

## Standard Metal Film Resistors



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 colored 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".

### FEATURES

- Low cost
- Low noise
- Small size (SFR16S)
- Lead (Pb)-free solder contacts
- Pure tin plating provides compatibility with lead (Pb)-free and lead containing soldering processes
- Compatible with "Restriction of the use of Hazardous Substances" (RoHS) directive 2002/95/EC (issue 2004)



### APPLICATIONS

- General purpose resistors

TECHNICAL SPECIFICATIONS			
DESCRIPTION	VALUE		
	SFR16S	SFR25	SFR25H
Resistance range	± 5 %; 1 Ω to 3 MΩ ± 1 %; 4.99 Ω to 3 MΩ jumper (0 Ω)	± 5 %; 0.22 Ω to 10 MΩ ± 1 %; 1 Ω to 10 MΩ jumper (0 Ω)	
Resistance tolerance	± 1 %, E24/E96 series; ± 5 %, E24 series		
Temperature coefficient: R < 4.7 Ω 4.7 Ω ≤ R ≤ 100 kΩ 100 kΩ < R ≤ 1 MΩ R > 1 MΩ	≤± 250 × 10 <sup>-6</sup> /K ≤± 100 × 10 <sup>-6</sup> /K ≤± 250 × 10 <sup>-6</sup> /K ≤± 250 × 10 <sup>-6</sup> /K	≤± 100 × 10 <sup>-6</sup> /K ≤± 100 × 10 <sup>-6</sup> /K ≤± 100 × 10 <sup>-6</sup> /K ≤± 250 × 10 <sup>-6</sup> /K	≤± 100 × 10 <sup>-6</sup> /K ≤± 100 × 10 <sup>-6</sup> /K ≤± 100 × 10 <sup>-6</sup> /K ≤± 250 × 10 <sup>-6</sup> /K
Absolute maximum dissipation at T <sub>amb</sub> = 70 °C	0.5 W	0.4 W	0.5 W
Thermal resistance, R <sub>th</sub>	170 K/W	200 K/W	150 K/W
Maximum permissible voltage	200 V	250 V	350 V
Noise: R < 68 kΩ 68 kΩ ≤ R ≤ 100 kΩ 100 kΩ ≤ R ≤ 1 MΩ R > 1 MΩ	max. 0.1 μV/V max. 0.5 μV/V max. 1.5 μV/V max. 1.5 μV/V	max. 0.1 μV/V max. 0.1 μV/V max. 0.1 μV/V max. 1.5 μV/V	max. 0.1 μV/V max. 0.1 μV/V max. 0.1 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 range climatic tests: R ≤ 1 MΩ R > 1 MΩ	± 2 % + 0.05 Ω  ± 1 % + 0.05 Ω ± 1 % + 0.05 Ω	± 2 % + 0.05 Ω  ± 1 % + 0.05 Ω ± 1 % + 0.05 Ω	± 2 % + 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



**12NC INFORMATION**

- The resistors have a 12-digit numeric code starting with 23.
- The subsequent 6 or 7 digits indicate the resistor type and packing.
- The remaining digits indicate the resistance value:
  - The first 3 digits for 1 % or 2 digits for 5 % indicate the resistance value.
  - The last digit indicates the resistance decade.

**Last Digit of 12NC 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

**Last Digit of 12NC for ± 1 % Tolerance**

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

**12NC Example**

The 12NC of a SFR25 resistor, value 5600 Ω ± 5 %, taped on a bandolier of 5000 units in ammpack is: 2322 181 43562.

