Standard metal film resistors SFR16S/25/25H

FEATURES

- Low cost
- Low noise
- Small size (SFR16S).

APPLICATIONS

- General purpose resistors.

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 leads of electrolytic copper are welded to the end-caps.

The resistors are coated with a coloured lacquer (light-blue for type SFR16S; light-green for type SFR25 and red-brown for type SFR25H) 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 60068-2045"*.

QUICK REFERENCE DATA

DESCRIPTION	VALUE		
	SFR16S	**SFR25**	**SFR25H**
Resistance range	1 Ω to 3 MΩ	1 Ω to 10 MΩ and jumper (0 Ω)	
Resistance tolerance	±5%, E24 series		
Temperature coefficient:			
$R < 4.7\ \Omega$	$\leq \pm 250 \times 10^{-6}$/K	$\leq \pm 100 \times 10^{-6}$/K	$\leq \pm 100 \times 10^{-6}$/K
$4.7\ \Omega \leq R \leq 100\ k\Omega$	$\leq \pm 100 \times 10^{-6}$/K	$\leq \pm 100 \times 10^{-6}$/K	$\leq \pm 100 \times 10^{-6}$/K
$100\ k\Omega < R \leq 1\ M\Omega$	$\leq \pm 250 \times 10^{-6}$/K	$\leq \pm 100 \times 10^{-6}$/K	$\leq \pm 100 \times 10^{-6}$/K
$R > 1\ M\Omega$	$\leq \pm 250 \times 10^{-6}$/K	$\leq \pm 250 \times 10^{-6}$/K	$\leq \pm 250 \times 10^{-6}$/K
Absolute maximum dissipation at T_{amb} = 70 °C	0.5 W	0.4 W	0.5 W
Thermal resistance, R_{th}	170 K/W	200 K/W	150 K/W
Maximum permissible voltage	200 V	250 V	350 V
Noise:			
$R < 68\ k\Omega$	max. 0.1 μV/V	max. 0.1 μV/V	max. 0.1 μV/V
$68\ k\Omega \leq R \leq 100\ k\Omega$	max. 0.5 μV/V	max. 0.1 μV/V	max. 0.1 μV/V
$100\ k\Omega \leq R \leq 1\ M\Omega$	max. 1.5 μV/V	max. 0.1 μV/V	max. 0.1 μV/V
$R > 1\ M\Omega$	max. 1.5 μV/V	max. 1.5 μV/V	max. 1.5 μV/V
Basic specifications	IEC 60115-1 and 60115-2		
Climatic category (IEC 60068)	55/155/56		
Stability, ΔR/R max., after:			
load:			
$R \leq 1\ M\Omega$	±1% + 0.05 Ω	±1% + 0.05 Ω	±1% + 0.05 Ω
$R > 1\ M\Omega$	±1% + 0.05 Ω	±1% + 0.05 Ω	±2% + 0.1 Ω
climatic tests:			
$R \leq 1\ M\Omega$	±1% + 0.05 Ω	±1% + 0.05 Ω	±1% + 0.05 Ω
$R > 1\ M\Omega$	±1% + 0.05 Ω	±1% + 0.05 Ω	±2% + 0.1 Ω
soldering	±0.25% + 0.05 Ω	±0.25% + 0.05 Ω	±0.25% + 0.05 Ω
short time overload	±0.25% + 0.05 Ω	±0.25% + 0.05 Ω	±1% + 0.05 Ω

ORDERING INFORMATION

Table 1 Ordering code indicating 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
SFR16S	–	22 187 73...	22 187 53...	22 187 83...
SFR25	06 184 03...	22 181 53...	22 181 43...	22 181 63...
SFR25 jumper(1)	–	–	22 181 90019	–
SFR25H	–	22 186 16...	22 186 76...	22 186 26...

Note

1. The jumper has a maximum resistance R_{max} = 10 mΩ at 5 A.

Ordering code (12NC)

- The resistors have a 12-digit ordering code starting with 23
- The subsequent 7 digits indicate the resistor type and packaging; see Table 1.
- 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 2.

Table 2 Last digit of 12NC

RESISTANCE DECADE	LAST DIGIT
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 to 9.76 MΩ	5
10 MΩ	6

