Thin Film Mini-MELF Resistors

SMM 0204 thin film MELF resistors are the perfect choice for most fields of modern professional electronics where reliability and stability are of major concern. The typical applications in the fields of automotive, industrial and medical equipment reflect the outstanding level of proven reliability.

FEATURES

- Advanced metal film technology
- AEC-Q200 qualified
- Approval acc. EN 140401-803 available on request
- Excellent stability in different environmental conditions
- Best in class pulse load capability
- Sulfur resistance verified according to ASTM B 809
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

AUTOMOTIVE GRADE

Pb-free

RoHS COMPLIANT

HALOGEN FREE

GREEN (5-2008)

APPLICATIONS

- Automotive
- Telecommunication
- Industrial
- Medical equipment

TECHNICAL SPECIFICATIONS

DESCRIPTION	SMM0204
DIN size	0204
Metric CECC size	RC 3715M
Resistance range	0.22 Ω to 10 MΩ
Resistance tolerance	± 5 %; ± 1 %; ± 0.5 %; ± 0.25 %; ± 0.1 %
Temperature coefficient	± 100 ppm/K; ± 50 ppm/K; ± 25 ppm/K; ± 15 ppm/K
Rated dissipation P_{70} (1)	0.4 W
Operating voltage, $U_{max.}$ AC/DC	200 V
Operating temperature range	-55 °C to 155 °C
Permissible voltage against ambient (insulation): 1 min; U_{ins}	300 V
Failure rate: $FIT_{observed}$	≤ 0.1 x 10^{-9}/h
Zero-Ohm-Resistor: OMM0204	$R_{max.}$ = 10 mΩ; $I_{max.}$ = 3 A

Notes

- The IECQ-CECC approved product versions SMM0204 EN803 E0 and OMM0204 EN803 E0 respectively feature a quality factor π_Q = 3 for the purpose of system MTBF calculations, compared with π_Q = 10 for the standard versions.

(1) Please refer to APPLICATION INFORMATION below.

APPLICATION INFORMATION

The power dissipation on the resistor generates a temperature rise against the local ambient, depending on the heat flow support of the printed-circuit board (thermal resistance). The rated dissipation applies only if the permitted film temperature is not exceeded. Furthermore, a high level of ambient temperature or of power dissipation may raise the temperature of the solder joint, hence special solder alloys or board materials may be required to maintain the reliability of the assembly.

These resistors do not feature a limited lifetime when operated within the permissible limits. However, resistance value drift increasing over operating time may result in exceeding a limit acceptable to the specific application, thereby establishing a functional lifetime. At the maximum permissible film temperature of 155 °C the useful lifetime is specified for 8000 h. The designer may estimate the performance of the particular resistor application or set certain load and temperature limits in order to maintain a desired stability.

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MAXIMUM RESISTANCE CHANGE AT RATED DISSIPATION				
OPERATION MODE		**PRECISION**	**STANDARD**	**POWER**
Rated dissipation, P_{70}	SMM0204	0.07 W	0.25 W	0.4 W
Operating temperature range		-10 °C to 85 °C	-55 °C to 125 °C	-55 °C to 155 °C
Permissible film temperature, $\vartheta_{F\ max.}$		85 °C	125 °C	155 °C
Max. resistance change at P_{70} for resistance range, $\Delta R/R$ after:	SMM0204	10 Ω to 1 MΩ	0.22 Ω to 1 MΩ	0.22 Ω to 10 MΩ
	1000 h	≤ 0.05 %	≤ 0.15 %	≤ 0.25 %
	8000 h	≤ 0.1 %	≤ 0.3 %	≤ 0.5 %
	225 000 h	≤ 0.25 %	≤ 0.75 %	-

TEMPERATURE COEFFICIENT AND RESISTANCE RANGE				
TYPE / SIZE	**TCR**	**TOLERANCE**	**RESISTANCE**	**E-SERIES**
SMM0204	± 100 ppm/K	± 5 %	0.22 Ω to 10 MΩ	E24
	± 50 ppm/K	± 1 %	0.82 Ω to 10 MΩ	E24; E96
		± 0.5 %	10 Ω to 1 MΩ	E24; E96; E192
	± 25 ppm/K	± 0.5 %	10 Ω to 1 MΩ	E24; E96; E192
		± 0.25 %	22 Ω to 511 kΩ	
		± 0.1 %	43 Ω to 511 kΩ	
	± 15 ppm/K	± 0.5 %	10 Ω to 221 kΩ	E24; E96; E192
		± 0.25 %	22 Ω to 221 kΩ	
		± 0.1 %	43 Ω to 221 kΩ	
	Jumper	≤ 10 mΩ; $I_{max.}$ = 3 A		

