

## Lead (Pb)-Bearing Thin Film MINI-MELF Resistors With Established Reliability



### FEATURES

- IECQ-CECC approved to EN 140401-803, version E
- Established reliability, failure rate level E8
- Stable metal film on high quality ceramic
- SnPb termination plating, Pb content > 6 %
- Meets Bellcore, MIL, and ESCC plating requirements
- Single Lot Date Code
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)



### APPLICATIONS

- Medical
- Military
- Aerospace

TECHNICAL SPECIFICATIONS	
DESCRIPTION	MS1 .... EN803 E8
DIN size	0204
Metric size code (EN/CECC style)	RC3715M
Resistance range	1 $\Omega$ to 2.21 M $\Omega$
Resistance tolerance	$\pm 1 \%$ ; $\pm 0.1 \%$
Temperature coefficient	$\pm 50$ ppm/K; $\pm 15$ ppm/K
Rated dissipation, $P_{70}$	0.25 W
Operating voltage, $U_{\max}$ , AC <sub>RMS</sub> or DC	200 V
Film temperature, $\vartheta_F$ max.	125 °C
Operating temperature range	-55 °C to 125 °C
Max. resistance change at $P_{70}$ for resistance range, $ \Delta R/R $ max. after:	1 $\Omega$ to 332 k $\Omega$
1000 h	$\leq 0.25 \%$
8000 h	$\leq 0.5 \%$
Insulation resistance	$\geq 10$ G $\Omega$
Permissible voltage against ambient (insulation): 1 min; $U_{\text{ins}}$	300 V
Assessed failure rate level	E8 = $10^{-8}$ /h
Quality factor, $\pi_Q$	0.03
Failure rate: FIT <sub>observed</sub>	$< 0.1 \times 10^{-9}$ /h

### Notes

- 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
- Failure rate level E8 ( $10^{-8}$ /h,  $\pi_Q = 0.03$ ), corresponding to MIL level S, is superior to level E7 ( $10^{-7}$ /h,  $\pi_Q = 0.1$ ), E6 ( $10^{-6}$ /h,  $\pi_Q = 0.3$ ) or E5 ( $10^{-5}$ /h,  $\pi_Q = 1$ ) and thus can be used as a replacement

**TEMPERATURE COEFFICIENT AND RESISTANCE RANGE (1)**

TYPE	TCR	TOLERANCE	RESISTANCE	E-SERIES
MS1 .... EN803 E8	$\pm 50$ ppm/K	$\pm 1$ %	1 $\Omega$ to 2.21 M $\Omega$	E96
	$\pm 15$ ppm/K	$\pm 0.1$ %	75 $\Omega$ to 100 k $\Omega$	E192

**Notes**

- Other TCR or tolerances, or combinations thereof, or resistance values from other E-series than given are not permitted in EN 140401-803 for version E products
- (1) For the approved IECQ-CECC resistance range, please refer to [www.vishay.com/doc?28946](http://www.vishay.com/doc?28946)

**PACKAGING**

TYPE	CODE	QUANTITY	PACKAGING STYLE	WIDTH	PITCH	PACKAGING DIMENSIONS
MS1 .... EN803 E8	B1	1000	Antistatic blister tape acc. IEC 60286-3, Type 2a	8 mm	4 mm	$\varnothing$ 180 mm / 7"
	B3	3000				

**PART NUMBER AND PRODUCT DESCRIPTION****PART NUMBER: MS1CECCWE5620BB300**

M	S	1	C	E	C	C	W	E	5	6	2	0	B	B	3	0	0
TYPE/SIZE			VERSION			TCR			RESISTANCE			TOLERANCE		PACKAGING			
MS1CECC			W = EN 140401-803; version E; failure rate level E8			C = ± 50 ppm/K E = ± 15 ppm/K			3 digit value 1 digit multiplier			F = ± 1 % B = ± 0.1 %		B1 B3			
									MULTIPLIER								
									8 = *10 <sup>-2</sup>								
									9 = *10 <sup>-1</sup>								
									0 = *10 <sup>0</sup>								
									1 = *10 <sup>1</sup>								
									2 = *10 <sup>2</sup>								
									3 = *10 <sup>3</sup>								
									4 = *10 <sup>4</sup>								

