, mass, and relevant physical dimensions) | | | | | |
|---|------------------------|--------------------------|--------------------------|-------------|-----------|
| TYPE | D _{max.} (mm) | L ₁ max. (mm) | L ₂ max. (mm) | Ø d (mm) | MASS (mg) |
| NFR25 | 2.5 | 6.5 | 7.5 | 0.58 ± 0.05 | 201 |
| NFR25H | | | | | |

| PART NUMBER AND PRODUCT DESCRIPTION | | | | | | |
|---------------------------------------|---|--------------------------|--|-----------|--------------------------|---|
| Part Number: NFR250002207JA100 | | | | | | |
| N | F | R | 2 | 5 | 0 | 0 |
| 0 | 0 | 0 | 0 | 2 | 2 | 0 |
| 7 | J | A | 1 | 0 | 0 | |
| MODEL/SIZE | VARIANT | TCR/MATERIAL | VALUE | TOLERANCE | PACKAGING ⁽¹⁾ | SPECIAL |
| NFR2500 NFR25H | 0 = neutral Z = value overload (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 % | N2 A5 A1 R5 | Up to 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 % | N2 A5 A1 R5 | 1K0 = 1 kΩ 4R7 = 4.7 Ω | | | |

Notes

- The PART NUMBER is shown to facilitate the introduction of the unified part numbering system
- ⁽¹⁾ Please refer to table PACKAGING, see next page

PRODUCTS WITH RADIAL LEADS (NFR25, NFR25H)


| DIMENSIONS (Radial taping) | | | | |
|----------------------------|---|-------|-------------|------|
| SYMBOL | PARAMETER | VALUE | TOLERANCE | UNIT |
| P | Pitch of components | 12.7 | ± 1.0 | mm |
| P ₀ | Feed-hole pitch | 12.7 | ± 0.2 | mm |
| P ₁ | Feed-hole centre to lead at topside at the tape | 3.85 | ± 0.5 | mm |
| P ₂ | Feed-hole center to body center | 6.35 | ± 1.0 | mm |
| F | Lead-to-lead distance | 4.8 | + 0.7 / - 0 | mm |
| W | Tape width | 18.0 | ± 0.5 | mm |
| W ₀ | Minimum hold down tape width | 5.5 | - | mm |
| H ₁ | Component height | 29.0 | Max. | mm |
| H ₀ | Lead wire clinch height | 16.5 | ± 0.5 | mm |
| H | Height of component from tape center | 19.5 | ± 1 | mm |
| D ₀ | Feed-hole diameter | 4.0 | ± 0.2 | mm |
| L | Maximum length of snipped lead | 11.0 | - | mm |
| L ₁ | Minimum lead wire (tape portion) shortest lead | 2.5 | - | mm |

Note

- Please refer document number 28721 "Packaging" for more detail

MARKING

The nominal resistance and tolerance are marked on the resistor using four colored bands in accordance with IEC 60062, marking codes for resistors and capacitors. 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 60063.

OUTLINES

The length of the body (L₁) 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 60294).

| LIMITING VALUES | | |
|-----------------|-----------------------------------|--------------------------------|
| TYPE | LIMITING VOLTAGE $U^{(1)}$ (V) | LIMITING POWER P_{70} (W) |
| NFR25 | 250 | 0.33 |
| NFR25H | 350 | 0.5 |

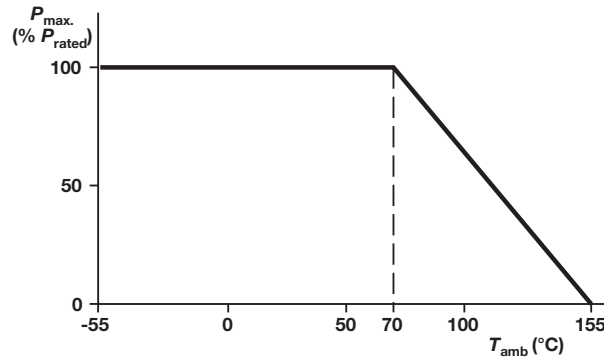
Note

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



DERATING

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

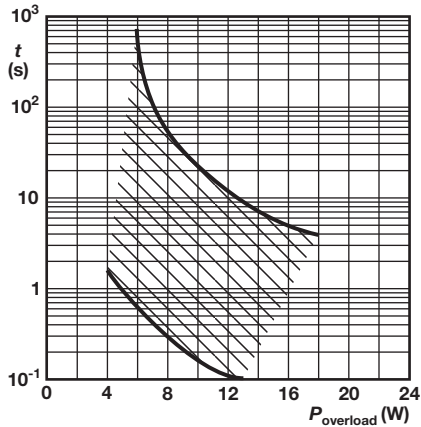


Maximum dissipation (P_{max}) in percentage of rated power as a function of the ambient temperature (T_{amb})

