STANDARD FILM RESISTOR - SFR

FEATURES

- Metal film technology
- Non-flammable
- General purpose
- Small size (SFR16S)
- High stability
- Low cost and low noise
- Jumper available (SFR16S and SFR25)
- Various forming styles
- Various packaging and taping configurations

QUICK REFERENCE DATA

DESCRIPTION	SFR16S		SFR25		SFR25H	
Resistance range	1Ω - 3MΩ	4.99Ω - 2.4MΩ	0.22Ω - 10MΩ	1Ω - 10MΩ	0.22Ω - 10MΩ	1Ω - 10MΩ
Tolerance and series	±5%, E24	±1%, E24/E96	±5%, E24	±1%, E24/E96	±5%, E24	±1%, E24/E96
Maximum dissipation at $T_{amb.}$ = 70°C	0.5W		0.4W		0.5W	
Limiting voltage (DC or RMS)	200V		250V		350V	
Rated voltage [1]	$\sqrt{P_n \times R}$					
Temperature coefficient						
R < 4.7Ω:	±250ppm/°C	±100ppm/°C	-		-	
4.7 ≤ R ≤ 200kΩ:	±100ppm/°C		-		-	
R > 200kΩ:	±250ppm/°C		-		-	
R ≤ 1MΩ:	-		±100ppm/°C		±100ppm/°C	
R > 1MΩ:	-		±250ppm/°C		±250ppm/°C	
Basic specification	IEC 60115-1 and 60115-4					
Climatic category (IEC 60068)	55/155/56					

DESCRIPTION	SFR16S		SFR25		SFR25H	
Stability $\Delta R/R_{max.}$ after:						
Load	±1% +0.05Ω	±0.5%+0.05Ω (2) ±1% +0.05W (3)	±1% +0.05Ω	±0.5%+0.05Ω	±1% +0.05Ω	±0.5%+0.05Ω
Climatic tests	±1% +0.05Ω	±0.5%+0.05Ω (2) ±1% +0.05Ω (3)	±1% +0.05Ω	±0.5%+0.05Ω	±1% +0.05Ω	±0.5%+0.05Ω
Resistance to soldering heat	±0.25% +0.05Ω		±0.25% +0.05Ω	±0.1 +0.05Ω	±0.25 +0.05Ω	±0.1%+0.05Ω
Short time overload	±0.25% +0.05Ω					

(1) Maximum rated voltage is the limiting voltage
(2) For R ≤ 200kΩ
(3) For R > 200KΩ

TECHNOLOGY

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 non-flammable lacquer, which provides electrical, mechanical and climatic protection. The coating is resistant to all cleaning solvents in accordance with MIL-STD-202, method 215 and IEC 60068-2-45.

MECHANICAL DATA

AXIAL STYLE

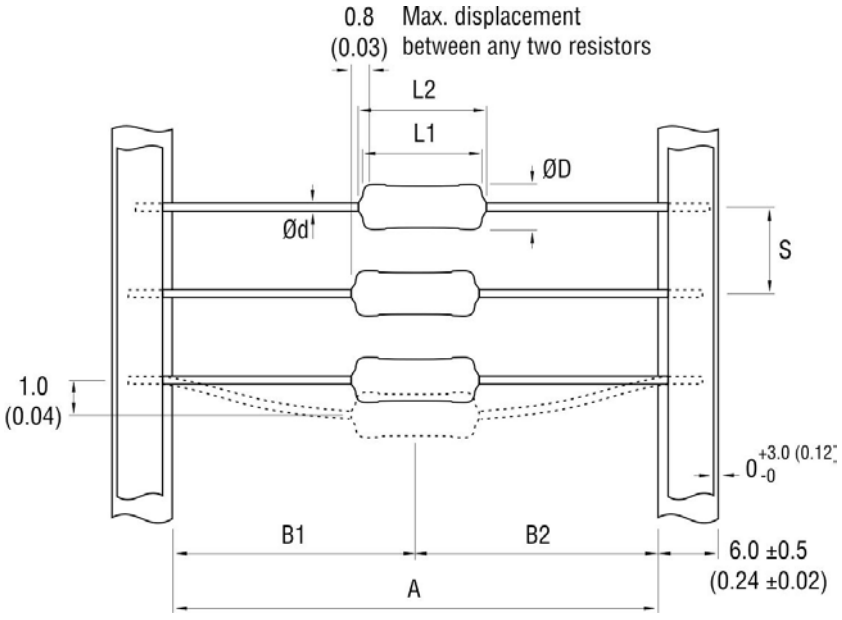

Fig. 1

Table 1. Mechanical Data.

PRODUCT	$L1_{max.}$	$L2_{max.}$	$ØD_{max.}$	Ød	A	$\|B1-B2\|_{max.}$	S	WEIGHT gr/100 pcs.
SFR16S	3.2 (0.13)	3.4 (0.14)	1.9 (0.08)	0.45 ±0.05 Cu (0.018 ±0.002)	52.5 ±1.5 (2.07 ±0.06)	1.2 (0.05)	5.0 ±0.1 (0.20 ±0.01)	11.5
					26.0 ±1.5 (1.03 ±0.06)			8.0
SFR25	6.5 (0.26)	-	2.5 (0.10)	0.58 ±0.05 Cu (0.023 ±0.002)	52.5 ±1.5 (2.07 ±0.06)	1.2 (0.05)	5.0 ±0.1 (0.20 ±0.01)	21.0
					26.0 ±1.5 (1.03 ±0.06)			15.0
SFR25H	6.5 (0.26)	7.0 (0.28)	2.5 (0.10)	0.58 ±0.05 Cu (0.023 ±0.002)	52.5 ±1.5 (2.07 ±0.06)	1.2 (0.05)	5.0 ±0.1 (0.20 ±0.01)	22.0
					26.0 ±1.5 (1.03 ±0.06)			16.0

