DATA SHEET

PR01/02/03
Professional power metal film resistors

Product specification
Supersedes data of 13th July 2001
File under BCcomponents, BC08

2002 Feb 20

COMPONENTS

Professional power metal film resistors PR01/02/03

FEATURES

- High power in small packages
- Different lead materials for different applications
- Defined interruption behaviour.

APPLICATIONS

- All general purpose power applications.

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, nonflammable lacquer which provides electrical, mechanical and climatic protection. This coating is not resistant to aggressive fluxes. The encapsulation is resistant to all cleaning solvents in accordance with *“MIL-STD-202E, method 215”*, and *“IEC 60068-2-45”*.

QUICK REFERENCE DATA

DESCRIPTION	VALUE				
	PR01	PR02		PR03	
		Cu-lead	FeCu-lead	Cu-lead	FeCu-lead
Resistance range	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 and series	±1% (E24, E96 series); ±5% (E24 series); see notes 1 and 2				
Maximum dissipation at T_{amb} = 70 °C:					
R < 1 Ω	0.6 W	1.2 W	–	1.6 W	–
1 Ω ≤ R	1 W	2 W	1.3 W	3 W	2.5 W
Thermal resistance (R_{th})	135 K/W	75 K/W	115 K/W	60 K/W	75 K/W
Temperature coefficient	$\leq \pm 250 \times 10^{-6}$/K				
Maximum permissible voltage (DC or RMS)	350 V	500 V		750 V	
Basic specifications	IEC 60115-1 and 60115-4				
Climatic category (IEC 60068)	55/155/56				
Stability after:					
load	ΔR/R max.: ±5% + 0.1 Ω				
climatic tests	ΔR/R max.: ±3% + 0.1 Ω				
soldering	ΔR/R max.: ±1% + 0.05 Ω				

Notes

1. 1% tolerance is available for R_n-range from 1R upwards.
2. 2% tolerance is available on request for R_n-range from 1R upwards.

Professional power metal film resistors PR01/02/03

ORDERING INFORMATION

Table 1 Ordering code indicating resistor type and packaging. Preferred types in **bold**.

TYPE	LEAD ∅ (mm)	TOL (%)	ORDERING CODE 23.. ... . (BANDOLIER)					
			AMMOPACK					REEL
			RADIAL TAPED		STRAIGHT LEADS			
					52 mm	52 mm	63 mm	52 mm
			4000 units	3000 units	5000 units	1000 units	500 units	5000 units
PR01	Cu 0.6	1	–	–	**22 196 1....**	–	–	–
		5	**06 197 03...**	–	**22 193 14...**	06 197 53...	–	**06 197 23...**
PR02	Cu 0.8	1	–	–	–	**22 197 1....**	–	–
		5	–	**06 198 03...**	–	**06 198 53...**	–	**06 198 23...**
	FeCu 0.6	5	–	–	–	22 194 54...	–	–
PR03	Cu 0.8	5	–	–	–	–	**22 195 14...**	–
		1	–	–	–	–	**06 199 6...**	–
	FeCu 0.6	5	–	–	–	–	**22 195 54...**	–

Table 2 Ordering code indicating resistor type and packaging. Preferred types in **bold**.

TYPE	LEAD ∅ (mm)	TOL (%)	ORDERING CODE 23.. ... . (LOOSE IN BOX)			
			DOUBLE KINK			
			PITCH = 17.8 (mm)	PITCH = 25.4 (mm)	PITCH(1)(2)(3)	
			1000 units	500 units	1000 units	500 units
PR01	Cu 0.6	5	22 193 03...	–	–	–
	FeCu 0.6	5	22 193 43...	–	**22 193 53...**(1)	–
PR02	Cu 0.8	5	22 194 23...	–	–	–
	FeCu 0.6	5	22 194 83...	–	–	–
	FeCu 0.8	5	–	–	**22 194 63...**(2)	–
PR03	Cu 0.8	5	–	22 195 23...	–	–
	FeCu 0.6	5	–	22 195 83...	–	–
	FeCu 0.8	5	–	–	–	**22 195 63...**(3)

Notes

1. PR01 pitch 12.5 mm.
2. PR02 pitch 15.0 mm.
3. PR03 pitch 20.0 mm.

Professional power metal film resistors PR01/02/03

Ordering code (12NC)

- The resistors have a 12-digit ordering code starting with 23.
- The first 7 digits indicate the resistor type and packaging; see Tables 1 and 2.
- The remaining 3 digits indicate the resistance value:
  - The first 2 digits indicate the resistance value.
  - The last digit indicates the resistance decade in accordance with Table 3.

Table 3 Last digit of 12NC

RESISTANCE DECADE	LAST DIGIT
0.22 to 0.91 Ω	7
1 to 9.76 Ω	8
10 to 97.6 Ω	9
100 to 976 Ω	1
1 to 9.76 kΩ	2
10 to 97.6 kΩ	3
100 to 976 kΩ	4
1 MΩ	5

Ordering example

The ordering code for resistor type PR02 with Cu leads and a value of 750 Ω, supplied on a bandolier of 1000 units in ammopack, is: 2322 194 13751.

FUNCTIONAL DESCRIPTION

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”*.

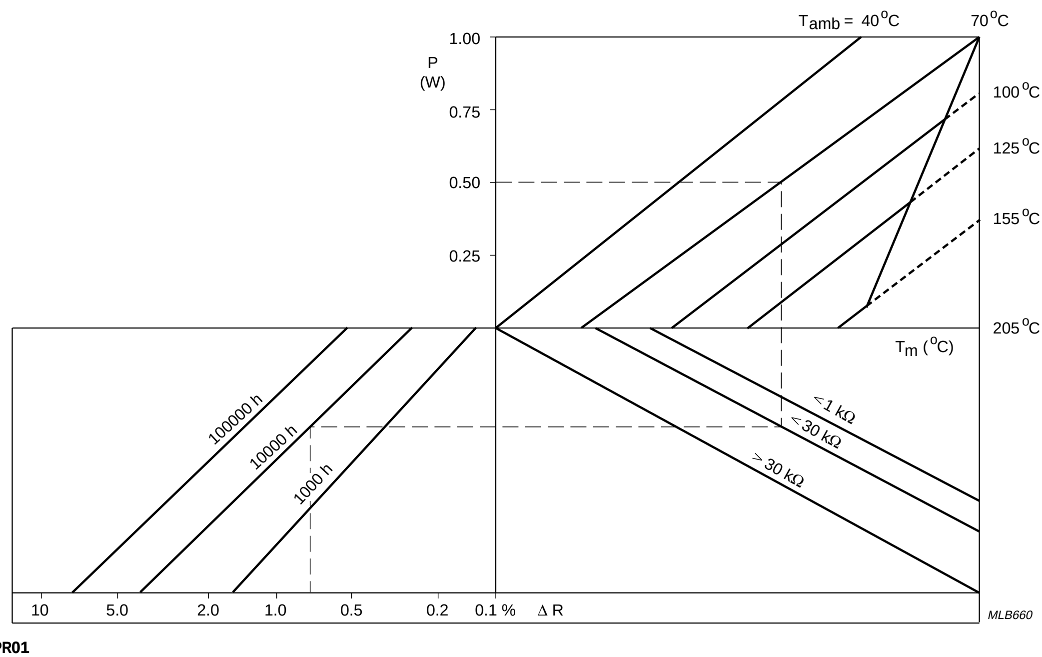
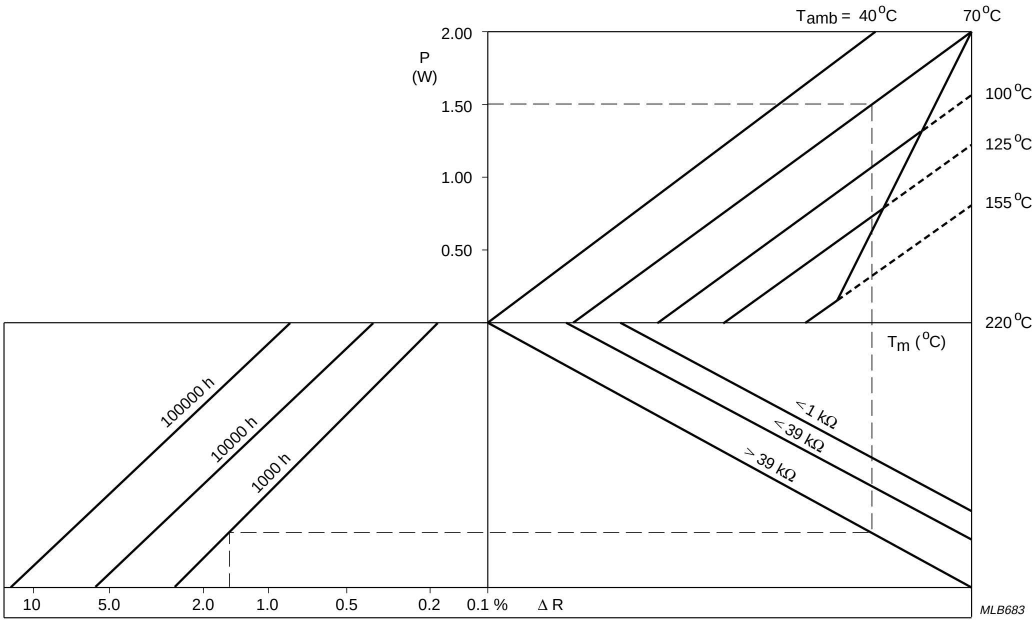