Notes

- The color of the body coating is light green for jumpers and for a temperature coefficient of ± 50 ppm/K or of ± 100 ppm/K, pink for ± 25 ppm/K, or violet for ± 15 ppm/K.
- Zero ohm jumper are marked with one centered black band.

PACKAGING						
TYPE / SIZE	**CODE**	**QUANTITY**	**CARRIER TAPE**	**WIDTH**	**PITCH**	**REEL DIAMETER**
SMM0204 OMM0204	B1 (1)	1000 (1)	Antistatic blister tape acc. IEC 60286-3 Type 2a	8 mm	4 mm	180 mm/7"
	B3	3000				
	B0	10 000				330 mm/13"
SMM0204 EN803 E0 OMM0204 EN803 E0	B1	1000	Antistatic blister tape acc. IEC 60286-3 Type 2a	8 mm	4 mm	180 mm/7"
	B3	3000				
	B0	10 000				330 mm/13"

Note

(1) Package of 1000 pieces, code B1, is available only for products with TCR ± 25 ppm/K or ± 15 ppm/K, and with tolerance ± 0.25 % or ± 0.1 %. Bulk case acc. IEC 60286-6 available on request.

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PART NUMBER AND PRODUCT DESCRIPTION

Part Number: SMM02040C5620FB000
Part Number: SMM0204VC5620FB000
Part Number: OMM02040000000B000

S	M	M	0	2	0	4	0	C	5	6	2	0	F	B	0	0	0
O	M	M	0	2	0	4	0	0	0	0	0	0	0	B	0	0	0

TYPE / SIZE	VERSION	TCR	RESISTANCE	TOLERANCE	PACKAGING
SMM0204 **OMM0204**	**0** = Neutral **V** = EN 140401-803, version A, nominal failure rate level E0	**E** = ± 15 ppm/K **D** = ± 25 ppm/K **C** = ± 50 ppm/K **B** = ± 100 ppm/K **0** = Jumper	**3 digit value** **1 digit multiplier** **0000** = Jumper 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** = $*10^{1}$	**B** = ± 0.1 % **C** = ± 0.25 % **D** = ± 0.5 % **F** = ± 1 % **J** = ± 5 % **0** = Jumper	**B1** **B3** **B0**

Product Description: SMM0204 50 562R 1 % B0
Product Description: SMM0204 50 562R 1 % B0 EN803 E0
Product Description: OMM0204 0R0 B0

SMM0204	**50**	**562R**	**1 %**	**B0**	-
OMM0204	-	**0R0**	-	**B0**	-
TYPE / SIZE	TCR	RESISTANCE	TOLERANCE	PACKAGING	VERSION
SMM0204 **OMM0204**	± **15** ppm/K ± **25** ppm/K ± **50** ppm/K ± **100** ppm/K	**100R** = 100 Ω **2M21** = 2.21 MΩ **0R0** = JUMPER	**± 0.1 %** **± 0.25 %** **± 0.5 %** **± 1 %** **± 5 %**	**B1** **B3** **B0**	

Notes

- Products can be ordered using either the PART NUMBER or the PRODUCT DESCRIPTION.
- Products according to EN 140401-803 can be ordered by usng the related ordering code "SMM0204V...".

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DESCRIPTION

Production is strictly controlled and follows an extensive set of instructions established for reproducibility. A homogeneous film of metal alloy is deposited on a high grade ceramic body (Al_2O_3) and conditioned to achieve the desired temperature coefficient. Nickel plated steel termination caps are firmly pressed on the metallized rods. A special laser is used to achieve the target value by smoothly cutting a helical groove in the resistive layer without damaging the ceramic. The resistor elements are covered by a protective coating designed for electrical, mechanical and climatic protection. The terminations receive a final pure tin on nickel and copper plating for enhanced temperature cycling stability. Four or five color code rings designate the resistance value and tolerance in accordance with **IEC 60062** (1).