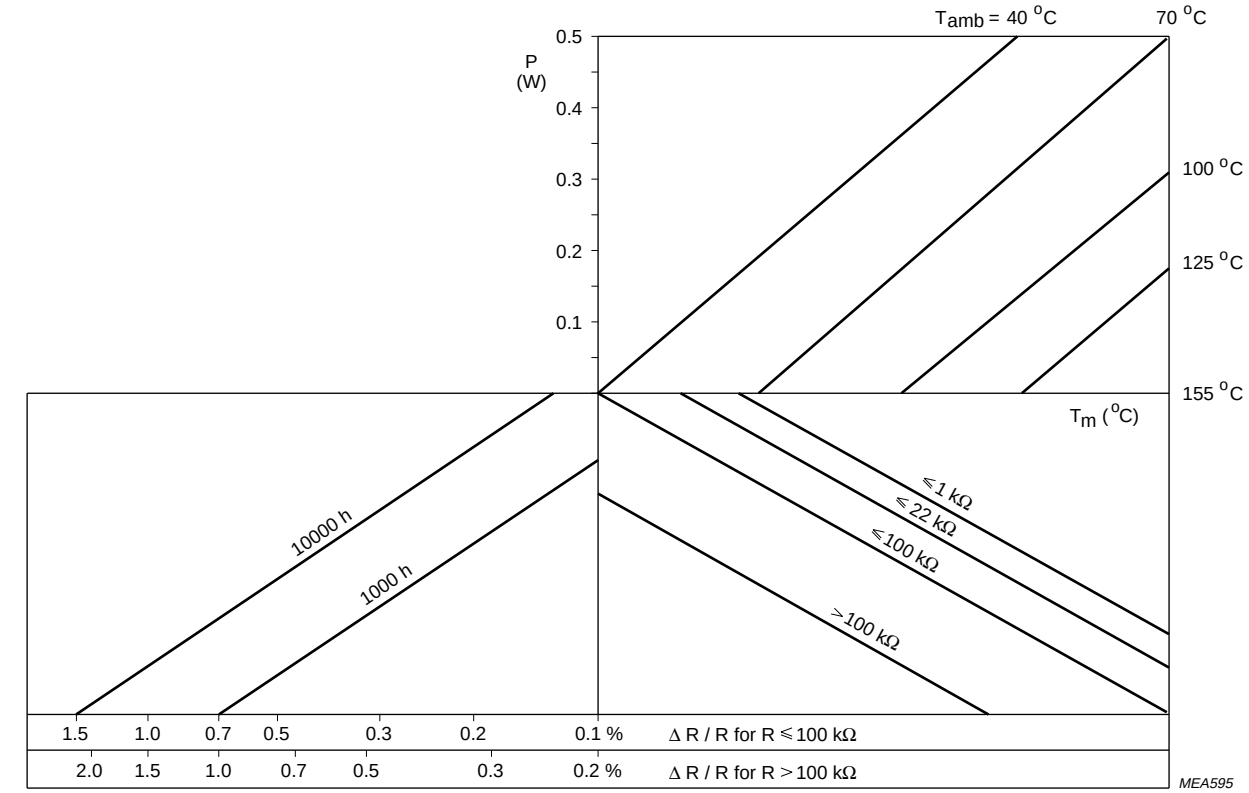
ORDERING EXAMPLE

The ordering code of a SFR25 resistor, value 5600 Ω ±5%, taped on a bandolier of 5000 units in ammopack is: 2322 181 43562.

FUNCTIONAL DESCRIPTION

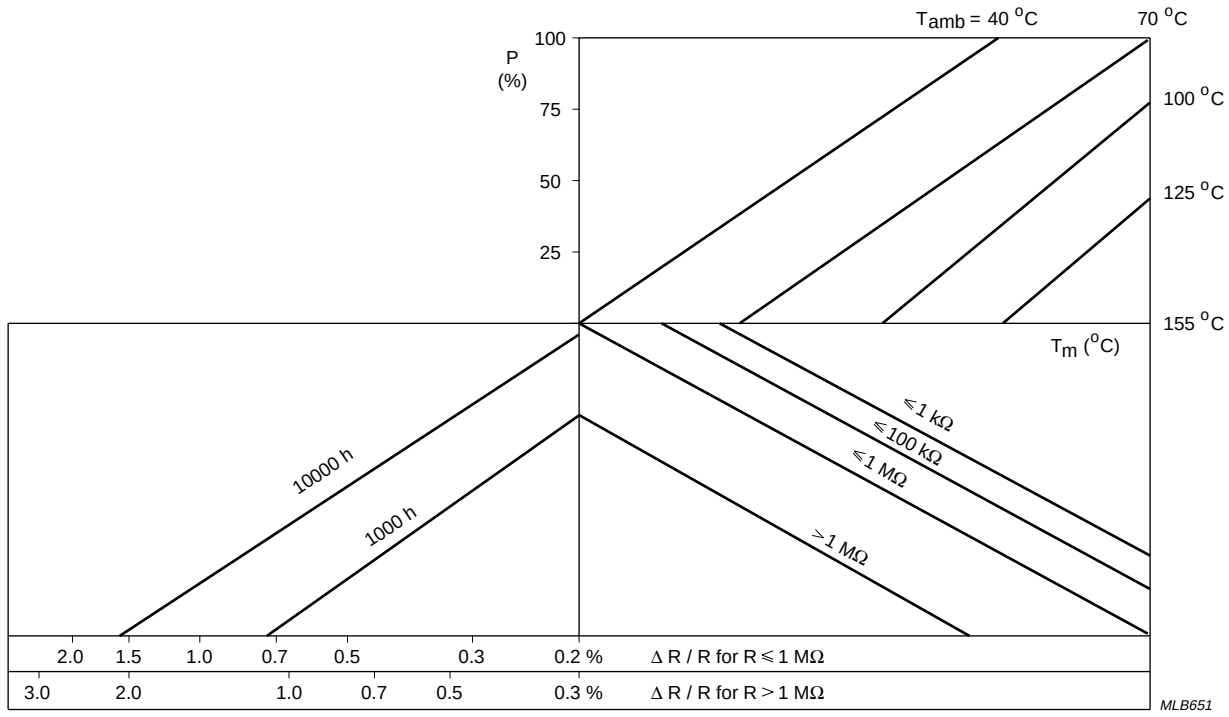
Product characterization

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"*.