Fig.1 Drift nomogram.

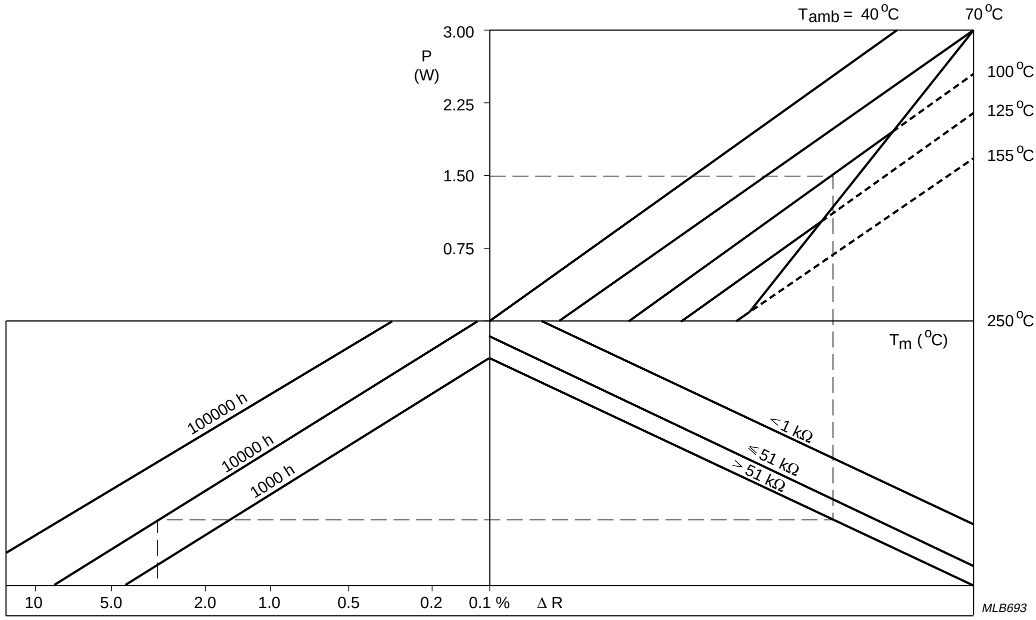
Professional power metal film resistors PR01/02/03



PR02

Fig.2 Drift nomogram.

Professional power metal film resistors PR01/02/03



PR03

Fig.3 Drift nomogram.

Professional power metal film resistors PR01/02/03

Limiting values

TYPE	LEAD MATERIAL	RANGE	LIMITING VOLTAGE[1] (V)	LIMITING POWER (W)
PR01	Cu	R < 1 Ω	350	0.6
		1 Ω ≤ R		1.0
PR02	Cu	R < 1 Ω	500	1.2
		1 Ω ≤ R		2.0
	FeCu	1 Ω ≤ R		1.3
PR03	Cu	R < 1 Ω	750	1.6
		1 Ω ≤ R		3.0
	FeCu	1 Ω ≤ R		2.5

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 205 °C for PR01, 220 °C for PR02 and 250 °C for PR03.

DERATING

The power that the resistor can dissipate depends on the operating temperature; see Fig.4.

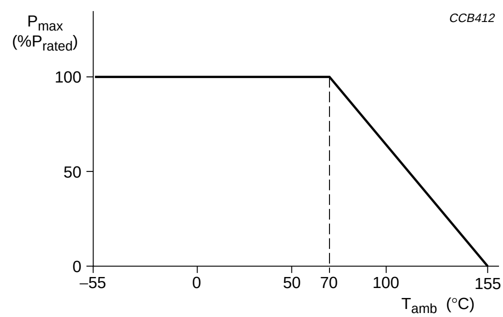
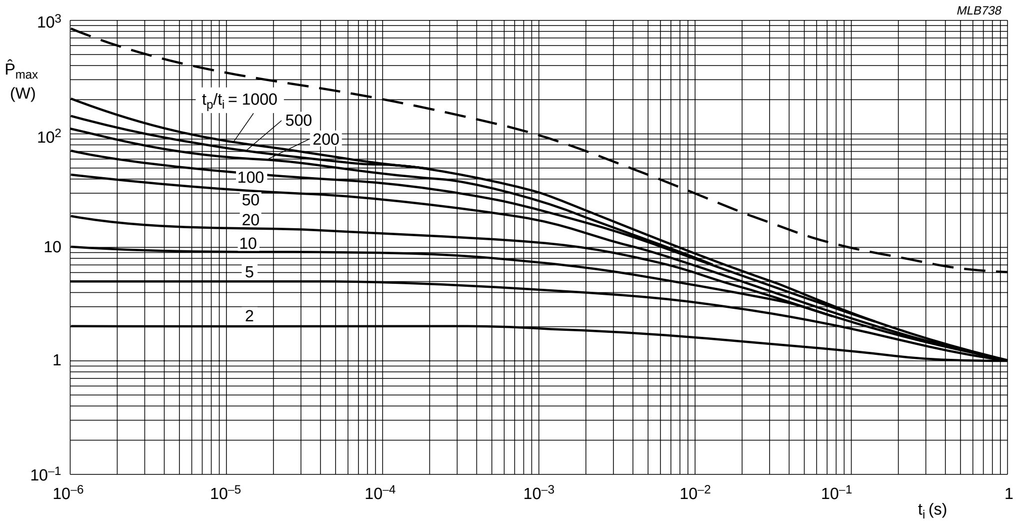


Fig.4 Maximum dissipation (P_{max}) in percentage of rated power as a function of the ambient temperature (T_{amb}).