12NC - resistor type and packing					
TYPE	TOL.	ORDERING CODE 23.. ... ..			
		BANDOLIER IN AMMOPACK			BANDOLIER ON REEL
		RADIAL TAPED	STRAIGHT LEADS		STRAIGHT LEADS
		4000 units	1000 units	5000 units	5000 units
SFR16S	± 5 %	–	..22 187 73...	..22 187 53...	..06 187 23...
	± 1 %	–	–	..06 187 3...	..06 187 1....
	jumper <sup>1)</sup>	–	–	..06 187 90013	..22 187 90346
SFR25	± 5 %	..06 184 03...	..22 181 53...	..22 181 43...	..22 181 63...
	± 1 %	–	–	..22 188 2...	..06 181 8....
	jumper <sup>2)</sup>	–	<b>..22 181 90018</b>	..22 181 90019	..06 181 90011
SFR25H	± 5 %	–	..22 186 16...	..22 186 76...	..06 186 63...
	± 1 %	–	–	..22 186 3....	..06 186 8....

1. The jumper has a maximum resistance R<sub>max</sub> = 30 mΩ at 3 A (SFR16S).
2. The jumper has a maximum resistance R<sub>max</sub> = 10 mΩ at 5 A (SFR25).

**PART NUMBER**

PART NUMBER: SFR2500001001FA500

S	F	R	2	5	0	0	0	0	1	0	0	1	F	A	5	0	0
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MODEL/SIZE	SPECIAL CHARACTER	TC/MATERIAL	VALUE	TOLERANCE	PACKING <sup>1)</sup>	SPECIAL
SFR16S0 SFR2500 SFR25H0	0 = neutral Z = value overflow (Special)	0 = standard Z = jumper	3 digit value 1 digit multiplier <b>Multiplier:</b> 7 = *10 <sup>-3</sup> 2 = *10 <sup>2</sup> 8 = *10 <sup>-2</sup> 3 = *10 <sup>3</sup> 9 = *10 <sup>-1</sup> 4 = *10 <sup>4</sup> 0 = *10 <sup>0</sup> 5 = *10 <sup>5</sup> 1 = *10 <sup>1</sup>	F = ± 1 % J = ± 5 % Z = jumper	N4 A5 A1 R5	The 2 digits are used for all special parts. 00 = standard

PRODUCT DESCRIPTION: SFR25 1 % A5 1K0

SFR25	1 %	A5	1K0
MODEL/SIZE	TOLERANCE	PACKING <sup>1)</sup>	RESISTANCE VALUE
SFR16S SFR25 SFR25H	± 1 % ± 5 %	A1 A5	47K = 47 KΩ 50R1 = 50.1 Ω

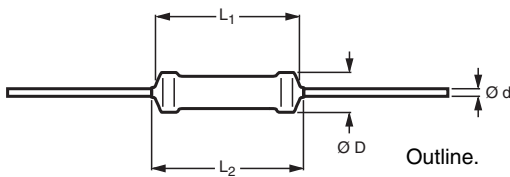
<sup>1)</sup> Please refer to table PACKING.

**Note**

Products can be ordered using either the 12NC or the PART NUMBER. The PART NUMBER is shown to facilitate the introduction of a unified part numbering system. Currently, this PART NUMBER is applicable in the Americas only.

PACKING			
CODE	PIECES	DESCRIPTION	MODEL/SIZE
N4	4000	Bandolier in ammopack radial taped	SFR25
A5	5000	Bandolier in ammopack straight leads	SFR16S, SFR25, SFR25H
A1	1000	Bandolier in ammopack straight leads	SFR16S, SFR25, SFR25H
R5	5000	Bandolier on reel straight leads	SFR16S, SFR25, SFR25H

## DIMENSIONS



DIMENSIONS - resistor types and relevant physical dimensions in millimeters				
TYPE	Ø D MAX.	L <sub>1</sub> MAX.	L <sub>2</sub> MAX.	Ø d
SFR16S	1.9	3.5	4.1	0.45 ± 0.05
SFR25	2.5	6.5	7.5	0.58 ± 0.05
SFR25H	2.5	6.5	7.5	0.58 ± 0.05

MASS PER 100 UNITS	
TYPE	MASS (g)
SFR16S	10.2
SFR25	20.5
SFR25H	20.5

## OUTLINES

The length of the body (L<sub>1</sub>) 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").

