

## Hi-Rel Thin Film MINI-MELF Resistors


**HALOGEN  
FREE**

### FEATURES

- High-reliability product
- ESA approved to ESCC 4001/022
- Advanced thin film technology
- SnPb termination plating, minimum 6 % Pb
- Single Lot Date Code
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)

### APPLICATIONS

- Aerospace
- Avionics
- Military

MS1 .... ESCC high-reliability thin film MINI-MELF resistors are the premium choice for the design and manufacture of equipment where matured technology and proven reliability are of the 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 is granted by the European Space Components Coordination and registered in the ESCC Qualified Parts List, REP005.

TECHNICAL SPECIFICATIONS	
DESCRIPTION	MS1 .... ESCC
DIN size	0204
Metric size code (EN/CECC style)	RC3715M
Resistance range	2.21 $\Omega$ to 5.11 M $\Omega$
Resistance tolerance	$\pm 1\%$ ; $\pm 0.5\%$ ; $\pm 0.1\%$
Temperature coefficient	$\pm 50$ ppm/K; $\pm 25$ 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
Permissible film temperature, $\vartheta_{F max}$ .	125 °C
Operating temperature range	-55 °C to 125 °C
Max. resistance change at $P_{70}$ , $ \Delta R $ max., after:	
1000 h	$\leq (0.35\% R + 50 \text{ m}\Omega)$
2000 h	$\leq (0.5\% R + 50 \text{ m}\Omega)$
Permissible voltage against ambient (insulation):	
1 min; $U_{ins RMS}$	500 V
Storage temperature range	-65 °C to +155 °C

#### Note

- 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

TEMPERATURE COEFFICIENT AND RESISTANCE RANGE				
TYPE / SIZE	TCR	TOLERANCE	RESISTANCE	E-SERIES
MS1 .... ESCC	± 50 ppm/K	± 1 %	2.21 Ω to 5.11 MΩ	E96
	± 25 ppm/K	± 0.5 %	10.0 Ω to 1.00 MΩ	
		± 0.1 %	43.2 Ω to 1.00 MΩ	
	± 15 ppm/K	± 0.1 %	43.2 Ω to 221 kΩ	

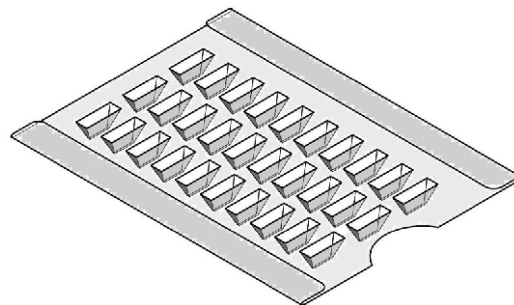
**Notes**

- The listed combinations of TCR, tolerance and resistance range are a subset of those combinations approved to ESCC 4001/022
- Resistance values from other E-series than given are not permitted in ESCC 4001/022

PACKAGING						
TYPE / SIZE	CODE	QUANTITY <sup>(1)</sup>	PACKAGING STYLE	WIDTH	PITCH	PACKAGING DIMENSIONS
MS1 .... ESCC	BX	≥ 100 to 499	Antistatic blister tape acc. IEC 60286-3, Type 2a <sup>(3)</sup>	8 mm	4 mm	Box
		≥ 500 <sup>(2)</sup>				Reel, Ø 180 mm / 7"
	LX	≤ 30	Matrix case <sup>(4)</sup>	-	7.8 mm	92 mm x 70 mm x 6 mm

**Notes**

- <sup>(1)</sup> The minimum order quantity is 30 pieces, except for samples for Lot Validation Testing
- <sup>(2)</sup> The maximum reel capacity is 3000 pieces
- <sup>(3)</sup> The tape leader is extended to 500 mm cover tape, including 200 mm carrier tape with empty compartments
- <sup>(4)</sup> The matrix case is not specified dissipative or conductive and thus may not be suitable for use in ESD protected areas