The result of the determined production is verified by an extensive testing procedure performed on 100 % of the individual resistors. This includes full screening for the elimination of products with a potential risk of early field failures (feasible for $R \geq 10\ \Omega$) according to EN 140401-803, 2.1.2.2. Only accepted products are laid directly into the blister tape in accordance with **IEC 60286-3, Type 2a** (1).

ASSEMBLY

The resistors are suitable for processing on automatic SMD assembly systems. They are suitable for automatic soldering using wave, reflow or vapor phase as shown in **IEC 61760-1** (1). The encapsulation is resistant to all cleaning solvents commonly used in the electronics industry, including alcohols, esters and aqueous solutions. The suitability of conformal coatings, potting compounds and their processes, if applied, shall be qualified by appropriate means to ensure the long-term stability of the whole system.

The resistors are completely lead (Pb)-free, the pure tin plating provides compatibility with lead (Pb)-free and lead containing soldering processes. Solderability is specified for 2 years after production or requalification, however, excellent solderability is proven after extended storage in excess of 10 years. The permitted storage time is 20 years. The immunity of the plating against tin whisker growth has been proven under extensive testing.

All products comply with the **IEC 62474**, Material Declaration for Products of and for the Electrotechnical Industry.

The dedicated database (2), that list declarable substances, ensures full compliance with the following directives:

- 2000/53/EC End of Life Vehicle Directive (ELV) and Annex II (ELV II)
- 2011/65/EU Restriction of the use of Hazardous Substances Directive (RoHS)
- 2012/19/EU Waste Electrical and Electronic Equipment Directive (WEEE)

APPROVALS

The resistors are qualified according to AEC-Q200. Resistors approved according to EN 140401-803 are available by using the related ordering code.

RELATED PRODUCTS

MELF resistors of other sizes are available:

Thin Fim Micro-MELF Resistors SMM0102
(www.vishay.com/doc?20003)

Thin Fim MELF Resistors SMM0207
(www.vishay.com/doc?20005)

Resistors are available with established reliability in accordance with **EN 140401-803 Version E**. Please refer to datasheet “MELF Resistors with Established Reliability” (www.vishay.com/doc?28707).

MS1 .... ESCC high-reliability thin film MINI-MELF resistors are the premium choice for design and manufacture of equipment, where matured technology and proven reliability are of utmost importance. They are regularly used in communication and research satellites and fit equally well into aircraft and military electronic systems.

Approval of the MS1 .... ESCC products is granted by the European Space Components Coordination and registered in the ESCC Qualified Parts List, REP005.
(www.vishay.com/doc?28790).

Notes

(1) The quoted IEC standards are also released as EN standards with the same number and identical contents.

(2) IEC 62474 database can be found at: http://std.iec.ch/iec62474.

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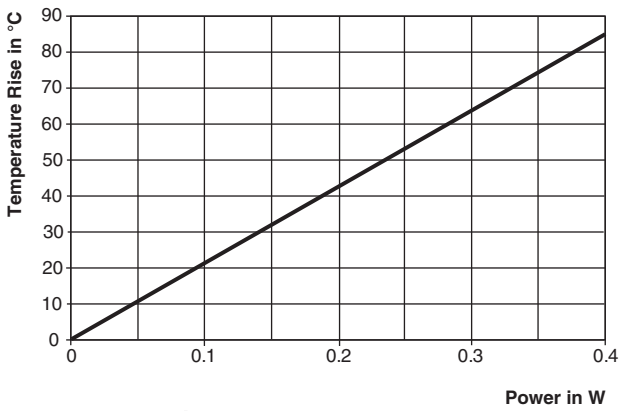
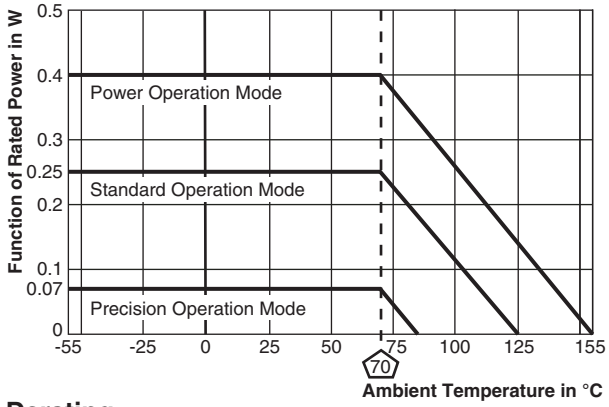
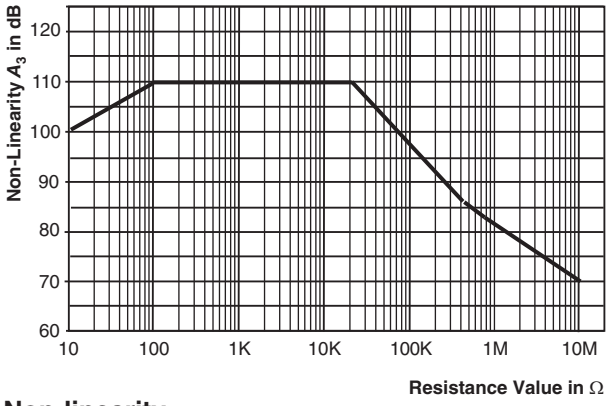
FUNCTIONAL PERFORMANCE