**PRODUCT DESCRIPTION: MS1 15 562R 0.1 % B3 EN803 E8**

MS1	15	562R	0.1 %	B3	EN803	E8
TYPE/SIZE	TCR	RESISTANCE	TOLERANCE	PACKAGING	VERSION	FAILURE RATE LEVEL
MS1	$\pm 50$ ppm/K $\pm 15$ ppm/K	562R = 562 $\Omega$ 4K64 = 4.64 k $\Omega$	$\pm 1$ % $\pm 0.1$ %	B1 B3	EN 140401-803; version E	E8

**Notes**

- The products can be ordered using either the PART NUMBER or the PRODUCT DESCRIPTION
- Products within a packaging unit are Single Lot Date Code



## EN 140401-803 ORDERING INFORMATION

Example of the ordering information for a resistor: MS1 15 562R 0.1 % B3 EN803 E8

### EN140401-803EZRC3715MP562RBE8B

The elements used in the component number have the following meaning:

<b>EN140401-803</b>	EN detail specification number
<b>EZ</b>	Assessment level for the zero-defect approach
<b>RC3715M</b>	Style (size)
<b>P</b>	Temperature coefficient, according to EN 60062 R = $\pm 50$ ppm/K; P = $\pm 15$ ppm/K
<b>562R</b>	Resistance value, according to EN 60062, 4 characters
<b>B</b>	Tolerance on rated resistance, according to EN 60062 F = $\pm 1$ %; B = $\pm 0.1$ %
<b>E8</b>	Failure rate level according to EN 60115-1, annex ZR
<b>B</b>	SnPb termination plating

### Notes

- The ordering information according to EN 140401-803:2017 shown above succeeds and replaces the ordering information according to earlier versions of the detail specification EN 140401-803 or its predecessor CECC 40401-803, for example:  
CECC 40401-803 EZ RC3715M E 562R B E8  
CECC 40401-803 S RC3715 E 562R B E8  
with EZ; S Assessment level, where EZ is successor to and superior replacement for S  
RC3715M; RC3715 Style, with added suffix M for "metric"  
E Temperature coefficient, according to the detail specification  
C =  $\pm 50$  ppm/K; E =  $\pm 15$  ppm/K
- EN 140401-803 succeeds the prior specifications CECC 40401-803, CECC 40401-001 (now "Version E") and CECC 40401-005 (now "Version A")



## 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 ( $\text{Al}_2\text{O}_3$ ) and conditioned to achieve the desired temperature coefficient. Nickel plated steel termination caps are firmly pressed on the metallized rod. A special laser is used to achieve the target value by smoothly cutting a helical groove in the resistive layer without damaging the ceramics. The resistor elements are covered by a protective coating designed for electrical, mechanical and climatic protection. The terminations receive a final tin-lead (SnPb) on nickel plating. Five color code rings designate the resistance value and tolerance in accordance with **IEC 60062** <sup>(1)</sup>.

The result of the determined production is verified by an extensive testing procedure performed on 100 % of the individual resistors. Only accepted products are placed into the blister tape in accordance with **IEC 60286-3** <sup>(1)</sup>, **Type 2a**. Products within a packaging unit are from the same production lot and carry the same date code.

## ASSEMBLY

The resistors are suitable for processing on automatic SMD assembly systems. They are suitable for automatic soldering using wave, reflow or vapour phase as shown in **IEC 61760-1** <sup>(1)</sup>. 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.

Solderability is specified for 2 years after production. The permitted storage time is 20 years. The terminations are plated with SnPb solder, controlled for a minimum lead (Pb) content of 6 % for compliance with the respective requirements of Bellcore, MIL, and ESCC specifications.

## MATERIALS

Vishay acknowledges the IEC 62474 <sup>(1)</sup>, Material Declaration for Products of and for the Electrotechnical Industry, and complies with the reporting requirements on declarable substances given therein <sup>(2)</sup>.