Dimensions unless specified in mm (inches)

MOUNTING

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

ELECTRICAL CHARACTERISTICS

DERATING

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

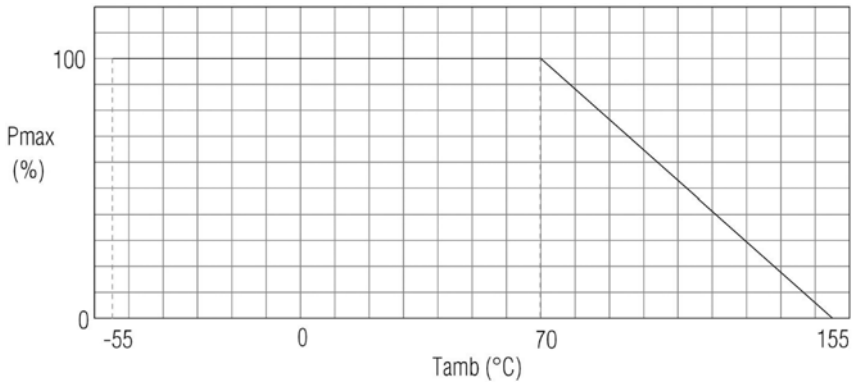

Fig. 2. Maximum dissipation (P_{max}) in percentage of rated power as a function of ambient temperature (T_{amb})

APPLICATION INFORMATION

SFR16S

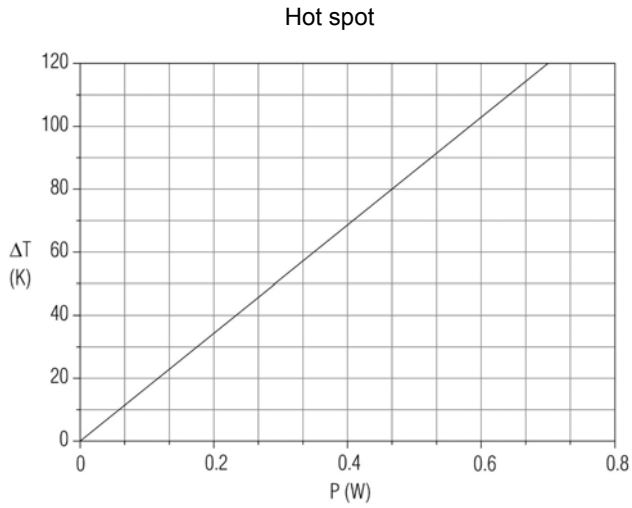

Fig. 3 - Hot spot temperature rise (ΔT) as a function of dissipated power.

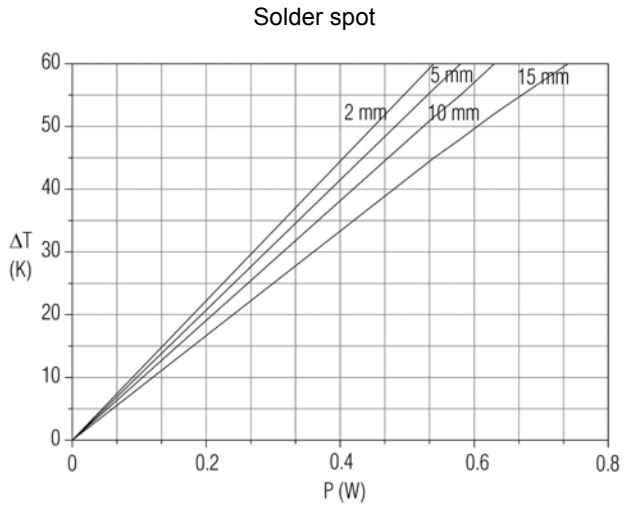

Fig. 4 - Temperature rise (ΔT) at the lead end (soldering point) as a function of dissipated power at various leads.

SFR25

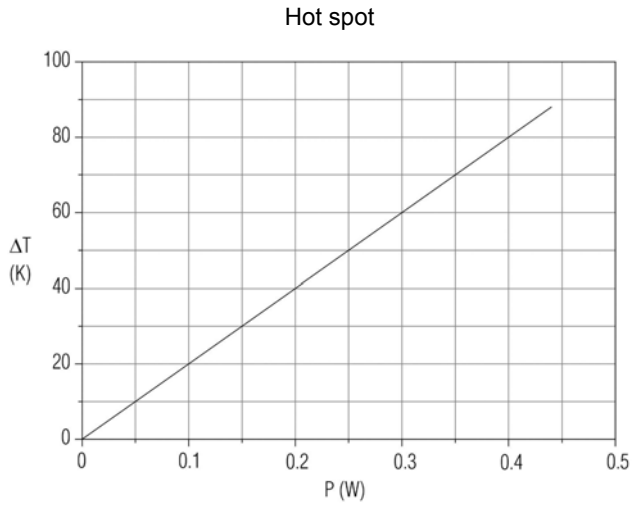

Fig. 5 - Hot spot temperature rise (ΔT) as a function of dissipated power.