## MARKING

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

## FUNCTIONAL PERFORMANCE PRODUCT CHARACTERIZATION

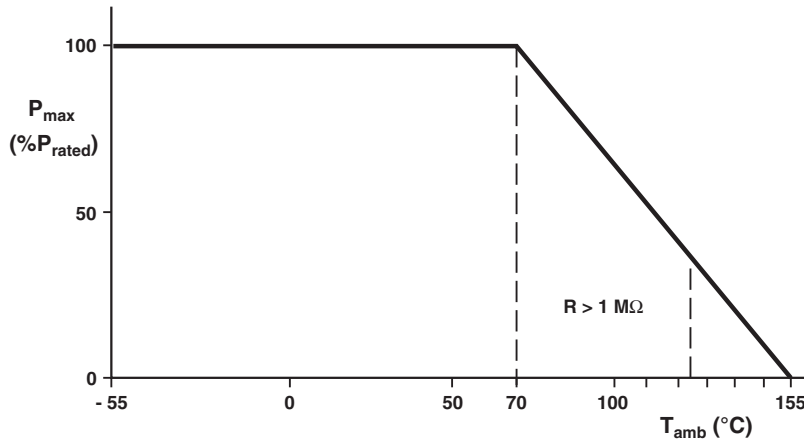
Standard values of nominal resistance are taken from the E96/E24 series for resistors with a tolerance of ± 1 % or ± 5 %. The values of the E96/E24 series are in accordance with "IEC publication 60063".

LIMITING VALUES		
TYPE	LIMITING VOLTAGE <sup>1)</sup> (V)	LIMITING POWER (W)
SFR16S	200	0.5
SFR25	250	0.4
SFR25H	350	0.5

### Note

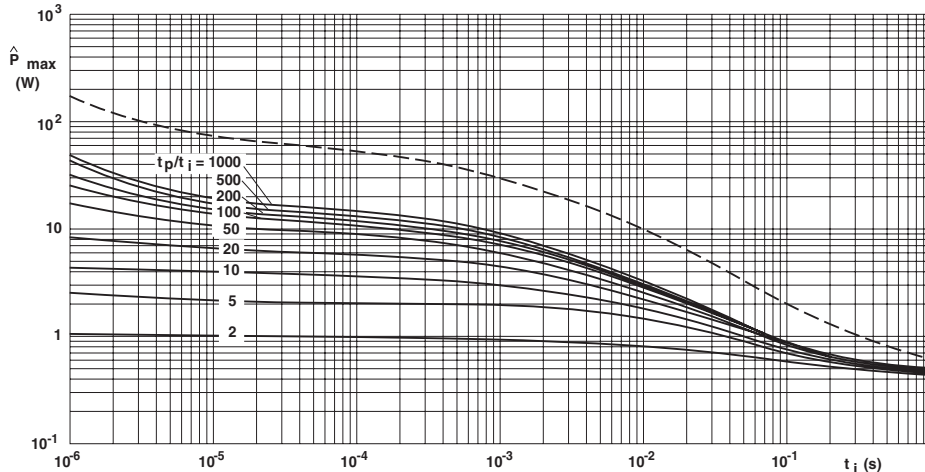
- The maximum voltage that may be continuously applied to the resistor element, see "IEC publication 60115-1". The maximum permissible hot-spot temperature is 155 °C.