SFR16S

Fig.1 Drift nomogram.



SFR25(H)
P_n = 0.4 W (**SFR25**) or 0.5 W (**SFR25H**).

Fig.2 Drift nomogram.

Limiting values

TYPE	LIMITING VOLTAGE(1) (V)	LIMITING POWER (W)
SFR16S	200	0.5
SFR25	250	0.4
SFR25H	350	0.5

Note

1. The maximum voltage that may be continuously applied to the resistor element, see *"IEC publication 60115-1"*.

The maximum permissible hot-spot temperature is 155 °C.

DERATING

The power that the resistor can dissipate depends on the operating temperature; see Fig.3.

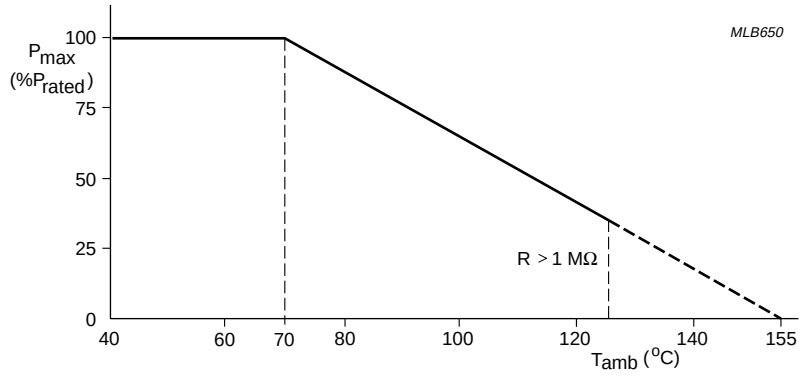
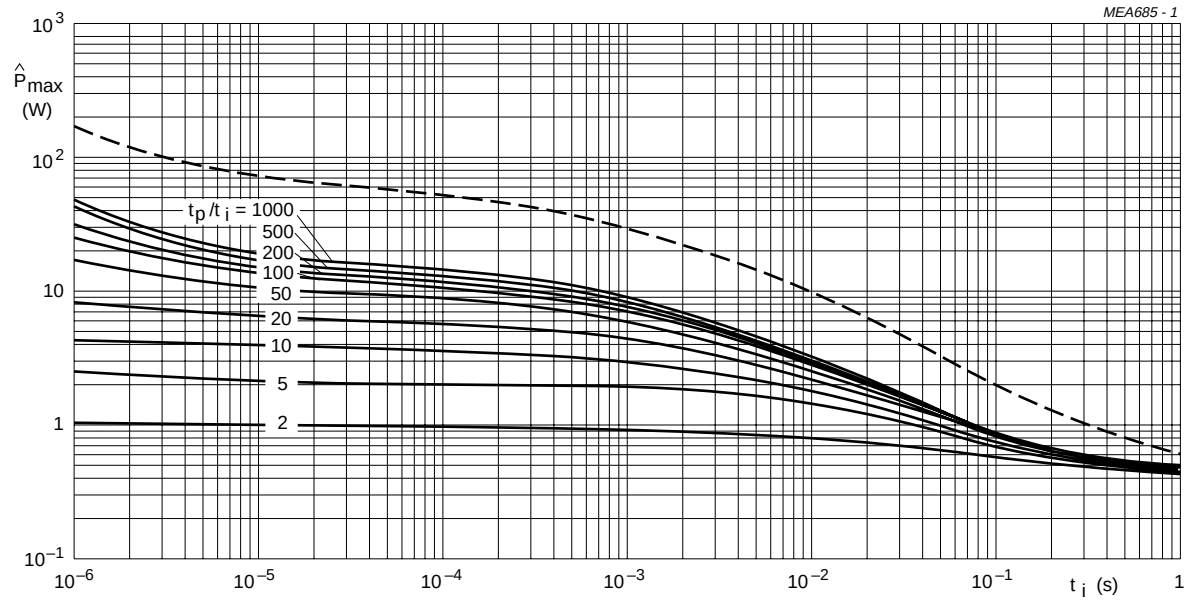


