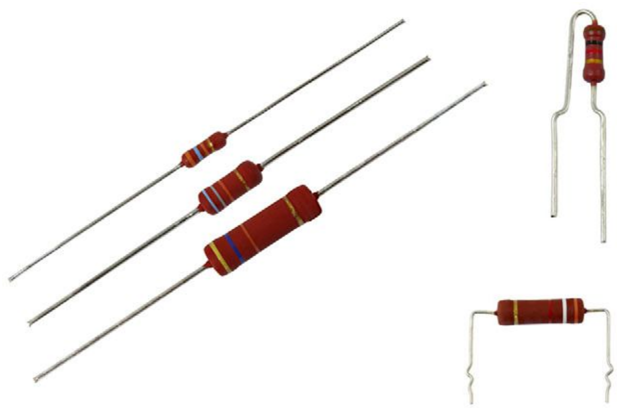
Power Metal Film Leaded Resistors



LINKS TO ADDITIONAL RESOURCES

3D Models

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 or copper-clad iron are welded to the end-caps. The resistors are coated with a red, non-flammable lacquer which provides electrical, mechanical and climatic protection. This coating is not resistant to aggressive fluxes and cleaning solvents. The encapsulation is resistant to all cleaning solvents in accordance with IEC 60068-2-45.

FEATURES

- High power in small packages (1 W / 0207 size to 3 W / 0617 size)
- Meets active and passive flammability requirements as defined in IEC 60115-1
- Flameproof insulation coating meets UL 94 V-0 requirements
- Defined fusing characteristics
- Technology: metal film
- AEC-Q200 qualified
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

Pb-free
RoHS COMPLIANT
HALOGEN FREE

APPLICATIONS

- All general purpose power applications
- Automotive electronics
- Lighting ballast

TECHNICAL SPECIFICATIONS

DESCRIPTION	PR01	PR02 Cu-LEAD	PR02 FeCu-LEAD	PR03 Cu-LEAD	PR03 FeCu-LEAD
DIN size	0207	0411	0411	0617	0617
Resistance range (1)	0.22 Ω to 1 MΩ	0.33 Ω to 1 MΩ	1 Ω to 1 MΩ	0.68 Ω to 1 MΩ	1 Ω to 1 MΩ
Resistance tolerance (2)	± 1 %; ± 5 %	± 1 %; ± 5 %	± 1 %; ± 5 %	± 1 %; ± 5 %	± 1 %; ± 5 %
Temperature coefficient	± 250 ppm/K	± 250 ppm/K	± 250 ppm/K	± 250 ppm/K	± 250 ppm/K
Rated dissipation, P_{70}					
$1\ \Omega \leq R$	1 W	2 W	1.3 W	3 W	2.5 W
$R < 1\ \Omega$	0.6 W	1.2 W	-	1.6 W	-
Thermal resistance (R_{th})	135 K/W	75 K/W	115 K/W	60 K/W	75 K/W
Operating voltage, $U_{max.}$ AC/DC	350 V	500 V	500 V	750 V	750 V
E-series	E24, E96 (± 1 %); E24 (± 5 %)				
Basic specification	IEC 60115-1				
Stability after:					
Endurance test (1000 h, P_{70})	ΔR max.: ± (5 % R + 0.1 Ω)				
Damp heat test (56 days)	ΔR max.: ± (3 % R + 0.1 Ω)				
Soldering (10 s, 260 °C)	ΔR max.: ± (1 % R + 0.05 Ω)				

Notes

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

(2) 1 % tolerance is available for R_n-range from 1 Ω upwards

TERMINATION WIRE TYPES					
PRODUCT TYPE	PACKAGING CODE	STYLE	MATERIAL	WIRE DIAMETER	PITCH
PR01	A1, A5, R5	Axial	Cu	0.58 mm	n/a
	N4	Radial	Cu	0.58 mm	4.8 mm
	L1	Radial	Cu	0.58 mm	17.8 mm
	L1	Radial	FeCu	0.58 mm	17.8 mm
	K1	Radial	FeCu	0.58 mm	12.5 mm
PR02	A1, R5	Axial	Cu	0.78 mm	n/a
	A1	Axial	FeCu	0.58 mm	n/a
	N3, R2	Radial	Cu	0.78 mm	4.8 mm
	L1	Radial	Cu	0.78 mm	17.8 mm
	L1	Radial	FeCu	0.58 mm	17.8 mm
	B1	Radial	FeCu	0.78 mm	15 mm
PR03	AC	Axial	Cu	0.78 mm	n/a
	AC	Axial	FeCu	0.58 mm	n/a
	DC	Radial	Cu	0.78 mm	25.4 mm
	DC	Radial	FeCu	0.58 mm	25.4 mm
	PC	Radial	FeCu	0.78 mm	20 mm

APPLICATION INFORMATION

The power dissipation on the resistor generates a temperature rise against the local ambient, depending on the heat flow support of the printed-circuit board (thermal resistance). The rated dissipation applies only if the permitted film temperature is not exceeded. Furthermore, a high level of ambient temperature or of power dissipation may raise the temperature of the solder joint, hence special solder alloys or board materials may be required to maintain the reliability of the assembly.

These resistors do not feature a limited lifetime when operated within the permissible limits. However, resistance value drift increasing over operating time may result in exceeding a limit acceptable to the specific application, thereby establishing a functional lifetime. The designer may estimate the performance of the particular resistor application or set certain load and temperature limits in order to maintain a desired stability.

OPERATION MODE		POWER
		P_{70}
Rated dissipation	**PR01**	1 W
	PR02	2 W
	PR03	3 W
Applied maximum film temperature, $\vartheta_{F\ max.}$		250 °C
Max. resistance change at rated dissipation for resistance range:	**PR01**	0.22 Ω to 1 MΩ
	PR02	0.33 Ω to 1 MΩ
	PR03	0.68 Ω to 1 MΩ
$\lvert\Delta R/R\rvert_{max.}$ (at P_{70}) after:	1000 h	5.0 % R + 0.1 Ω

PART NUMBER AND PRODUCT DESCRIPTION

Part Number: PR02000201001JA100

P	R	0	2	0	0	2	0	1	0	0	1	J	A	1	0	0

TYPE/SIZE	VARIANT	WIRE TYPES	TCR/MATERIAL	RESISTANCE	TOLERANCE	PACKAGING	SPECIAL
PR0100 **PR0200** **PR0300**	**0** = neutral **Z** = value overflow (special)	**1** = Cu 0.58 (PR01) **2** = Cu 0.78 (PR02, PR03) **3** = FeCu 0.58 (PR01, PR02, PR03) **4** = FeCu 0.78 (PR02, PR03)	**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** = $*10^{2}$ **3** = $*10^{3}$ **4** = $*10^{4}$	**F** = ± 1 % **J** = ± 5 %	**N4** **R2** **N3** **L1** **A5** **DC** **A1** **K1** **AC** **B1** **R5** **PC**	**00** = standard

Product Description: PR02 5 % A1 1K0

PR02	5 %	A1	1K0
TYPE	TOLERANCE	PACKAGING	RESISTANCE VALUE
PR01 **PR02** **PR03**	**1 %** **5 %**	**N4** **R2** **N3** **L1** **A5** **DC** **A1** **K1** **AC** **B1** **R5** **PC**	**1K0** = 1 kΩ **4K75** = 4.75 kΩ

Note

- The products can be ordered using either the PRODUCT DESCRIPTION or the PART NUMBER