Vishay acknowledges the REACH regulation (1907/2006/EC) and the related list of substances of very high concern (SVHC) <sup>(3)</sup> for its supply chain.

Except for the intentionally added lead (Pb) in the termination finish, the products do not contain any of the declarable substances as per IEC 62474, or as per the SVHC list, see [www.vishay.com/how/leadfree](http://www.vishay.com/how/leadfree).

Vishay pursues the elimination of conflict minerals from its supply chain, see the Conflict Minerals Policy at [www.vishay.com/doc?49037](http://www.vishay.com/doc?49037).

## APPROVALS

Where applicable, the resistors are approved within the **IECQ-CECC** Quality Assessment System for Electronic Components to the detail specification **EN 140401-803**, which refers to **EN 60115-1**, **EN 60115-8** and the variety of environmental test procedures of the **IEC 60068** <sup>(1)</sup> series.

Conformity is attested by the use of the **CECC** logo () as the mark of conformity on the package label.

The Vishay Draloric production facility is registered with the CAGE code D1018.

## RELATED PRODUCTS

A parallel family of lead (Pb)-free MINI-MELF resistors SMM0204 ... EN803 E8 with established reliability is available, see the datasheet:

- “SMM0204 ... EN803 E8 - Thin Film MINI-MELF Resistors with Established Reliability”  
([www.vishay.com/doc?28786](http://www.vishay.com/doc?28786))

A wider range of TCR, tolerance and resistance values, plus the option of values from a different E series is available with lead (Pb)-free MINI-MELF products SMM0204 ... EN803 E0 approved to **EN 140401-803**, version A, without established reliability, nominal failure rate level E0 (quality factor  $\pi_Q = 3$ ). A further range of MINI-MELF products SMM0204 is available without any approval (quality factor  $\pi_Q = 10$ ).

Lead (Pb)-free **Zero Ohm Jumpers** are available under the product description **OMM0204**.

For details, see the datasheet:

- SMM0204 - Thin Film Mini-MELF Resistors  
([www.vishay.com/doc?20004](http://www.vishay.com/doc?20004))

## Notes

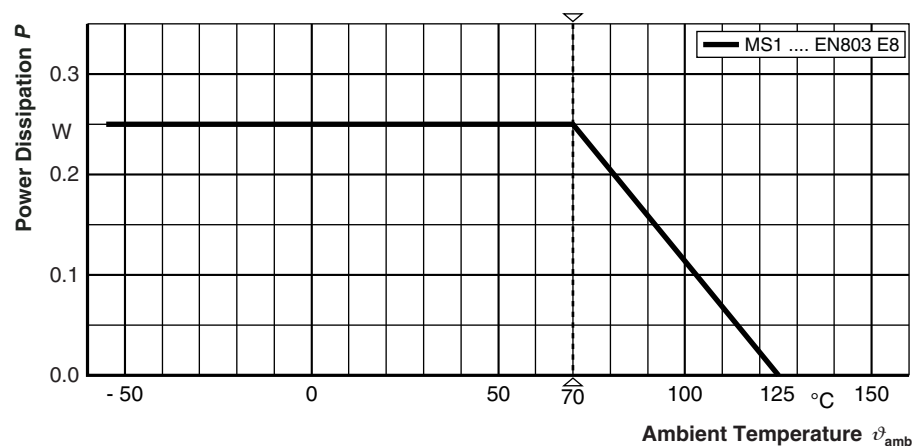
<sup>(1)</sup> The quoted IEC standards are also released as EN standards with the same number and identical contents

<sup>(2)</sup> The IEC 62474 list of declarable substances is maintained in a dedicated database, which is available at <http://std.iec.ch/iec62474>

