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 (max. 1.5 µV/V for $R > 1$ MΩ)
- Small size (SFR16S-0204, SFR25/25H-0207)
- 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	± 5 %; 0.22 Ω to 10 MΩ	
	± 1 %; 4.99 Ω to 3 MΩ	± 1 %; 1 Ω to 10 MΩ	
	jumper (0 Ω)	jumper (0 Ω)	
Resistance Tolerance	± 1 %, E24/E96 series; ± 5 %, E24 series		
Temperature Coefficient:			
$R < 4.7$ Ω	≤ ± 250 x 10^{-6}/K	≤ ± 100 x 10^{-6}/K	≤ ± 100 x 10^{-6}/K
4.7 Ω ≤ R ≤ 100 kΩ	≤ ± 100 x 10^{-6}/K	≤ ± 100 x 10^{-6}/K	≤ ± 100 x 10^{-6}/K
100 kΩ < R ≤ 1 MΩ	≤ ± 250 x 10^{-6}/K	≤ ± 100 x 10^{-6}/K	≤ ± 100 x 10^{-6}/K
$R > 1$ MΩ	≤ ± 250 x 10^{-6}/K	≤ ± 250 x 10^{-6}/K	≤ ± 250 x 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:			
$R < 68$ kΩ	max. 0.1 µV/V	max. 0.1 µV/V	max. 0.1 µV/V
68 kΩ ≤ R ≤ 100 kΩ	max. 0.5 µV/V	max. 0.1 µV/V	max. 0.1 µV/V
100 kΩ ≤ 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
Basic Specifications	IEC 60115-1 and 60115-2		
Climatic Category (IEC 60068)	55/155/56		
Stability, ΔR max., After:			
Load:			
R range	± (2 % R + 0.05 Ω)	± (2 % R + 0.05 Ω)	± (2 % R + 0.05 Ω)
Climatic Tests:			
R ≤ 1 MΩ	± (1 % R + 0.05 Ω)	± (1 % R + 0.05 Ω)	± (1 % R + 0.05 Ω)
$R > 1$ MΩ	± (1 % R + 0.05 Ω)	± (1 % R + 0.05 Ω)	± (2 % R + 0.1 Ω)
Soldering	± (0.25 % R + 0.05 Ω)	± (0.25 % R + 0.05 Ω)	± (0.25 % R + 0.05 Ω)
Short Time Overload	± (0.25 % R + 0.05 Ω)	± (0.25 % R + 0.05 Ω)	± (1 % R + 0.05 Ω)

Note:

- R value is measured with probe distance of 24 ± 1 mm using 4-terminal method

12NC INFORMATION

- The resistors have a 12-digit numeric code starting with 23.
- The subsequent 6 digits for 1 % or 7 digits for 5 % indicate the resistor type and packaging.
- 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 ammopack is: 2322 181 43562.

12NC - resistor type and packaging

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 (1)	–	–	..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 (2)	–	..22 181 90018	..22 181 90019	..06 181 90011
SFR25H	± 5 %	–	..22 186 16...	..22 186 76...	..06 186 63...
	± 1 %	–	–	..22 186 3....	..06 186 8....

Notes:
(1) The jumper has a maximum resistance $R_{max.}$ = 30 mΩ at 3 A (SFR16S).
(2) The jumper has a maximum resistance $R_{max.}$ = 10 mΩ at 5 A (SFR25).

PART NUMBER AND PRODUCT DESCRIPTION

PART NUMBER: SFR2500001001FA500

S	F	R	2	5	0	0	0	0	1	0	0	1	F	A	5	0	0

MODEL/SIZE	SPECIAL CHARACTER	TCR/MATERIAL	VALUE	TOLERANCE	PACKAGING (3)	SPECIAL
SFR16S0 **SFR2500** **SFR25H0**	**0** = Neutral **Z** = Value overflow (special)	**0** = Standard **Z** = Jumper	**3 digit value** **1 digit multiplier** MULTIPLIER **7** = $*10^{-3}$ **2** = $*10^{2}$ **8** = $*10^{-2}$ **3** = $*10^{3}$ **9** = $*10^{-1}$ **4** = $*10^{4}$ **0** = $*10^{0}$ **5** = $*10^{5}$ **1** = $*10^{1}$ **Z** = 0000	**F** = ± 1 % **J** = ± 5 % **Z** = Jumper	**N4** **A5** **A1** **R5**	The 2 digits are used for all special parts. **00** = Standard