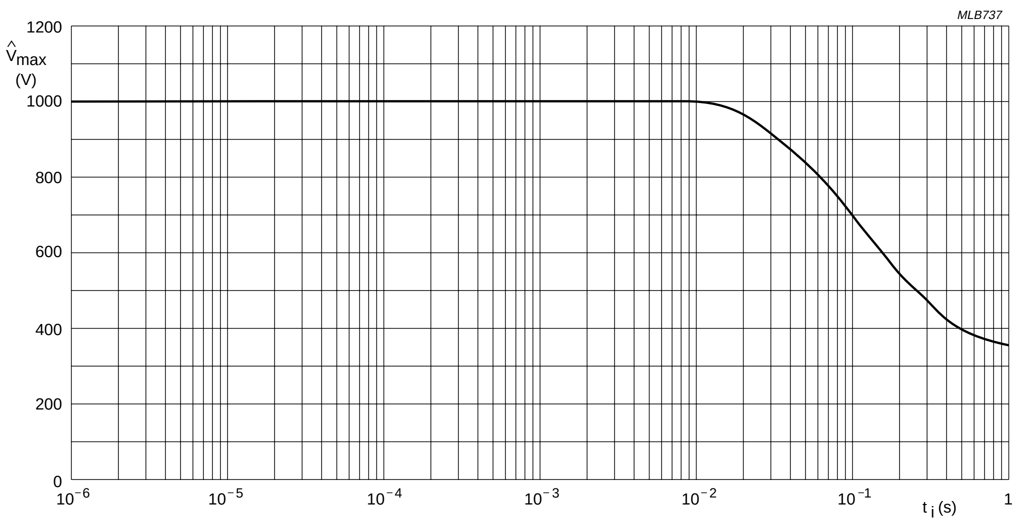
Professional power metal film resistors PR01/02/03

PULSE LOADING CAPABILITIES



PR01

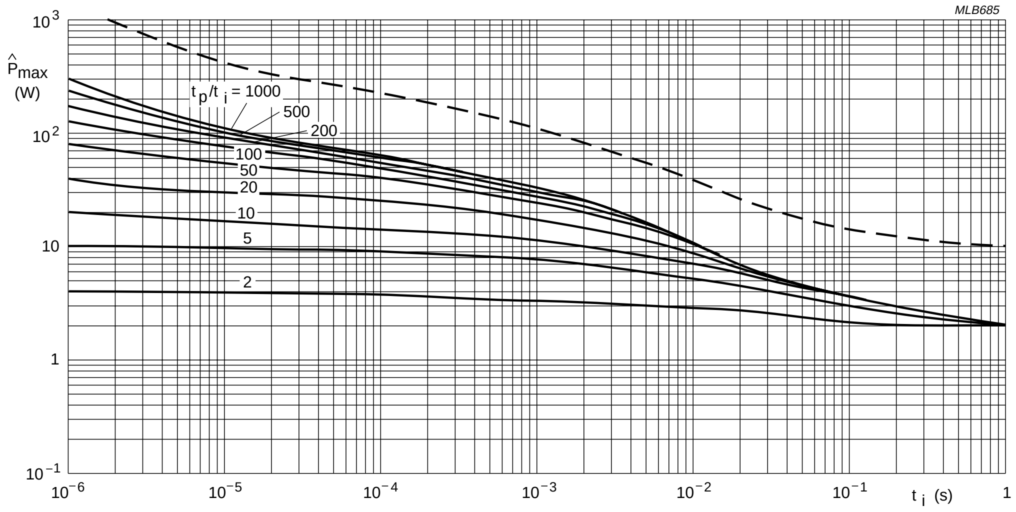
Fig.5 Pulse on a regular basis; maximum permissible peak pulse power ($\hat{P}_{max}$) as a function of pulse duration (t_i).



PR01

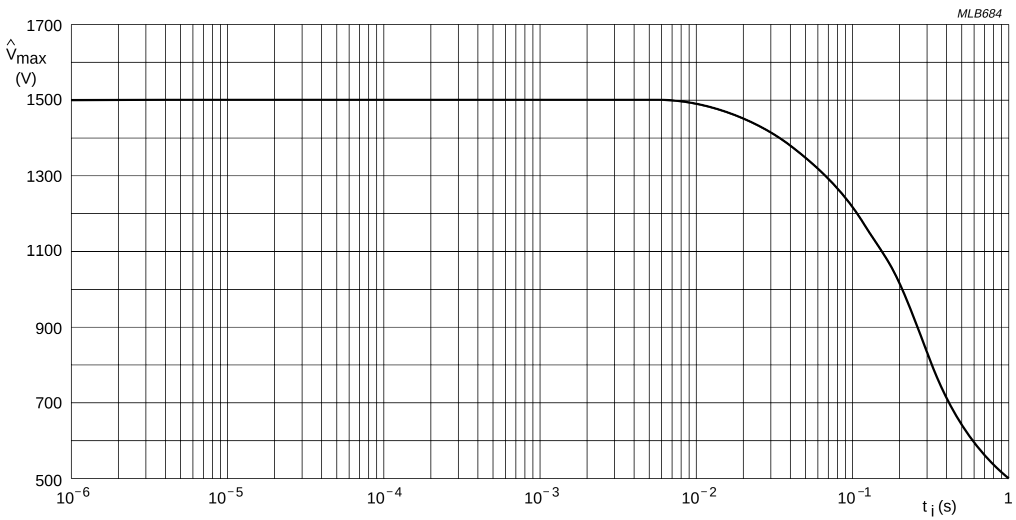
Fig.6 Pulse on a regular basis; maximum permissible peak pulse voltage ($\hat{V}_{max}$) as a function of pulse duration (t_i).

Professional power metal film resistors PR01/02/03



PR02

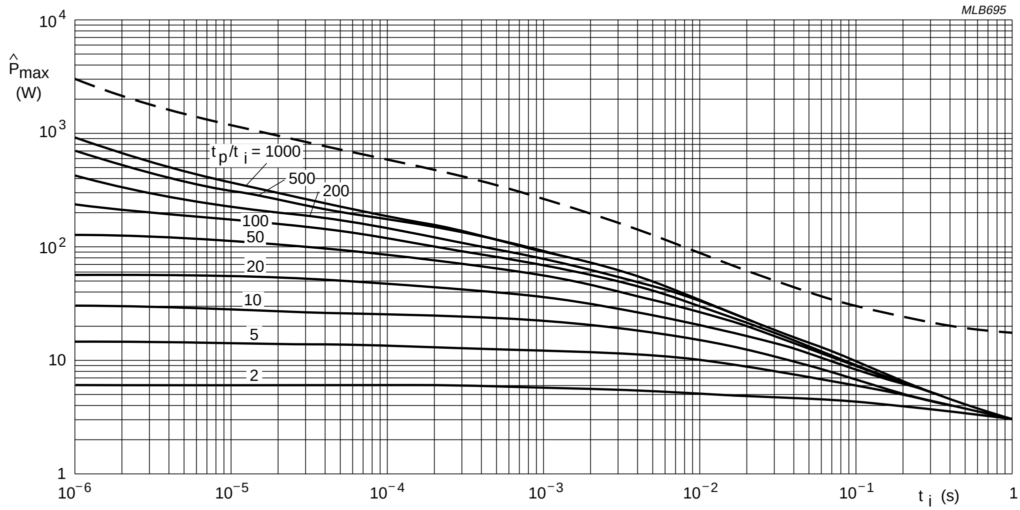
Fig.7 Pulse on a regular basis; maximum permissible peak pulse power ($\hat{P}_{max}$) as a function of pulse duration (t_i).



PR02

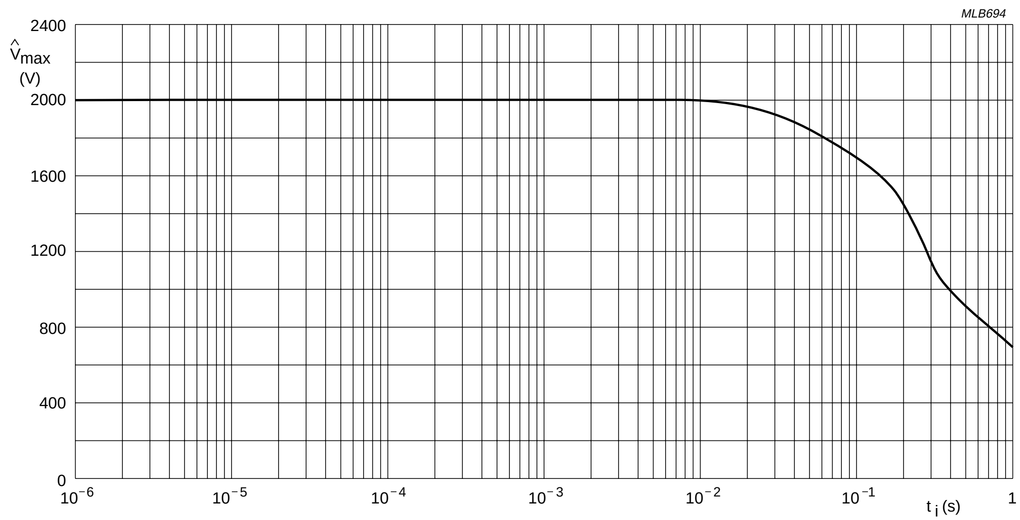
Fig.8 Pulse on a regular basis; maximum permissible peak pulse voltage ($\hat{V}_{max}$) as a function of pulse duration (t_i).