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

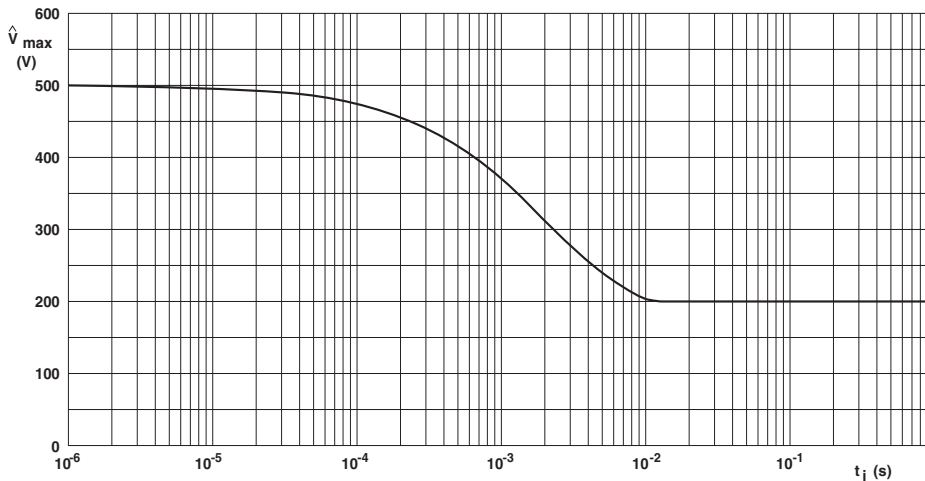


Maximum dissipation ( $P_{max}$ ) in percentage of rated power as a function of the ambient temperature ( $T_{amb}$ ).

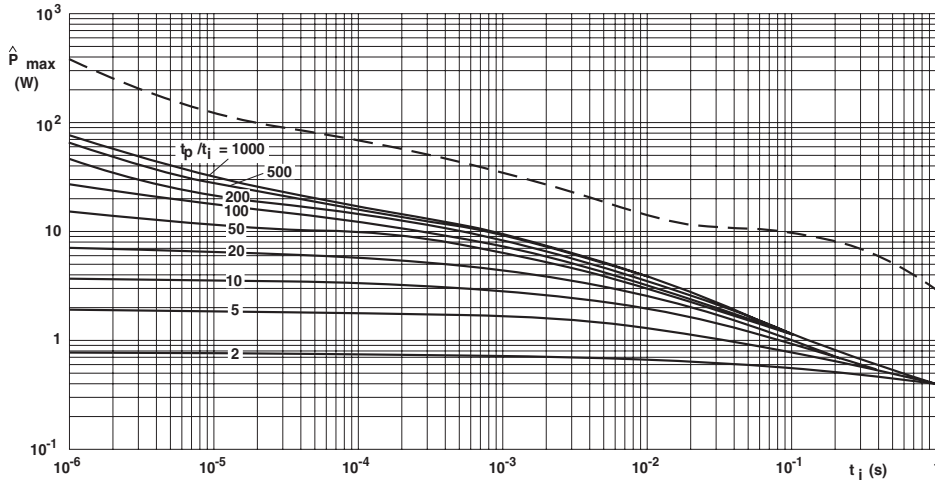
**Derating**



**SFR16S** Pulse on a regular basis; maximum permissible peak pulse power ( $\hat{P}_{max}$ ) as a function of pulse duration ( $t_i$ )

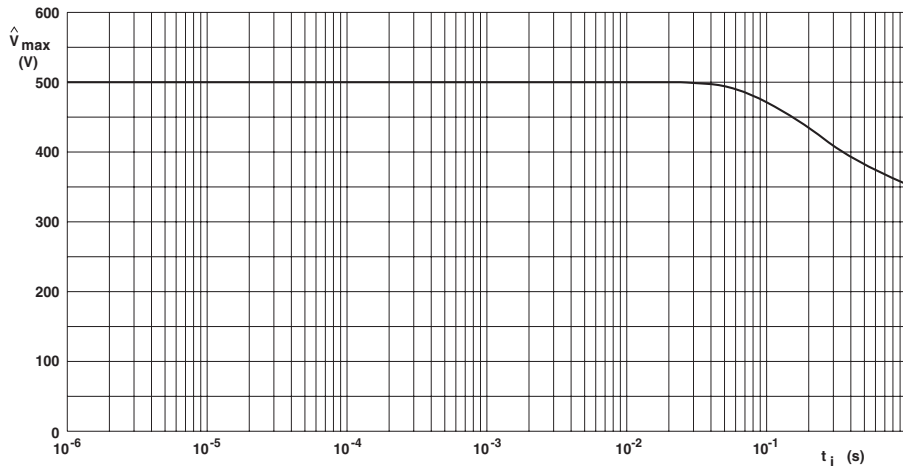


**SFR16S** Pulse on a regular basis; maximum permissible peak pulse voltage ( $\hat{V}_{max}$ ) as a function of pulse duration ( $t_i$ )