PACKAGING

PRODUCT TYPE	CODE	QUANTITY	DESCRIPTION	PITCH	TAPE WIDTH	DIMENSION
PR01	A5	5000	Ammo pack acc. to IEC 60286-1	5 mm	52 mm	75 mm x 114 mm x 260 mm
	A1	1000	Ammo pack acc. to IEC 60286-1	5 mm	52 mm	78 mm x 31 mm x 260 mm
	N4	4000	Ammo pack acc. to IEC 60286-2	-	-	45 mm x 262 mm x 330 mm
	L1	1000	Loose in bulk	-	-	105 mm x 70 mm x 205 mm
	K1	1000	Loose in bulk	-	-	105 mm x 70 mm x 205 mm
	R5	5000	Reel pack acc. to IEC 60286-1	5 mm	52 mm	93 mm x 300 mm x 298 mm
PR02	A1	1000	Ammo pack acc. to IEC 60286-1	5 mm	52 mm	72 mm x 80 mm x 258 mm
	N3	3000	Ammo pack acc. to IEC 60286-2	-	-	45 mm x 262 mm x 330 mm
	L1	1000	Loose in bulk	-	-	105 mm x 70 mm x 205 mm
	B1	1000	Loose in bulk	-	-	105 mm x 70 mm x 205 mm
	R5	5000	Reel pack acc. to IEC 60286-1	5 mm	52 mm	90 mm x 375 mm x 375 mm
	R2	2000	Reel pack acc. to IEC 60286-2	-	-	90 mm x 375 mm x 375 mm
PR03	AC	500	Ammo pack acc. to IEC 60286-1	10 mm	63 mm	83 mm x 58 mm x 256 mm
	DC	500	Loose in bulk	-	-	105 mm x 70 mm x 205 mm
	PC	500	Loose in bulk	-	-	105 mm x 70 mm x 205 mm

DESCRIPTION

Production is strictly controlled and follows an extensive set of instructions established for reproducibility. A homogeneous film of metal alloy is deposited on a high grade ceramic body and conditioned to achieve the desired temperature coefficient. Plated steel termination caps are firmly pressed on the metalized rods. Mostly, a special laser is used to achieve the target value by smoothly cutting a helical groove in the resistive layer without damaging the ceramics. Connecting wires of electrolytic copper plated with 100 % pure tin are welded to the termination caps. The resistor elements are covered by a red, non-flammable lacquer protective coating designed for electrical, mechanical, and climatic protection. Four or five color code rings designate the resistance value and tolerance in accordance with **IEC 60062**.

The result of the determined production is verified by an extensive testing procedure performed on 100 % of the individual resistors. Only accepted products are stuck directly on the adhesive tapes in accordance with **IEC 60286-1** or for the radial versions in accordance with **IEC 60286-2**.

MATERIALS

Vishay acknowledges the following systems for the regulation of hazardous substances:

- IEC 62474, Material Declaration for Products of and for the Electrotechnical Industry, with the list of declarable substances given therein [(1)]
- The Global Automotive Declarable Substance List (GADSL) [(2)]
- The REACH regulation (1907/2006/EC) and the related list of substances with very high concern (SVHC) [(3)] for its supply chain

The products do not contain any of the banned substances as per IEC 62474, GADSL, or the SVHC list, see www.vishay.com/how/leadfree.
Hence the products fully comply with the following directives:

- 2000/53/EC End-of-Life Vehicle Directive (ELV) and Annex II (ELV II)
- 2011/65/EU Restriction of the Use of Hazardous Substances Directive (RoHS) with amendment 2015/863/EU
- 2012/19/EU Waste Electrical and Electronic Equipment Directive (WEEE)

Vishay pursues the elimination of conflict minerals from its supply chain, see the Conflict Minerals Policy at www.vishay.com/doc?49037.

ASSEMBLY

The resistors are suitable for processing on automatic insertion equipment and cutting and bending machines. Excellent solderability is proven, even after extended storage. They are suitable for automatic soldering using wave or dipping.

The resistors are completely lead (Pb)-free, the pure tin plating provides compatibility with lead (Pb)-free and lead-containing soldering processes. The immunity of the plating against tin whisker growth, in compliance with IEC 60068-2-82, has been proven under extensive testing.

The encapsulant is resistant to cleaning solvent specified in IEC 60068-2-45. The suitability of conformal coatings, if applied, shall be qualified by appropriate means to ensure the long-term stability of the whole system.

RELATED PRODUCTS

For a correlated range of Metal Film Resistors see the datasheet:

"High Ohmic / High Voltage Metal Film Leaded Resistors", www.vishay.com/doc?30260

For product that offers high power dissipation and metal oxide film technology see the datasheet:

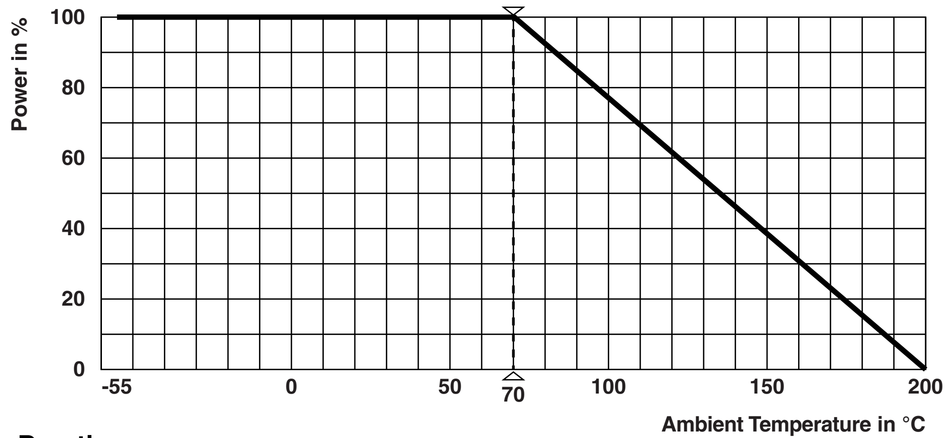
"High Power Metal Oxide Leaded Resistors", www.vishay.com/doc?20128

Notes

(1) The IEC 62474 list of declarable substances is maintained in a dedicated database, which is available at http://std.iec.ch/iec62474
(2) The Global Automotive Declarable Substance List (GADSL) is maintained by the American Chemistry Council, and available at www.gadsl.org
(3) The SVHC list is maintained by the European Chemical Agency (ECHA) and available at http://echa.europa.eu/candidate-list-table

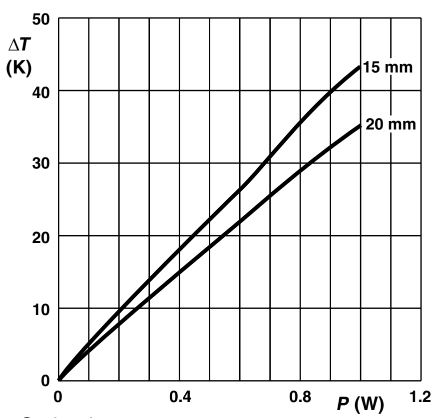
FUNCTIONAL PERFORMANCE

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



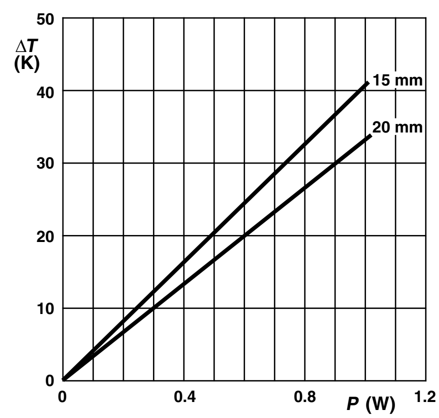
Derating

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



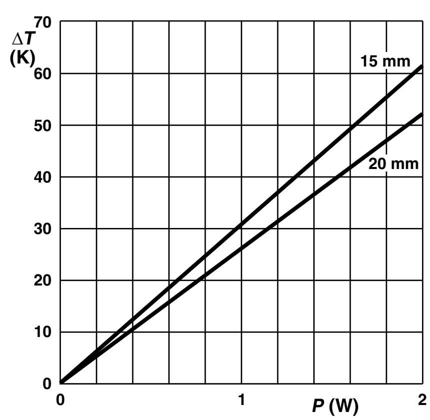
Ø 0.58 mm Cu-leads
Minimum distance from resistor body to PCB = 1 mm

PR01 Temperature rise (Δ*T*) at the lead end (soldering point) as a function of dissipated power at various lead lengths after mounting.



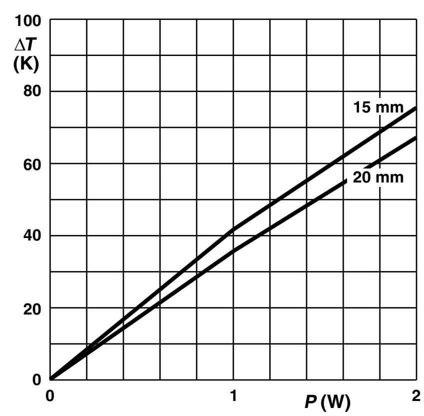
Ø 0.58 mm FeCu-leads
Minimum distance from resistor body to PCB = 1 mm

PR01 Temperature rise (Δ*T*) at the lead end (soldering point) as a function of dissipated power at various lead lengths after mounting.



