DATA SHEET

SFR16S/25/25H
5033E/5043E/5053H
Standard metal film resistors

Product specification
Supersedes data of 31st July 2000
File under BCcomponents, BC08

2001 Jan 17

BC COMPONENTS

Standard metal film resistors

SFR16S/25/25H 5033E/5043E/5053H

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 (5033E)	**SFR25 (5043E)**	**SFR25H (5053H)**
Resistance range	1 Ω to 3 MΩ	1 Ω to 10 MΩ and jumper (0 Ω)	
Resistance tolerance	±1%; ±5%; E24/E96 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	TOL. (%)	12NC	NAFTA PART NUMBER	TAPING (mm)	SPQ (units)
SFR25[1] (SFR55)	±1	2306 181 8....	5043EDxxxxxF12AF5	52	5000; tape & reel
SFR25	±5	2306 181 63...	5043EMxxxxxJ12AFX	52	5000; tape & reel
SFR25[1] (SFR55)	±1	2322 188 2....	5043EDxxxxxF5AAF5	52	5000; ammopack
SFR25	±5	2322 181 43...	2322 181 43xxx	52	5000; ammopack
SFR25 jumper[2]	–	2306 181 90011	5043EM0R000J12AFX	52	5000; tape & reel
SFR25 jumper[2]	–	2322 181 90019	5043EM0R000J18AFX	52	5000; ammopack
SFR25H	±1	2306 186 8....	5053HDxxxxxF12AF5	52	5000; tape & reel
SFR25H	±5	2306 186 63...	5053HMxxxxxJ12AFX	52	5000; tape & reel
SFR25H	±5	2322 186 76...	2322 186 76xxx	52	5000; ammopack
SFR16S	±1	2306 187 1....	5033EDxxxxxF12AF5	52	5000; tape & reel
SFR16S	±5	2306 187 23...	5033EMxxxxxJ12AFX	52.5	5000; tape & reel
SFR16S	±1	2306 187 3....	2306 187 3....	52.5	5000; ammopack
SFR16S	±5	2322 187 53...	2322 187 53...	52.5	5000; ammopack
SFR16S jumper[2]	–	2306 187 90013	2306 187 90013	52.5	5000; tape & reel

Notes

1. In North America, the SFR25 1% is also known as SFR55.
2. The jumper has a maximum resistance R_{max} = 10 mΩ at 5 A.

Composition of the clear text code (NAFTA P/N)

- The resistors have an ordering code starting with 50
- The subsequent digits indicate the resistor type, temperature coefficient, ohmic value, tolerance and packaging; see Table 1
- The ohmic value is represented by 5 digits; see Table 2
- For temperature coefficient and tolerance, see Table 3.

Table 2 Examples of the ohmic value

OHMIC VALUE	5 DIGIT VALUE
1 Ω	1R000
10 Ω	10R00
100 Ω	100R0
1 kΩ	1K000
10 kΩ	10K00
100 kΩ	100K0
1 MΩ	1M000

Table 3 Letter coding for temperature coefficient and tolerance

TC ($\times 10^{-6}$/K)	LETTER CODE	TOL. (%)	LETTER CODE
200	M	±5	J
100	D	±1	F

ORDERING EXAMPLE: CLEAR TEXT CODE

The ordering code of a SFR25 resistor, value 5600 Ω ±1%, taped on a bandolier of 5000 units in tape on reel is: 5043ED5K600F12AF5.

Composition of the 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 digits indicate the resistance value:
  - The first 2 or 3 digits indicate the resistance value.
  - The last digit indicates the resistance decade in accordance with Tables 4 or 5.

Table 4 Last digit for ±**5%** tolerance

RESISTANCE DECADE	LAST DIGIT
0.10 to 0.91 Ω	7
1 to 9.1 Ω	8
10 to 91 Ω	9
100 to 910 Ω	1
1 to 9.1 kΩ	2
10 to 91 kΩ	3
100 to 910 kΩ	4
1 to 9.1 MΩ	5
≥10 MΩ	6

Table 5 Last digit for ±**1%** tolerance

RESISTANCE DECADE	LAST DIGIT
0.10 to 0.976 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 to 9.76 MΩ	5
≥10 MΩ	6