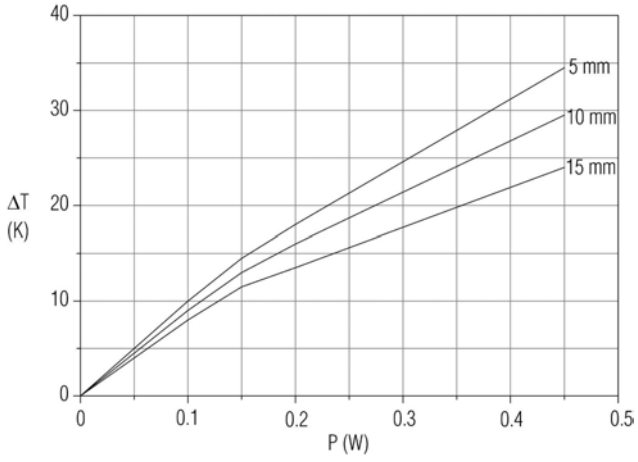

Fig. 6 - Temperature rise (ΔT) at the lead end (soldering point) as a function of dissipated power at various leads.

SFR25H

Hot spot

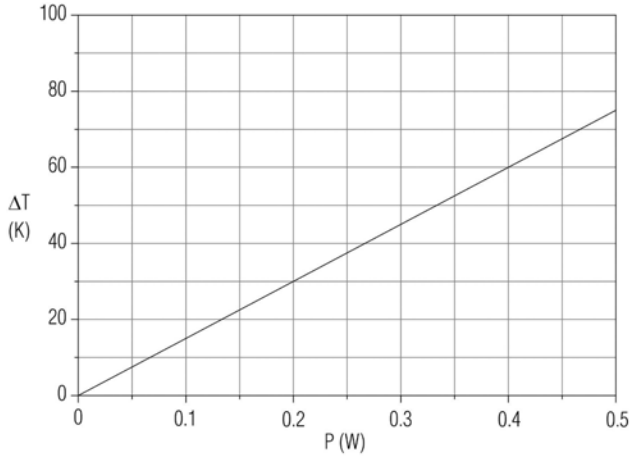

Fig. 7 - Hot spot temperature rise (ΔT) as a function of dissipated power.

Solder spot

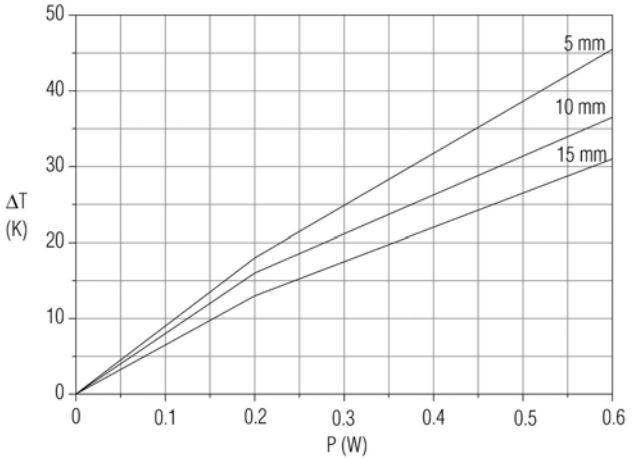

Fig. 8 - Temperature rise (ΔT) at the lead end (soldering point) as a function of dissipated power at various leads.

PULSE LOADING CAPABILITIES

SFR16S

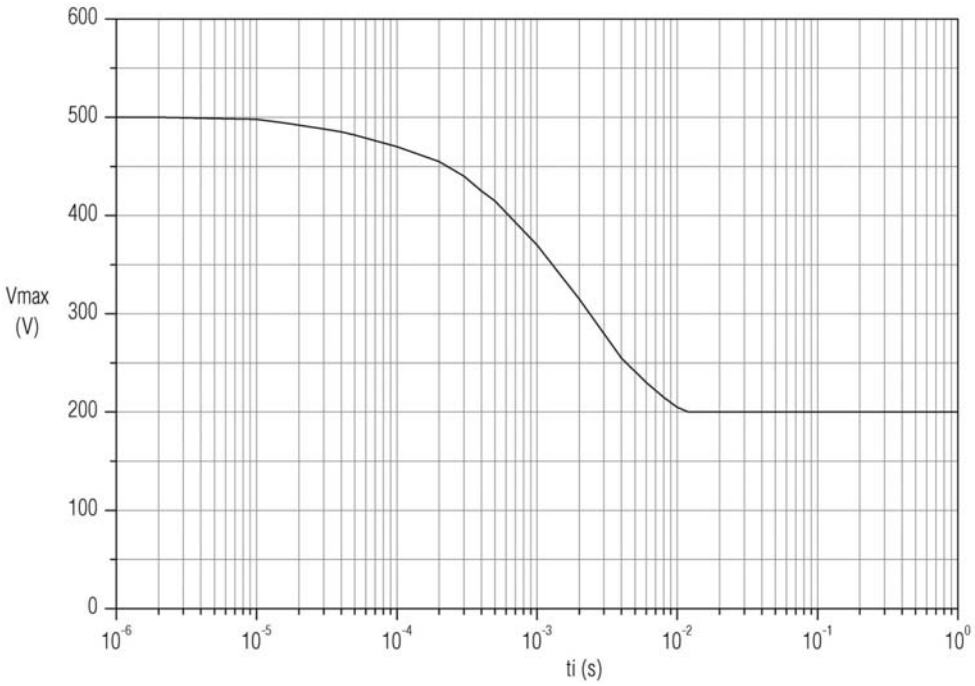

Fig. 9 - Pulse on a regular basis, maximum permissible peak pulse voltage (V_{max}) as a function of pulse duration (ti)