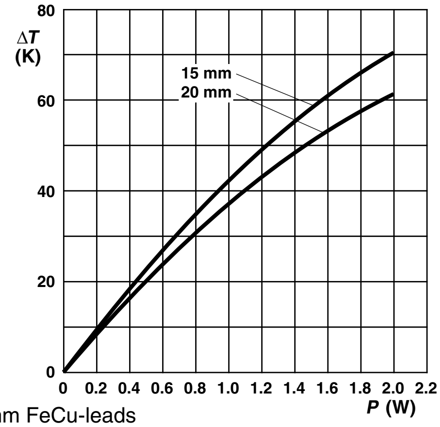
Ø 0.58 mm FeCu-leads
Minimum distance from resistor body to PCB = 1 mm

PR02 Temperature rise (Δ*T*) at the lead end (soldering point) as a function of dissipated power at various lead lengths after mounting.



Ø 0.78 mm Cu-leads
Minimum distance from resistor body to PCB = 1 mm

PR02 Temperature rise (Δ*T*) at the lead end (soldering point) as a function of dissipated power at various lead lengths after mounting.



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Minimum distance from resistor body to PCB = 1 mm

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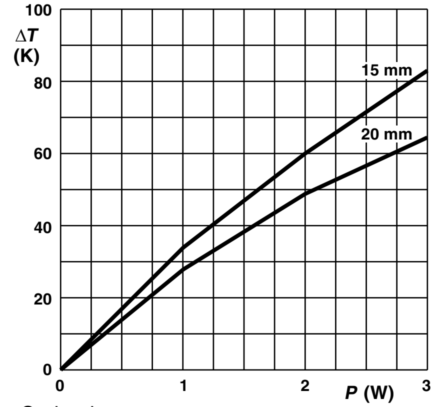
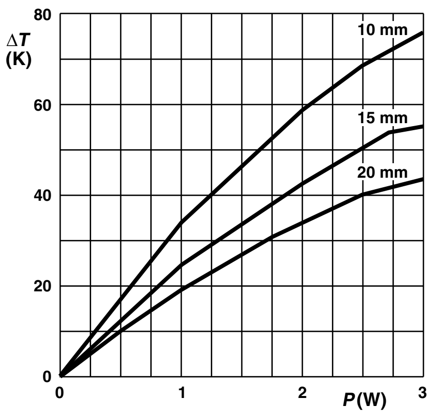


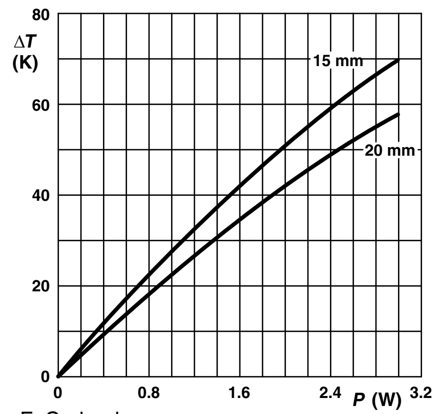
Ø 0.78 mm Cu-leads
Minimum distance from resistor body to PCB = 1 mm

PR03 Temperature rise (Δ*T*) at the lead end (soldering point) as a function of dissipated power at various lead lengths after mounting.



Ø 0.58 mm FeCu-leads
Minimum distance from resistor body to PCB = 1 mm

PR03 Temperature rise (Δ*T*) at the lead end (soldering point) as a function of dissipated power at various lead lengths after mounting.



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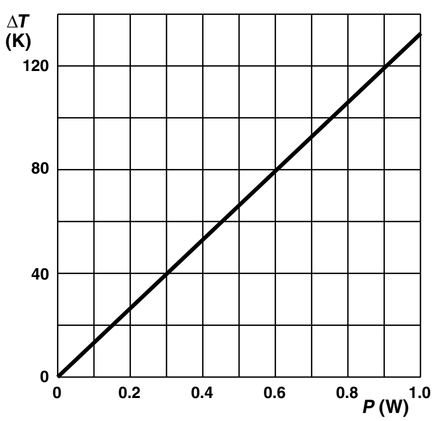
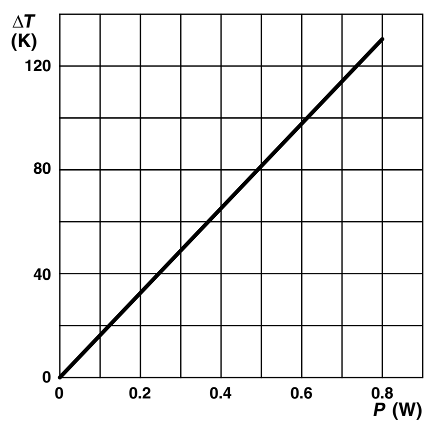


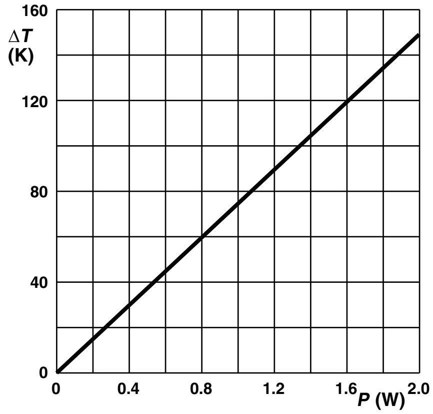
Ø 0.58 mm Cu-leads

PR01 Hot-spot temperature rise (Δ*T*) as a function of dissipated power.



Ø 0.58 mm FeCu-leads

PR01 Hot-spot temperature rise (Δ*T*) as a function of dissipated power.



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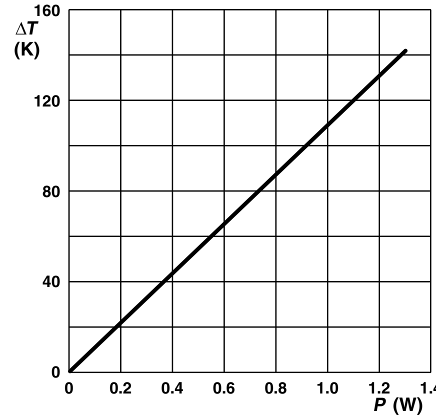
PR02 Hot-spot temperature rise (Δ*T*) as a function of dissipated power.



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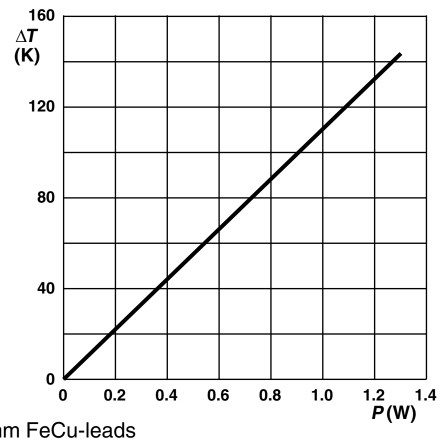
PR02 Hot-spot temperature rise (Δ*T*) as a function of dissipated power.



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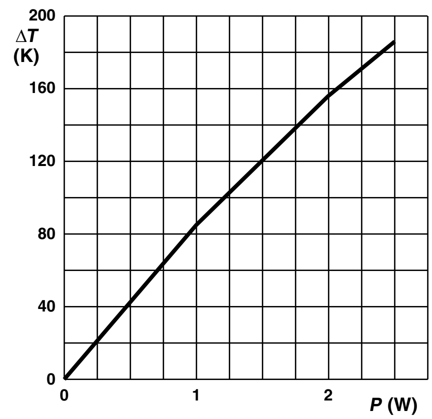

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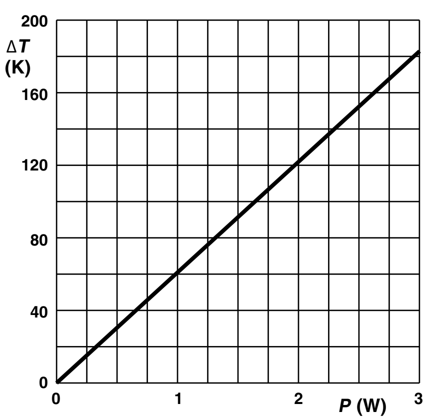
PR03 Hot-spot temperature rise (Δ*T*) as a function of dissipated power.