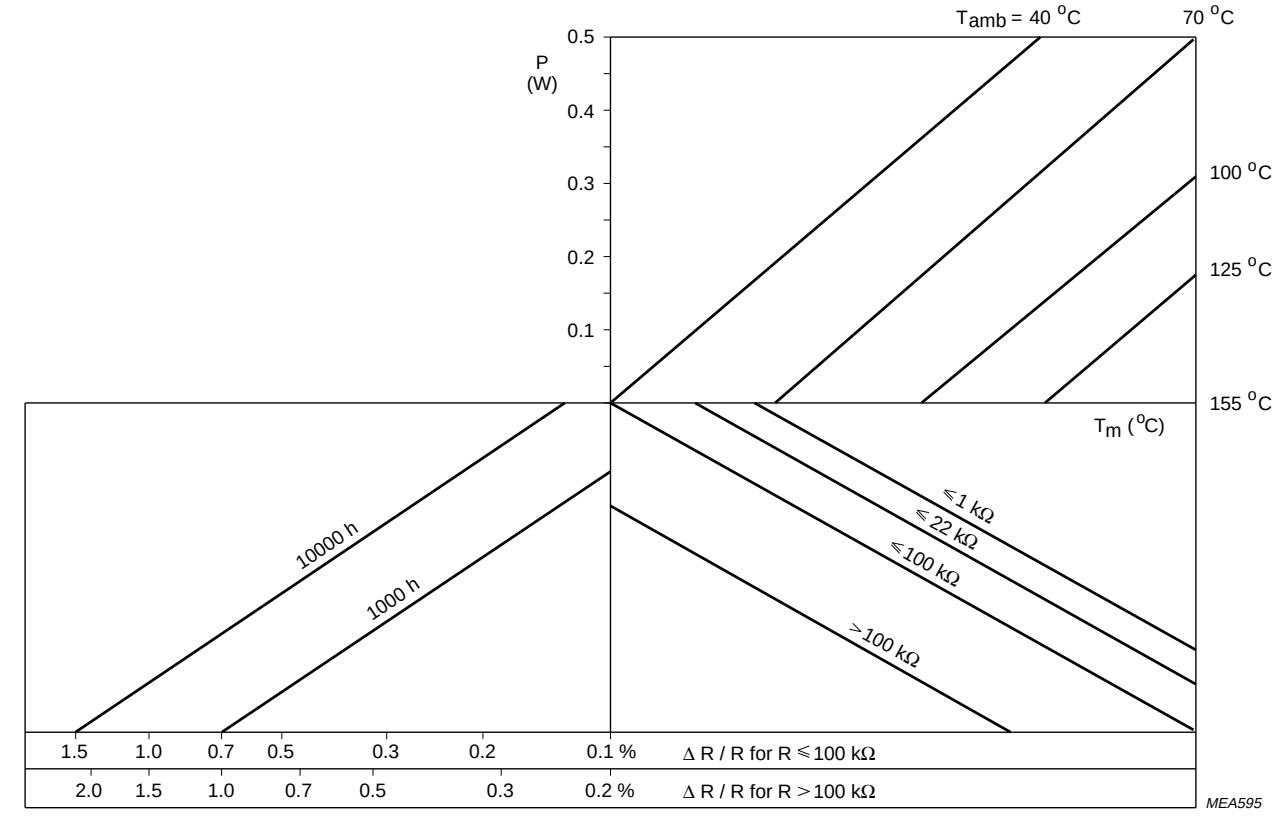
ORDERING EXAMPLE: 12NC

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

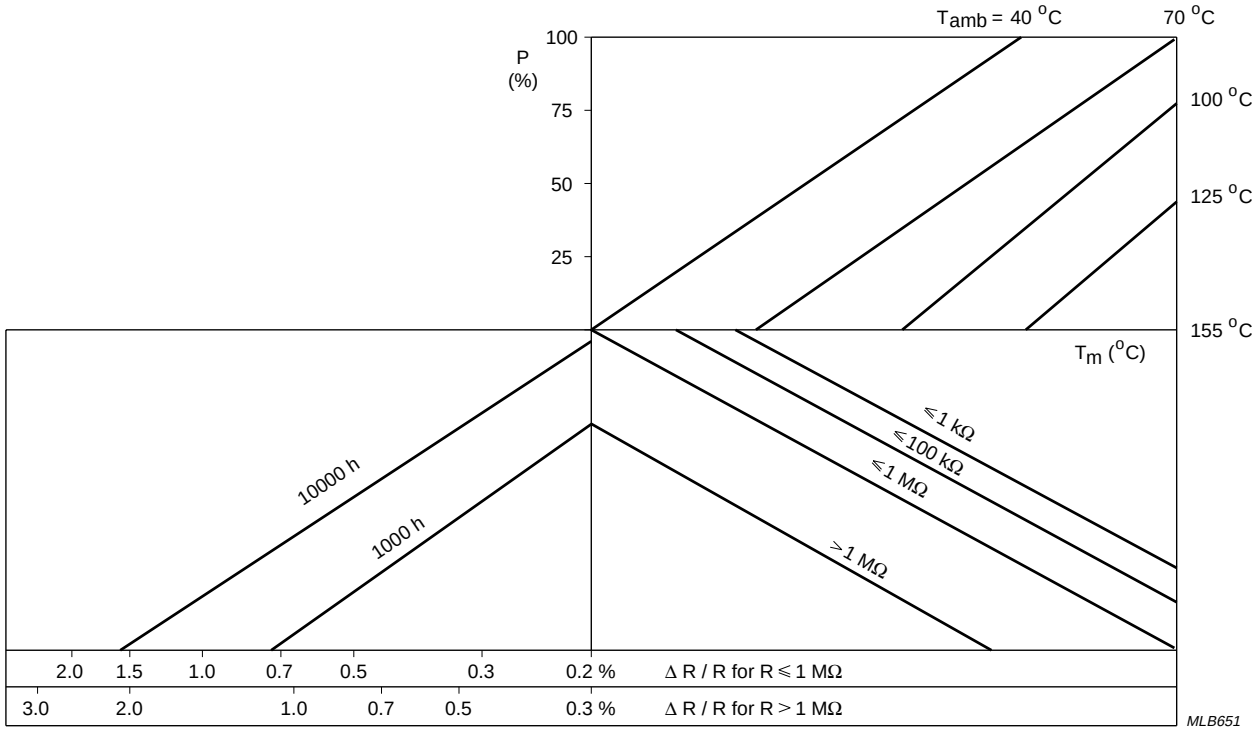
Product characterization

Standard values of nominal resistance are taken from the E24/E96 series for resistors with a tolerance of ±5%; ±1%. The values of the E24/E96 series are in accordance with *"IEC publication 60063"*.



SFR16S
5033E

Fig.1 Drift nomogram.