Professional power metal film resistors PR01/02/03



PR03

Fig.9 Pulse on a regular basis; maximum permissible peak pulse power ($\hat{P}_{max}$) as a function of pulse duration (t_i).

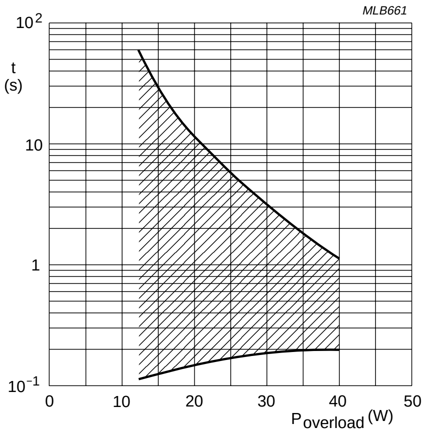


PR03

Fig.10 Pulse on a regular basis; maximum permissible peak pulse voltage ($\hat{V}_{max}$) as a function of pulse duration (t_i).

Professional power metal film resistors PR01/02/03

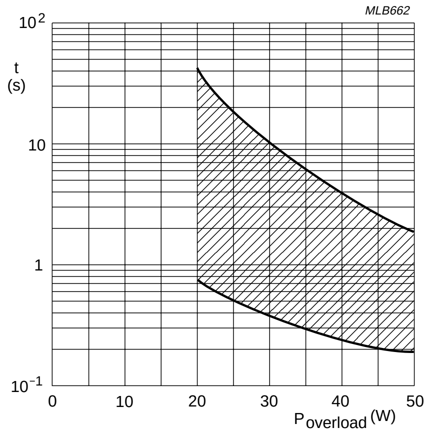
INTERRUPTION CHARACTERISTICS



The graph is based on measured data under constant voltage conditions; these data may deviate according to the application.

PR01

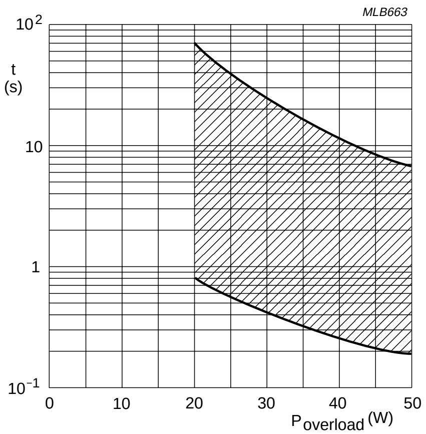
Fig.11 Time to interruption as a function of overload power for range: 0R22 ≤ R_n < 1R.



The graph is based on measured data under constant voltage conditions; these data may deviate according to the application.

PR01

Fig.12 Time to interruption as a function of overload power for range: 1R ≤ R_n ≤ 15R.

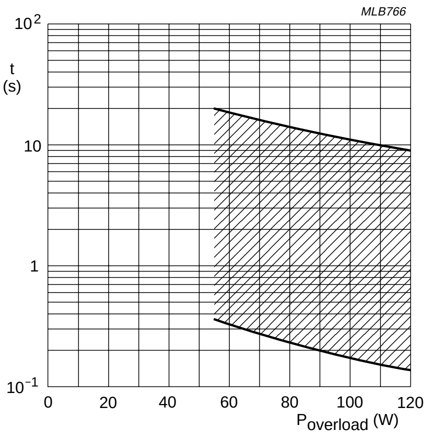


The graph is based on measured data under constant voltage conditions; these data may deviate according to the application.

PR01

Fig.13 Time to interruption as a function of overload power for range: 16R ≤ R_n ≤ 560R.

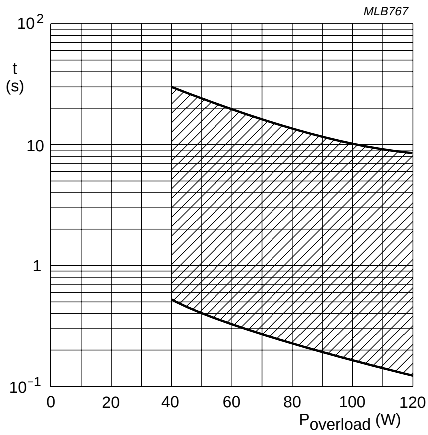
Professional power metal film resistors PR01/02/03



The graph is based on measured data under constant voltage conditions; these data may deviate according to the application.

PR02

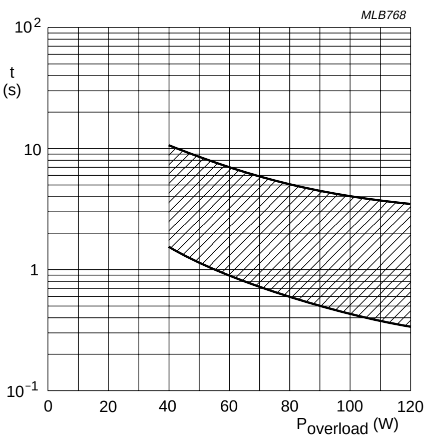
Fig.14 Time to interruption as a function of overload power for range: $0.33R \leq R_n < 5R$.



The graph is based on measured data under constant voltage conditions; these data may deviate according to the application.

PR02

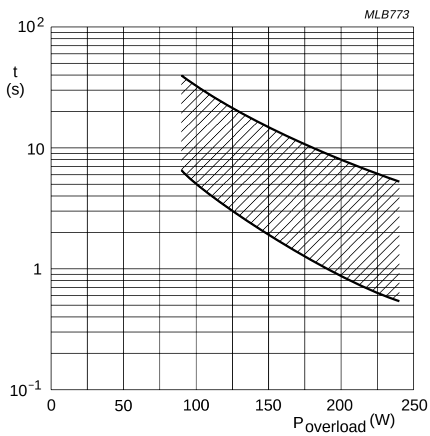
Fig.15 Time to interruption as a function of overload power for range: $5R \leq R_n < 68R$.



The graph is based on measured data under constant voltage conditions; these data may deviate according to the application.

PR02

Fig.16 Time to interruption as a function of overload power for range: $68R \leq R_n \leq 560R$.



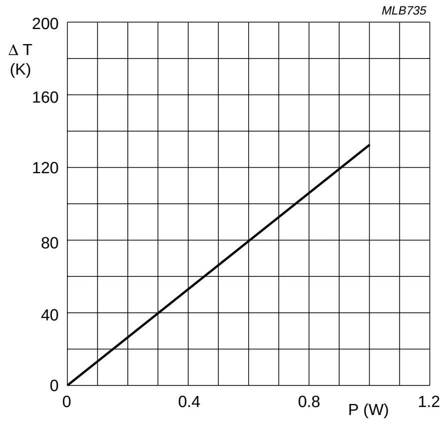
The graph is based on measured data under constant voltage conditions; these data may deviate according to the application.

PR03

Fig.17 Time to interruption as a function of overload power for range: $0.68R \leq R_n \leq 560R$.