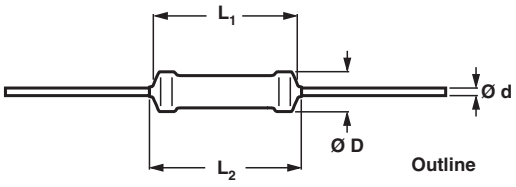
PRODUCT DESCRIPTION: SFR25 1 % A5 1K0

SFR25	1 %	A5	1K0
MODEL/SIZE	TOLERANCE	PACKAGING (3)	RESISTANCE VALUE
SFR16S **SFR25** **SFR25H**	± **1** % ± **5** %	**N4** **A5** **A1** **R5**	**47K** = 47 kΩ **51R1** = 51.1 Ω

Notes:
(3) Please refer to table PACKAGING.
• The PART NUMBER is shown to facilitate the introduction of a unified part numbering system for ordering products.

PACKAGING			
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 $D_{max.}$**	**$L_{1\ max.}$**	**$L_{2\ max.}$**	**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_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”).

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

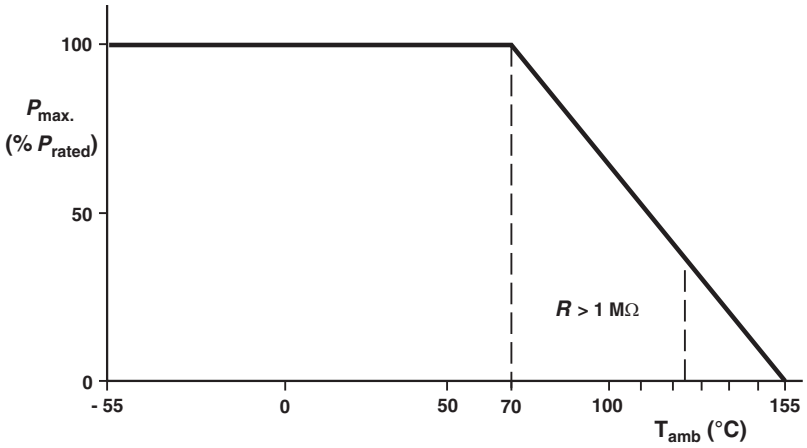
Standard values of nominal resistance are taken from the E96/E24 series for resistors with a tolerance of ± 1 % or ± 5 %. The values of the E96/E24 series are in accordance with “IEC publication 60063”.

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

Note:

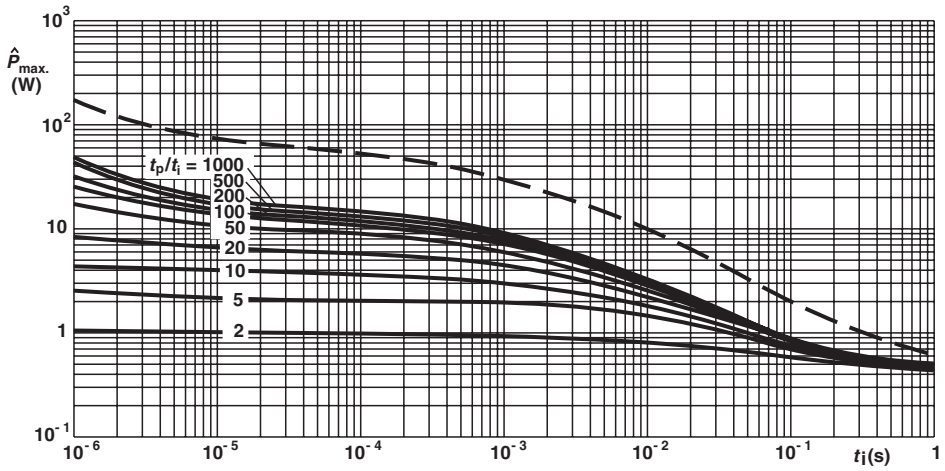
(1) The maximum voltage that may be continuously applied to the resistor element, see “IEC publication 60115-1”. The maximum permissible hot-spot temperature is 155 °C.