SFR25(H)

P_n = 0.4 W (**5043E**) or 0.5 W (**5053H**).

Fig.2 Drift nomogram.

Limiting values

TYPE	LIMITING VOLTAGE(1) (V)	LIMITING POWER (W)
SFR16S/5033E	200	0.5
SFR25/5043E	250	0.4
SFR25H/5053H	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.

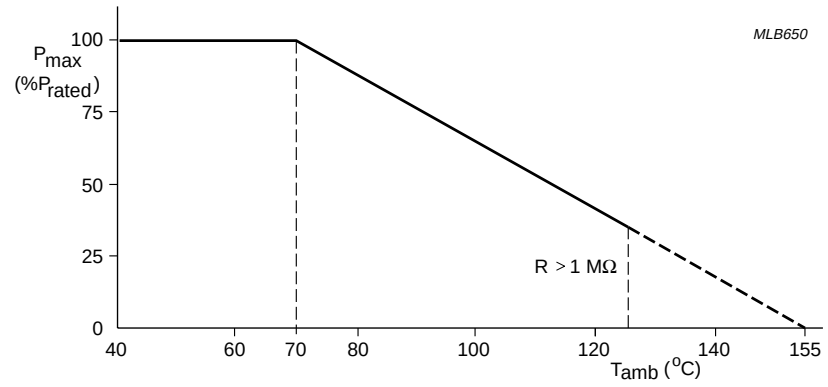


Fig.3 Maximum dissipation (P_{max}) in percentage of rated power as a function of the ambient temperature (T_{amb}).