Matrix Case



PART NUMBER AND PRODUCT DESCRIPTION					
PART NUMBER: MS1ESCC0E5620BBX00					
M	S	1	E	S	C
C	0	E	5	6	2
0	B	B	X	0	0
TYPE	VERSION	TCR	RESISTANCE	TOLERANCE	PACKAGING
MS1ESCC	0 = ESCC 4001/022	C = ± 50 ppm/K D = ± 25 ppm/K E = ± 15 ppm/K	3 digit value 1 digit multiplier  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>	F = ± 1 % D = ± 0.5 % B = ± 0.1 %	LX BX
PRODUCT DESCRIPTION: MS1 15 562R 0.1 % BX ESCC 4001/022					
MS1	15	562R	0.1 %	BX	ESCC 4001/022
TYPE	TCR	RESISTANCE	TOLERANCE	PACKAGING	SPECIFICATION
MS1	± 50 ppm/K ± 25 ppm/K ± 15 ppm/K	562R = 562 Ω 4K64 = 4.64 kΩ	± 1 % ± 0.5 % ± 0.1 %	LX BX	ESCC 4001/022

**Notes**

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

ESCC 4001/022 COMPONENT NUMBER AND ELECTRICAL CHARACTERISTICS	
Example of the component number and electrical characteristics for a resistor: MS1 15 562R 0.1 % ESCC 4001/022	
<b>400102201 5620B1</b>	
The elements used in the component number have the following meaning:	
<b>4001022</b> <b>01</b>	Detail specification number, ESCC <b>4001/022</b> Type variant, 01 for all MS1 products
The elements used in the electrical characteristics have the following meaning:	
<b>5620</b> <b>B</b> <b>1</b>	Resistance acc. IEC 60062, four-character code system Tolerance on rated resistance acc. IEC 60062 Temperature coefficient of resistance: 3 ..... ± 50 ppm/K 2 ..... ± 25 ppm/K 1 ..... ± 15 ppm/K



## 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<sub>2</sub>O<sub>3</sub>) 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 SnPb plating, controlled for a minimum lead content of 6 %. 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 a special matrix case packaging or into antistatic 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 vapor phase as shown in **IEC 61760-1** <sup>(1)</sup>. Solderability is specified for 2 years after production. The permitted storage time is 20 years.

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.

## 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).

## 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>

## APPROVALS

The resistors are approved to **ESCC 4001/022**. Conformity is indicated by the **ESCC Qualified Components** logo on the package label. Approval is granted by the European Space Components Coordination and registered in the ESCC Qualified Parts List, REP005.

## SCREENING TESTS

These products are subjected to a screening test according to the ruling of the generic specification **ESCC 4001** and the detail specification **ESCC 4001/022**.

The production is succeeded by production test sequences for resistance, plating properties, solderability, and dimensions. This sequence is followed by screening tests for overload, non-linearity, temperature coefficient, resistance at room temperature, and a visual inspection. A certificate of conformity provides summary information by reporting the numbers of rejects for each test or inspection.

The requirements for burn-in with measurement of resistance drift, for a test of bend strength of the end face plating, and for a vibration test are waived by the detail specification **ESCC 4001/022**. The seal test is not applicable since MS1 is not a hermetically sealed product.