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

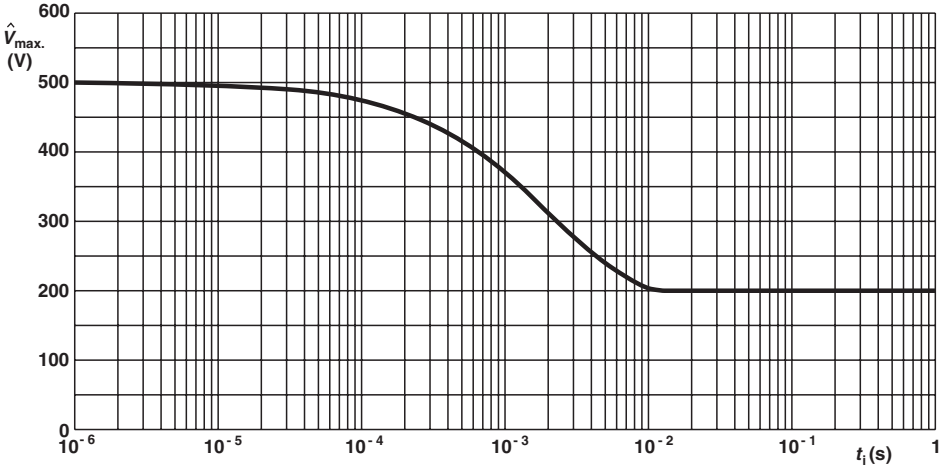


Maximum dissipation ($P_{max.}$) in percentage of rated power as a function of the ambient temperature (T_{amb}).

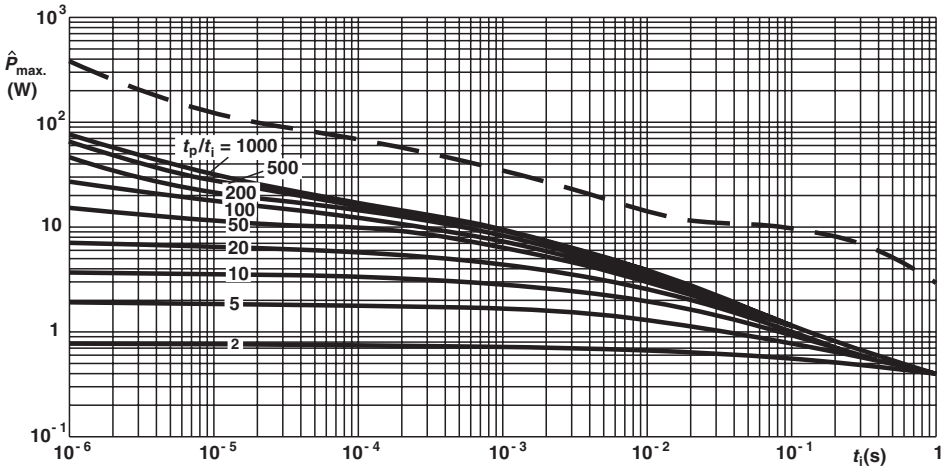
Derating



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

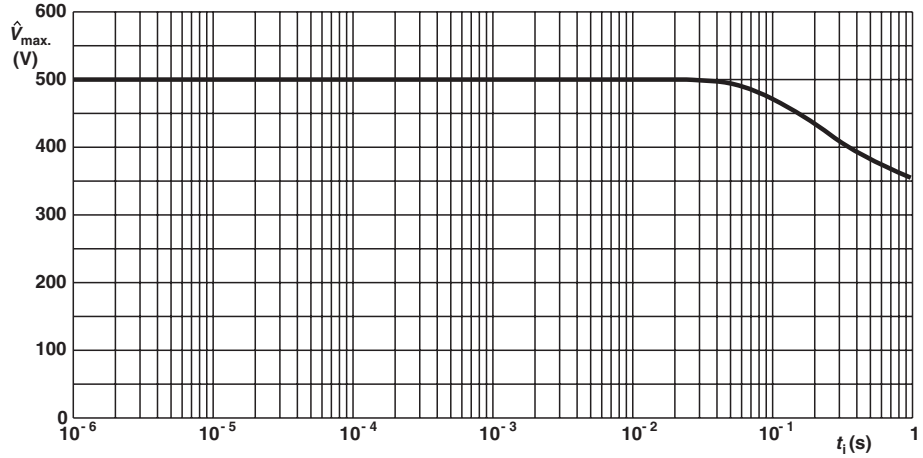


SFR16S Pulse on a regular basis; maximum permissible peak pulse voltage ($\hat{V}_{max.}$) as a function of pulse duration (t_i)