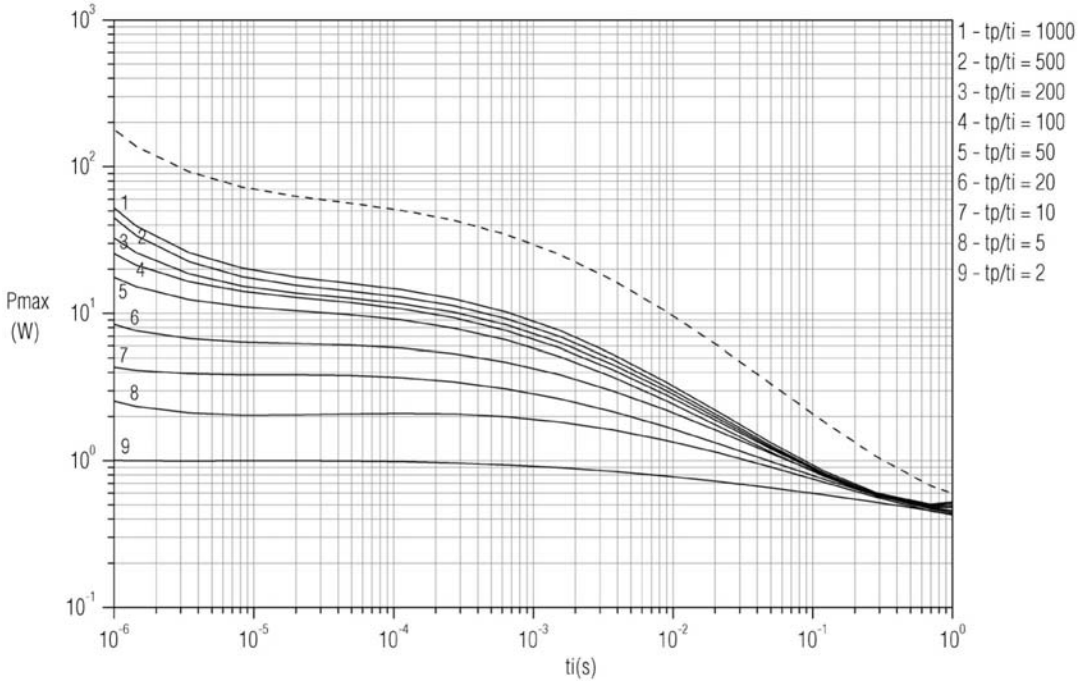

Fig. 10 - Pulse on a regular basis, maximum permissible peak pulse power (P_{max}) as a function of pulse duration (ti)

SFR25

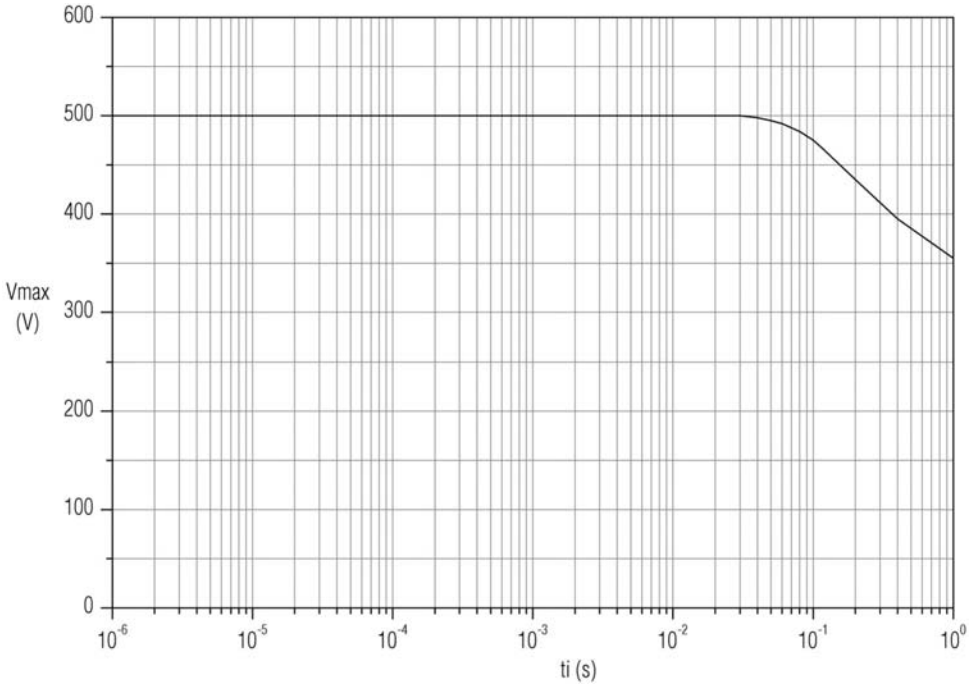

Fig. 11 - Pulse on a regular basis, maximum permissible peak pulse voltage (V_{max}) as a function of pulse duration (ti)