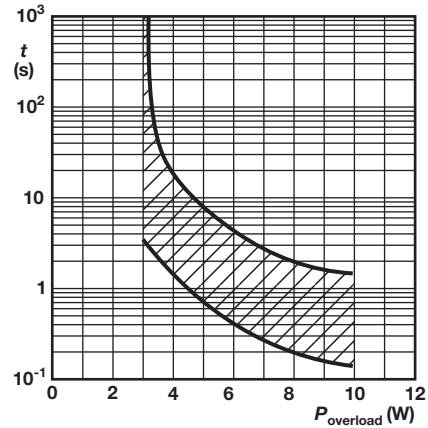
FUSING CHARACTERISTICS

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.

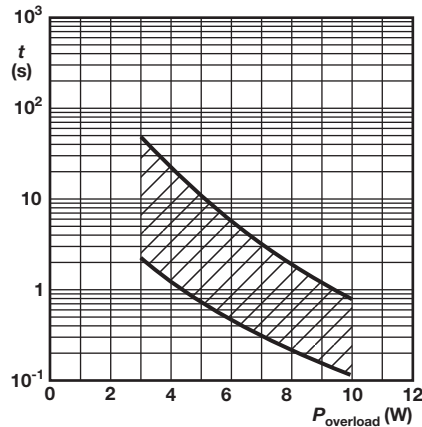
The fusing characteristic is measured under constant voltage.



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



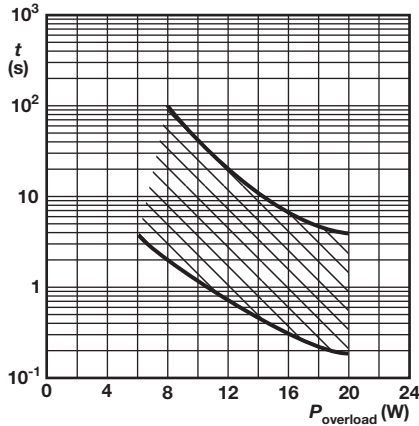
NFR25 This graph is based on measured data which may deviate according to the application.
Fusing Characteristics: $1 \Omega \leq R \leq 15 \text{ k}\Omega$



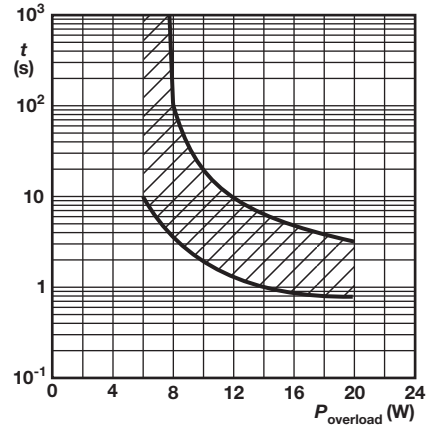
NFR25 This graph is based on measured data which may deviate according to the application.
Fusing Characteristics: $15 \Omega \leq R \leq 15 \text{ k}\Omega$