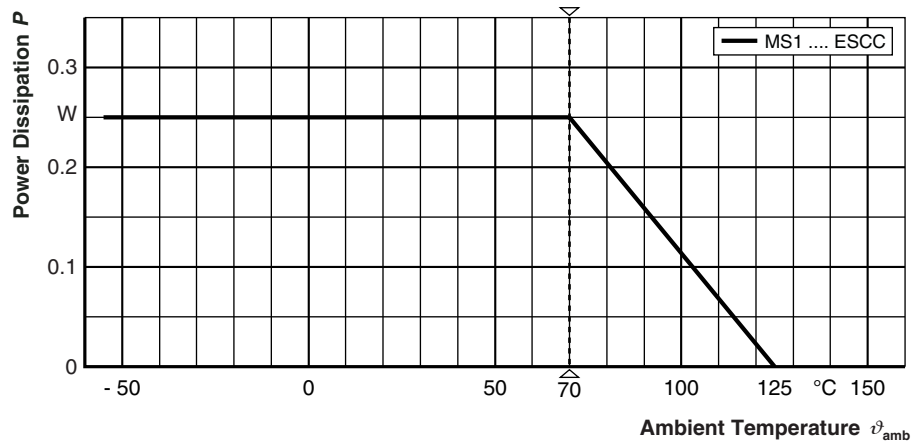
## LOT VALIDATION TESTS

Execution of Lot Validation Tests according to the ruling of **ESCC 4001** is available as a separate order item. This is to be combined with the dedicated order line for the required amount of samples, using packaging code "LX".

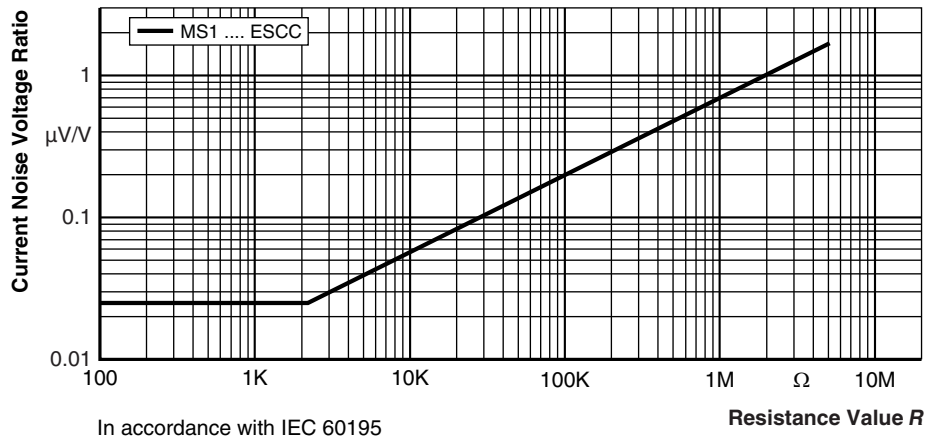
The applicable scope of the Lot Validation Tests, graduated to Group 1, Group 2, and Group 3, is illustrated in the datasheet with the number of samples required for each level.

Deliverable item to the Lot Validation Tests is the test report together with the used samples.