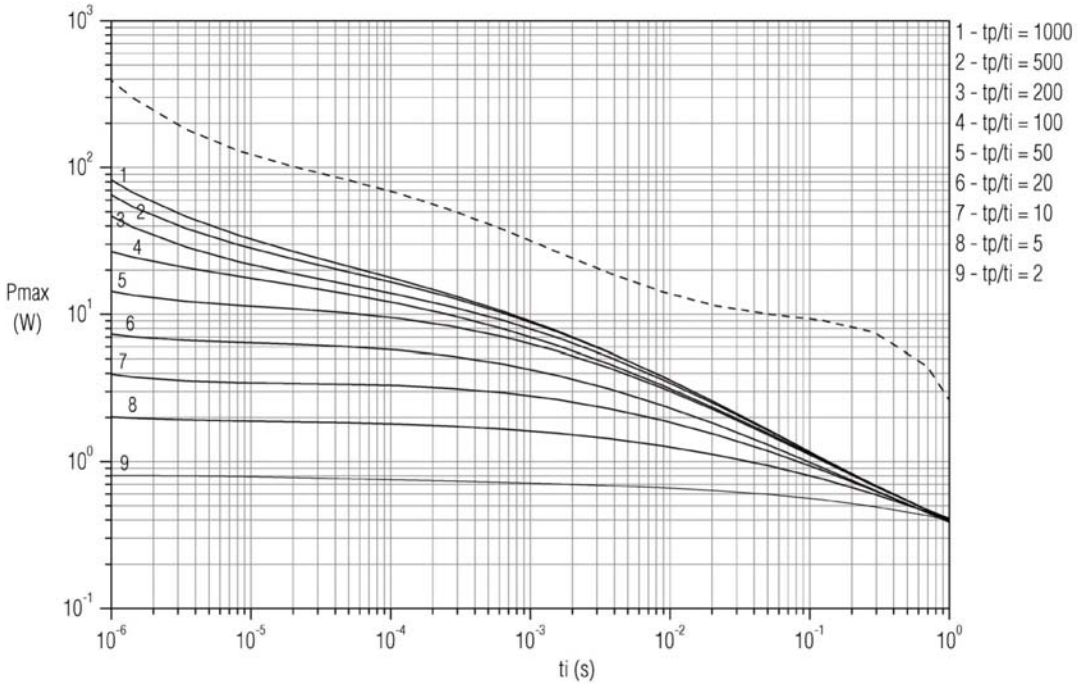

Fig. 12 - Pulse on a regular basis, maximum permissible peak pulse power (P_{max}) as a function of pulse duration (ti)

SFR25H

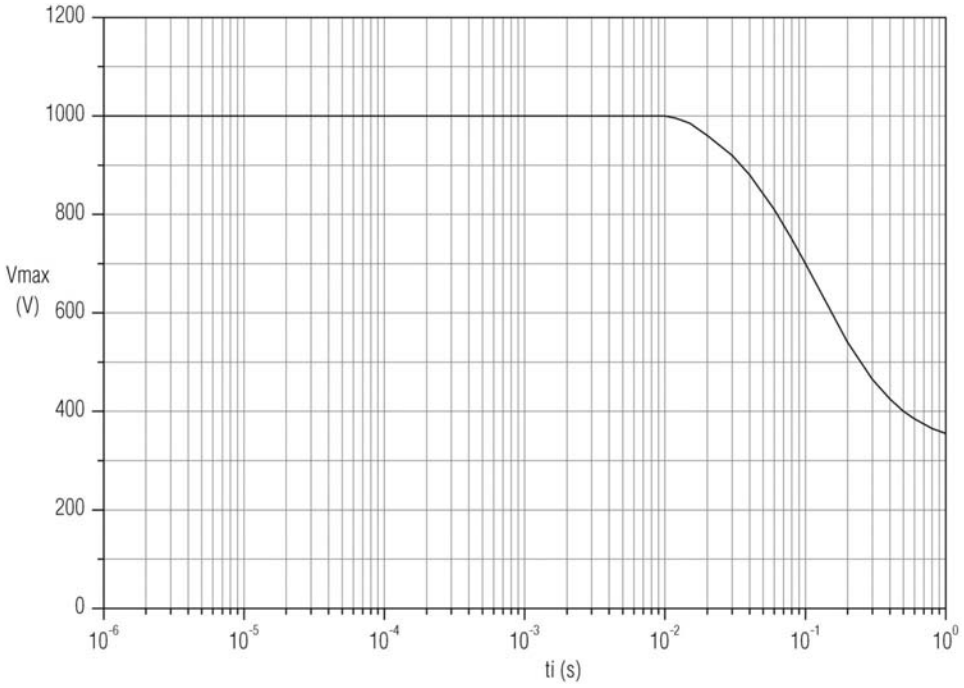

Fig. 13 - Pulse on a regular basis, maximum permissible peak pulse voltage (V_{max}) as a function of pulse duration (ti)