FUSING CHARACTERISTICS

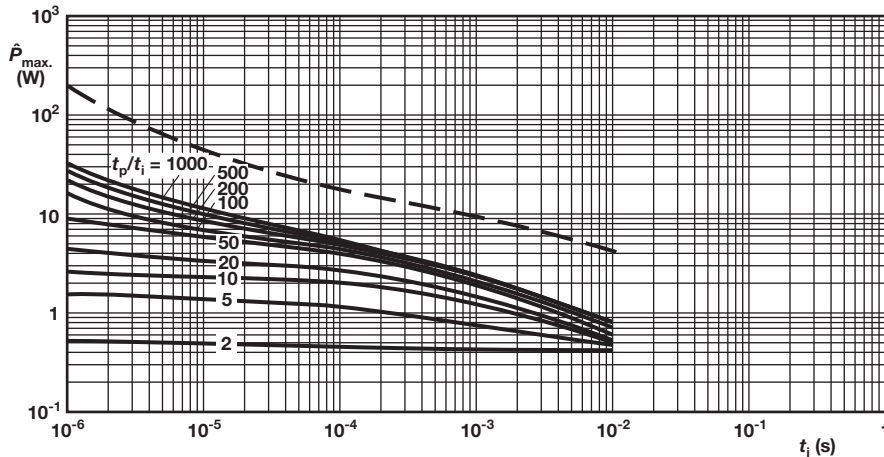


NFR25 This graph is based on measured data which may deviate according to the application.
Fusing Characteristics: $\leq 1 \Omega$

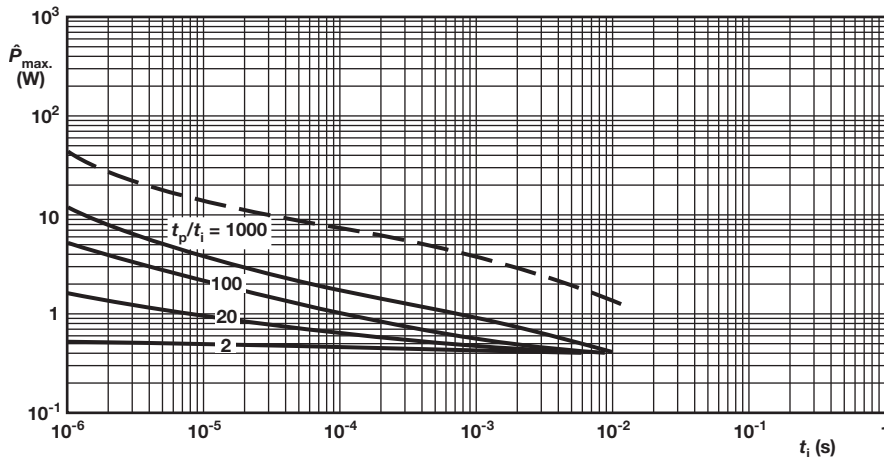


NFR25 This graph is based on measured data which may deviate according to the application.
Fusing Characteristics: $1 \Omega \leq R \leq 15 \Omega$

PULSE LOADING CAPABILITIES



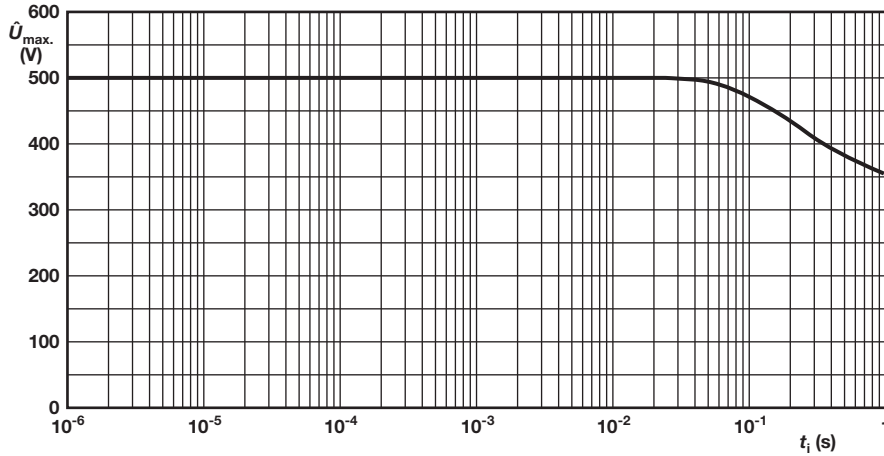
NFR25 Pulse on a regular basis; maximum permissible peak pulse power (\hat{P}_{max}) as a function of pulse duration (t_i), $0.22 \Omega \leq R \leq 1 \text{ k}\Omega$