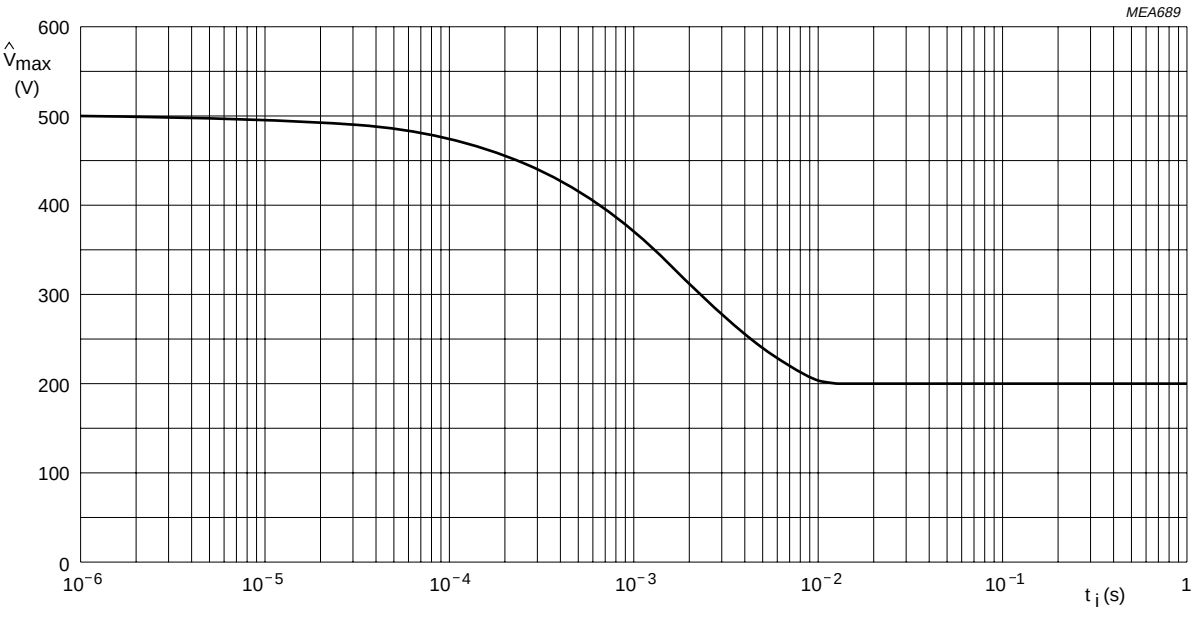
Fig.3 Maximum dissipation (P_{max}) in percentage of rated power as a function of the ambient temperature (T_{amb}).

PULSE LOADING CAPABILITIES



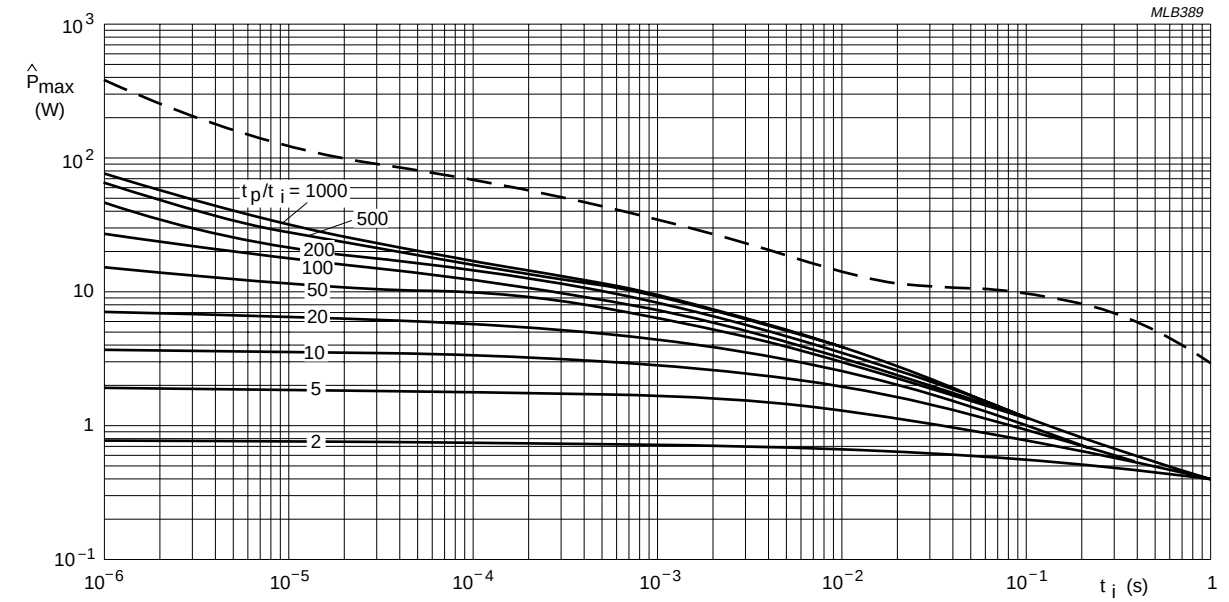
SFR16S

Fig.4 Pulse on a regular basis; maximum permissible peak pulse power ($\hat{P}_{max}$) as a function of pulse duration (t_i).