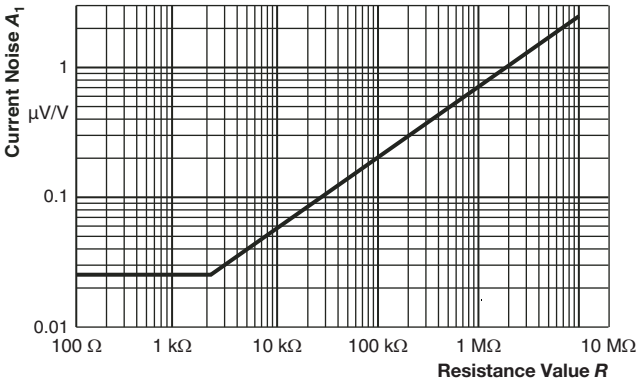
Temperature Rise



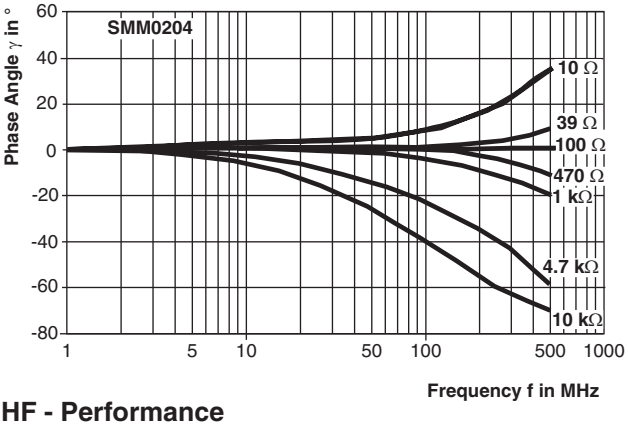
Derating



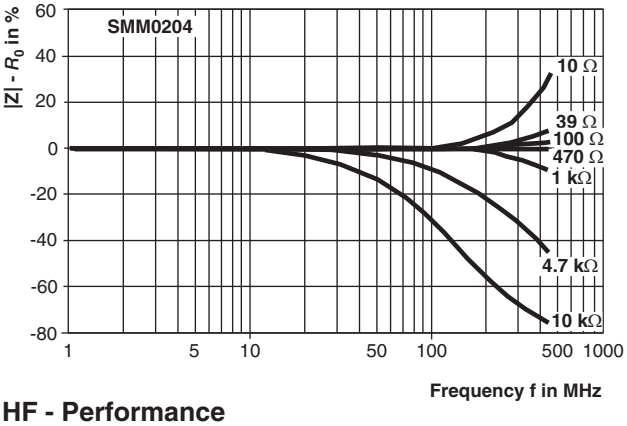
Non-linearity



Current Noise - A_1



HF - Performance



HF - Performance

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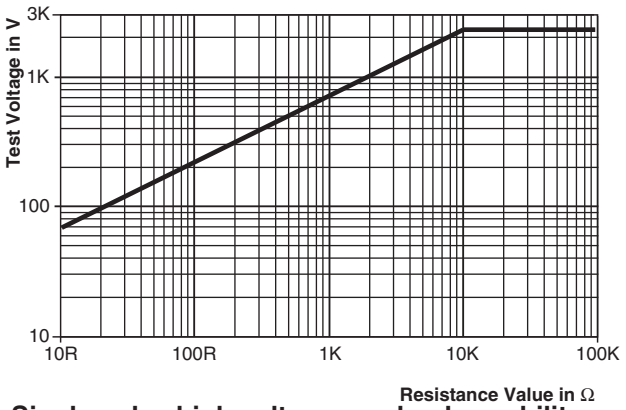
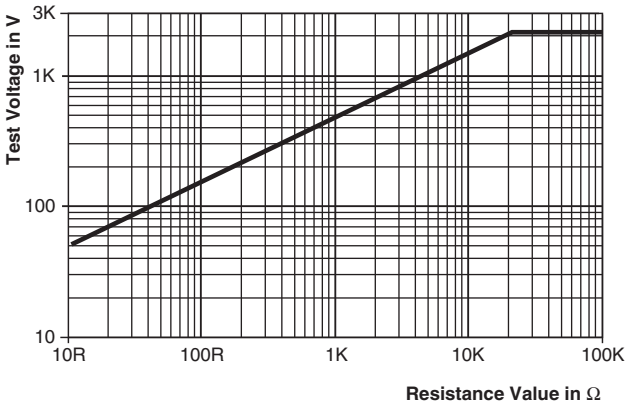
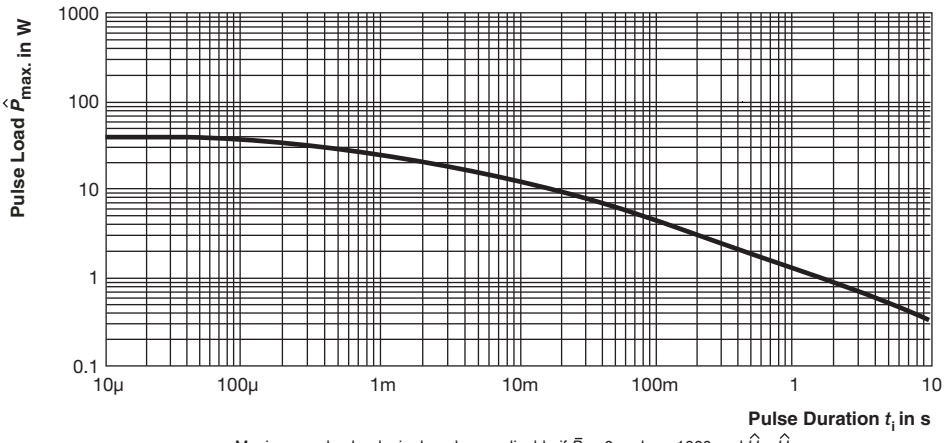