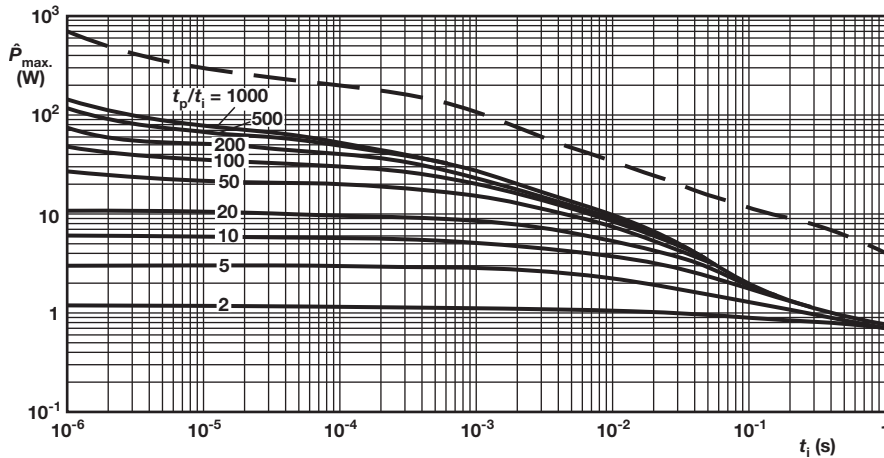
NFR25 Pulse on a regular basis; maximum permissible peak pulse power (\hat{P}_{max}) as a function of pulse duration (t_i), $15 \Omega \leq R \leq 15 \text{ k}\Omega$



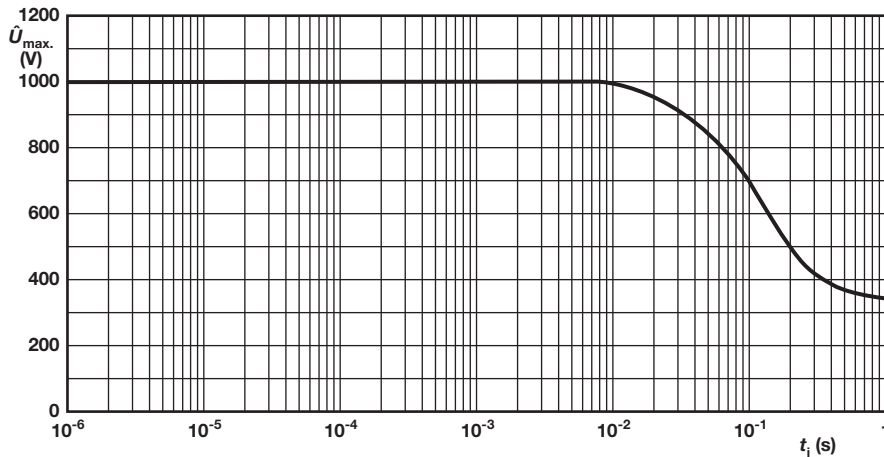
PULSE LOADING CAPABILITIES



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



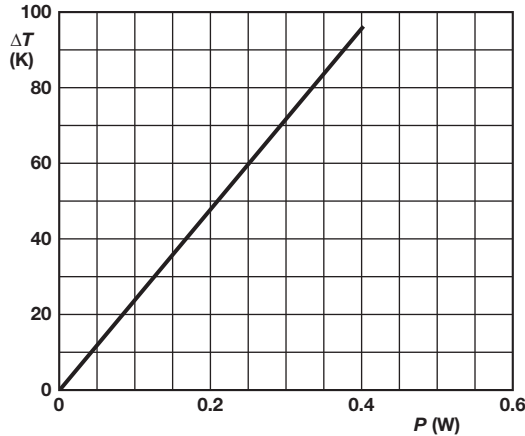
NFR25 Pulse on a regular basis; maximum permissible peak pulse power ($\hat{P}_{max.}$) as a function of pulse duration (t_i)



