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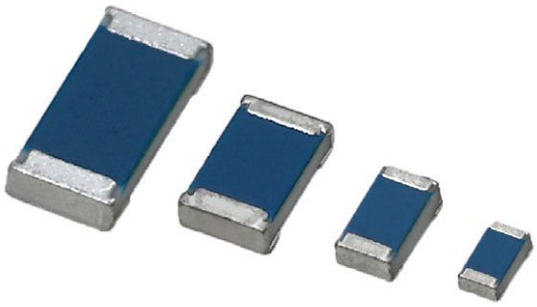
Precision Thin Film Chip Resistors



FEATURES

- Rated dissipation P_{70} up to 0.4 W for size 1206
- AEC-Q200 qualified
- Approved to EN 140401-801
- Superior temperature cycling robustness
- Advanced sulfur resistance verified according to ASTM B 809
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

AUTOMOTIVE GRADE

RoHS COMPLIANT

Automotive-grade MC AT precision thin film chip resistors are the perfect choice for most fields of modern precision electronics where reliability and stability is of major concern. Typical applications include automotive, telecommunication, industrial, medical equipment, precision test, and measuring equipment.

APPLICATIONS

- Automotive
- Telecommunication
- Industrial equipment
- Medical equipment

TECHNICAL SPECIFICATIONS				
DESCRIPTION	**MCS 0402 AT**	**MCT 0603 AT**	**MCU 0805 AT**	**MCA 1206 AT**
Imperial size	0402	0603	0805	1206
Metric size code	RR1005M	RR1608M	RR2012M	RR3216M
Resistance range	47 Ω to 221 kΩ	47 Ω to 511 kΩ	47 Ω to 1 MΩ	47 Ω to 1 MΩ
Resistance tolerance	± 0.1 %			
Temperature coefficient	± 25 ppm/K; ± 15 ppm/K; ± 10 ppm/K			
Rated dissipation P_{70} (1)	0.100 W	0.125 W	0.200 W	0.400 W
Operating voltage, $U_{max.}$ AC_{RMS}/DC	50 V	75 V	150 V	200 V
Permissible film temperature, $\vartheta_{F\ max.}$ (1)	155 °C			
Operating temperature range	-55 °C to 155 °C			
Permissible voltage against ambient (insulation): 1 min; U_{ins}	75 V	100 V	200 V	300 V
Failure rate: $FIT_{observed}$	≤ 0.1 x 10^{-9}/h			

Note

(1) Please refer to APPLICATION INFORMATION below.

APPLICATION INFORMATION

When the resistor dissipates power, a temperature rise above the ambient temperature occurs, dependent on the thermal resistance of the assembled resistor together with the printed circuit board. The rated dissipation applies only if the permitted film temperature is not exceeded.

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.

MAXIMUM RESISTANCE CHANGE AT RATED DISSIPATION			
OPERATION MODE		**STANDARD**	**POWER**
Rated dissipation, P_{70}	**MCS 0402 AT**	0.063 W	0.100 W
	MCT 0603 AT	0.100 W	0.125 W
	MCU 0805 AT	0.125 W	0.200 W
	MCA 1206 AT	0.250 W	0.400 W
Operating temperature range		-55 °C to 125 °C	-55 °C to 155 °C
Permissible film temperature, $\vartheta_{F\,max.}$		125 °C	155 °C
Max. resistance change at P_{70} for resistance range, $\lvert\Delta R/R\rvert$ after:	**MCS 0402 AT**	47 Ω to 221 kΩ	47 Ω to 221 kΩ
	MCT 0603 AT	47 Ω to 511 kΩ	47 Ω to 511 kΩ
	MCU 0805 AT	47 Ω to 1 MΩ	47 Ω to 1 MΩ
	MCA 1206 AT	47 Ω to 1 MΩ	47 Ω to 1 MΩ
	1000 h	≤ 0.1 %	≤ 0.2 %
	8000 h	≤ 0.2 %	≤ 0.4 %
	225 000 h	≤ 0.6 %	-

Note

- The presented operation modes do not refer to different types of resistors, but actually show examples of different loads, that lead to different film temperatures and different achievable load-life stability (drift) of the resistance value. A suitable low thermal resistance of the circuit board assembly must be safeguarded in order to maintain the film temperature of the resistors within the specified limits. Please consider the application note “Thermal Management in Surface-Mounted Resistor Applications” (www.vishay.com/doc?28844) for information on the general nature of thermal resistance.