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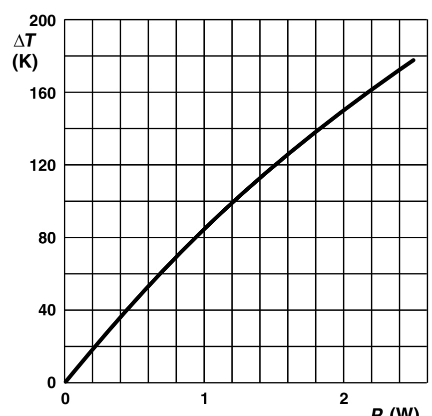
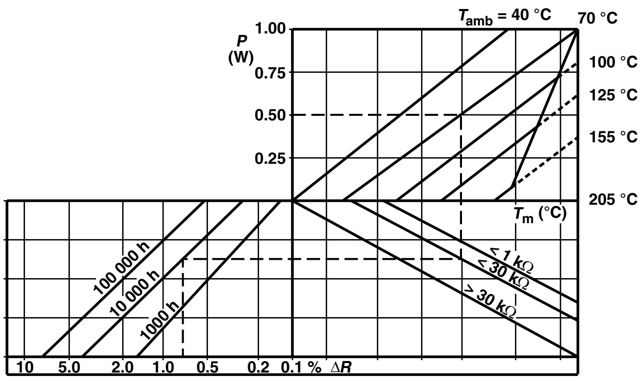
PR03 Hot-spot temperature rise (Δ*T*) as a function of dissipated power.



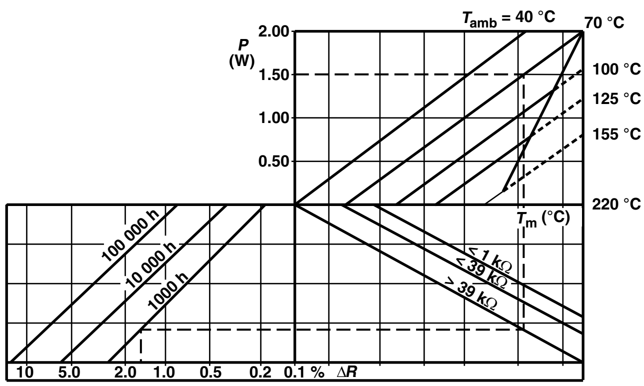
Ø 0.78 mm FeCu-leads

PR03 Hot-spot temperature rise (Δ*T*) as a function of dissipated power.

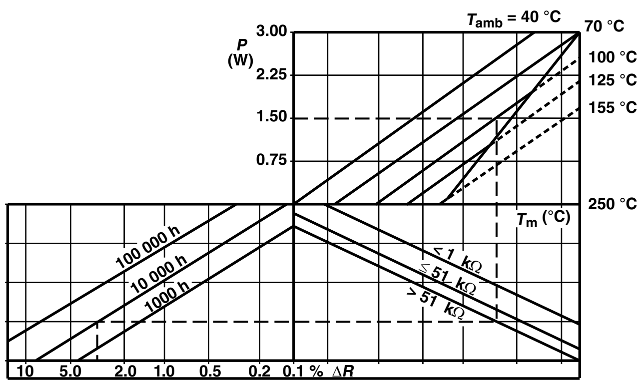
The maximum permissible hot-spot temperature is 205 °C for PR01, 220 °C for PR02 and 250 °C for PR03.