Single pulse high voltage overload capability 1.2/50 acc. EN 60115-1, 4.27

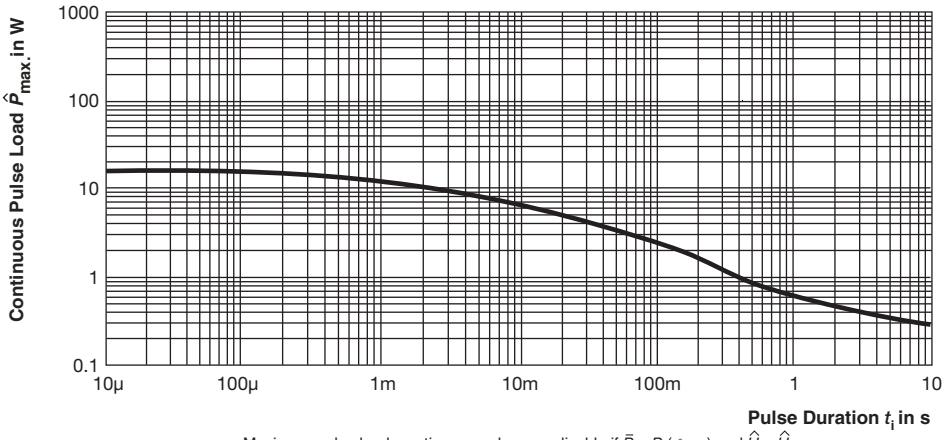


Single pulse high voltage overload capability 10/700 acc. EN 60115-1, 4.27



Maximum pulse load, single pulse; applicable if $\bar{P} \rightarrow 0$ and $n \leq 1000$ and $\hat{U} \leq \hat{U}_{max.}$;
for permissible resistance change equivalent to 8000 h operation in power operation mode