Professional power metal film resistors PR01/02/03

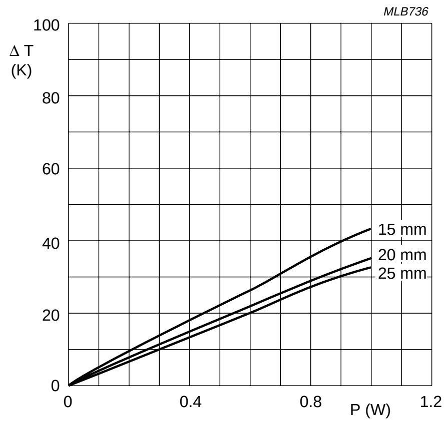
Application information



∅0.6 mm Cu-leads.

PR01

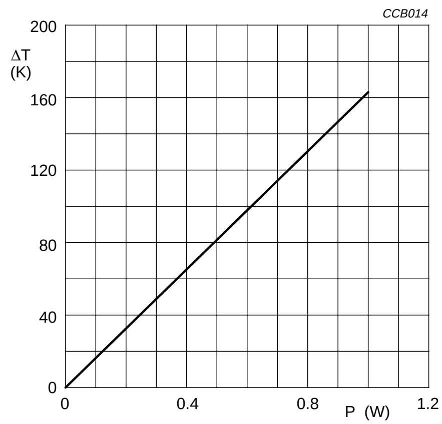
Fig.18 Hot-spot temperature rise (ΔT) as a function of dissipated power.



∅0.6 mm Cu-leads.
Minimum distance from resistor body to PCB = 1 mm.

PR01

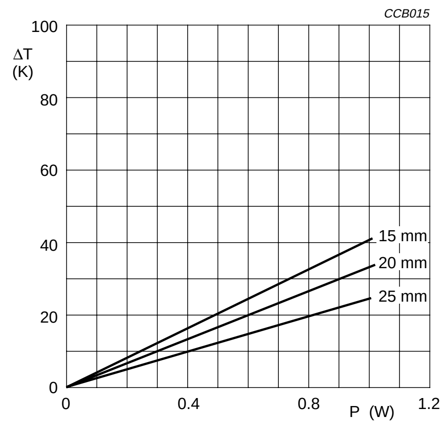
Fig.19 Temperature rise (ΔT) at the lead end (soldering point) as a function of dissipated power at various lead lengths after mounting.



∅0.6 mm FeCu-leads.

PR01

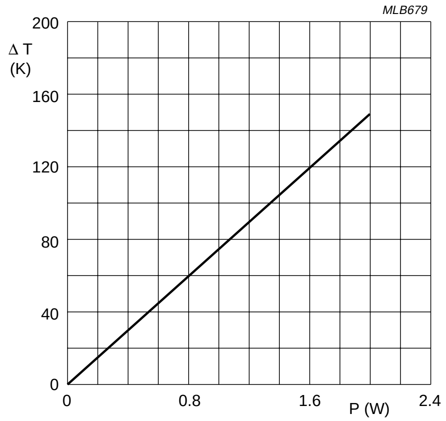
Fig.20 Hot-spot temperature rise (ΔT) as a function of dissipated power.



∅0.6 mm FeCu-leads.
Minimum distance from resistor body to PCB = 1 mm.

PR01

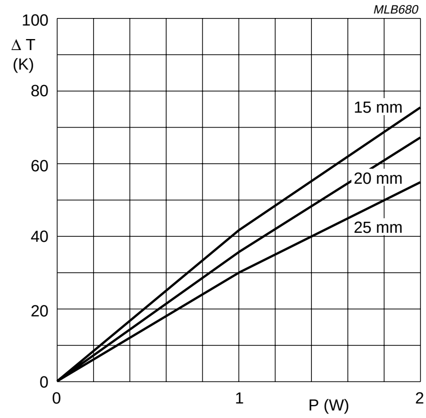
Fig.21 Temperature rise (ΔT) at the lead end (soldering point) as a function of dissipated power at various lead lengths after mounting.



∅0.8 mm Cu-leads.

PR02

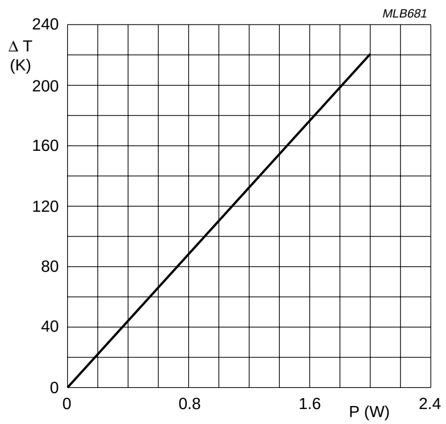
Fig.22 Hot-spot temperature rise (ΔT) as a function of dissipated power.



∅0.8 mm Cu-leads.
Minimum distance from resistor body to PCB = 1 mm.

PR02

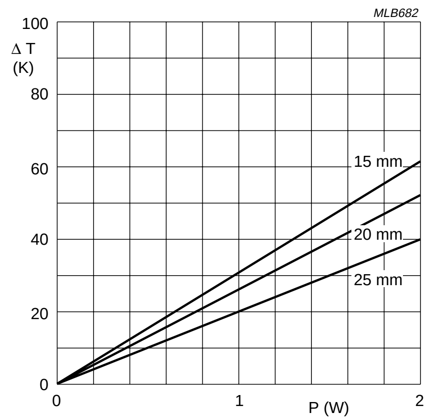
Fig.23 Temperature rise (ΔT) at the lead end (soldering point) as a function of dissipated power at various lead lengths after mounting.



∅0.6 mm FeCu-leads.

PR02

Fig.24 Hot-spot temperature rise (ΔT) as a function of dissipated power.

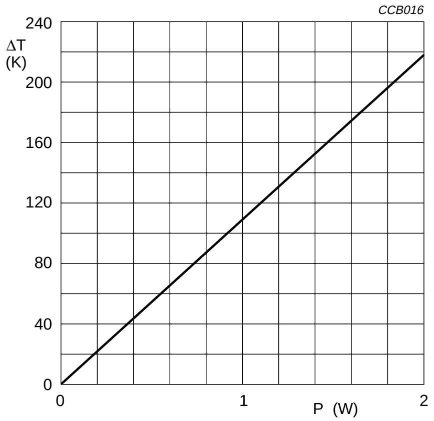


∅0.6 mm FeCu-leads.
Minimum distance from resistor body to PCB = 1 mm.

PR02

Fig.25 Temperature rise (ΔT) at the lead end (soldering point) as a function of dissipated power at various lead lengths after mounting.

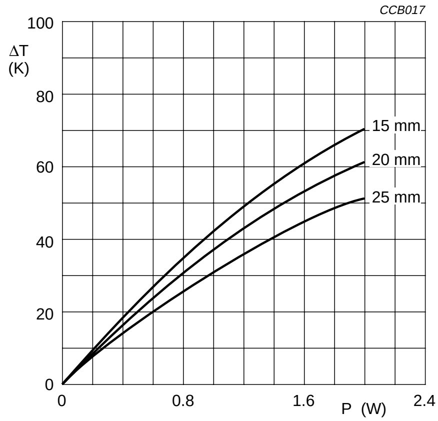
Professional power metal film resistors PR01/02/03



∅0.8 mm FeCu-leads.

PR02

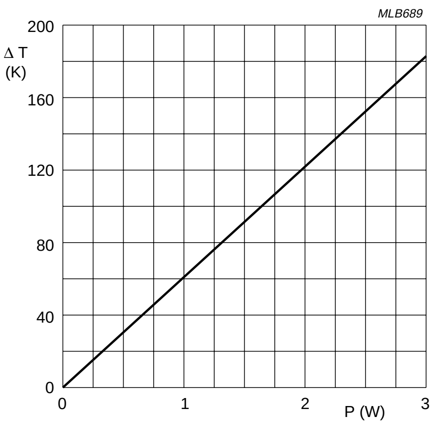
Fig.26 Hot-spot temperature rise (ΔT) as a function of dissipated power.