**FUNCTIONAL PERFORMANCE**

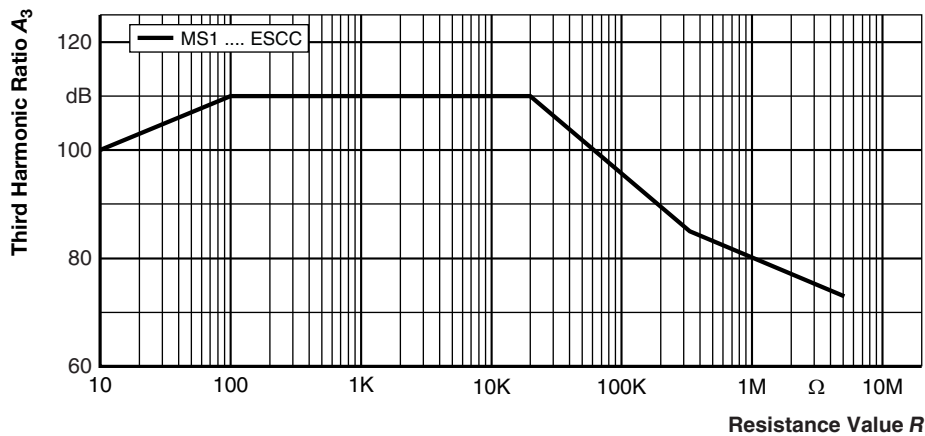


**Derating**



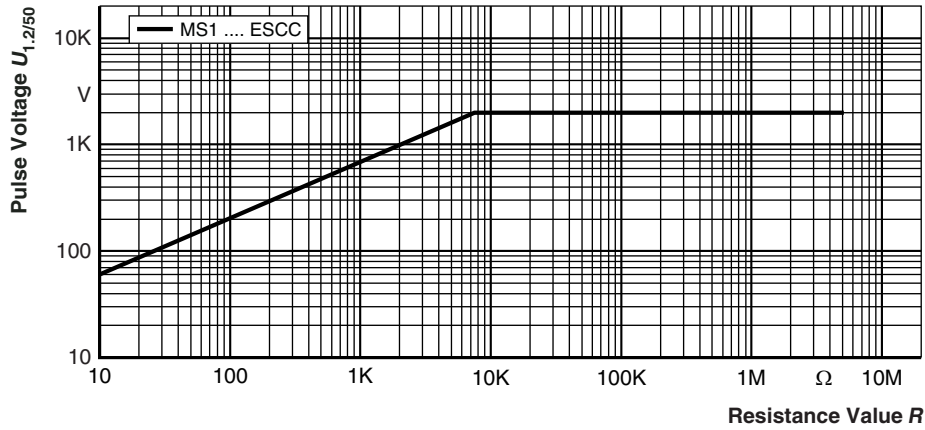
In accordance with IEC 60195

**Current Noise Voltage Ratio**



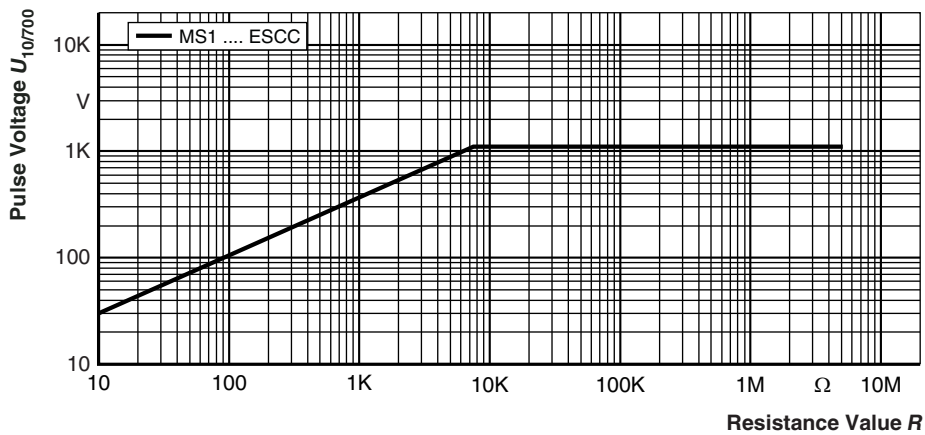
In accordance with IEC 60440, superior requirements adopted from EN 140401-803

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



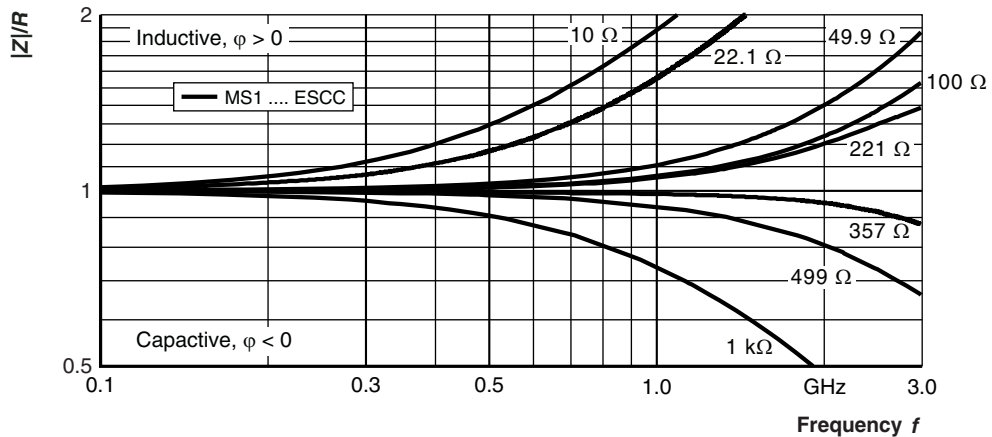
Pulse load rating in accordance with IEC 60115-1, 4.27; 1.2  $\mu$ s / 50  $\mu$ s;  
5 pulses at 12 s intervals; for permissible resistance change 0.5 %