Single Pulse



Maximum pulse load, continuous pulses; applicable if $\bar{P} \leq P\ (\vartheta_{amb})$ and $\hat{U} \leq \hat{U}_{max.}$;
for permissible resistance change equivalent to 8000 h operation in power operation mode

Continuous Pulse

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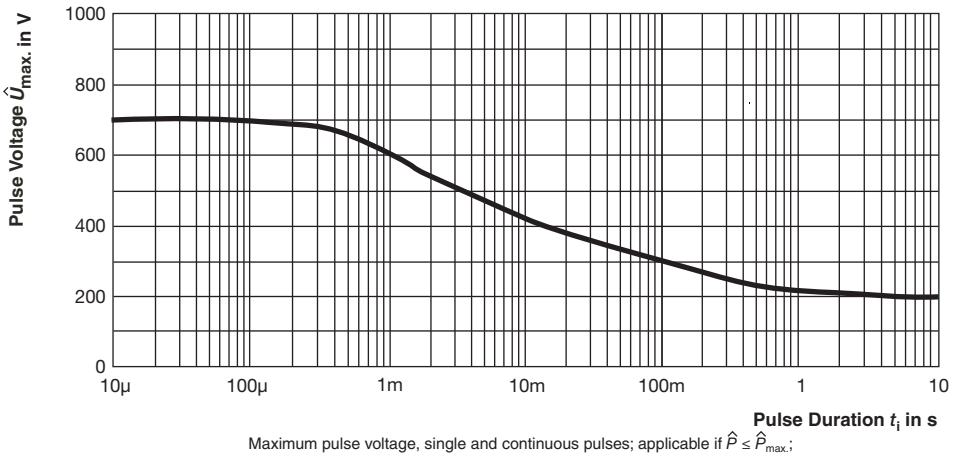

Maximum pulse voltage, single and continuous pulses; applicable if $\hat{P} \leq \hat{P}_{max.}$;
for permissible resistance change equivalent to 8000 h operation in power operation mode

Pulse Voltage

TESTS AND REQUIREMENTS

All tests are carried out in accordance with the following specifications:

EN 60115-1, generic specification

EN 60115-8 (successor of EN 140400), sectional specification

EN 140401-803, detail specification

IEC 60068-2-xx, test methods

The parameters stated in the Test Procedures and Requirements table are based on the required tests and permitted limits of EN 140401-803. The table presents only the most important tests, for the full test schedule refer to the documents listed above. However, some additional tests and a number of improvements against those minimum requirements have been included.

The testing also covers most of the requirements specified by EIA/ECA-703 and JIS-C-5201-1.

The tests are carried out under standard atmospheric conditions in accordance with IEC 60068-1, 4.3, whereupon the following values are applied:

Temperature: 15 °C to 35 °C

Relative humidity: 45 % to 75 %

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

A climatic category LCT / UCT / 56 is applied, defined by the lower category temperature (LCT), the upper category temperature (UCT), and the duration of exposure in the damp heat, steady state test (56 days).

The components are mounted for testing on printed circuit boards in accordance with EN 60115-8, 2.4.2, unless otherwise specified.

TEST PROCEDURES AND REQUIREMENTS

EN 60115-1 CLAUSE	IEC 60068-2 (1) TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE (ΔR)			
			SMM0204	< 1 Ω	1 Ω to < 10 Ω	10 Ω to ≤ 1 MΩ	> 1 MΩ
4.8.4.2	-	Temperature coefficient (1)	At (20 / -55 / 20) °C and (20 / 125 / 20) °C	± 100 ppm/K, ± 50 ppm/K, ± 25 ppm/K, ± 15 ppm/K			
4.25.1	-	Endurance at 70 °C: precision operation mode	$U = \sqrt{P_{70} \times R} \leq U_{max.}$; 1.5 h on; 0.5 h off; 70 °C; 1000 h			± (0.05 % R + 0.005 Ω)	
			70 °C; 8000 h			± (0.1 % R + 0.005 Ω)	
		Endurance at 70 °C: standard operation mode	$U = \sqrt{P_{70} \times R} \leq U_{max.}$; 1.5 h on; 0.5 h off; 70 °C; 1000 h	± (0.15 % R + 0.01 Ω)		± (0.1 % R + 0.005 Ω)	± (0.25 % R)
			70 °C; 8000 h	± (0.3 % R + 0.01 Ω)		± (0.2 % R + 0.005 Ω)	± (0.5 % R)