∅0.8 mm FeCu-leads.
Minimum distance from resistor body to PCB = 1 mm.

PR02

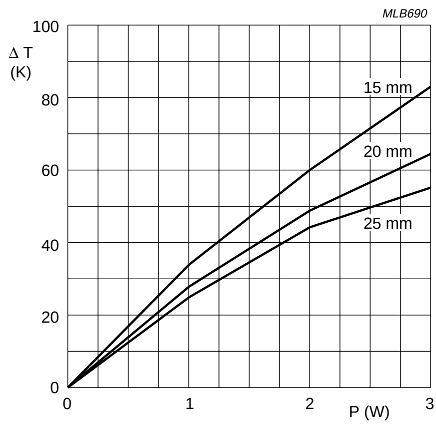
Fig.27 Temperature rise (ΔT) at the lead end (soldering point) as a function of dissipated power at various lead lengths after mounting.



∅0.8 mm Cu-leads.

PR03

Fig.28 Hot-spot temperature rise (ΔT) as a function of dissipated power.

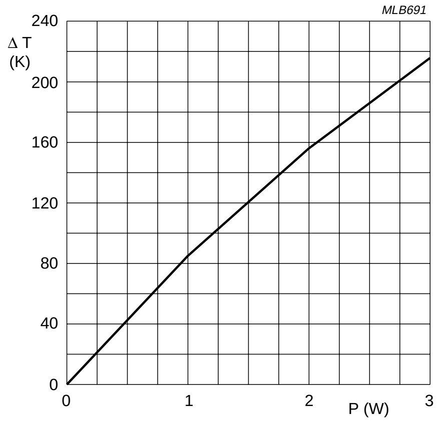


∅0.8 mm Cu-leads.
Minimum distance from resistor body to PCB = 1 mm.

PR03

Fig.29 Temperature rise (ΔT) at the lead end (soldering point) as a function of dissipated power at various lead lengths after mounting.

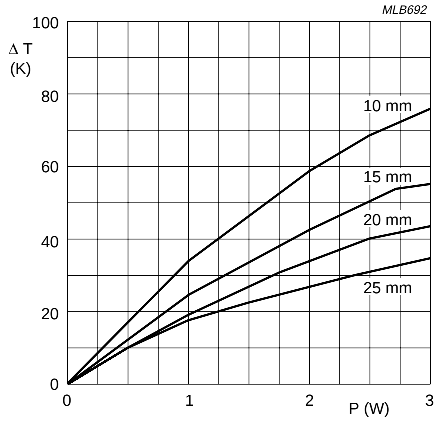
Professional power metal film resistors PR01/02/03



∅0.6 mm FeCu-leads.

PR03

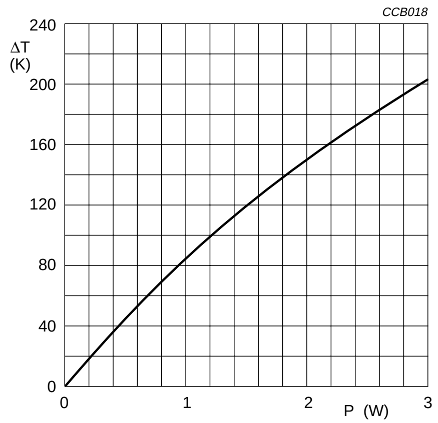
Fig.30 Hot-spot temperature rise (ΔT) as a function of dissipated power.



∅0.6 mm FeCu-leads.
Minimum distance from resistor body to PCB = 1 mm.

PR03

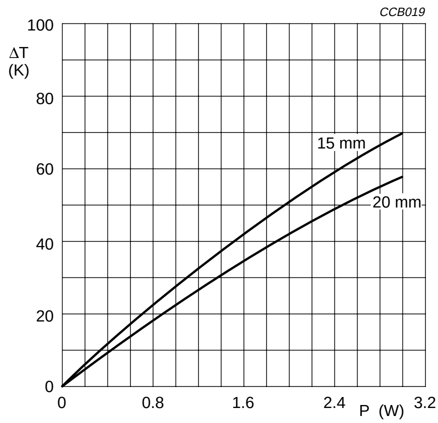
Fig.31 Temperature rise (ΔT) at the lead end (soldering point) as a function of dissipated power at various lead lengths after mounting.



∅0.8 mm FeCu-leads.

PR03

Fig.32 Hot-spot temperature rise (ΔT) as a function of dissipated power.

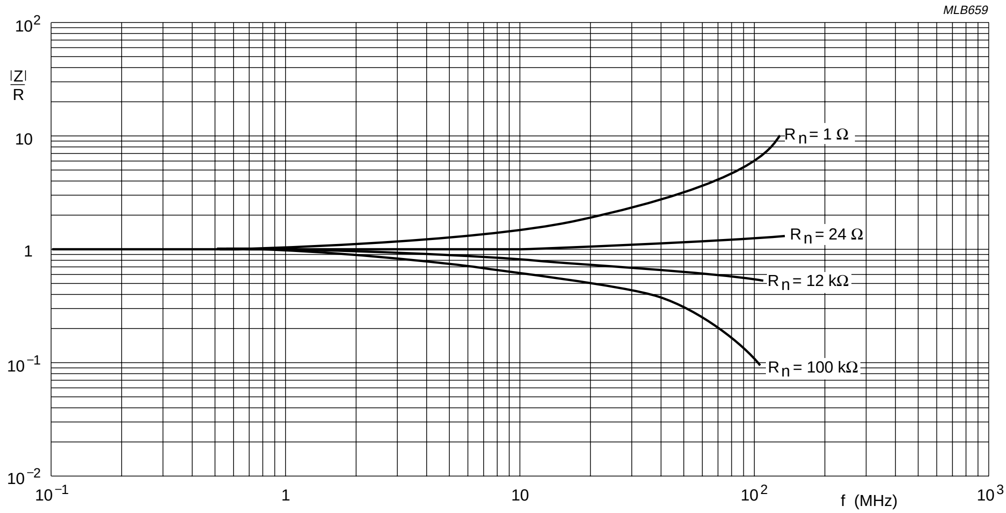


∅0.8 mm FeCu-leads.
Minimum distance from resistor body to PCB = 1 mm.

PR03

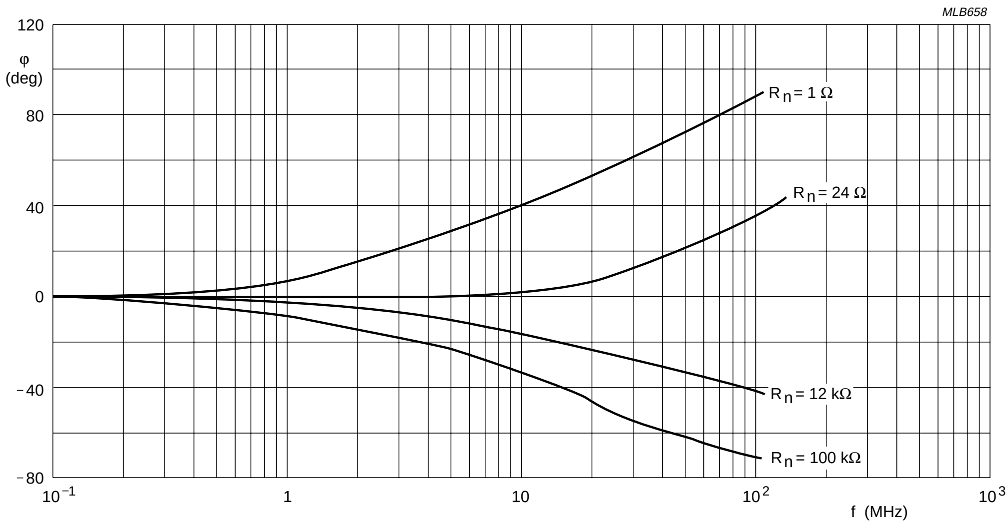
Fig.33 Temperature rise (ΔT) at the lead end (soldering point) as a function of dissipated power at various lead lengths after mounting.