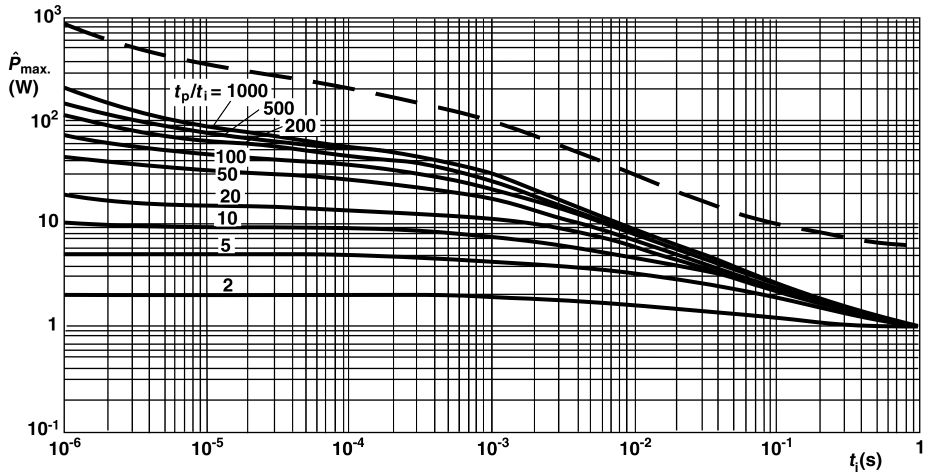
PR01 Drift nomogram



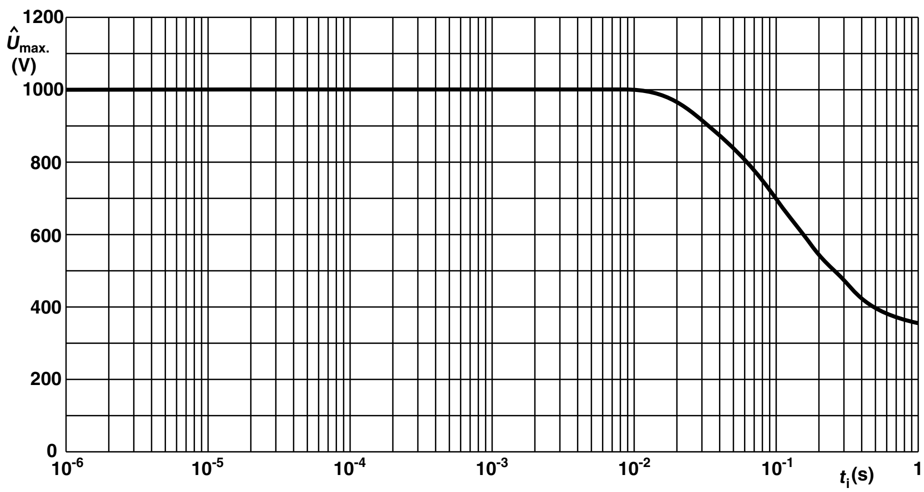
PR02 Drift nomogram



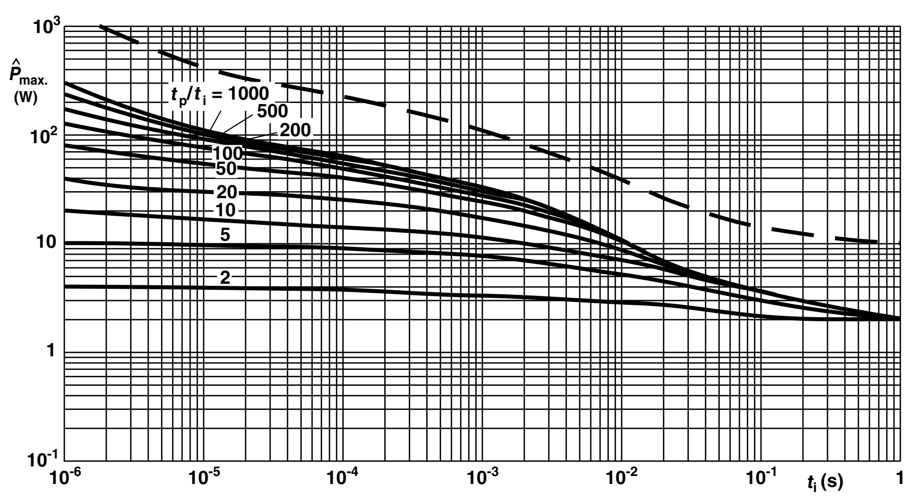
PR03 Drift nomogram



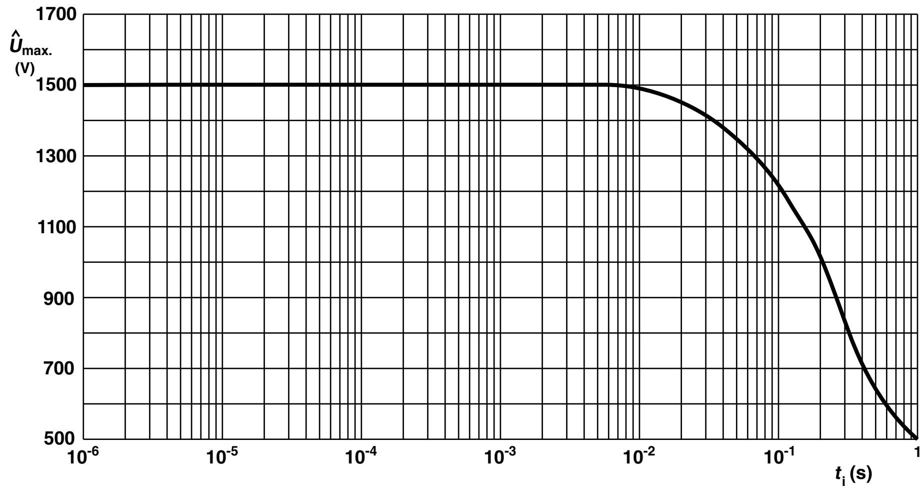
PR01 Pulse on a regular basis; maximum permissible peak pulse power ($\hat{P}_{max.}$) as a function of pulse duration (t_i)



PR01 Pulse on a regular basis; maximum permissible peak pulse voltage ($\hat{U}_{max.}$) as a function of pulse duration (t_i)



PR02 Pulse on a regular basis; maximum permissible peak pulse power ($\hat{P}_{max.}$) as a function of pulse duration (t_i)



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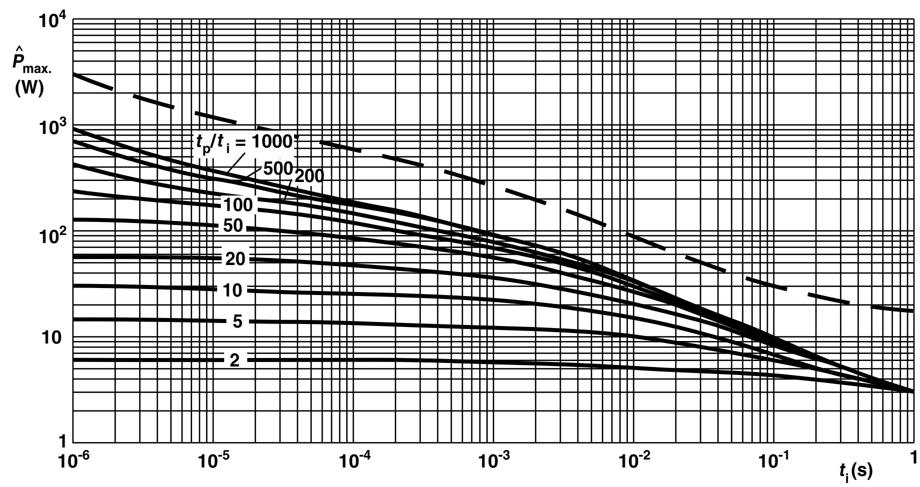

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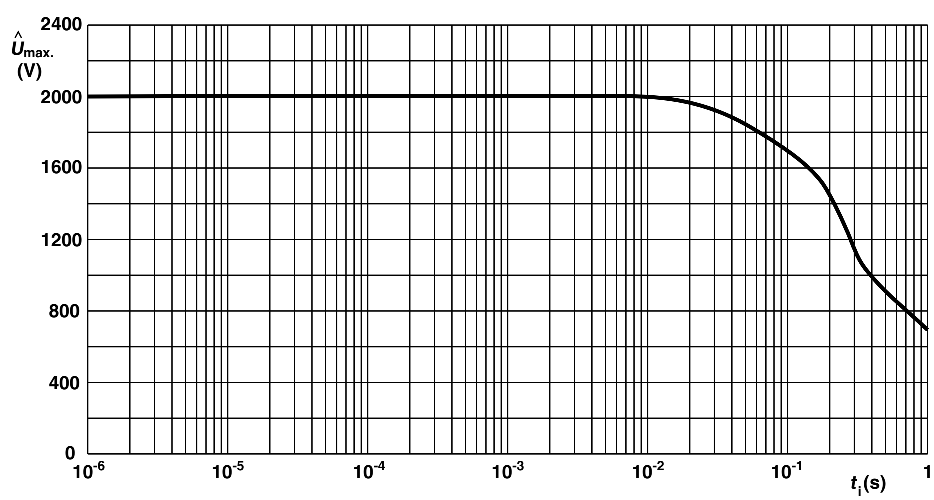

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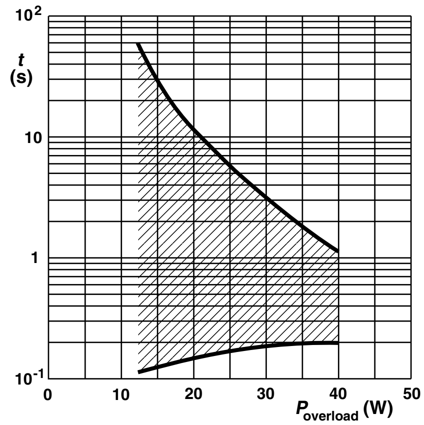
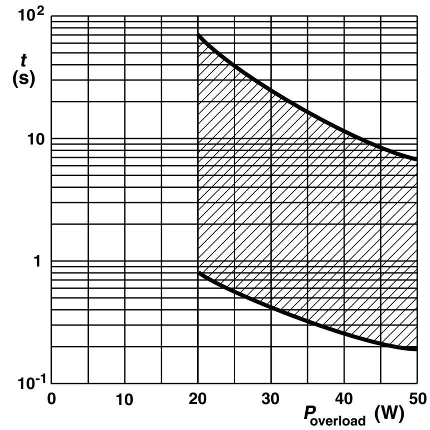
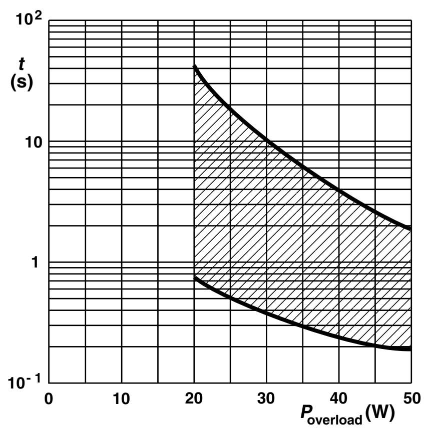


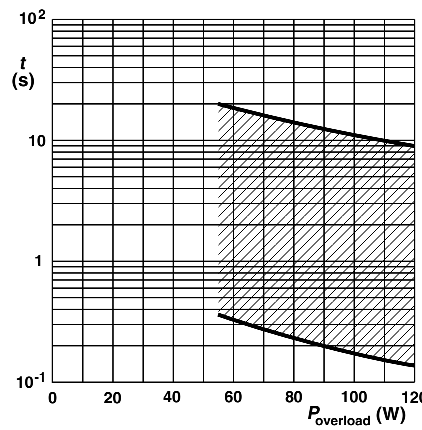
PR01 Time to interruption as a function of overload power
for range: 0.22 Ω ≤ R_n < 1 Ω
This graph is based on measured data under constant voltage conditions; the data may deviate according to the applications.



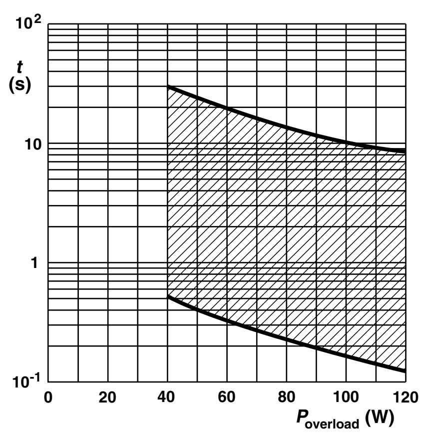
PR01 Time to interruption as a function of overload power
for range: 16 Ω ≤ R_n ≤ 560 Ω
This graph is based on measured data under constant voltage conditions; the data may deviate according to the applications.