**1.2  $\mu$ s / 50  $\mu$ s Pulse**



Pulse load rating in accordance with IEC 60115-1, 4.27; 10  $\mu$ s / 700  $\mu$ s;  
10 pulses at 1 min intervals; for permissible resistance change 0.5 %

**10  $\mu$ s / 700  $\mu$ s Pulse**



**RF-Behaviour**



**TESTS AND REQUIREMENTS**

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

ESCC 4001, generic specification, issue 5 (2019)

ESCC 4001/022, detail specification, issue 4 (2014)

The components are approved within the ESCC system. For the full test schedule refer to the documents listed above.

The tests are carried out in accordance with the stated specifications.

Unless otherwise specified the following standard atmospheric conditions apply:

Temperature: 15 °C to 35 °C

Relative humidity: 25 % to 75 %

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

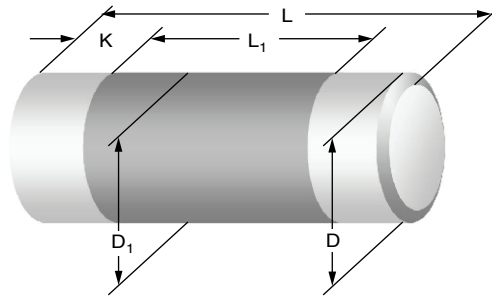
The components are mounted for testing on printed-circuit boards in accordance with EN 60115-8, 2.4.2, unless otherwise specified.