Professional power metal film resistors PR01/02/03



PR01

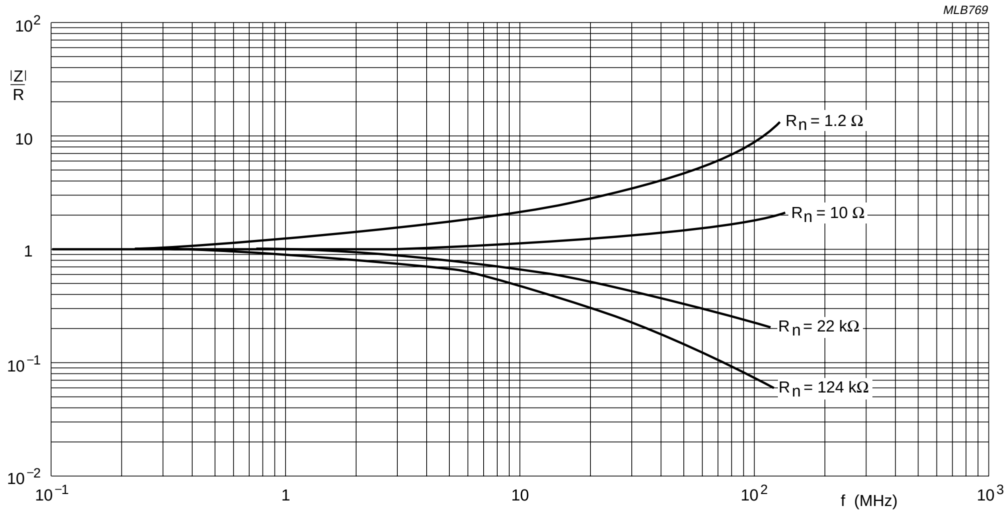
Fig.34 Impedance as a function of applied frequency.



PR01

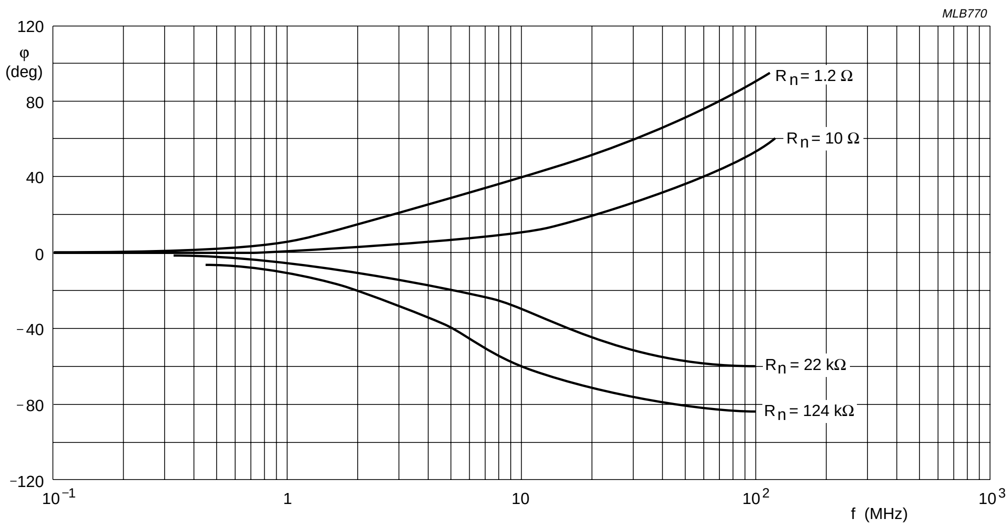
Fig.35 Phase angle as a function of applied frequency.

Professional power metal film resistors PR01/02/03



PR02

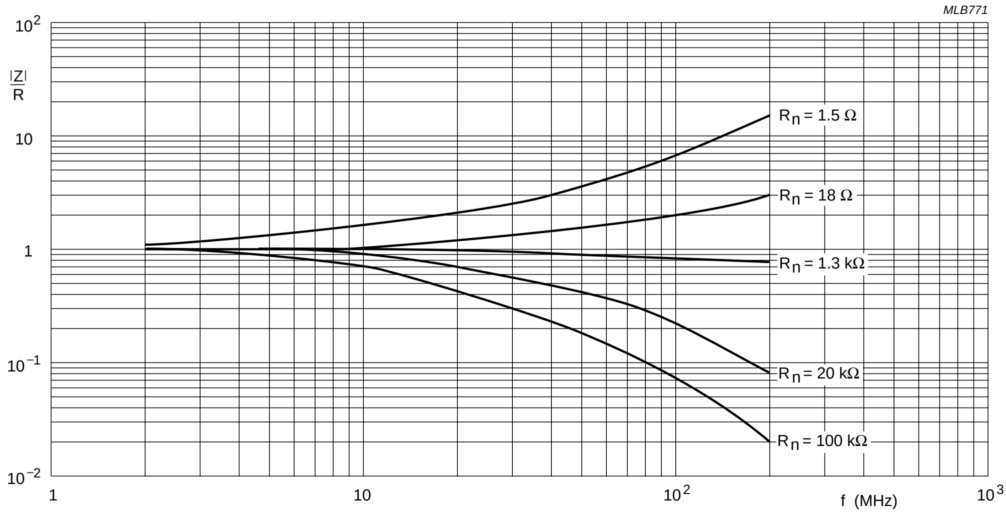
Fig.36 Impedance as a function of applied frequency.



PR02

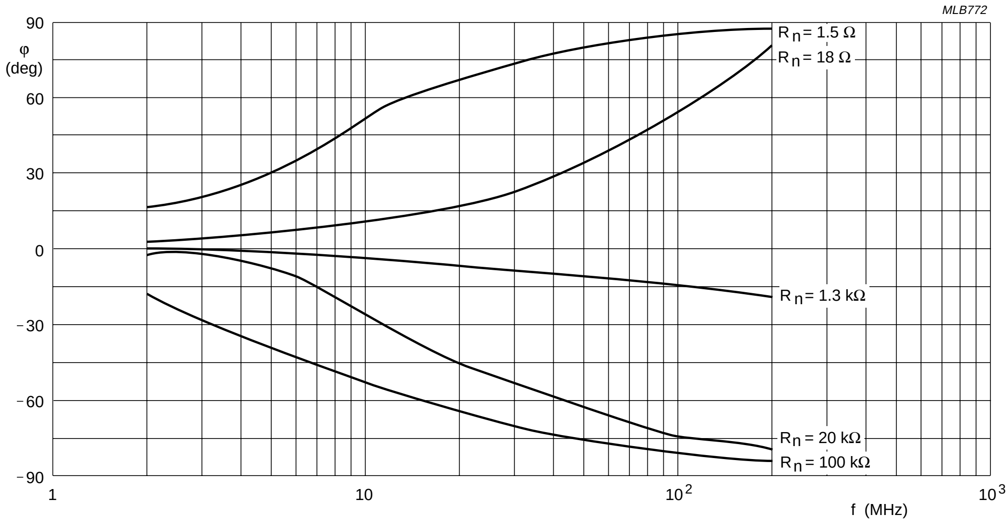
Fig.37 Phase angle as a function of applied frequency.

Professional power metal film resistors PR01/02/03



PR03

Fig.38 Impedance as a function of applied frequency.



PR03

Fig.39 Phase angle as a function of applied frequency.

Professional power metal film resistors PR01/02/03

MECHANICAL DATA

Mass per 100 units

TYPE	LEAD MATERIAL	MASS (g)
PR01	Cu	29
	FeCu	29
PR02	Cu	63
	FeCu	45
PR03	Cu	110
	FeCu	100

Mounting

The resistors are suitable for processing on automatic insertion equipment and cutting and bending machines.

Marking

The nominal resistance and tolerance are marked on the resistor using four coloured bands in accordance with IEC publication 60062, *"Colour codes for fixed resistors"*.