PULSE LOADING CAPABILITIES

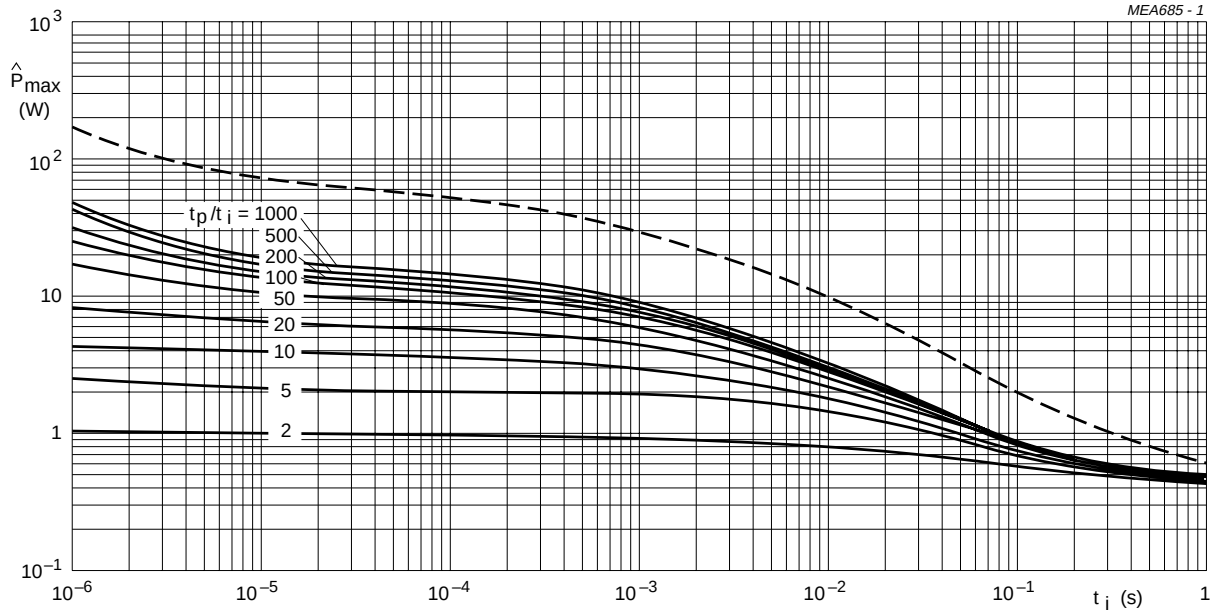


Fig.4 Pulse on a regular basis; maximum permissible peak pulse power ($\hat{P}_{max}$) as a function of pulse duration (t_i).