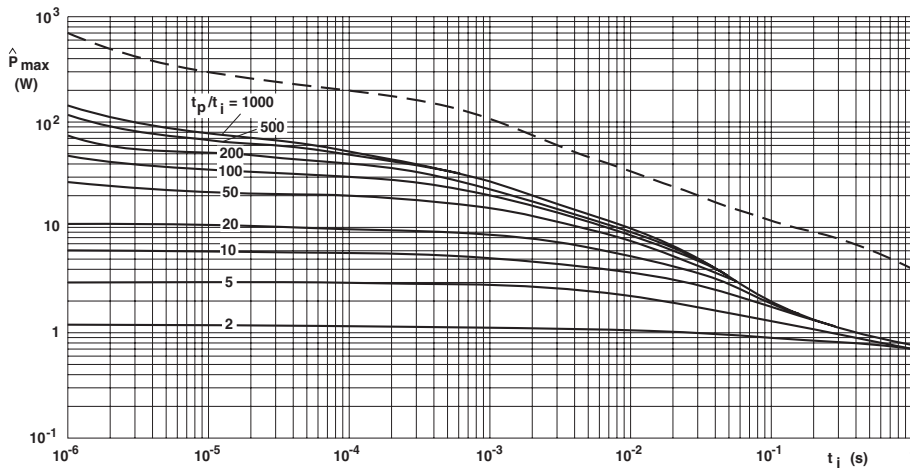


SFR25 Pulse on a regular basis; maximum permissible peak pulse power ( $\hat{P}_{max}$ ) as a function of pulse duration ( $t_i$ )

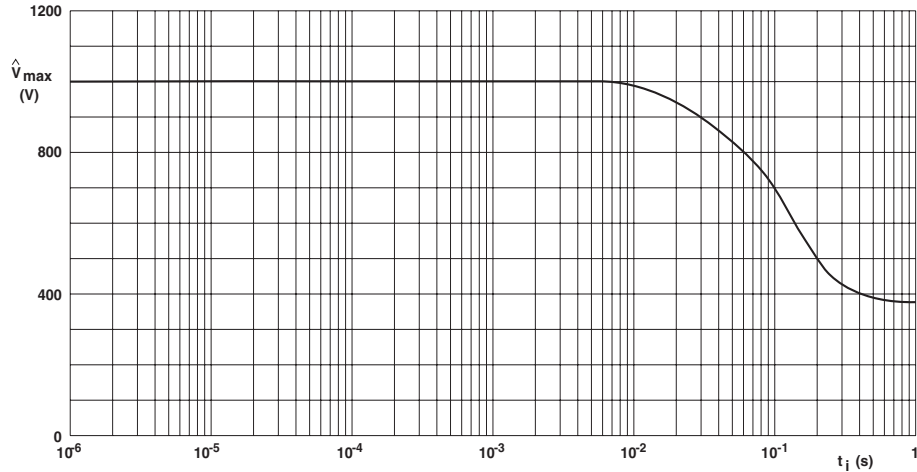
**Pulse Loading Capabilities**



SFR25 Pulse on a regular basis; maximum permissible peak pulse voltage ( $\hat{V}_{max}$ ) as a function of pulse duration ( $t_i$ )