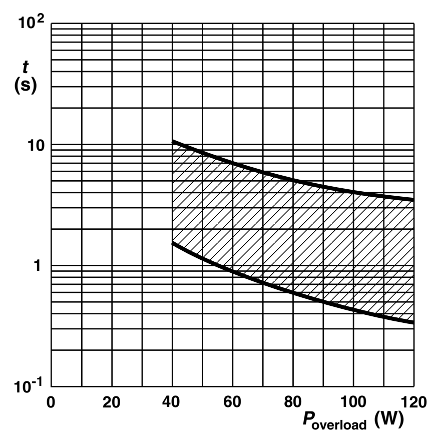
PR01 Time to interruption as a function of overload power
for range: 1 Ω ≤ R_n ≤ 15 Ω
This graph is based on measured data under constant voltage conditions; the data may deviate according to the applications.



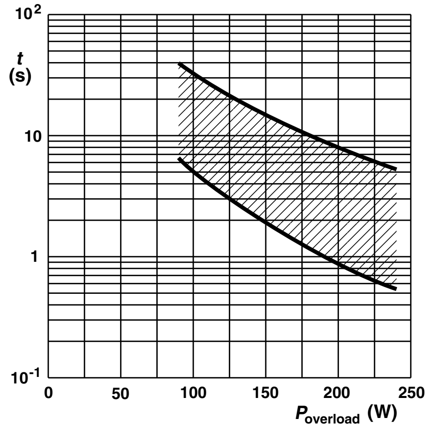
PR02 Time to interruption as a function of overload power
for range: 0.33 Ω ≤ R_n ≤ 5 Ω
This graph is based on measured data under constant voltage conditions; the data may deviate according to the applications.



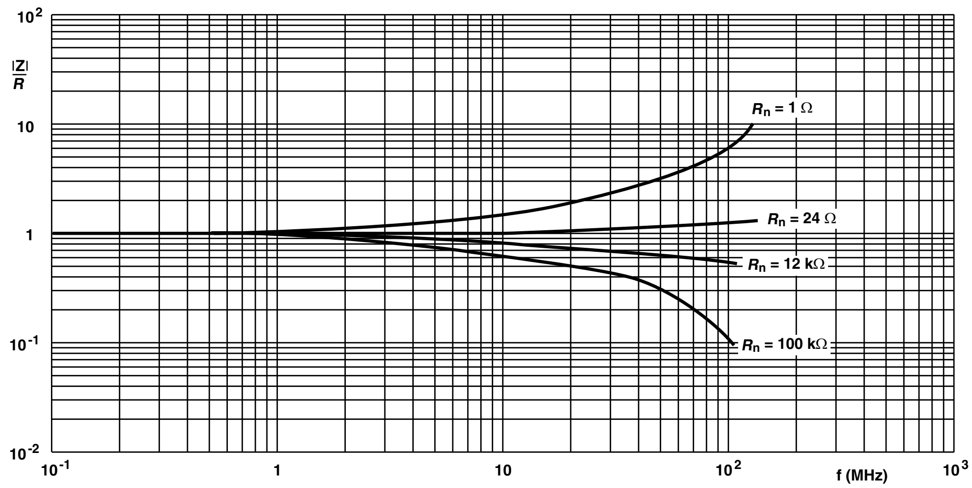
PR02 Time to interruption as a function of overload power
for range: 5 Ω ≤ R_n ≤ 68 Ω
This graph is based on measured data under constant voltage conditions; the data may deviate according to the applications.



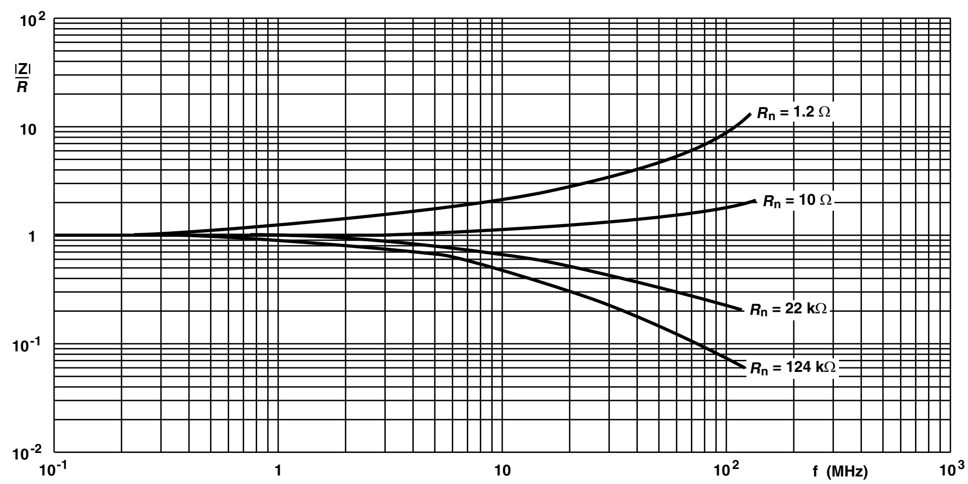
PR02 Time to interruption as a function of overload power
for range: 68 Ω ≤ R_n ≤ 560 Ω
This graph is based on measured data under constant voltage conditions; the data may deviate according to the applications.



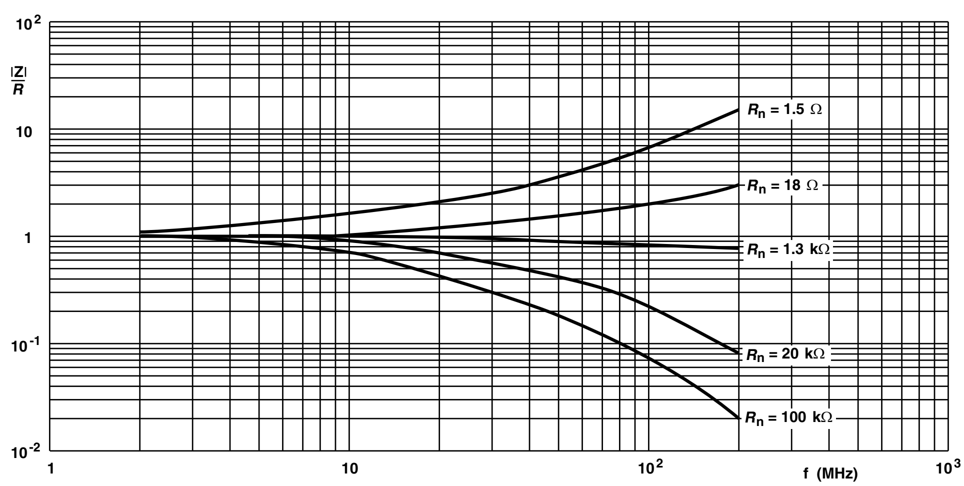
PR03 Time to interruption as a function of overload power for range: 0.68 Ω ≤ R_n ≤ 560 Ω
This graph is based on measured data under constant voltage conditions; the data may deviate according to the applications.



PR01 Impedance as a function of applied frequency



PR02 Impedance as a function of applied frequency



PR03 Impedance as a function of applied frequency

TESTS PROCEDURES AND REQUIREMENTS

All tests are carried out in accordance with the following specifications:

IEC 60115-1, generic specification

IEC 60068-2-xx, test methods

The table presents only the most important tests, for the full test schedule refer to the documents listed above. However, some additional tests and a number of improvements against those minimum requirements have been included.

The tests are carried out under standard atmospheric conditions in accordance with IEC 60068-1, 4.3, whereupon the following values are applied:

Temperature: 15 °C to 35 °C

Relative humidity: 25 % to 75 %

Air pressure: 86 kPa to 106 kPa (860 mbar to 1060 mbar).

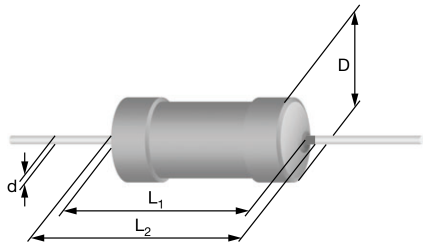
A climatic category LCT / UCT / 56 is applied, defined by the lower category temperature (LCT = -55 °C), the upper category temperature (UCT = 155 °C), and the duration of exposure in the damp heat, steady state test (56 days). The components are mounted for testing on printed circuit boards in accordance with IEC 60115-1, 5.5 unless otherwise specified.