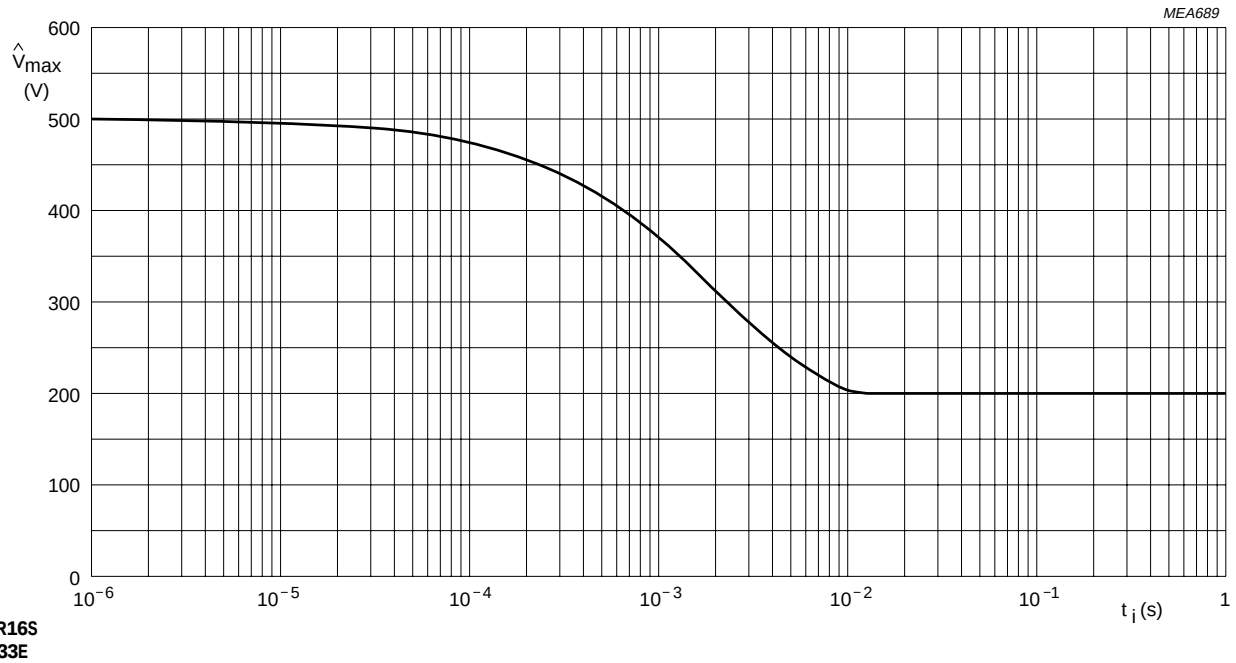
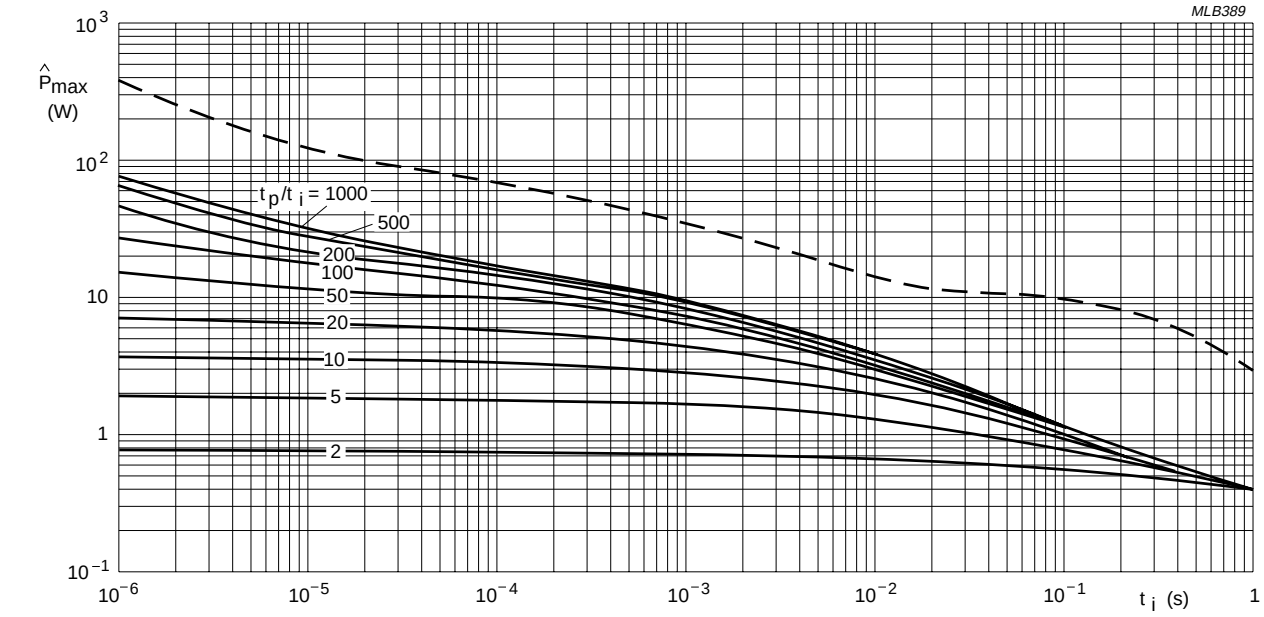
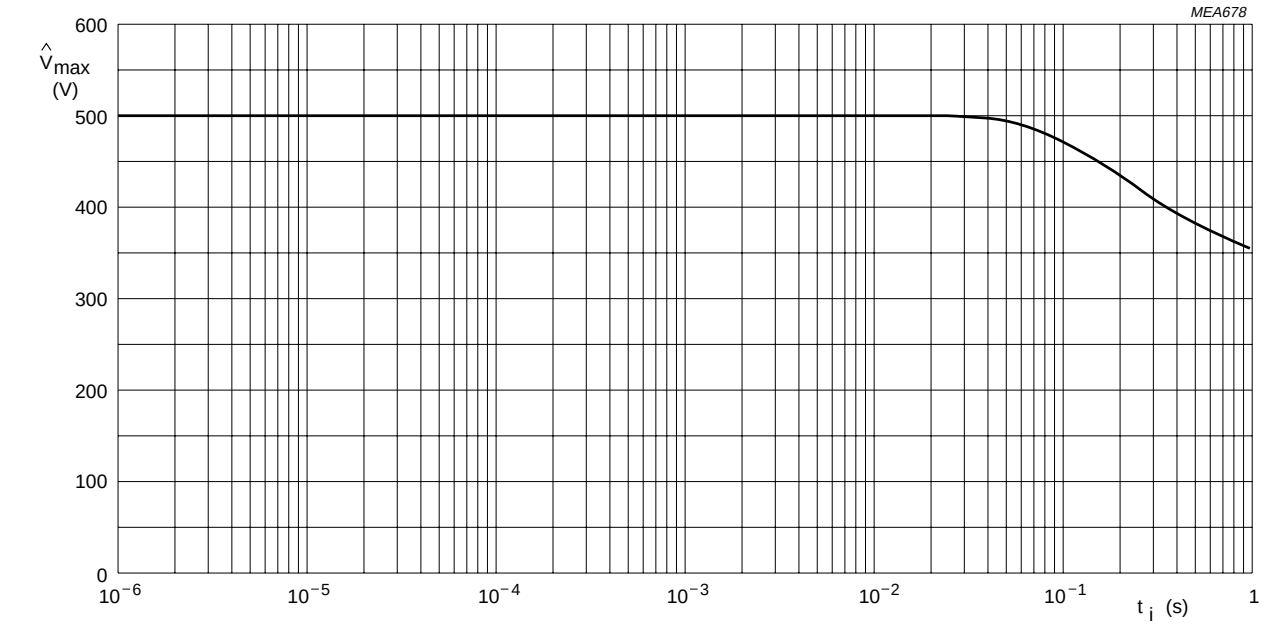


Fig.5 Pulse on a regular basis; maximum permissible peak pulse voltage ($\hat{V}_{max}$) as a function of pulse duration (t_i).