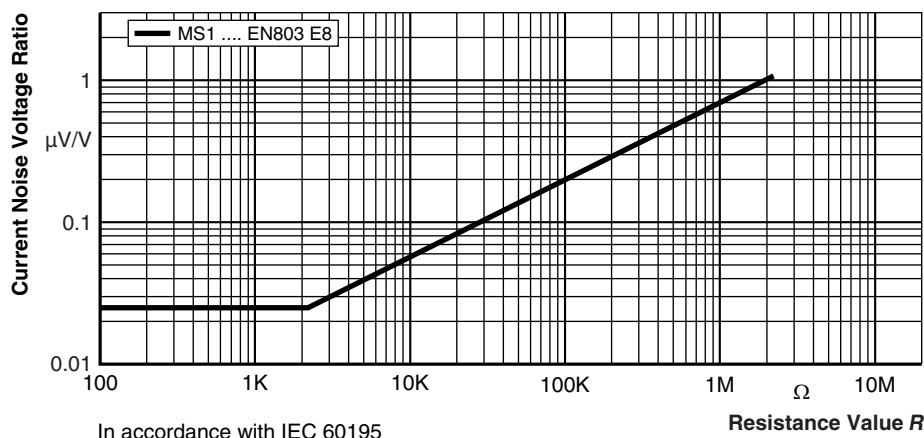
<sup>(3)</sup> The SVHC list is maintained by the European Chemical Agency (ECHA) and available at <http://echa.europa.eu/candidate-list-table>



## FUNCTIONAL PERFORMANCE

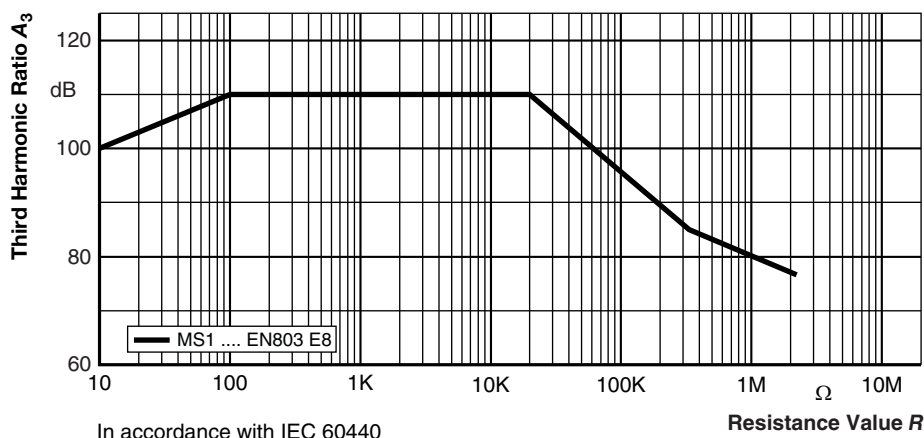


### Derating



In accordance with IEC 60195

### Current Noise Voltage Ratio



In accordance with IEC 60440

### Non-Linearity - Third Harmonic Ratio $A_3$

**TESTS AND REQUIREMENTS**

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

EN 60115-1, generic specification

EN 60115-8, 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: 25 % 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 ( $\Delta R$ )		
				STABILITY CLASS 0.25 OR BETTER	STABILITY CLASS 0.5 OR BETTER	STABILITY CLASS 2 OR BETTER
			Stability for product types: <b>MS1 .... EN803 E8</b>	10 $\Omega$ to 332 k $\Omega$	< 10 $\Omega$	> 332 k $\Omega$
4.5	-	Resistance	-	$\pm 1 \% R$ ; $\pm 0.1 \% R$	$\pm 1 \% R$	$\pm 1 \% R$
4.7	-	Voltage proof	$U = 1.4 \times U_{ins}$ ; 60 s	No flashover or breakdown		
4.13	-	Short time overload	$U = 2.5 \times \sqrt{P_{70} \times R}$ $\leq 2 \times U_{max}$ ; 5 s	$\pm (0.05 \% R + 10 \text{ m}\Omega)$	$\pm (0.1 \% R + 10 \text{ m}\Omega)$	$\pm (0.5 \% R + 50 \text{ m}\Omega)$
4.17	58 (Td)	Solderability	Solder bath method; SnPb40; non-activated flux (235 $\pm$ 5) °C; (2 $\pm$ 0.2) s	Good tinning ( $\geq 95 \%$ covered); no visible damage		
4.8	-	Temperature coefficient	(20/-55/20) °C and (20/125/20) °C	$\pm 50 \text{ ppm/K}$ ; $\pm 15 \text{ ppm/K}$	$\pm 50 \text{ ppm/K}$	$\pm 50 \text{ ppm/K}$
4.32	21 (Ue <sub>3</sub> )	Shear (adhesion)	45 N	No visible damage		
4.33	21 (Ue <sub>1</sub> )	Substrate bending	Depth 2 mm, 3 times	No visible damage; no open circuit in bent position $\pm (0.05 \% R + 10 \text{ m}\Omega)$ $\pm (0.1 \% R + 10 \text{ m}\Omega)$ $\pm (0.5 \% R + 50 \text{ m}\Omega)$		
4.19	14 (Na)	Rapid change of temperature	30 min at - 55 °C and 30 min at 125 °C;			
			5 cycles 1000 cycles	$\pm (0.05 \% R + 10 \text{ m}\Omega)$ $\pm (0.25 \% R + 50 \text{ m}\Omega)$	$\pm (0.1 \% R + 10 \text{ m}\Omega)$ $\pm (0.25 \% R + 50 \text{ m}\Omega)$	$\pm (0.25 \% R + 50 \text{ m}\Omega)$ $\pm (0.25 \% R + 50 \text{ m}\Omega)$