TEST PROCEDURES AND REQUIREMENTS				
ESCC 4001 PARAGRAPH	ESCC 4001/022 PARAGRAPH	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE ( $\Delta R$ )
			Stability for product types: <b>MS1 .... ESCC</b>	2.21 $\Omega$ to 5.11 M $\Omega$
<b>PRODUCTION CONTROL (CHART F2)</b>				
8.3.2	2.5.1	Resistance	(22 $\pm$ 3) °C	$\pm$ 1 % R; $\pm$ 0.5 % R; $\pm$ 0.1 % R
4.5	(ESCC 23500) 1.8.2	Plating - Thickness - Pb contents	X-ray fluorescence analysis	SnPb layer $\geq$ 3 $\mu$ m $\geq$ 6 % Pb
8.14	(IEC 60068-2-20, Ta)	Solderability	Solder bath method; SnPb40; non-activated flux; (235 $\pm$ 5) °C; (2 $\pm$ 0.5) s	Good tinning ( $\geq$ 95 % covered); No visible damage; $\pm$ (0.15 % R + 50 m $\Omega$ )
8.6	1.6	Dimension check	-	-
<b>SCREENING TESTS (CHART F3)</b>				
8.1	2.3 1.5	Overload	$U = \sqrt{10 \times P_{70} \times R} \leq 630$ V 0.1 s	$\pm$ (0.25 % R + 50 m $\Omega$ )
8.2	(IEC 60440)	Non-linearity (3 <sup>rd</sup> harmonic ratio)	-	$A_3 \geq A_{3 \text{ min}}$ , according to diagram non-linearity; $(A_3 - 2 \times \sigma)_{\text{Lot}} \leq A_3 \leq (A_3 + 2 \times \sigma)_{\text{Lot}}$
8.3.3	2.5.2	Resistance at high and low temperature (temperature coefficient)	- (55 $\pm$ 3) °C (125 $\pm$ 3) °C	$\pm$ 50 ppm/K; $\pm$ 25 ppm/K; $\pm$ 15 ppm/K
8.3.2	2.5.1	Resistance	(22 $\pm$ 3) °C	$\pm$ 1 % R; $\pm$ 0.5 % R; $\pm$ 0.1 % R
8.6	1.6	External visual inspection	-	-
<b>QUALIFICATION AND PERIODIC TESTS (CHART F4)</b>				
8.11.2	2.1.1.2	Robustness of terminations:		
8.11.2.1	(IEC 60115-1, 4.32)	Adhesion (shear test)	5 N; 10 s	No visible damage; $\pm$ (0.25 % R + 50 m $\Omega$ )
8.12	(IEC 60068-2-20, Tb) 2.4	Resistance to soldering heat	Solder bath method; (260 $\pm$ 5) °C; (10 $\pm$ 1) s	$\pm$ (0.15 % R + 50 m $\Omega$ )
8.10	1.5	Climatic sequence:		$\pm$ (0.5 % R + 50 m $\Omega$ ) $R_{\text{ins}} \geq 1$ G $\Omega$
8.10.2	(IEC 60068-2-2, Ba)	Dry heat	125 °C; 16 h	
8.10.3	(IEC 60068-2-30, Db)	Damp heat, cyclic	55 °C; $\geq$ 90 % RH; 24 h; 1 cycle	
8.10.4	(IEC 60068-2-1, Aa)	Cold	- 55 °C; 1 h off; 0.75 h on	
8.10.5	(IEC 60068-2-13, M)	Low air pressure	2 kPa; (25 $\pm$ 10) °C; 1 h; $U = \sqrt{P_{70} \times R} \leq U_{\text{max}}$ .	
8.10.6	(IEC 60068-2-30, Db)	Damp heat, cyclic	55 °C; $\geq$ 90 % RH; 24 h; 5 cycles	
8.10.7	-	DC load	$U = \sqrt{P_{70} \times R} \leq U_{\text{max}}$ ; 1 min	



TEST PROCEDURES AND REQUIREMENTS				
ESCC 4001 PARAGRAPH	ESCC 4001/022 PARAGRAPH	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE ( $\Delta R$ )
			Stability for product types:	2.21 $\Omega$ to 5.11 M $\Omega$
			<b>MS1 .... ESCC</b>	
8.3.1.2.2	(IEC 60115-1, 4.6.1.5)	Insulation resistance	V-shaped test jig $U = 500$ V; 1 min	$R_{ins} \geq 1$ G $\Omega$
8.3.1.3.2	(IEC 60115-1, 4.7) 1.5	Voltage proof	V-shaped test jig $U_{RMS} = 1.4 \times U_{ins RMS}$ ; $f = (50 \pm 10)$ Hz; 1 min	No breakdown; no flashover
8.13	2.7 1.5	Endurance at operating life	$U = \sqrt{P_{70} \times R} \leq U_{max.}$ ; 1.5 h on; 0.5 h off 70 °C; 1000 h 70 °C; 2000 h	$\pm (0.35 \% R + 50 \text{ m}\Omega)$ $\pm (0.5 \% R + 50 \text{ m}\Omega)$ $R_{ins} \geq 1$ G $\Omega$
8.14	(IEC 60068-2-20, Ta)	Solderability	Solder bath method; SnPb40; non-activated flux (235 $\pm$ 5) °C; (2 $\pm$ 0.5) s	Good tinning ( $\geq 95$ % covered); no visible damage; $\pm (0.15 \% R + 50 \text{ m}\Omega)$
8.15	(ESCC 24800)	Permanence of marking	a) Ethyl alcohol b) Isopropyl alcohol 25 °C; 3 x 1 min hard toothbrush; 3 x 10 strokes	Marking legible; no visible damage