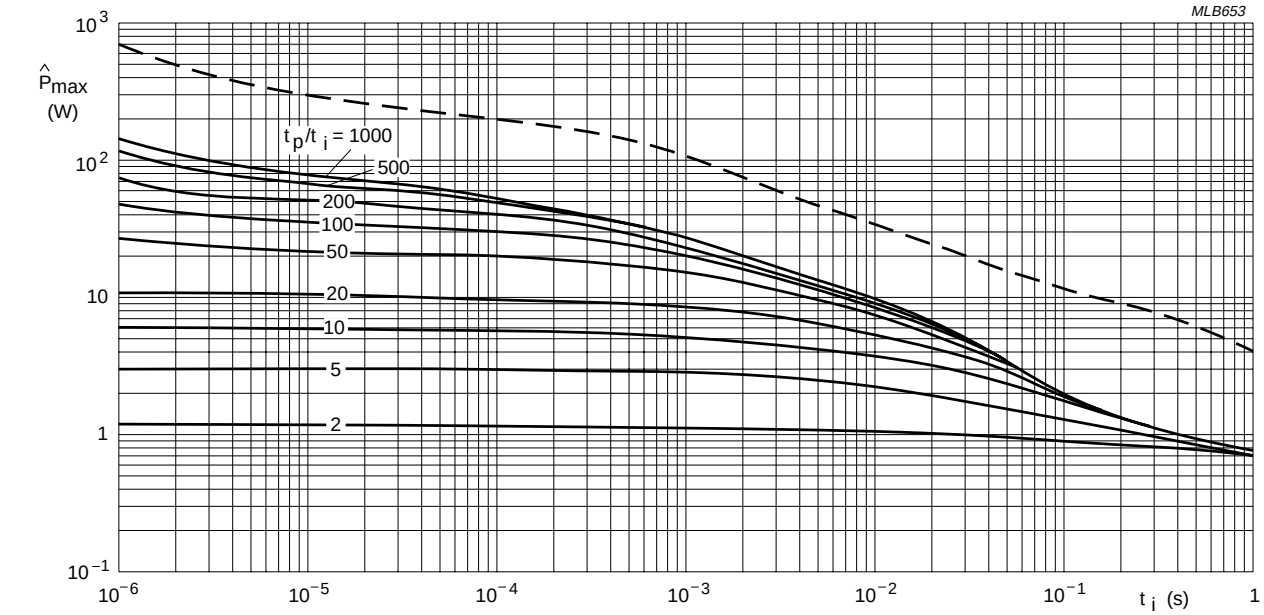
SFR25
5043E

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



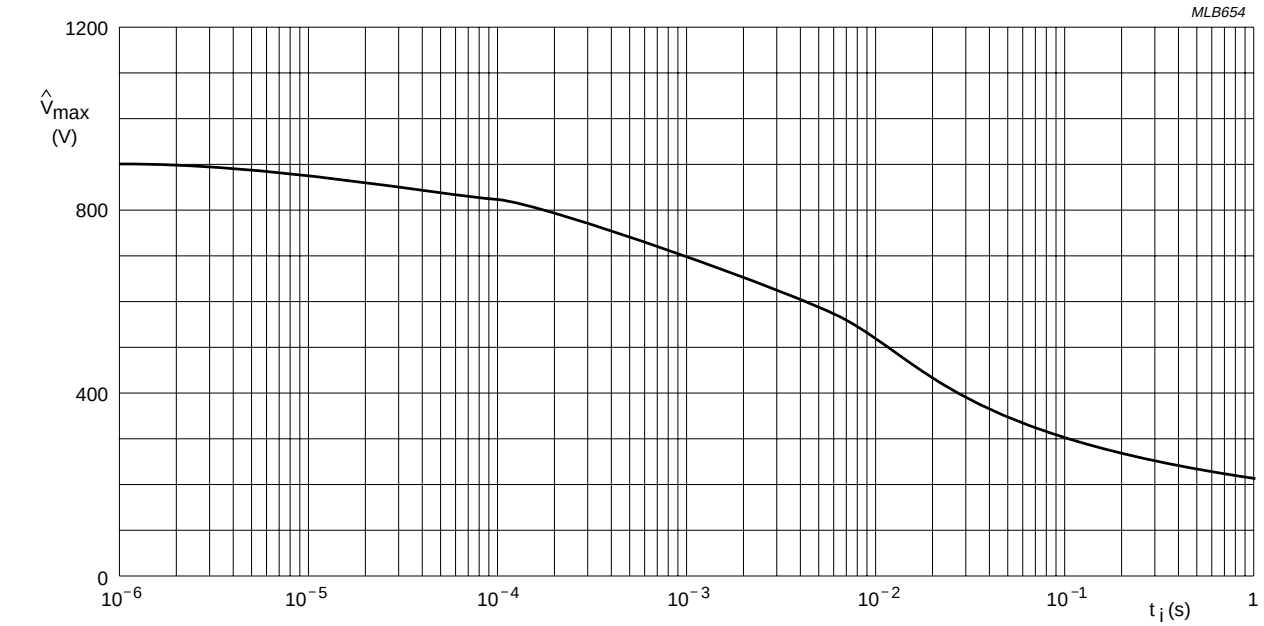
SFR25
5043E

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



SFR25H
5053H

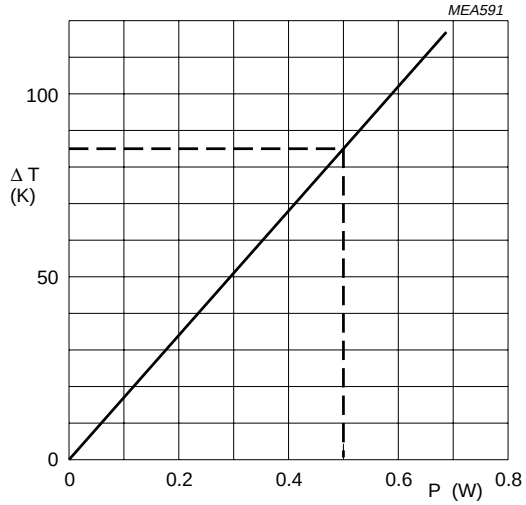
Fig.8 Pulse on a regular basis; maximum permissible peak pulse power ($\hat{P}_{max}$) as a function of pulse duration (t_i).



SFR25H
5053H