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TEST PROCEDURES AND REQUIREMENTS

EN 60115-1 CLAUSE	IEC 60068-2 (1) TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE (ΔR)			
			SMM0204	< 1 Ω	1 Ω to < 10 Ω	10 Ω to ≤ 1 MΩ	> 1 MΩ
4.25.1	-	Endurance at 70 °C: power operation mode	$U = \sqrt{P_{70} \times R}$ ≤ $U_{max.}$; 1.5 h on; 0.5 h off; 70 °C; 1000 h 70 °C; 8000 h	± (0.25 % R + 0.01 Ω) ± (0.5 % R + 0.01 Ω)			
4.25.3	-	Endurance at upper category temperature	125 °C; 1000 h	± (0.15 % R + 0.01 Ω)		± (0.1 % R + 0.005 Ω)	± (0.25 % R)
			155 °C; 1000 h	± (0.3 % R + 0.01 Ω)		± (0.2 % R + 0.005 Ω)	± (0.5 % R)
4.24	78 (Cab)	Damp heat, steady state	(40 ± 2) °C; 56 days; (93 ± 3) % RH	± (0.15 % R + 0.01 Ω)			± (0.25 % R)
4.39	67 (Cy)	Damp heat, steady state, accelerated	(85 ± 2) °C (85 ± 5) % RH $U = \sqrt{0.3 \times P_{70} \times R}$ ≤ 100 V and U = 0.3 x $U_{max.}$; (the smaller value is valid) 1000 h	± (0.25 % R + 0.01 Ω)			± (2 % R)
-	-	Cold	-55 °C; 2000 h	± (0.1 % R + 0.01 Ω)			
4.19	14 (Na)	Rapid change of temperature	30 min at LCT and 30 min at UCT; LCT = -55 °C; UCT = 125 °C; 1000 cycles	± (0.15 % R + 0.01 Ω)			± (0.25 % R)
			LCT = -55 °C; UCT = 155 °C; 1000 cycles	± (0.5 % R + 0.01 Ω)			
4.13	-	Short time overload: standard operation mode	$U = 2.5 \times \sqrt{P_{70} \times R}$ ≤ 2 x $U_{max.}$; 5 s	± (0.03 % R + 0.01 Ω)			± (0.1 % R)
		Short time overload: power operation mode		± (0.05 % R + 0.01 Ω)			± (0.1 % R)
4.27	-	Single pulse high voltage overload: standard operation mode	Severity no. 4: $U = 10 \times \sqrt{P_{70} \times R}$ ≤ 2 x $U_{max.}$; 10 pulses 10 µs/700 µs	± (0.15 % R + 0.01 Ω)			
		Single pulse high voltage overload: power peration mode		± (0.15 % R + 0.01 Ω)			

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TEST PROCEDURES AND REQUIREMENTS