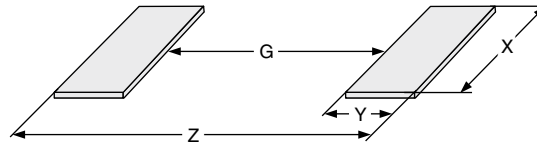


**DIMENSIONS**


DIMENSIONS AND MASS						
TYPE / SIZE	L (mm)	D (mm)	L <sub>1</sub> min. (mm)	D <sub>1</sub> (mm)	K (mm)	MASS (mg)
MS1 .... ESCC	3.60 + 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 2/3 of the band is visible from each radial angle of view. The last color band for tolerance is wider than the other bands. The body coating is of light green color, temperature coefficients other than ± 50 ppm/K are marked with color dots, yellow for ± 25 ppm/K or orange for ± 15 ppm/K



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)
MS1 .... ESCC	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 61188-5-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



**LOT VALIDATION TESTS**

Execution of Lot Validation Tests is available as a separate order item. Deliverable item to the Lot Validation Tests is the test report together with the used samples. The samples need to be ordered as a separate item.

SCOPE OF LOT VALIDATION TESTS			
<b>GROUP 1</b>	<b>ENVIRONMENTAL AND MECHANICAL</b>		<b>48 samples</b>
	Robustness of terminations: shear (adhesion)	ESCC 4001, 8.11.2.1	(6 samples)
	Resistance to soldering heat	ESCC 4001, 8.12	(6 samples)
	Climatic sequence	ESCC 4001, 8.10	(previously tested samples)
<b>GROUP 2</b>	<b>ENDURANCE</b>		<b>36 samples</b>
	Endurance at operating life, 2000 h	ESCC 4001, 8.13	(15 samples)
<b>GROUP 3</b>	<b>ELECTRICAL AND ASSEMBLY</b>		<b>21 samples</b>
	Insulation resistance	ESCC 4001, 8.3.1.2.2	(15 samples)
	Voltage proof	ESCC 4001, 8.3.1.3.2	
	Solderability	ESCC 4001, 8.14	(6 samples)
	Permanence of marking	ESCC 4001, 8.15	

PART NUMBER AND PRODUCT DESCRIPTION FOR LOT VALIDATION TESTS																	
<b>PART NUMBER: LOTCHG-LV1-4001022</b>																	
L	O	T	C	H	G	-	L	V	1	-	4	0	0	1	0	2	2
PREFIX						LOT VALIDATION TEST				SPECIFICATION							
LOTCHG						LV1 = LVT Group 1 LV2 = LVT Group 2 LV3 = LVT Group 3				ESCC 4001/022							
<b>PRODUCT DESCRIPTION: MS1 ESCC 4001/022 LVT1</b>																	
MS1				ESCC 4001/022				LVT1									
MODEL				SPECIFICATION				LOT VALIDATION TEST									
MS1				ESCC 4001/022				LVT1 = LVT Group 1 LVT2 = LVT Group 2 LVT3 = LVT Group 3									

**Note**

- Execution of Lot Validation Tests can be ordered using either the PART NUMBER or the PRODUCT DESCRIPTION

ORDER TEXT EXAMPLE			
An order of a Lot Validation Test shall be combined with a dedicated order line for the required amount of samples, using packaging code "LX", see the example below:			
POS	QTY	ITEM	
...			
0010	650	MS1 15 562R 0.1 % BX ESCC 4001/022 400102201 5620B1	{Quantity for consumption}
0011	36	MS1 15 562R 0.1 % LX ESCC 4001/022 400102201 5620B1	{Quantity for LVT samples}
0012	1	MS1 ESCC 4001/022 LVT2	{Lot Validation Test, Group 2}
...			



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