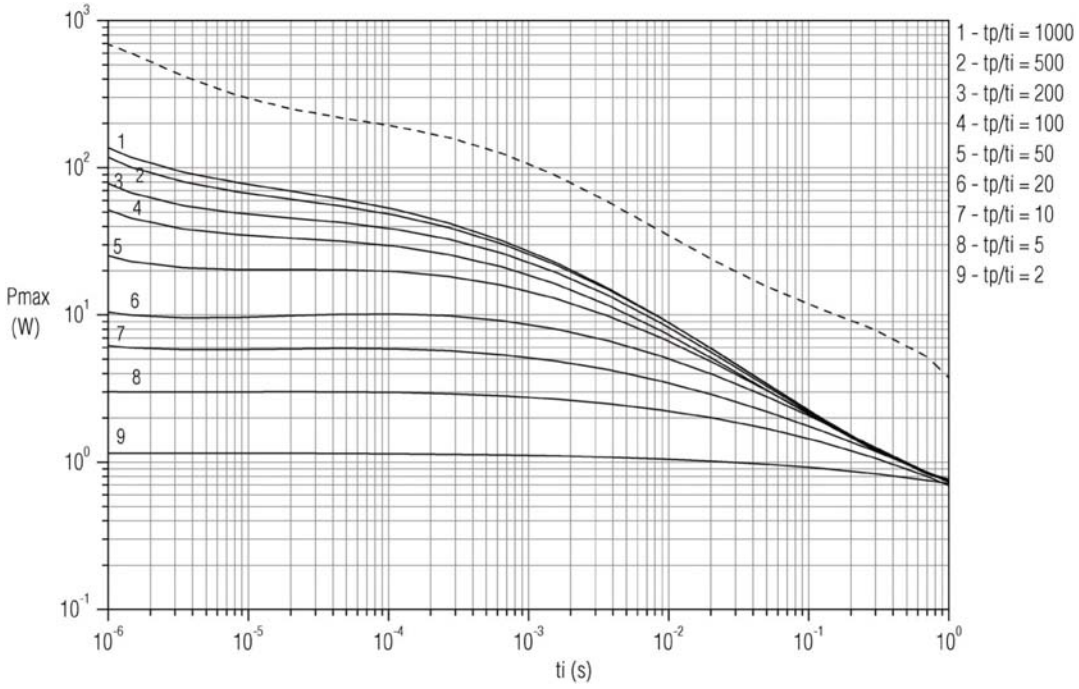

Fig. 14 - Pulse on a regular basis, maximum permissible peak pulse power (P_{max}) as a function of pulse duration (ti)

MARKING

The nominal resistance and tolerance are marked on the resistor using four or five colored bands in accordance with IEC publication 60062 “Color code for fixed resistors”. Standard values of nominal resistance are taken from the E24/E96 series for resistors with a tolerance of ±5% or ±1%. The values of the E24/E96 series are in accordance with IEC publication 60063.

ORDERING INFORMATION

Table 2. Ordering code.

PRODUCT	TOLERANCE	ORDERING CODE	TAPING	LEAD ∅	PACKAGING	QUANTITY pcs.
SFR16S	±5%	2322 187 53xxx	52.5 (2.07)	0.45 Cu (0.018)	AMMOPACK	5000
		2306 187 23xxx			REEL	
		2322 187 43xxx	26.0 (3.03)		AMMOPACK	
	±1%	2306 187 7xxxx			AMMOPACK	
		2306 187 1xxxx	52.5 (2.07)		REEL	
		2306 187 3xxxx			AMMOPACK	

PRODUCT	TOLERANCE	ORDERING CODE	TAPING	LEAD ∅	PACKAGING	QUANTITY pcs.
SFR25	±5%	2306 181 43xxx	26.0 (1.03)	0.58 Cu (0.023)	AMMOPACK	4000
		2322 181 43xxx	52.5 (2.07)		AMMOPACK	5000
		2322 181 63xxx			REEL	
	±1%	2322 188 2xxxx	52.5 (2.07)		AMMOPACK	
		2322 181 8xxxx			REEL	
SFR25H	±5%	2306 186 43xxx	26.0 (1.03)	0.58 Cu (0.023)	AMMOPACK	4000
		2306 186 63xxx	52.5 (2.07)		REEL	5000
		2322 186 76xxx			AMMOPACK	
	±1%	2322 186 3xxxx	52.5 (2.07)		AMMOPACK	
		2306 186 8xxxx			REEL	

Dimensions unless specified in mm (inches)
Check "***Formed leads***" specification to see related part-numbers

Table 3. Last digit of ordering code

RESISTANCE DECADE (5%)	RESISTANCE DECADE (1%)	LAST DIGIT
1 - 9.1 Ω	4.99 - 9.76 Ω	8
10 - 91 Ω	10 - 97.6 Ω	9
100 - 910 Ω	100 - 976 Ω	1
1 - 9.1 kΩ	1 - 9.76 kΩ	2
10 - 91 kΩ	10 - 97.6 kΩ	3
100 - 910 kΩ	100 - 976 kΩ	4
1 - 3 MΩ	1 - 2.4 MΩ	5

The resistors have a 12 digit ordering code starting with 2306 or 2322. The next 5 digits indicate the resistor type and packaging see table 2.
For 5% tolerance the last 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.

For 1% tolerance the last 4 digits indicate the resistance value:
- The first 3 digits indicate the resistance value;
- The last digit indicates the resistance decade in accordance with table 3.

Example:
SFR16S, 680 Ω, ±5%, taping distance 52.5 mm, ammopack 5000 pcs is **2322 187 53681**.

NAFTA ORDERING INFORMATION

Table 4. NAFTA ordering code.

PRODUCT	TOLERANCE	NAFTA ORDERING CODE	TAPING	LEAD ∅	PACKAGING	QUANTITY pcs.
SFR16S	±5%	5033EMxxxxxJ18AFX	52.5 (2.07)	0.45 Cu (0.018)	AMMOPACK	5000
		5033EMxxxxxJ12AFX			REEL	
		5033EMxxxxxJ26M	26.0 (1.03)		AMMOPACK	
	±1%	5033EDxxxxxF26M			AMMOPACK	
		5033EDxxxxxF18AF5	52.5 (2.07)		AMMOPACK	
		5033EDxxxxxF12AF5			REEL	
SFR25	±5%	5043EMxxxxxJ26M	26.0 (1.03)	0.58 Cu (0.023)	AMMOPACK	4000
		5043EMxxxxxJ12AFX	52.5 (2.07)		REEL	5000
		5043EMxxxxxJ18AFX			AMMOPACK	
	±1%	5043EDxxxxxF12AF5	52.5 (2.07)		REEL	
		5043EDxxxxxF18AF5			AMMOPACK	
SFR25H	±5%	5053EMxxxxxJ26M	26.0 (1.03)	0.58 Cu (0.023)	AMMOPACK	4000
		5053HDxxxxxJ18AFX	52.5 (2.07)		AMMOPACK	5000
		5053HMxxxxxJ12AFX			REEL	
	±1%	5053HMxxxxxF18AFX	52.5 (2.07)		AMMOPACK	
		5053HDxxxxxF12AF5			REEL	

Dimensions unless specified in mm (inches)

Table 5. Examples of the ohmic value.