TEST PROCEDURES AND REQUIREMENTS

IEC 60115-1 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE ($\Delta R_{max.}$)
9.1	-	Visual examination		No holes; clean surface; no damage
9.2	-	Dimensions (outline)	Gauge (mm)	See Straight and Kinked Dimensions tables
5.6	-	Resistance		± 5 % R
12.1	-	Insulation resistance	Maximum voltage (DC) after 1 min; metal block method	$R_{ins\ min.}$: 10^4 MΩ
12.2	-	Voltage proof	$U_{RMS} = U_{ins}$; 60 s	No breakdown or flashover
6.2	-	Temperature coefficient	At (20 / -55 / 20) °C and (20 / 155 / 20) °C	≤ ± 250 ppm/K
9.5	21 (Ua_1) 21 (Ub) 21 (Uc)	Robustness of terminations	Tensile, bending, and torsion	No damage $\Delta R_{max.}$: ± (0.5 % R + 0.05 Ω)
11.1	20 (Ta)	Solderability	+235 °C; 2 s; solder bath method; SnPb40	Good tinning (≥ 95 % covered, no visible damage)
			+245 °C; 3 s; solder bath method; SnAg3Cu0.5	Good tinning (≥ 95 % covered, no visible damage)
11.2	20 (Tb)	Resistance to soldering heat	Unmounted components (260 ± 5) °C; (10 ± 1) s	$\Delta R_{max.}$: ± (1 % R + 0.05 Ω)
10.1	14 (Na)	Rapid change of temperature	30 min at -55 °C and 30 min at +200 °C; 5 cycles	No visual damage **PR01**: $\Delta R_{max.}$: ± (1 % R + 0.05 Ω) **PR02**: $\Delta R_{max.}$: ± (1 % R + 0.05 Ω) **PR03**: $\Delta R_{max.}$: ± (2 % R + 0.05 Ω)
9.9	27 (Ea)	Bump	3 x 1500 bumps in three directions; 40 g	No damage $\Delta R_{max.}$: ± (0.5 % R + 0.05 Ω)
9.11	6 (Fc)	Vibration	10 sweep cycles per direction; 10 Hz to 2000 Hz; 1.5 mm or 200 m/s^2	No damage $\Delta R_{max.}$: ± (0.5 % R + 0.05 Ω)

TEST PROCEDURES AND REQUIREMENTS				
IEC 60115-1 CLAUSE	**IEC 60068-2 TEST METHOD**	**TEST**	**PROCEDURE**	**REQUIREMENTS PERMISSIBLE CHANGE ($\Delta R_{max.}$)**
10.3		Climatic sequence:		
10.3.4.2	2 (Bb)	Dry heat	200 °C; 16 h	
10.3.4.3	30 (Db)	Damp heat, cyclic	55 °C; 24 h; 90 % to 100 % RH; 1 cycle	
10.3.4.4	1 (Ab)	Cold	-55 °C; 2 h	$R_{ins\ min.}$: 10^3 MΩ $\Delta R_{max.}$: ± (1.5 % R + 0.1 Ω)
10.3.4.5	13 (M)	Low air pressure	8.5 kPa; 2 h; 15 °C to 35 °C	
10.3.4.6	30 (Db)	Damp heat, cyclic	55 °C; 5 days; 95 % to 100 % RH; 5 cycles	
10.4	78 (Cab)	Damp heat (steady state)	(40 ± 2) °C; 56 days; (93 ± 3)% RH	$\Delta R_{max.}$: ± (3 % R + 0.1 Ω)
7.1	-	Endurance (at 70 °C)	$U = \sqrt{P_{70} \times R}$ or $U = U_{max.}$; 1.5 h on; 0.5 h off; 70 °C; 1000 h	$\Delta R_{max.}$: ± (5 % R + 0.1 Ω)
12.3	-	Active flammability	Accidental overload test	No damage, no flaming of gauze cylinder
11.3	45 (XA)	Component solvent resistance	Isopropyl alcohol (used in industrial application) +23 °C; toothbrush method	Marking legible; no visible damage
12.4	-	Passive flammability	Needle flame test	No ignition of product, no ignition of under layer burning time is less than 30 s

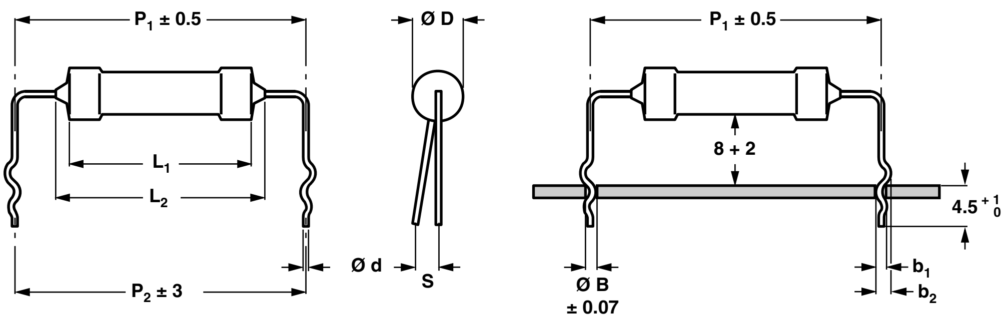
DIMENSIONS



Type with straight leads

DIMENSIONS - Straight lead type and relevant physical dimensions; see straight leads outline

TYPE	Ø $D_{MAX.}$ (mm)	$L_{1\ MAX.}$ (mm)	$L_{2\ MAX.}$ (mm)	TERMINATION WIRE MATERIAL (Cu OR FeCu) AND WIRE DIAMETER (Ø d)		MASS (mg)
				MATERIAL	Ø d (mm)	
PR01	2.5	6.5	8.0	Cu	0.58 ± 0.05	212
				FeCu	0.58 ± 0.05	207
PR02	3.9	10.0	12.0	Cu	0.78 ± 0.05	504
				FeCu	0.58 ± 0.05	455
				FeCu	0.78 ± 0.05	496
PR03	5.2	16.7	19.5	Cu	0.78 ± 0.05	1192
				FeCu	0.58 ± 0.05	1079
				FeCu	0.78 ± 0.05	1185



Type with double kink

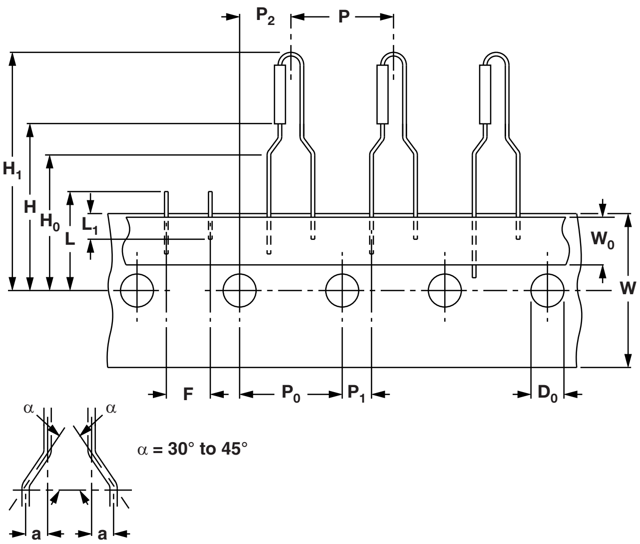
Dimensions in millimeters

DIMENSIONS - Double kink lead type and relevant physical dimensions; see double kinked outline