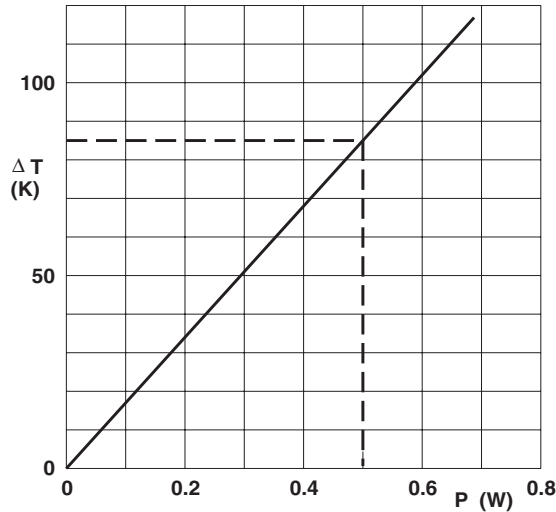


SFR25H Pulse on a regular basis; maximum permissible peak pulse power ( $\hat{P}_{max}$ ) as a function of pulse duration ( $t_i$ )

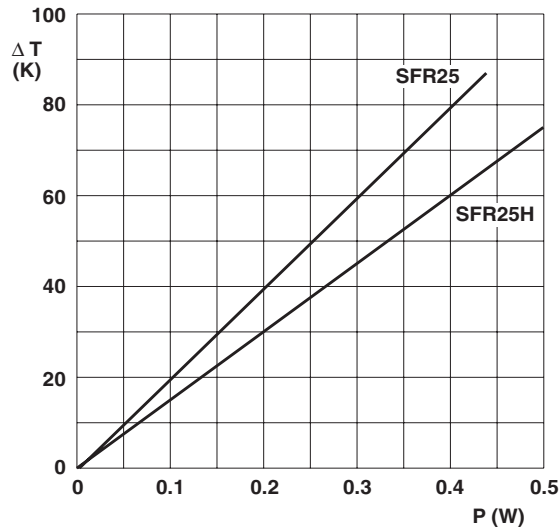


SFR25H Pulse on a regular basis; maximum permissible peak pulse voltage ( $\hat{V}_{max}$ ) as a function of pulse duration ( $t_i$ )

**Pulse Loading Capabilities**



SFR16S Hot-spot temperature rise ( $\Delta T$ ) as a function of dissipated power



SFR25/SFR25H Hot-spot temperature rise ( $\Delta T$ ) as a function of dissipated power

**Application Information**

**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 the Test Procedures and Requirements table 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.

TEST PROCEDURES AND REQUIREMENTS							
IEC 60115-1 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	RESISTANCE RANGE	REQUIREMENTS		
					SFR16S	SFR25	SFR25H
4.16	21 (U)	robustness of terminations:			number of failures < $10 \times 10^{-6}$		
4.16.2	21 (Ua1)	tensile all samples	$\varnothing$ 0.45 mm, load 5 N; 10 s $\varnothing$ 0.58 mm, load 10 N; 10 s				
4.16.3	21 (Ub)	bending half number of samples	$\varnothing$ 0.45 mm, load 2.5 N; $4 \times 90^\circ$ $\varnothing$ 0.58 mm, load 5 N; $4 \times 90^\circ$				
4.16.4	21 (Uc)	torsion other half of samples	$3 \times 360^\circ$ in opposite directions				
4.17	20 (Ta)	solderability	2 s; 235 °C; flux 600		good tinning; no damage		
4.18	20 (Tb)	resistance to soldering heat	3.5 s; 350 °C; solder bath method		$\Delta R/R$ max.: $\pm 0.25\% + 0.05 \Omega$		
4.19	14 (Na)	rapid change of temperature	30 minutes at - 55 °C and 30 minutes at + 155 °C; 5 cycles		$\Delta R/R$ max.: $\pm 0.25\% + 0.05 \Omega$		
4.20	29 (Eb)	bump	$3 \times 1500$ bumps in 3 directions; 40 g		no damage $\Delta R/R$ max.: $\pm 0.25\% + 0.05 \Omega$		
4.22	6 (Fc)	vibration	frequency 10 to 500 Hz; displacement 1.5 mm or acceleration 10 g; 3 directions; total 6 hours ( $3 \times 2$ hours)		no damage $\Delta R/R$ max.: $\pm 0.25\% + 0.05 \Omega$		
4.23	2 (Ba) 30 (Db) 1 (Aa) 13 (M) 30 (Db)	climatic sequence:			$R_{ins}$ min.: 1000 M $\Omega$  $\Delta R/R$ max.: $\pm 1\% + 0.05 \Omega$		
4.23.2		dry heat	16 hours; 155 °C				
4.23.3		damp heat (accelerated) 1 <sup>st</sup> cycle	24 hours; 55 °C; 90 to 100 % RH				
4.23.4		cold	2 hours; - 55 °C				
4.23.5		low air pressure	2 hours; 8.5 kPa; 15 to 35 °C				
4.23.6		damp heat (accelerated) remaining cycles	5 days; 55 °C; 95 to 100 % RH	$R \leq 1 M\Omega$  $R > 1 M\Omega$			
4.24.2	3 (Ca)	damp heat (steady state)	56 days; 40 °C; 90 to 95 % RH; dissipation 0.01 P <sub>n</sub>		$R_{ins}$ min.: 1000 M $\Omega$ $\Delta R/R$ max.: $\pm 2\% + 0.05 \Omega$		