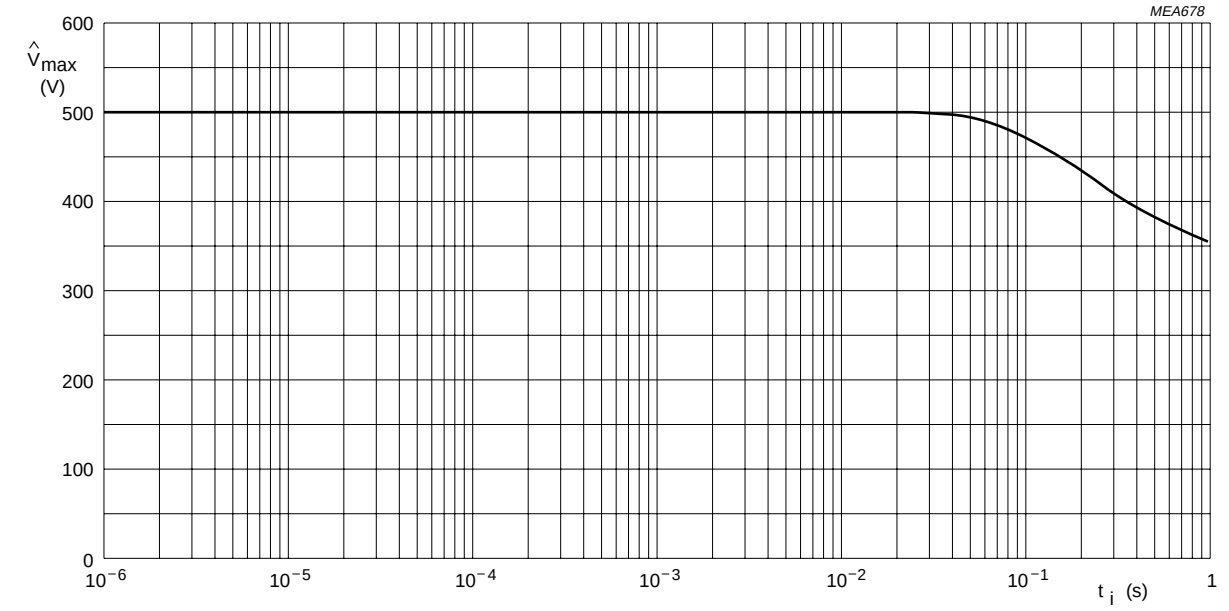
SFR16S

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



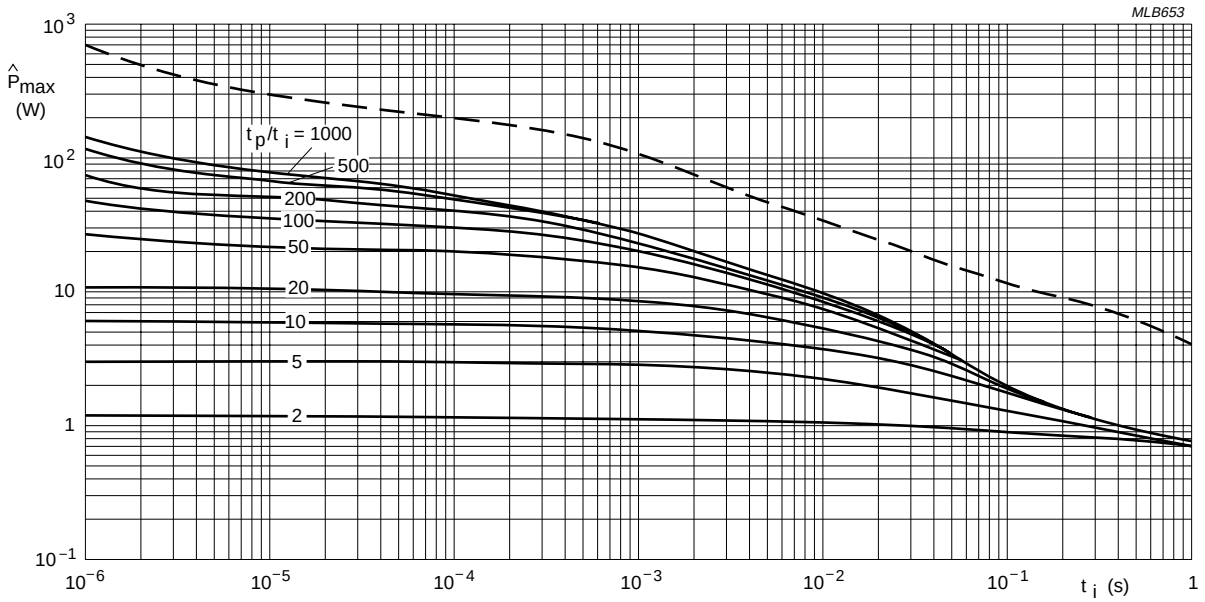
SFR25

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



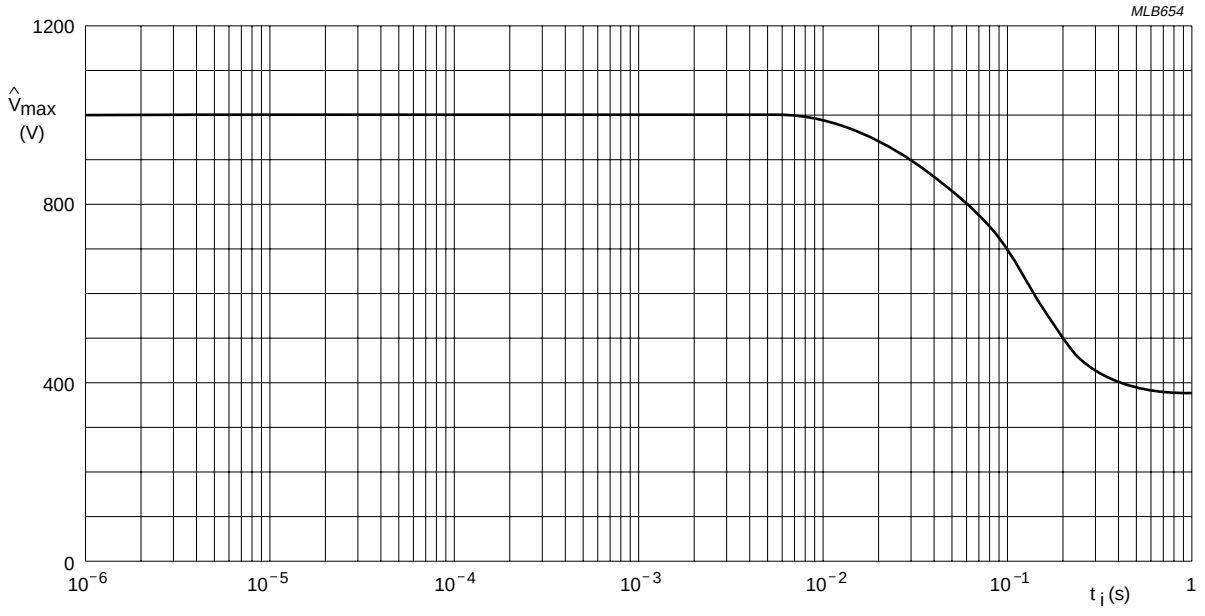
SFR25

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



SFR25H

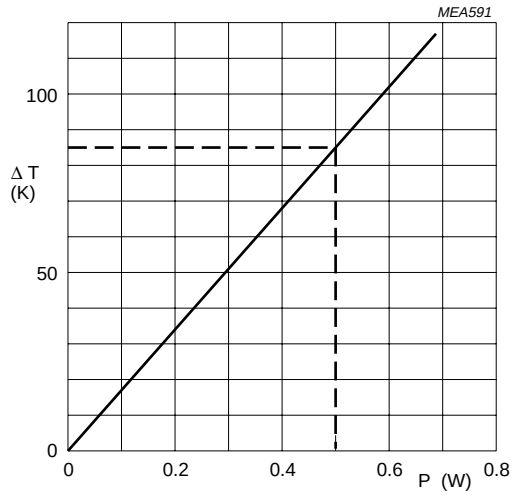