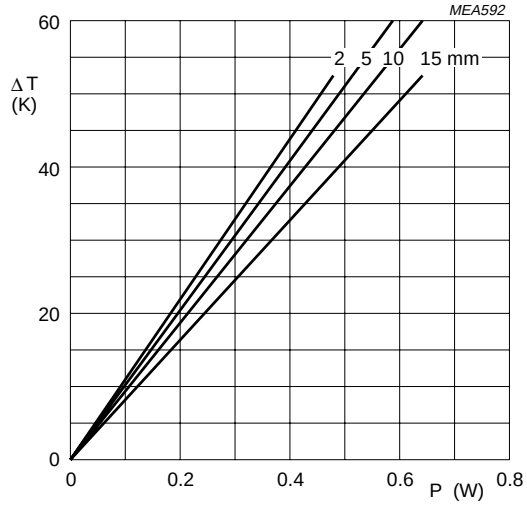
Fig.9 Pulse on a regular basis; maximum permissible peak pulse voltage ($\hat{V}_{max}$) as a function of pulse duration (t_i).

Application information



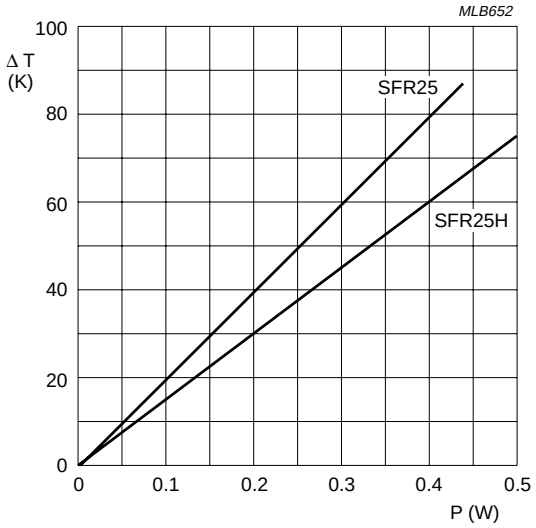
SFR16S
5033E

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



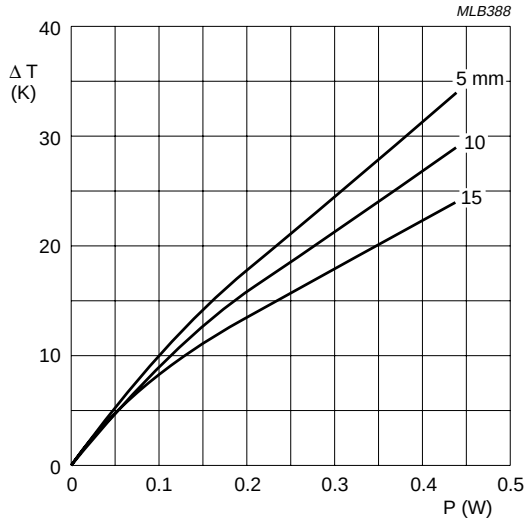
SFR16S
5033E

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.