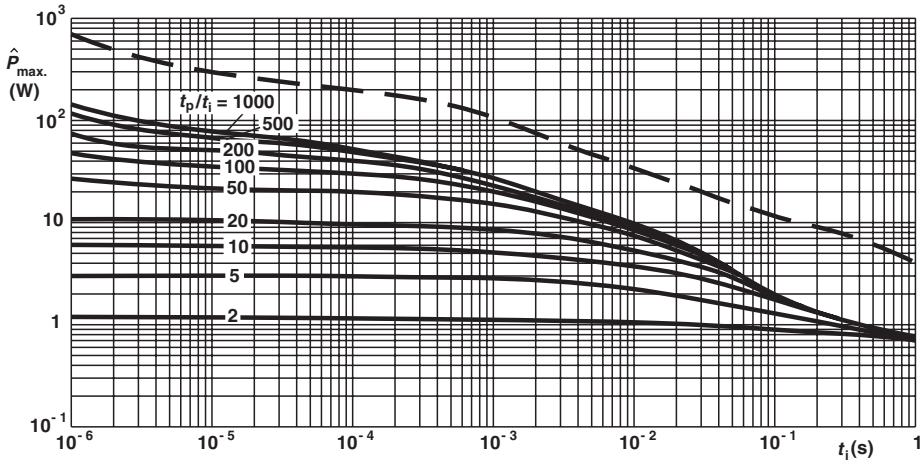


SFR25 Pulse on a regular basis; maximum permissible peak pulse power ($\hat{P}_{max.}$) as a function of pulse duration (t_i)

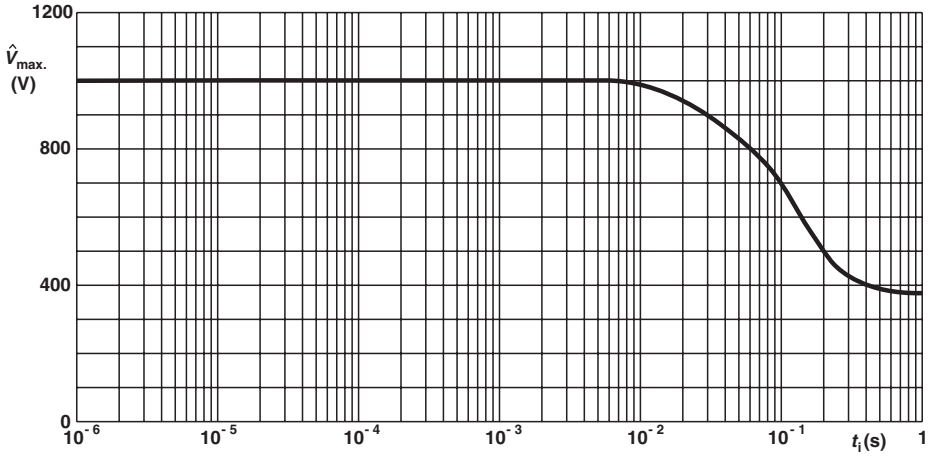
Pulse Loading Capabilities



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

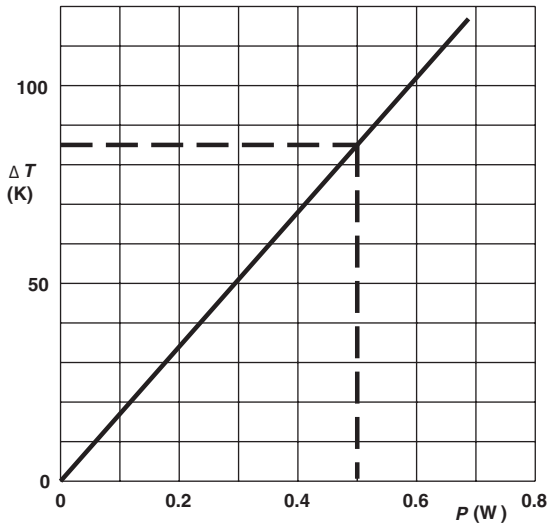


SFR25H Pulse on a regular basis; maximum permissible peak pulse power ($\hat{P}_{max.}$) as a function of pulse duration (t_i)

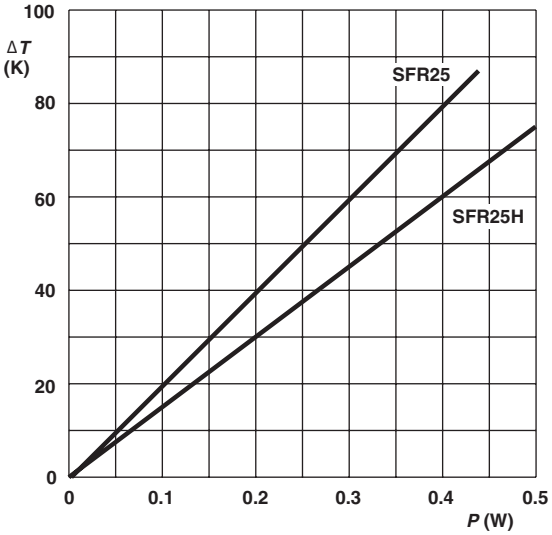


SFR25H Pulse on a regular basis; maximum permissible peak pulse voltage ($\hat{V}_{max.}$) as a function of pulse duration (t_i)