Fig.8 Pulse on a regular basis; maximum permissible peak pulse power ($\hat{P}_{max}$) as a function of pulse duration (t_i).



SFR25H

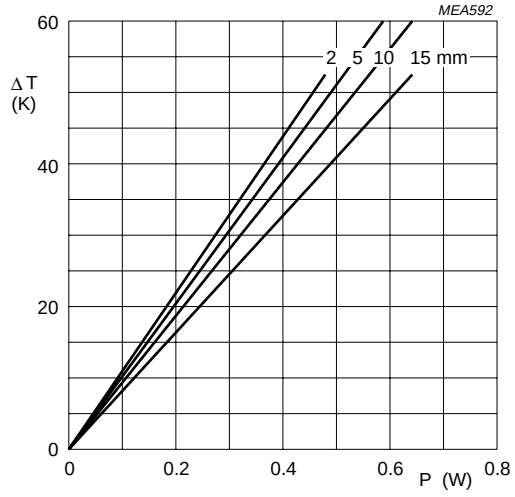
Fig.9 Pulse on a regular basis; maximum permissible peak pulse voltage ($\hat{V}_{max}$) as a function of pulse duration (t_i).

Application information



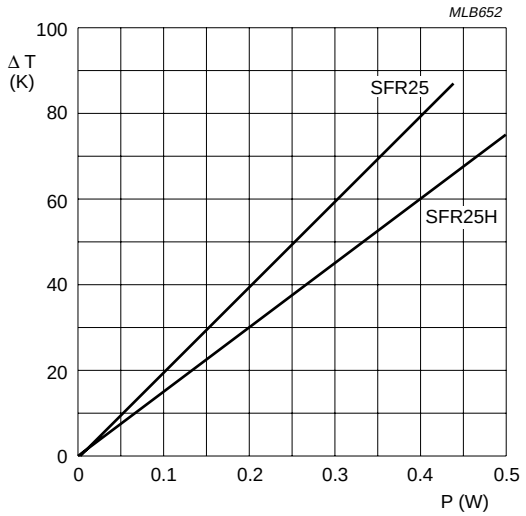
SFR16S

Fig.10 Hot-spot temperature rise (ΔT) as a function of dissipated power.