Outlines

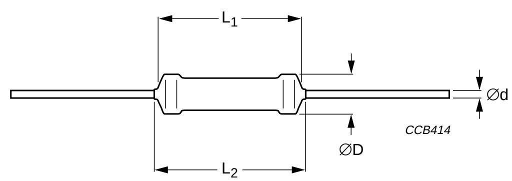
The length of the body (L_1) is measured by inserting the leads into holes of two identical gauge plates and moving these plates parallel to each other until the resistor body is clamped without deformation
("IEC publication 60294").

Mounting pitch

TYPE	LEAD STYLE	PITCH	
		mm	e
PR01	straight leads	12.5[1]	5[1]
	radial taped	4.8	2
	double kink large pitch	17.8	7
	double kink small pitch	12.5	5
PR02	straight leads	15.0[1]	6[1]
	radial taped	4.8	2
	double kink large pitch	17.8	7
	double kink small pitch	15.0	6
PR03	straight leads	23.0[1]	9[1]
	double kink large pitch	25.4	10
	double kink small pitch	20.0	8

Note

1. Recommended minimum value.



For dimensions see Table 4.

Fig.40 Type with straight leads.

Table 4 Straight lead type and relevant physical dimensions: see Fig.40

TYPE	∅D MAX. (mm)	L_1 MAX. (mm)	L_2 MAX. (mm)	∅d (mm)
PR01	2.5	6.5	8.5	0.58 ±0.05
PR02	3.9	10.0	12.0	0.8 ±0.03
				0.58 ±0.05
PR03	5.2	16.7	19.5	0.8 ±0.03
				0.58 ±0.05

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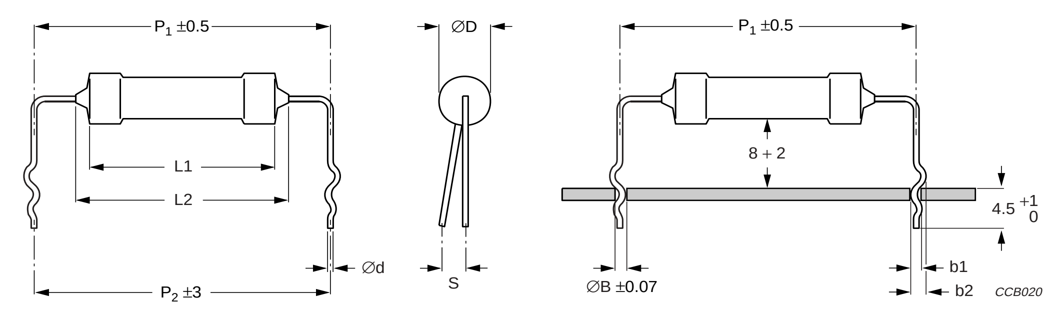

Dimensions in mm.
For dimensions see Tables 4 and 5.

Fig.41 Type with double kink.

Table 5 Double kink lead type and relevant physical dimensions; see Fig.41

TYPE	LEAD STYLE	∅d (mm)	b1 (mm)	b2 (mm)	∅D MAX. (mm)	P_1 (mm)	P_2 (mm)	S MAX. (mm)	∅B (mm)
PR01	double kink large pitch	0.58 ±0.05	1.10 +0.25/–0.20	1.45 +0.25/–0.20	2.5	17.8	17.8	2	0.8
	double kink small pitch	0.58 ±0.05	1.10 +0.25/–0.20	1.45 +0.25/–0.20		12.5	12.5	2	0.8
PR02	double kink large pitch	0.58 ±0.05	1.10 +0.25/–0.20	1.45 +0.25/–0.20	3.9	17.8	17.8	2	0.8
		0.8 ±0.03	1.30 +0.25/–0.20	1.65 +0.25/–0.20		17.8	17.8	2	1.0
	double kink small pitch	0.8 ±0.03	1.30 +0.25/–0.20	1.65 +0.25/–0.20		15.0	15.0	2	1.0
PR03	double kink large pitch	0.58 ±0.05	1.10 +0.25/–0.20	1.45 +0.25/–0.20	5.2	25.4	25.4	2	0.8
		0.8 ±0.03	1.30 +0.25/–0.20	1.65 +0.25/–0.20		25.4	25.4	2	1.0
	double kink small pitch	0.8 ±0.03	1.30 +0.25/–0.20	2.15 +0.25/–0.20		22.0	20.0	2	1.0

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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: **L**ower **C**ategory **T**emperature, **U**pper **C**ategory **T**emperature; 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 Table 6 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.

All soldering tests are performed with mildly activated flux.

Table 6 Test procedures and requirements

IEC 60115-1 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
Tests in accordance with the schedule of IEC publication 60115-1				
4.4.1		visual examination		no holes; clean surface; no damage
4.4.2		dimensions (outline)	gauge (mm)	see Tables 4 and 5
4.5		resistance	applied voltage (+0/–10%): $R < 10\ \Omega$: 0.1 V $10\ \Omega \leq R < 100\ \Omega$: 0.3 V $100\ \Omega \leq R < 1\ k\Omega$: 1 V $1\ k\Omega \leq R < 10\ k\Omega$: 3 V $10\ k\Omega \leq R < 100\ k\Omega$: 10 V $100\ k\Omega \leq R < 1\ M\Omega$: 25 V $R = 1\ M\Omega$: 50 V	$R - R_{nom}$: max. ±5%
4.18	20 (Tb)	resistance to soldering heat	thermal shock: 3 s; 350 °C; 6 mm from body	$\Delta R/R$ max.: ±1% + 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	maximum voltage 500 V (RMS) during 1 minute; metal block method	no breakdown or flashover

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IEC 60115-1 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS
4.16	21 (U)	robustness of terminations:		
4.16.2	21 (Ua1)	tensile all samples	load 10 N; 10 s	number of failures: $<1 \times 10^{-6}$
4.16.3	21 (Ub)	bending half number of samples	load 5 N; 4 × 90°	number of failures: $<1 \times 10^{-6}$
4.16.4	21 (Uc)	torsion other half of samples	3 × 360° in opposite directions	no damage ΔR/R max.: ±0.5% + 0.05 Ω
4.20	29 (Eb)	bump	3 × 1500 bumps in three directions; 40 g	no damage ΔR/R max.: ±0.5% + 0.05 Ω
4.22	6 (Fc)	vibration	frequency 10 to 500 Hz; displacement 1.5 mm or acceleration 10 g; three directions; total 6 hours (3 × 2 hours)	no damage ΔR/R max.: ±0.5% + 0.05 Ω
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; 5 cycles	no visual damage **PR01**: ΔR/R max.: ±1% + 0.05 Ω **PR02**: ΔR/R max.: ±1% + 0.05 Ω **PR03**: ΔR/R max.: ±2% + 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 MΩ ΔR/R max.: ±3% + 0.1 Ω
4.24.2	3 (Ca)	damp heat (steady state) (IEC)	56 days; 40 °C; 90 to 95% RH; loaded with 0.01 P_n (IEC steps: 4 to 100 V)	R_{ins} min.: 1000 MΩ ΔR/R max.: ±3% + 0.1 Ω
4.25.1		endurance (at 70 °C)	1000 hours; loaded with P_n or V_{max}; 1.5 hours on and 0.5 hours off	ΔR/R max.: ±5% + 0.1 Ω
4.8.4.2		temperature coefficient	at 20/LCT/20 °C and 20/UCT/20 °C (TC × 10^{-6}/K)	≤±250
Other tests in accordance with IEC 60115 clauses and IEC 60068 test method				
4.17	20 (Tb)	solderability (after ageing)	8 hours steam or 16 hours 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 (DC) after 1 minute; metal block method	R_{ins} min.: 10^4 MΩ
see 2nd amendment to IEC 60115-1, Jan. '87		pulse load		see Figs 5, 6, 7, 8, 9 and 10