Pulse Loading Capabilities



SFR16S Hot-spot temperature rise (ΔT) as a function of dissipated power



SFR25/SFR25H Hot-spot temperature rise (ΔT) 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:					
4.16.2	21 (Ua1)	tensile all samples	Ø 0.45 mm, load 5 N; 10 s Ø 0.58 mm, load 10 N; 10 s		number of failures < 10 x 10^{-6}		
4.16.3	21 (Ub)	bending half number of samples	Ø 0.45 mm, load 2.5 N; 4 x 90° Ø 0.58 mm, load 5 N; 4 x 90°		number of failures < 10 x 10^{-6}		
4.16.4	21 (Uc)	torsion other half of samples	3 x 360° in opposite directions		no damage ΔR max.: ± (0.25 % R + 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	3.5 seconds; 350 °C; solder bath method		ΔR max.: ± (0.25 % R + 0.05 Ω)		
4.19	14 (Na)	rapid change of temperature	30 min at - 55 °C and 30 min at + 155 °C; 5 cycles		ΔR max.: ± (0.25 % R + 0.05 Ω)		
4.20	29 (Eb)	bump	3 x 1500 bumps in 3 directions; 40 g		no damage ΔR max.: ± (0.25 % R + 0.05 Ω)		
4.22	6 (Fc)	vibration	Frequency 10 Hz to 500 Hz; displacement 1.5 mm or acceleration 10 g; 3 directions; total 6 h (3 x 2 h)		no damage ΔR max.: ± (0.25 % R + 0.05 Ω)		
4.23		climatic sequence:			R_{ins} min.: 1000 MΩ		
4.23.2	2 (Ba)	dry heat	16 h; 155 °C				
4.23.3	30 (Db)	damp heat (accelerated) 1st cycle	24 h; 55 °C; 90 % to 100 % RH				
4.23.4	1 (Aa)	cold	2 h; - 55 °C				
4.23.5	13 (M)	low air pressure	2 h; 8.5 kPa; 15 °C to 35 °C				
4.23.6	30 (Db)	damp heat (accelerated) remaining cycles	5 days; 55 °C; 95 % to 100 % RH	$R \leq 1$ MΩ	ΔR max.: ± (1 % R + 0.05 Ω)		
				$R > 1$ MΩ	ΔR max.: ± (1 % R + 0.05 Ω)		ΔR max. ± (2 % R + 0.1
4.24.2	3 (Ca)	damp heat (steady state)	56 days; 40 °C; 90 % to 95 % RH; dissipation 0.01 Pn		R_{ins} min.: 1000 MΩ ΔR max.: ± (2 % R + 0.05 Ω)		

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 h at 70 °C; Pn or $V_{max.}$		ΔR max.: ± (2 % R + 0.05 Ω)		
4.8.4		temperature coefficient	between - 55 °C and + 155 °C (TCR x 10^{-6}/K)	$R < 4.7$ Ω $R \leq 100$ kΩ $R \leq 1$ MΩ $R > 1$ MΩ	≤ ± 250 ≤ ± 100 ≤ ± 250 ≤ ± 250	≤ ± 100 ≤ ± 100 ≤ ± 100 ≤ ± 250	≤ ± 100 ≤ ± 100 ≤ ± 100 ≤ ± 250
4.7		voltage proof on insulation	U_{RMS} = 400 V (**SFR16S**) or U_{RMS} = 600 V (**SFR25** and **SFR25H**); during 1 min; V-block method		no breakdown		
4.12		noise	"IEC publication 60195"	$R < 68$ kΩ $R \leq 100$ kΩ $R \leq 1$ 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
4.6.1.1		insulation resistance	$U_{max.}$ DC = 500 V during 1 min; V-block method		R_{ins} min.: 1000 MΩ		
4.13		short time overload	Room temperature; P = 6.25 x Pn (**SFR25**) or 6.25 x 0.25 W (**SFR16S**); 5 s ON, 45 s OFF ($V \leq 2 \times V_{max.}$); 10 cycles		ΔR max.: ± (0.25 % R + 0.05 Ω)		ΔR max.: ± (1 % R + 0.05 Ω)
		intermittent overload in accordance with "JIS-C5202 5.8"	16 x 0.16 W; 1 s ON and 25 s OFF; 10 000 ± 200 cycles; $V_{max.}$ = 600 V		ΔR max.: ± (0.75 % R + 0.05 Ω)	-	-
see 2nd amendment to "IEC 60115-1", Jan. '87		pulse load			see Pulse Loading Capabilities graphs		

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All product specifications and data are subject to change without notice.

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