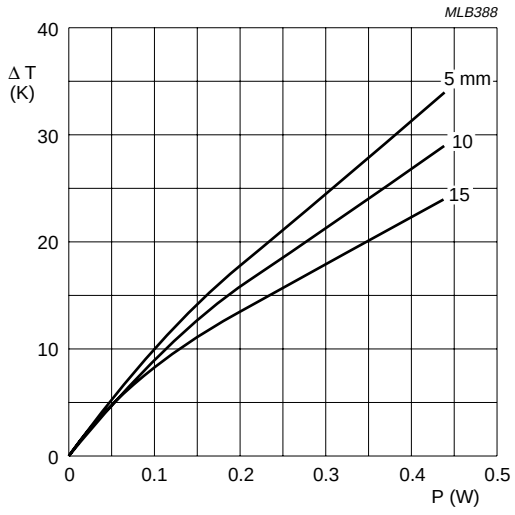
SFR16S

Fig.11 Temperature rise (ΔT) at the end of the lead (soldering point) as a function of dissipated power at various lead lengths after mounting.



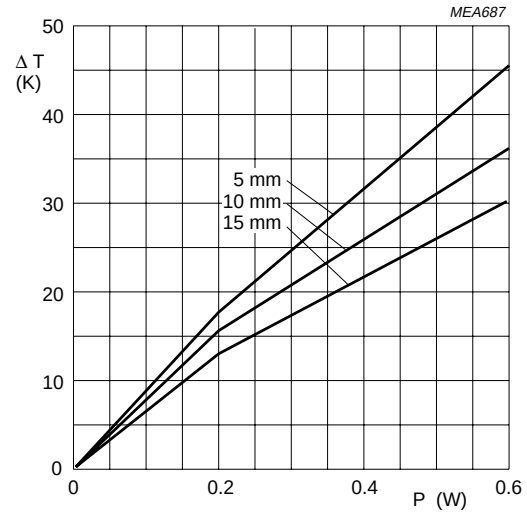
SFR25/SFR25H

Fig.12 Hot-spot temperature rise (ΔT) as a function of dissipated power.



SFR25

Fig.13 Temperature rise (ΔT) at the end of the lead (soldering point) as a function of dissipated power at various lead lengths after mounting.



SFR25H

Fig.14 Temperature rise (ΔT) at the end of the lead (soldering point) as a function of dissipated power at various lead lengths after mounting.

MECHANICAL DATA

Mass per 100 units

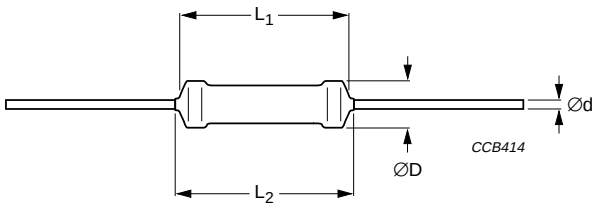
TYPE	MASS (g)
SFR16S	12.5
SFR25	25

Marking

The nominal resistance and tolerance are marked on the resistor using four or five 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")*.



For dimensions see Table 3.

Fig.15 Outline.

Table 3 Resistor type and relevant physical dimensions; see Fig.15

TYPE	∅D MAX. (mm)	L_1 MAX. (mm)	L_2 MAX. (mm)	∅d (mm)
SFR16S	1.9	3.2	3.4	0.45 ±0.05
SFR25	2.5	6.5	7.0	0.58 ±0.05
SFR25H	2.5	6.5	7.0	0.58 ±0.05

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of *"IEC publication 60115-1"*, category 55/155/56 (rated temperature range –55 °C to +155 °C; 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 68, *"Recommended basic climatic and mechanical robustness testing procedure for electronic components"* and under standard atmospheric conditions according to *"IEC 60068-1"*, subclause 5.3.

Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45% to 75%

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

In Table 4 the tests and requirements are listed with reference to the relevant clauses of *"IEC publications 60115-1 and 60068"*; 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.