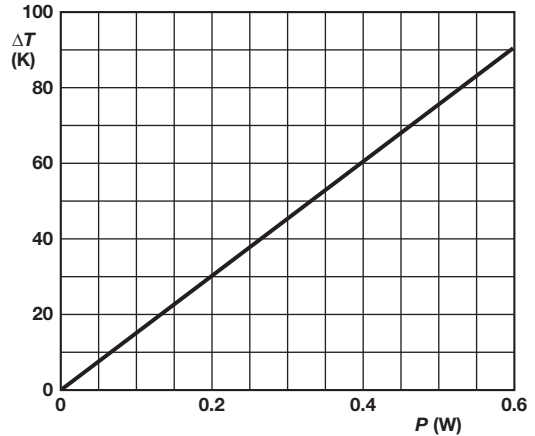
NFR25 Pulse on a regular basis; maximum permissible peak pulse power ($\hat{P}_{max.}$) as a function of pulse duration (t_i)



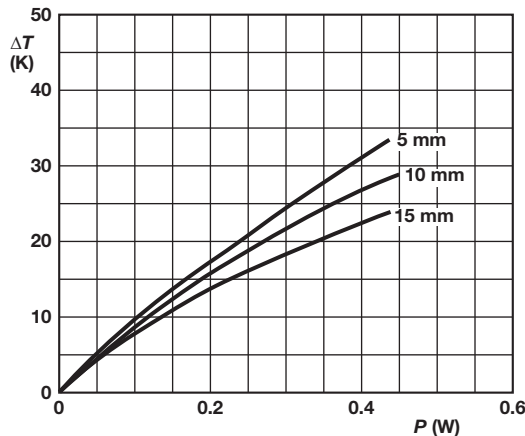
APPLICATION INFORMATION



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

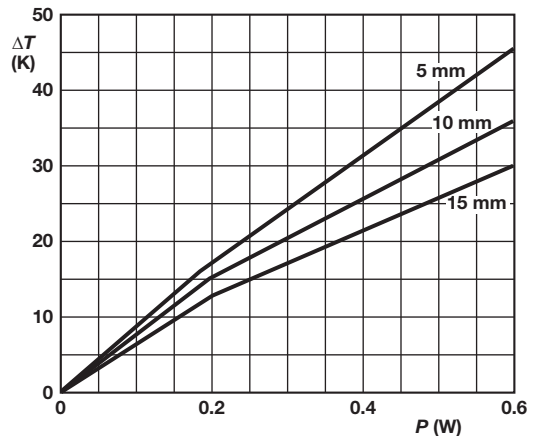


NFR25 Hot-spot temperature rise (ΔT) as a function of dissipated power



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



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

TESTS AND REQUIREMENTES

Essentially all tests are carried out in accordance with IEC 60115-1 specification, category LCT/UCT/56 (rated temperature range: Lower category temperature, upper category temperature; damp heat, long term, 56 days). The tests are carried out in accordance with IEC 60068-2-xx test method, "Recommended basic climatic and mechanical robustness testing procedure for electronic components" and under standard atmospheric conditions according to IEC 60068-1, 5.3.