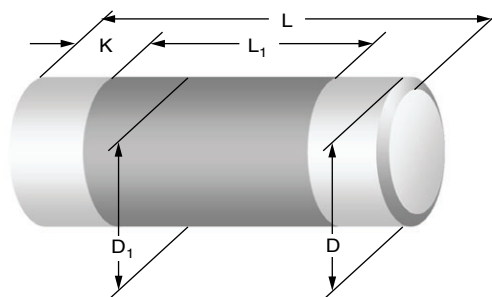


TEST PROCEDURES AND REQUIREMENTS						
EN 60115-1 CLAUSE	IEC 60068-2 (1) TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE ( $\Delta R$ )		
			Stability for product types:	STABILITY CLASS 0.25 OR BETTER	STABILITY CLASS 0.5 OR BETTER	STABILITY CLASS 2 OR BETTER
			MS1 .... EN803 E8	10 $\Omega$ to 332 k $\Omega$	< 10 $\Omega$	> 332 k $\Omega$
4.23		Climatic sequence:				
4.23.2	2 (Ba)	Dry heat	125 °C; 16 h			
4.23.3	30 (Db)	Damp heat, cyclic	55 °C; $\geq 90$ % RH; 24 h; 1 cycle			
4.23.4	1 (Aa)	Cold	- 55 °C; 2 h	$\pm (0.25 \% R + 50 \text{ m}\Omega)$	$\pm (0.5 \% R + 50 \text{ m}\Omega)$	$\pm (2 \% R + 100 \text{ m}\Omega)$
4.23.5	13 (M)	Low air pressure	1 kPa; (25 $\pm$ 10) °C; 1 h			
4.23.6	30 (Db)	Damp heat, cyclic	55 °C; $\geq 90$ % RH; 24 h; 5 cycles			
4.23.7	-	DC load	$U = \sqrt{P_{70} \times R} \leq U_{\max.};$ 1 min			
4.25.1	-	Endurance at 70 °C	$U = \sqrt{P_{70} \times R} \leq U_{\max.}$ 1.5 h on; 0.5 h off; 70 °C; 1000 h 70 °C; 8000 h	$\pm (0.25 \% R + 50 \text{ m}\Omega)$ $\pm (0.5 \% R + 50 \text{ m}\Omega)$	$\pm (0.25 \% R + 50 \text{ m}\Omega)$ $\pm (0.5 \% R + 50 \text{ m}\Omega)$	$\pm (0.5 \% R + 50 \text{ m}\Omega)$ $\pm (1 \% R + 50 \text{ m}\Omega)$
4.18	58 (Td)	Resistance to soldering heat	Solder bath method; (260 $\pm$ 5) °C; (10 $\pm$ 1) s	$\pm (0.05 \% R + 10 \text{ m}\Omega)$	$\pm (0.1 \% R + 10 \text{ m}\Omega)$	$\pm (0.5 \% R + 50 \text{ m}\Omega)$
4.35	-	Flammability, needle flame test	IEC 60695-11-5 (1); 10 s	No burning after 30 s		
4.24	78 (Cab)	Damp heat, steady state	(40 $\pm$ 2) °C; (93 $\pm$ 3) % RH; 56 days	$\pm (0.25 \% R + 50 \text{ m}\Omega)$	$\pm (0.5 \% R + 50 \text{ m}\Omega)$	$\pm (2 \% R + 100 \text{ m}\Omega)$
4.25.3	-	Endurance at upper category temperature	125 °C; 1000 h	$\pm (0.25 \% R + 50 \text{ m}\Omega)$	$\pm (0.5 \% R + 50 \text{ m}\Omega)$	$\pm (0.5 \% R + 50 \text{ m}\Omega)$
4.40	-	Electrostatic discharge (human body model)	IEC 61340-3-1 (1); 3 pos. + 3 neg. discharge; 2 kV	$\pm (0.5 \% R + 50 \text{ m}\Omega)$		
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 legible, no visible damage		
4.22	6 (Fc)	Vibration, endurance by sweeping	f = 10 Hz to 2000 Hz; $\hat{x}, \hat{y}, \hat{z} \leq 1.5 \text{ mm};$ $A \leq 200 \text{ m/s}^2$ ; 7.5 h; 10 sweeps per axis	$\pm (0.05 \% R + 10 \text{ m}\Omega)$	$\pm (0.1 \% R + 10 \text{ m}\Omega)$	$\pm (0.5 \% R + 50 \text{ m}\Omega)$
4.39	-	Periodic electric overload	$U = \sqrt{15 \times P_{70} \times R}$ $\leq 2 \times U_{\max.};$ 0.1 s on; 2.5 s off; 1000 cycles	$\pm (1 \% R + 50 \text{ m}\Omega)$		
4.27	-	Single pulse high voltage overload; 10 $\mu\text{s}$ /700 $\mu\text{s}$	$\hat{U} = 10 \times \sqrt{P_{70} \times R}$ $\leq 2 \times U_{\max.};$ 10 pulses	$\pm (0.5 \% R + 50 \text{ m}\Omega)$		