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

The ohmic value in the NAFTA ordering code (see table 4) is represented by the “xxxxx” in the middle of the above ordering code. Table 5 gives some examples on how to use these 5 digits.

Example:
SFR16S, 1000Ω, ±5%, taping distance 52.5mm, ammopack 5000 pcs is **5033EM1K000J18AFX**

PACKAGING

TAPE IN AMMOPACK

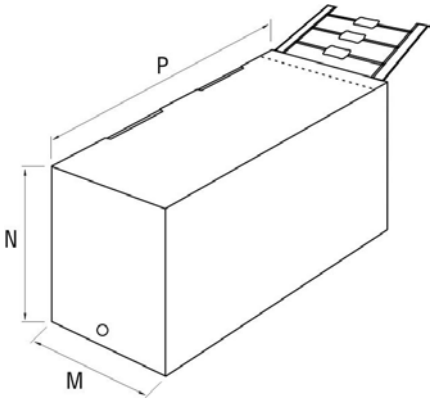

Table 6. Ammopack.

PRODUCT	TAPING	M	N	P	QUANTITY (pcs)
SFR16S	52.5 ±1.5 (2.07 ±0.06)	79 (3.2)	73 (2.9)	260 (10.3)	5000
	26.0 ±1.5 (1.03 ±0.06)	51 (2.1)	79 (3.2)	255 (10.1)	5000
SFR25	52.5 ±1.5 (2.07 ±0.06)	78 (3.1)	98 (3.9)	260 (10.3)	5000
	26.0 ±1.5 (1.03 ±0.06)	52 (2.1)	98 (3.9)	255 (10.1)	4000
SFR25H	52.5 ±1.5 (2.07 ±0.06)	78 (3.1)	98 (3.9)	260 (10.3)	5000
	26.0 ±1.5 (1.03 ±0.06)	52 (2.1)	98 (3.9)	255 (10.1)	4000

Dimensions unless specified in mm (inches)

TAPE ON REEL

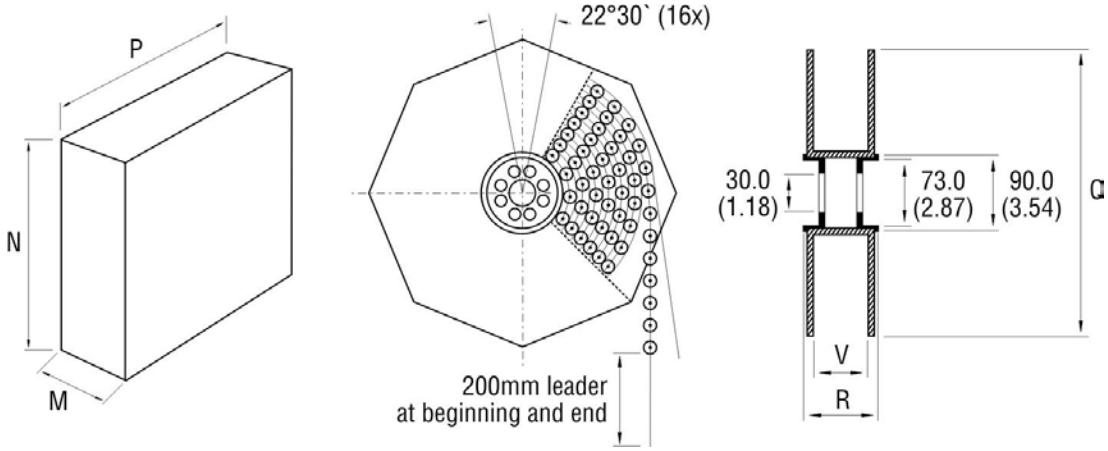

Table 7. Reel.

PRODUCT	TAPING	M	N	P	Q	V	R	QUANTITY (pcs)
SFR16S	52.5 ±1.5 (2.07 ±0.06)	92 (3.7)	273 (10.8)	273 (10.8)	267 (10.6)	75 (3.0)	86 (3.4)	5000
SFR25	52.5 ±1.5 (2.07 ±0.06)	92 (3.7)	311 (12.3)	311 (12.3)	305 (12.1)	75 (3.0)	86 (3.4)	5000
SFR25H	52.5 ±1.5 (2.07 ±0.06)	92 (3.7)	311 (12.3)	311 (12.3)	305 (12.1)	75 (3.0)	86 (3.4)	5000

Dimensions unless specified in mm (inches)

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the schedule of IEC publications 60115–1, category 55/155/56 (rated temperature range -55 to +155 °C; damp heat, long term, 56 days and along the lines of IEC publications 60068-2); “Recommended basic climatic and mechanical robustness testing procedure for electronic components” and under standard atmosphere conditions according to IEC 60068-1 subclause 5.3, unless otherwise specified.
In some instances deviations from IEC applications were necessary for our specified method.

Table 8. Test and requirements.