TYPE	Ø $D_{MAX.}$ (mm)	$L_{1\ MAX.}$ (mm)	$L_{2\ MAX.}$ (mm)	TERMINATION WIRE MATERIAL (Cu OR FeCu) AND WIRE DIAMETER (Ø d)		MASS (mg)	PITCH (mm)	P_1 (mm)	P_2 (mm)	b_1 (mm)	b_2 (mm)	$S_{MAX.}$ (mm)	Ø B (mm)
				MATERIAL	Ø d (mm)								
PR01	2.5	6.5	8.0	Cu	0.58 ± 0.05	212	17.8	17.8 ± 0.5	17.8 ± 3	1.10 + 0.25 / - 0.20	1.45 + 0.25 / - 0.20	2	0.8 ± 0.07
				FeCu	0.58 ± 0.05	207	12.5	12.5 ± 0.5	12.5 ± 3	1.10 + 0.25 / - 0.20	1.45 + 0.25 / - 0.20	2	0.8 ± 0.07
				FeCu	0.58 ± 0.05	207	17.8	17.8 ± 0.5	17.8 ± 3	1.10 + 0.25 / - 0.20	1.45 + 0.25 / - 0.20	2	0.8 ± 0.07
PR02	3.9	10.0	12.0	Cu	0.78 ± 0.05	504	17.8	17.8 ± 0.5	17.8 ± 3	1.10 + 0.25 / - 0.20	1.45 + 0.25 / - 0.20	2	1.0 ± 0.07
				FeCu	0.58 ± 0.05	455	17.8	17.8 ± 0.5	17.8 ± 3	1.10 + 0.25 / - 0.20	1.45 + 0.25 / - 0.20	2	0.8 ± 0.07
				FeCu	0.78 ± 0.05	496	15.0	15.0 ± 0.5	15.0 ± 3	1.30 + 0.25 / - 0.20	1.65 + 0.25 / - 0.20	2	1.0 ± 0.07
PR03	5.2	16.7	19.5	Cu	0.78 ± 0.05	1192	25.4	25.4 ± 0.5	25.4 ± 3	1.10 + 0.25 / - 0.20	1.65 + 0.25 / - 0.20	2	1.0 ± 0.07
				FeCu	0.58 ± 0.05	1079	25.4	25.4 ± 0.5	25.4 ± 3	1.10 + 0.25 / - 0.20	1.65 + 0.25 / - 0.20	2	1.0 ± 0.07
				FeCu	0.78 ± 0.05	1185	20	22.0 ± 0.5	20.0 ± 3	1.30 + 0.25 / - 0.20	1.8 ± 0.3	2	1.0 ± 0.07

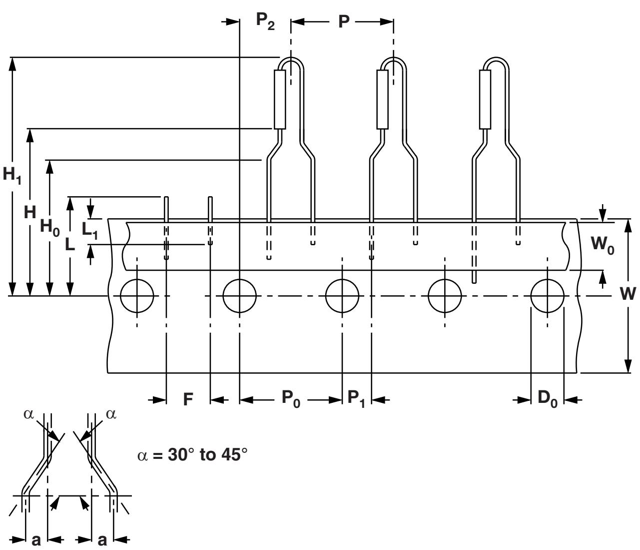
PR01, PR02 WITH RADIAL TAPING

PR01 - Height for insertion (max.) = 29 mm



DIMENSIONS in millimeters		
Pitch of components	P	12.7 ± 1.0
Feed-hole pitch	P_0	12.7 ± 0.2
Feed-hole center to lead at topside at the tape	P_1	3.85 ± 0.5
Feed-hole center to body center	P_2	6.35 ± 1.0
Lead spacing	F	4.8 +0.7/-0
Width of carrier tape	W	18.0 ± 0.5
Minimum hold down tape width	W_0	5.5
Height for insertion (max.)	H1	29
Lead wire clinch height	H_0	16.5 ± 0.5
Body to hole center	H	19.5 ± 1
Feed-hole diameter	D_0	4.0 ± 0.2
Height for cutting (max.)	L	11.0
Minimum lead wire (tape portion) shortest lead	L_1	2.5

PR02 - Height for insertion (max.) = 32 mm



DIMENSIONS in millimeters		
Pitch of components	P	12.7 ± 1.0
Feed-hole pitch	P_0	12.7 ± 0.2
Feed-hole center to lead at topside at the tape	P_1	3.85 ± 0.5
Feed-hole center to body center	P_2	6.35 ± 1.0
Lead spacing	F	4.8 +0.7/-0
Width of carrier tape	W	18.0 ± 0.5
Minimum hold down tape width	W_0	5.5
Height for insertion (max.)	H1	32
Lead wire clinch height	H_0	16.5 ± 0.5
Body to hole center	H	19.5 ± 1
Feed-hole diameter	D_0	4.0 ± 0.2
Height for cutting (max.)	L	11.0
Minimum lead wire (tape portion) shortest lead	L_1	2.5

MARKING

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

12NC INFORMATION FOR HISTORICAL CODING REFERENCE

The resistors have a 12-digit numeric code starting with 23

For 5 % tolerance:

- The next 7 digits indicate the resistor type and packing
- The remaining 3 digits indicate the resistance value:
  - The first 2 digits indicate the resistance value
  - The last digit indicates the resistance decade

For 1 % tolerance:

- The next 6 digits indicate the resistor type and packing
- The remaining 4 digits indicate the resistance value:
  - The first 3 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 9.76 Ω	8
10 Ω to 97.6 Ω	9
100 Ω to 976 Ω	1
1 Ω to 9.76 kΩ	2
10 Ω to 97.6 kΩ	3
100 Ω to 976 kΩ	4
1 MΩ	5

12NC Example

The 12NC for resistor type PR02 with Cu leads and a value of 750 Ω with 5 % tolerance, supplied on a bandolier of 1000 units in ammopack, is: 2306 198 53751.

12NC - Resistor Type and Packaging [1]

TYPE	LEAD Ø mm	TOL. (%)	23.. ... . (BANDOLIER)						
			AMMOPACK					REEL	
			RADIAL TAPED		STRAIGHT LEADS				RADIAL TAPED
					52 mm	52 mm	63 mm	52 mm	
			4000 UNITS	3000 UNITS	5000 UNITS	1000 UNITS	500 UNITS	5000 UNITS	2000 UNITS
PR01	Cu 0.58	1	-	-	**22 196 1....**	06 191 2....	-	06 191 5....	-
		5	06 197 03...	-	**22 193 14...**	06 197 53...	-	**06 197 23...**	-
PR02	Cu 0.78	1	-	22 197 2....	-	**22 197 1....**	-	-	**2322 197 5....**
		5	-	06 198 03...	-	**06 198 53...**	-	-	**2322 198 04...**
	FeCu 0.58	5	-	-	-	22 194 54...	-	-	-
PR03	Cu 0.78	5	-	-	-	-	**22 195 14...**	-	-
		1	-	-	-	-	**06 199 6...**	-	-
	FeCu 0.58	5	-	-	-	-	**22 195 54...**	-	-

Notes

- Preferred types in bold

(1) Other packaging versions are available on request

12NC - Resistor Type and Packaging

TYPE	LEAD Ø mm	TOL. (%)	23.. ... . (LOOSE IN BOX)			
			DOUBLE KINK			
			PITCH = 17.8 mm	PITCH = 25.4 mm	PITCH [2][3][4]	
			1000 UNITS	500 UNITS	1000 UNITS	500 UNITS
PR01	Cu 0.58	5	22 193 03...	-	-	-
	FeCu 0.58	5	22 193 43...	-	**22 193 53...** [2]	-
PR02	Cu 0.78	5	22 194 23...	-	-	-
	FeCu 0.58	5	22 194 83...	-	-	-
	FeCu 0.78	5	-	-	**22 194 63...** [3]	-
PR03	Cu 0.78	5	-	22 195 23...	-	-
	FeCu 0.58	5	-	22 195 83...	-	-
	FeCu 0.78	5	-	-	-	**22 195 63...** [4]

Notes

- Preferred types in bold

(2) PR01 pitch 12.5 mm

(3) PR02 pitch 15.0 mm

(4) PR03 pitch 20.0 mm, with reversed kinking direction as opposed to the drawing for the type with double kink figure

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