**Note**

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

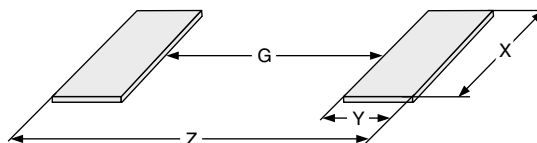
## DIMENSIONS



DIMENSIONS AND MASS						
TYPE	L (mm)	D (mm)	L <sub>1</sub> min. (mm)	D <sub>1</sub> (mm)	K (mm)	MASS (mg)
MS1 .... EN803 E8	3.6 + 0/- 0.15	1.5 + 0 / - 0.2	1.65	D + 0 / - 0.15	0.7 ± 0.2	22

### Note

- Color code marking is applied according to IEC 60062 <sup>(1)</sup> in five bands. Each color band appears as a single solid line, voids are permissible if at least  $\frac{2}{3}$  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. The color of the body coating is light green for a temperature coefficient of  $\pm 50$  ppm/K, or violet for  $\pm 15$  ppm/K



RECOMMENDED SOLDER PAD DIMENSIONS								
TYPE	WAVE SOLDERING				REFLOW SOLDERING			
	G (mm)	Y (mm)	X (mm)	Z (mm)	G (mm)	Y (mm)	X (mm)	Z (mm)
MS1 .... EN803 E8	1.5	1.5	1.8	4.5	1.6	1.25	1.7	4.1

### Notes

- The given solder pad dimensions reflect the considerations for board design and assembly as outlined e.g. in standards IEC 61188-6-x <sup>(1)</sup>, or in publication IPC-7351. They do not guarantee any supposed thermal properties, however, they will be found adequate for most general applications

<sup>(1)</sup> The quoted IEC standards are also released as EN standards with the same number and identical contents





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