IEC 60115-1 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	RESISTANCE RANGE	REQUIREMENTS	
					Tolerance 5%	Tolerance 1%
4.6.1.1	-	Insulation resistance	500V (DC); during 1 minute; V-block method	-	$R_{ins\ min}$ 10^4 MΩ	
4.7	-	Voltage proof on insulation	400V (RMS) for SFR16S and 600V (RMS) for SFR25/SFR25H; during 1 minute; V-block method	-	No breakdown or flashover	
4.8	-	Temperature coefficient	Between - 55 °C and + 155 °C	SFR156S: R < 4.7 Ω R ≤ 200 KΩ R > 200 KΩ	 ±250 ppm/°C ±100 ppm/°C ±250 ppm/°C	 ±100 ppm/°C ±250 ppm/°C
				SFR25/SFR25H: R ≤ 1 MΩ R > 1 MΩ	±100 ppm/°C ±250 ppm/°C	
4.12	-	Noise	IEC publication 60195	SFR16S: R < 68 kΩ R ≤ 100 kΩ R > 100 kΩ	 ≤ 0.1 μV/V ≤ 0.5 μV/V ≤ 1.5 μV/V	
				SFR25/SFR25H: R ≤ 1 MΩ R > 1 MΩ	 ≤ 1.0 μV/V ≤ 1.5 μV/V	
4.13	-	Short time overload	Room temperature; P = 6.25 x 0.25W for SFR16S and P = 6.25 x Pn for SFR25/SFR25H; 5 s ON and 45 s OFF (V ≤ 2 x V_{max}); 10 cycles	-	$\Delta R/R_{max}$ ±0.25% +0.05Ω	

IEC 60115-1 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	RESISTANCE RANGE	REQUIREMENTS	
					Tolerance 5%	Tolerance 1%
4.16	21(U)	Robustness of terminations:			No damage	
4.16.2	21(Ua1)	Tensile all samples	Load 5 N; 10 s			
4.16.3	21(Ub)	Bending half number of samples	Load 2.5 N; 4 x 90°			
4.16.4	21(Uc)	Torsion other half of samples	3 x 360° in opposite directions		$\Delta R/R_{max}$ ±0.25% +0.05Ω	$\Delta R/R_{max}$ ±0.1% +0.05Ω
4.17	20(Ta)	Solderability (after ageing)	16 h at 155 °C; leads immersed in flux 600, leads immersed 2 mm for 2 ±0.5 s in a solder bath at 235 ±5 °C		Good tinning (≥ 95% covered); No damage	
4.18	20(Tb)	Resistance to soldering heat	Thermal shock: 3 seconds; 350 °C; 6 mm from body	SFR16S:	$\Delta R/R_{max}$ ±0.25% +0.05Ω	
				SFR25/SFR25H:	$\Delta R/R_{max}$ ±0.25% +0.05Ω	$\Delta R/R_{max}$ ±0.1% +0.05Ω
4.19	14(Na)	Rapid change of Temperature	30 minutes at -55 °C and 30 minutes at +155 °C;		No visual damage	
				SFR16S: R ≤ 100 K	$\Delta R/R_{max}$ ±0.25% +0.05Ω	$\Delta R/R_{max}$ ±0.25% +0.05Ω
				R > 100 K		$\Delta R/R_{max}$ ±0.1% +0.05Ω
				SFR25/SFR25H:	$\Delta R/R_{max}$ ±0.25% +0.05Ω	$\Delta R/R_{max}$ ±0.1% +0.05Ω
4.22	6(Fc)	Vibration	Frequency 10 to 500 Hz; displacement 1.5 mm or acceleration 10g; three directions; total 6 h (3x2 h)		No damage	
					$\Delta R/R_{max}$ ±0.25% +0.05Ω	$\Delta R/R_{max}$ ±0.1% +0.05Ω

IEC 60115-1 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	RESISTANCE RANGE	REQUIREMENTS	
					Tolerance 5%	Tolerance 1%
4.23		Climatic sequence:			$R_{ins\ min}$ 10^3 MΩ	
4.23.2	2(Ba)	Dry heat	16 h; 155 °C			
4.23.3	30(Db)	Damp heat (accelerated) 1st cycle	24 h; 25 °C to 55 °C; 90 to 100% RH			
4.23.4	1(Aa)	Cold	2 h; - 55 °C			
4.23.6	30(Db)	Damp heat (accelerated) remaining cycles	5 days; 25 °C to 55 °C; 90 to 100% R.H.	SFR16S: R ≤ 200 KΩ R > 200 KΩ	$\Delta R/R_{max}$ ±1% +0.05Ω	$\Delta R/R_{max}$ ±0.5% +0.05Ω $\Delta R/R_{max}$ ±1% +0.05Ω
				SFR25/SFR25H:	$\Delta R/R_{max}$ ±1% +0.05Ω	$\Delta R/R_{max}$ ±0.5% +0.05Ω
4.24	3(Ca)	Damp heat (steady state)	56 days; 40 °C; 90 to 95% R.H.; loaded with 0.01 Pn		$R_{ins\ min}$ 10^3 MΩ	
				SFR16S: R ≤ 200 KΩ R > 200 KΩ	$\Delta R/R_{max}$ ±1% +0.05Ω	$\Delta R/R_{max}$ ±0.5% +0.05Ω $\Delta R/R_{max}$ ±1% +0.05Ω
				SFR25/SFR25H:	$\Delta R/R_{max}$ ±1% +0.05Ω	$\Delta R/R_{max}$ ±0.5% +0.05Ω
4.25.1	-	Endurance (at 70 °C)	1000 h; loaded with Pn or V_{max}; 1.5 h ON and 0.5 h OFF	SFR16S: R ≤ 200 KΩ R > 200 KΩ	$\Delta R/R_{max}$ ±1% +0.05Ω	$\Delta R/R_{max}$ ±0.5% +0.05Ω $\Delta R/R_{max}$ ±1% +0.05Ω
				SFR25/SFR25H:	$\Delta R/R_{max}$ ±1% +0.05Ω	$\Delta R/R_{max}$ ±0.5% +0.05Ω
4.29	45(Xa)	Component solvent resistance	Isopropyl alcohol followed by brushing in accordance with MIL STD 202		No visual damage	
See 2nd amendment to ÏEC 60115-1		Pulse load			See Figs. 9, 10, 11, 12, 13 and 14	