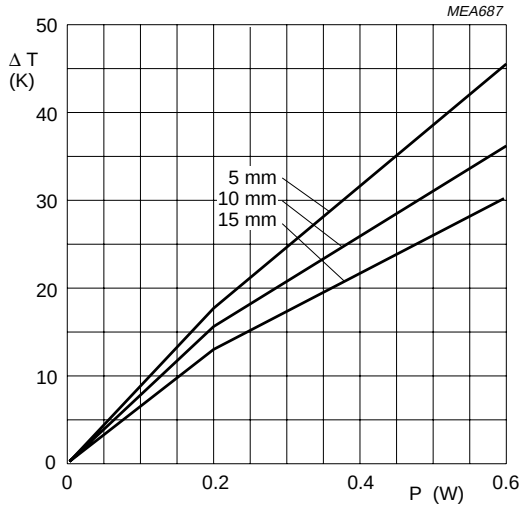
SFR25/SFR25H
5043E/5053H

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



SFR25
5043E

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
5053H

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

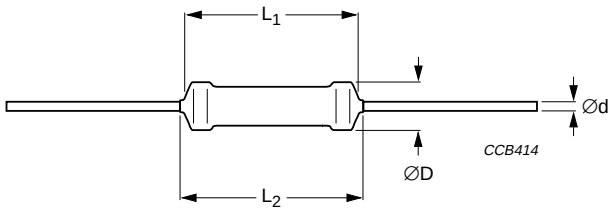
TYPE	MASS (g)
SFR16S/5033E	12.5
SFR25/5043E	25

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 6.

Fig.15 Outline.

Table 6 Resistor type and relevant physical dimensions; see Fig.15

TYPE	∅D MAX. (mm)	L_1 MAX. (mm)	L_2 MAX. (mm)	∅d (mm)
SFR16S/5033E	1.9	3.2	3.4	0.45 ±0.05
SFR25/5043E	2.5	6.5	7.0	0.58 ±0.05
SFR25H/5053H	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 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 7 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.

Table 7 Test procedures and requirements

IEC 60115-1 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	RESISTANCE RANGE	REQUIREMENTS		
					SFR16S (5033E)	SFR25 (5043E)	SFR25H (5053H)
4.16	21 (U)	robustness of terminations:					
4.16.2	21 (Ua1)	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	21 (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	21 (Uc)	torsion other half of samples	$3 \times 360°$ in opposite directions		no damage ΔR/R max.: ±0.25% + 0.05 Ω		
4.17	20 (Ta)	solderability	2 s; 235 °C; flux 600		good tinning; no damage		
4.18	20 (Tb)	resistance to soldering heat	thermal shock: 3 s; 350 °C; 6 mm from body		ΔR/R max.: ±0.25% + 0.05 Ω		
4.19	14 (Na)	rapid change of temperature	30 minutes at –55 °C and 30 minutes at +155 °C; 5 cycles		ΔR/R max.: ±0.25% + 0.05 Ω		
4.20	29 (Eb)	bump	3×1500 bumps in 3 directions; 40 g		no damage ΔR/R max.: ±0.25% + 0.05 Ω		
4.22	6 (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 ΔR/R max.: ±0.25% + 0.05 Ω		

IEC 60115-1 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	RESISTANCE RANGE	REQUIREMENTS		
					SFR16S (5033E)	SFR25 (5043E)	SFR25H (5053H)
4.23		climatic sequence:			R_{ins} min.: 1000 MΩ		
4.23.2	2 (Ba)	dry heat	16 hours; 155 °C				
4.23.3	30 (Db)	damp heat (accelerated) 1st cycle	24 hours; 55 °C; 90 to 100% RH				
4.23.4	1 (Aa)	cold	2 hours; –55 °C				
4.23.5	13 (M)	low air pressure	2 hours; 8.5 kPa; 15 to 35 °C				
4.23.6	30 (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	3 (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 ($TC \times 10^{-6}$/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 60068-2 TEST METHOD	TEST	PROCEDURE	RESISTANCE RANGE	REQUIREMENTS		
					SFR16S (5033E)	SFR25 (5043E)	SFR25H (5053H)
4.13		short time overload	room temperature; $P = 6.25 \times P_n$ (**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		