Table 4 Test procedures and requirements

IEC 60115-1 CLAUSE	IEC 60068 TEST METHOD	TEST	PROCEDURE	RESISTANCE RANGE	REQUIREMENTS		
					SFR16S	SFR25	SFR25H
4.16	U	robustness of terminations:					
4.16.2	Ua	tensile all samples	∅0.45 mm, load 5 N; 10 s ∅0.58 mm, load 10 N; 10 s		number of failures $<10 \times 10^{-6}$		
4.16.3	Ub	bending half number of samples	∅0.45 mm, load 2.5 N; $4 \times 90°$ ∅0.58 mm, load 5 N; $4 \times 90°$		number of failures $<10 \times 10^{-6}$		
4.16.4	Uc	torsion other half of samples	$3 \times 360°$ in opposite directions		no damage $\Delta R/R$ max.: ±0.25% + 0.05 Ω		
4.17	Ta	solderability	2 s; 235 °C; flux 600		good tinning; no damage		
4.18	Tb	resistance to soldering heat	thermal shock: 3 s; 350 °C; 6 mm from body		$\Delta R/R$ max.: ±0.25% + 0.05 Ω		
4.19	Na	rapid change of temperature	30 minutes at –55 °C and 30 minutes at +155 °C; 5 cycles		$\Delta R/R$ max.: ±0.25% + 0.05 Ω		
4.20	Eb	bump	3×1500 bumps in 3 directions; 40 g		no damage $\Delta R/R$ max.: ±0.25% + 0.05 Ω		
4.22	Fc	vibration	frequency 10 to 500 Hz; displacement 1.5 mm or acceleration 10 g; 3 directions; total 6 hours (3×2 hours)		no damage $\Delta R/R$ max.: ±0.25% + 0.05 Ω		

IEC 60115-1 CLAUSE	IEC 60068 TEST METHOD	TEST	PROCEDURE	RESISTANCE RANGE	REQUIREMENTS		
					SFR16S	SFR25	SFR25H
4.23		climatic sequence:			R_{ins} min.: 1000 MΩ		
4.23.2	Ba	dry heat	16 hours; 155 °C				
4.23.3	Db	damp heat (accelerated) 1st cycle	24 hours; 55 °C; 90 to 100% RH				
4.23.4	Aa	cold	2 hours; –55 °C				
4.23.5	M	low air pressure	2 hours; 8.5 kPa; 15 to 35 °C				
4.23.6	Db	damp heat (accelerated) remaining cycles	5 days; 55 °C; 95 to 100% RH	R ≤ 1 MΩ	ΔR/R max.: ±1% + 0.05 Ω		
				R > 1 MΩ	ΔR/R max.: ±1% + 0.05 Ω		ΔR/R max.: ±2% + 0.1 Ω
4.24.2	Ca	damp heat (steady state)	56 days; 40 °C; 90 to 95% RH; dissipation 0.01 P_n		R_{ins} min.: 1000 MΩ ΔR/R max.: ±1% + 0.05 Ω		
4.25.1		endurance	1000 hours at 70 °C; P_n or V_{max}	R ≤ 1 MΩ	ΔR/R max.: ±1% + 0.05 Ω		
				R > 1 MΩ	ΔR/R max.: ±1% + 0.05 Ω		ΔR/R max.: ±2% + 0.1 Ω
4.8.4		temperature coefficient	between –55 °C and +155 °C (TC × 10^{-6}/K)	R < 4.7 Ω	≤±250	≤±100	≤±100
				R ≤ 100 kΩ	≤±100	≤±100	≤±100
				R ≤ 1 MΩ	≤±250	≤±100	≤±100
				R > 1 MΩ	≤±250	≤±250	≤±250
4.7		voltage proof on insulation	400 V (RMS) (**SFR16S**) or 600 V (RMS) (**SFR25** and **SFR25H**); during 1 minute; V-block method		no breakdown		
4.12		noise	*“IEC publication 60195”*	R < 68 kΩ	max. 0.1 μV/V	max. 0.1 μV/V	max. 0.1 μV/V
				R ≤ 100 kΩ	max. 0.5 μV/V	max. 0.1 μV/V	max. 0.1 μV/V
				R ≤ 1 MΩ	max. 1.5 μV/V	max. 0.1 μV/V	max. 0.1 μV/V
				R > 1 MΩ	max. 1.5 μV/V	max. 1.5 μV/V	max. 1.5 μV/V
4.6.1.1		insulation resistance	500 V (DC) during 1 minute; V-block method		R_{ins} min.: 1000 MΩ		

IEC 60115-1 CLAUSE	IEC 60068 TEST METHOD	TEST	PROCEDURE	RESISTANCE RANGE	REQUIREMENTS		
					SFR16S	**SFR25**	**SFR25H**
4.13		short time overload	room temperature; P = 6.25 × P_n (**SFR25**) or 6.25 × 0.25 W (**SFR16S**); 5 s on, 45 s off ($V \leq 2 \times V_{max}$); 10 cycles		ΔR/R max.: ±0.25% + 0.05 Ω		ΔR/R max.: ±1% + 0.05 Ω
		intermittent overload in accordance with *“JIS-C5202 5.8”*	16 × 0.16 W; 1 s on and 25 s off; 10000 ±200 cycles; V_{max} = 600 V		ΔR/R max.: ±0.75% + 0.05 Ω	–	–
see 2nd amendment to *“IEC 60115-1”*, Jan. ’87		pulse load			see Figs 4, 5, 6, 7, 8 and 9		