TEST PROCEDURES AND REQUIREMENTS							
IEC 60115-1 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	RESISTANCE RANGE	REQUIREMENTS		
					SFR16S	SFR25	SFR25H
4.25.1		endurance	1000 hours at 70 °C; $P_n$ or $V_{max}$		$\Delta R/R$ max.: $\pm 2\% + 0.05\ \Omega$		
4.8.4		temperature coefficient	between - 55 °C and + 155 °C ( $TC \times 10^{-6}/K$ )	R < 4.7 $\Omega$ R $\leq$ 100 k $\Omega$ R $\leq$ 1 M $\Omega$ R > 1 M $\Omega$	$\leq \pm 250$ $\leq \pm 100$ $\leq \pm 250$ $\leq \pm 250$	$\leq \pm 100$ $\leq \pm 100$ $\leq \pm 100$ $\leq \pm 250$	$\leq \pm 100$ $\leq \pm 100$ $\leq \pm 100$ $\leq \pm 250$
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 k $\Omega$ R $\leq$ 100 k $\Omega$ R $\leq$ 1 M $\Omega$ R > 1 M $\Omega$	max. 0.1 $\mu V/V$ max. 0.5 $\mu V/V$ max. 1.5 $\mu V/V$ max. 1.5 $\mu V/V$	max. 0.1 $\mu V/V$ max. 0.1 $\mu V/V$ max. 0.1 $\mu V/V$ max. 1.5 $\mu V/V$	max. 0.1 $\mu V/V$ max. 0.1 $\mu V/V$ max. 0.1 $\mu V/V$ max. 1.5 $\mu V/V$
4.6.1.1		insulation resistance	500 V (DC) during 1 minute; V-block method		$R_{ins}$ min.: 1000 M $\Omega$		
4.13		short time overload	room temperature; $P = 6.25 \times P_n$ (SFR25) or $6.25 \times 0.25\ W$ (SFR16S); 5 s on, 45 s off ( $V \leq 2 \times V_{max}$ ); 10 cycles		$\Delta R/R$ max.: $\pm 0.25\% + 0.05\ \Omega$		$\Delta R/R$ max.: $\pm 1\% + 0.05\ \Omega$
		intermittent overload in accordance with "JIS-C5202 5.8"	$16 \times 0.16\ W$ ; 1 s on and 25 s off; 10000 $\pm$ 200 cycles; $V_{max} = 600\ V$		$\Delta R/R$ max.: $\pm 0.75\%$ $+ 0.05\ \Omega$	–	–
see 2 <sup>nd</sup> amendment to "IEC 60115-1", Jan. '87		pulse load			see Pulse Loading Capabilities graphs		



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