EN 60115-1 CLAUSE	IEC 60068-2 [1] TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE (ΔR)			
			SMM0204	< 1 Ω	1 Ω to < 10 Ω	10 Ω to ≤ 1 MΩ	> 1 MΩ
4.37	-	Periodic electric overload: standard operation mode	$U = \sqrt{15 \times P_{70} \times R}$ ≤ 2 x $U_{max.}$; 0.1 s on; 2.5 s off; 1000 cycles	± (0.15 % R + 0.01 Ω)			
		Periodic electric overload: power operation mode		± (0.3 % R + 0.01 Ω)			
4.22	6 (Fc)	Vibration	Endurance by sweeping; 10 Hz to 2000 Hz; no resonance; amplitude ≤ 1.5 mm or ≤ 200 m/s^2; 7.5 h	± (0.05 % R + 0.01 Ω)			± (0.1 % R)
4.38	-	Electrostatic discharge (Human Body Model)	IEC 61340-3-1 [1]; 3 pos. + 3 neg. discharges SMM 0204: 2 kV	± (0.5 % R + 0.05 Ω)			
4.17.2	58 (Td)	Solderability	Solder bath method; SnPb40; non-activated flux (215 ± 3) °C; (3 ± 0.3) s	Good tinning (≥ 95% covered); no visible damage			
			Solder bath method; SnAg3Cu0.5 or SnAg3.5; non-activated flux; (235 ± 3) °C; (2 ± 0.2) s	Good tinning (≥ 95% covered); no visible damage			
4.18.2	58 (Td)	Resistance to soldering heat	Solder bath method; (260 ± 5) °C; (10 ± 1) s	± (0.1 % R + 0.01 Ω)		± (0.05 % R + 0.01 Ω)	
			Reflow method 2 (IR/forced gas convection); (260 ± 5) °C; (10 ± 1) s	± (0.05 % R + 0.01 Ω)		± (0.02 % R + 0.01 Ω)	
4.29	45 (XA)	Component solvent resistance	Isopropyl alcohol; 50 °C; method 2	No visible damage			
4.30	45 (XA)	Solvent resistance of marking	Isopropyl alcohol; 50 °C; method 1, toothbrush	Marking visible, no visible damage			
4.32	21 (Ue_3)	Shear (adhesion)	45 N	No visible damage			
4.33	21 (Ue_1)	Substrate bending	Depth 2 mm, 3 times	No visible damage, no open circuit in bent position ± (0.05 % + 0.005 Ω)			
4.7	-	Voltage proof	$U_{RMS} = U_{ins}$; 60 s	No flashover or breakdown			
4.35	-	Flammability	IEC 60695-11-5 [1]; needle flame test; 10 s	No burning after 30s			

Note

[1] The quoted IEC standards are also released as EN standards with the same number and identical contents.

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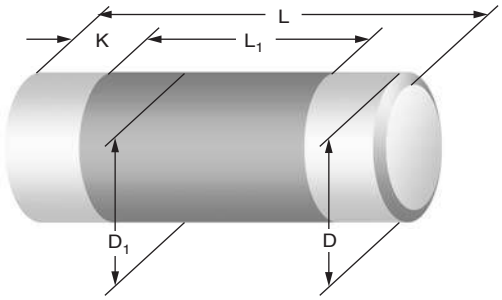
DIMENSIONS

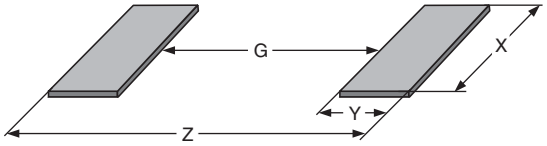


DIMENSIONS AND MASS						
TYPE / SIZE	L (mm)	D (mm)	$L_{1\ min.}$ (mm)	D_1 (mm)	K (mm)	MASS (mg)
SMM0204 OMM0204	3.6 + 0/- 0.2	1.4 + 0/- 0.1	1.8	D + 0/- 0.15	0.8 ± 0.1	22

Notes

- Color code marking is applied according to IEC 60062 (1) in four bands (E24 series) for 5 % tolerance, or in five bands (E96 or E192 series). Each color band appears as a single solid line, voids are permissible if at least $^2/_3$ of the band is visible from each radial angle of view. The last color band for tolerance is approximately 50 % wider than the other bands.

PATTERN STYLES FOR MELF RESISTORS



RECOMMENDED SOLDER PAD DIMENSIONS								
TYPE / SIZE	WAVE SOLDERING				REFLOW SOLDERING			
	G (mm)	Y (mm)	X (mm)	Z (mm)	G (mm)	Y (mm)	X (mm)	Z (mm)
SMM0204 OMM0204	1.5	1.5	1.8	4.5	1.7	1.2	1.6	4.1

Notes

- The rated dissipation applies only if the permitted film temperature is not exceeded. Furthermore, a high level of ambient temperature or of power dissipation may raise the temperature of the solder joint, hence special solder alloys or board materials may be required to maintain the reliability of the assembly. Specified power rating above standard operation mode requires dedicated heat-sink pads, which to a great extend depend on board materials and design. The given solder pad dimensions reflect the considerations for board design and assembly as outlined e.g. in standards IEC 61188-5-x (1), or in publication IPC-7351. They do not guarantee any supposed thermal properties, particularly as these are also strongly influenced by many other parameters.
  Please note however that applications for "power operation mode" require special considerations for the design of solder pads and adjacent conductor areas.

(1) The quoted IEC standards are also released as EN standards with the same number and identical contents.

For technical questions, contact: melf@vishay.com

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