In the Test Procedures and Requirements table the tests and requirements are listed with reference to the relevant clauses of IEC 60115-1 and IEC 60068-2-xx test methods. 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. 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 | |
| | | | | NFR01 | NFR03 |
| 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: 10 s; 260 °C; 3 mm from body | ΔR max.: $\pm (0.25 \% R + 0.05 \Omega)$ | |
| 4.29 | 45 (Xa) | Component solvent resistance | Isopropyl alcohol or H ₂ O followed by brushing | No visual damage | |
| 4.17 | 20 (Ta) | Solderability | 2 s; 235 °C: Solder bath method; SnPb40 3 s; 245 °C: Solder bath method; SnAg3Cu0.5 | Good tinning ($\geq 95 \%$ covered); no damage | |
| | | Solderability (after aging) | 8 h steam or 16 h, 155 °C; leads immersed 6 mm; for 2 s at 235 °C: Solder bath (SnPb40) for 3 s at 245 °C: Solder bath (SnAg3Cu0.5) method | Good tinning ($\geq 95 \%$ covered); no damage | |
| 4.7 | | Voltage proof on insulation | $U_{\text{RMS}} = 500 \text{ V}$ during 1 min; metal block method | No breakdown or flashover | |
| 4.16 | | Robustness of terminations: | | | |
| 4.16.2 | 21 (Ua1) | Tensile all samples | Load 10 N; 10 s | Number of failures $< 10 \times 10^{-6}$ | |
| 4.16.3 | 21 (Ub) | Bending half number of samples | Load 5 N; 4 x 90° | Number of failures $< 10 \times 10^{-6}$ | |
| 4.16.4 | 21 (Uc) | Torsion other half of samples | 3 x 360° in opposite directions | No damage ΔR max.: $\pm (0.25 \% R + 0.05 \Omega)$ | |
| 4.20 | 29 (Eb) | Bump | 3 x 1500 bumps in 3 directions; 40 g | No damage ΔR 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 ΔR 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 ΔR max.: $\pm (0.25 \% R + 0.05 \Omega)$ | |
| 4.23 | | Climatic sequence: | | | |
| 4.23.2 | 2 (Ba) | Dry heat | 16 h; 155 °C | | |
| 4.23.3 | 30 (Db) | Damp heat (accelerated) 1 st cycle | 24 h; 55 °C; 90 % to 100 % RH | | |
| 4.23.4 | 1 (Aa) | Cold | 2 h; -55 °C | | |
| 4.23.5 | 13 (M) | Low air pressure | 2 h; 8.5 kPa; 15 °C to 35 °C | | |
| 4.23.6 | 30 (Db) | Damp heat (accelerated) remaining cycles | 5 days; 55 °C; 95 % to 100 % RH | R_{ins} min. $10^3 \text{ M}\Omega$ ΔR max.: $\pm (1.5 \% R + 0.1 \Omega)$ | |
| 4.24 | 78 (Cab) | Damp heat (steady state) | 56 days; 40 °C; 90 % to 95 % RH; loaded with 0.01 P_{70} (IEC steps: 0 V to 100 V) | R_{ins} min. $10^3 \text{ M}\Omega$ ΔR max.: $\pm (1 \% R + 0.05 \Omega)$ | |
| 4.25.1 | | Endurance (at 70 °C) | 1000 h; loaded with P_{70} or U_{max} ; 1.5 h ON and 0.5 h OFF | ΔR max.: $\pm (1 \% R + 0.05 \Omega)$ | |
| 4.25.3 | | Endurance at upper category temperature | 1000 h; no load | ΔR max.: $\pm (1 \% R + 0.05 \Omega)$ | |
| 4.8 | | Temperature coefficient | Between -55 °C and +155 °C $0.22 \Omega \leq R \leq 4.7 \Omega$ $4.7 \Omega < R \leq 15 \Omega$ $15 \Omega < R \leq 15 \text{ k}\Omega$ | $\leq \pm 200 \text{ ppm/K}$ $\leq \pm 200 \text{ ppm/K}$ $\leq \pm 100 \text{ ppm/K}$ | $\leq \pm 200 \text{ ppm/K}$ $\leq \pm 100 \text{ ppm/K}$ $\leq \pm 100 \text{ ppm/K}$ |
| 4.12 | | Noise | IEC 60195 | $< 0.1 \mu\text{V/V}$ | |
| 4.26 | | Accidental overload | Cheese-cloth | Non flammable | |
| 4.6.1.1 | | Insulation resistance | Maximum voltage U_{max} , DC = 500 V after 1 min; metal block method | R_{ins} min. $10^4 \text{ M}\Omega$ | |



12NC INFORMATION FOR HISTORICAL CODING REFERENCE

- 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 value:
 - 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 Ω to 0.91 Ω | 7 |
| 1 Ω to 9.1 Ω | 8 |
| 10 Ω to 91 Ω | 9 |
| 100 Ω to 910 Ω | 1 |
| 1 kΩ to 9.1 kΩ | 2 |
| 10 kΩ to 15 kΩ | 3 |

12NC Example

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

| 12NC (Resistors Type and Packaging) | | | | |
|-------------------------------------|-----------------------|----------------|--------------|-------------------|
| TYPE | 23.. | | | |
| | BANDOLIER IN AMMOPACK | | | BANDOLIER ON REEL |
| | RADIAL TAPED | STRAIGHT LEADS | | STRAIGHT LEADS |
| | 2000 UNITS | 1000 UNITS | 5000 UNITS | 5000 UNITS |
| NFR25 | 22 204 03... | 22 205 13... | 22 205 33... | 22 205 23... |
| NFR25H | 22 207 03... | 22 207 13... | 22 207 33... | 22 207 23... |



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