TEMPERATURE COEFFICIENT AND RESISTANCE RANGE				
TYPE / SIZE	**TCR**	**TOLERANCE**	**RESISTANCE**	**E-SERIES**
MCS 0402 AT	± 25 ppm/K	± 0.1 %	47 Ω to 221 kΩ	E24; E192
	± 15 ppm/K		47 Ω to 100 kΩ	
	± 10 ppm/K		47 Ω to 10 kΩ	
MCT 0603 AT	± 25 ppm/K	± 0.1 %	47 Ω to 511 kΩ	E24; E192
	± 15 ppm/K		47 Ω to 221 kΩ	
	± 10 ppm/K		47 Ω to 22.1 kΩ	
MCU 0805 AT	± 25 ppm/K	± 0.1 %	47 Ω to 1 MΩ	E24; E192
	± 15 ppm/K		47 Ω to 332 kΩ	
	± 10 ppm/K		47 Ω to 33.2 kΩ	
MCA 1206 AT	± 25 ppm/K	± 0.1 %	47 Ω to 1 MΩ	E24; E192
	± 15 ppm/K		47 Ω to 511 kΩ	
	± 10 ppm/K		47 Ω to 43.2 kΩ	

PACKAGING

TYPE / SIZE	CODE	QUANTITY	PACKAGING STYLE	WIDTH	PITCH	PACKAGING DIMENSIONS
MCS 0402 AT	E1	1000	Paper tape acc. IEC 60286-3, Type 1a	8 mm	2 mm	Ø 180 mm/7"
	E5	5000				
	E0	10 000				
MCT 0603 AT	P1	1000			4 mm	Ø 180 mm/7"
	P5	5000				
	PW	20 000				Ø 330 mm/13"
MCU 0805 AT	P1	1000				Ø 180 mm/7"
	P5	5000				
	PW	20 000				Ø 330 mm/13"
MCA 1206 AT	P1	1000				Ø 180 mm/7"
	P5	5000				

PART NUMBER AND PRODUCT DESCRIPTION

Part Number: MCT0603MD4641BPW00

M	C	T	0	6	0	3	M	D	4	6	4	1	B	P	W	0	0

TYPE/SIZE	VERSION	TCR	RESISTANCE	TOLERANCE	PACKAGING
MCS0402 **MCT0603** **MCU0805** **MCA1206**	**M** = AT (Automotive)	**F** = ± 10 ppm/K **E** = ± 15 ppm/K **D** = ± 25 ppm/K	3 digit value 1 digit multiplier **Multiplier** **9** = $*10^{-1}$ **0** = $*10^{0}$ **1** = $*10^{1}$ **2** = $*10^{2}$ **3** = $*10^{3}$	**B** = ± 0.1 %	**E1** **E5** **E0** **P1** **P5** **PW**

Product Description: MCT 0603-25 0.1 % AT PW 4K64

MCT	0603	-25	0.1 %	AT	PW	4K64
TYPE	SIZE	TCR	TOLERANCE	VERSION	PACKAGING	RESISTANCE
MCS **MCT** **MCU** **MCA**	**0402** **0603** **0805** **1206**	± **10** ppm/K ± **15** ppm/K ± **25** ppm/K	± **0.1 %**	**AT** = Automotive	**E1** **E5** **E0** **P1** **P5** **PW**	**4K64** = 4.64 kΩ

Note

- Products can be ordered using either the PART NUMBER or PRODUCT DESCRIPTION.

DESCRIPTION

Production is strictly controlled and follows an extensive set of instructions established for reproducibility. A homogeneous film of special metal alloy is deposited on a high grade ceramic substrate (Al_2O_3) and conditioned to achieve the desired temperature coefficient. Specially designed inner contacts are deposited on both sides. A special laser is used to achieve the target value by smoothly cutting a meander groove in the resistive layer without damaging the ceramics. The resistor elements are covered by a unique protective coating designed for electrical, mechanical and climatic protection. The terminations receive a final pure matte tin on nickel plating.

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

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** (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 RoHS-compliant; the pure matte tin plating provides compatibility with lead (Pb)-free and lead-containing soldering processes. Solderability is specified for 2 years after production or requalification. The permitted storage time is 20 years. The immunity of the plating against tin whisker growth has been proven under extensive testing.

MATERIALS

Vishay acknowledges the following systems for the regulation of hazardous substances:

- IEC 62474, Material Declaration for Products of and for the Electrotechnical Industry, with the list of declarable substances given therein (2)
- The Global Automotive Declarable Substance List (GADSL) (3)
- The REACH regulation (1907/2006/EC) and the related list of substances with very high concern (SVHC) (4) for its supply chain

The products do not contain any of the banned substances as per IEC 62474, GADSL, or the SVHC list, see www.vishay.com/how/leadfree.

Hence the products fully comply 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) with amendment 2015/863/EU
- 2012/19/EU Waste Electrical and Electronic Equipment Directive (WEEE)

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

APPROVALS

The resistors are approved within the IECQ-CECC Quality Assessment System for Electronic Components to the detail specification **EN 140401-801** which refers to **EN 60115-1**, **EN 60115-8** and the variety of environmental test procedures of the **IEC 60068** (1) series. The detail specification refers to the climatic categories 55/125/56, which relates to the "standard operation mode" of this datasheet.

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

Vishay Beyschlag has achieved "**Approval of Manufacturer**" in accordance with **IECQ 03-1**. The release certificate for "**Technology Approval Schedule**" in accordance with **CECC 240001** based on **IECQ 03-3-1** is granted for the Vishay Beyschlag manufacturing process.

The resistors are qualified according to AEC-Q200.

RELATED PRODUCTS

For more information about products with higher operation temperature please refer to the **professional** datasheet (www.vishay.com/doc?28760).

Chip resistor arrays may be used in sensing applications or precision amplifiers where close matching between multiple resistors is necessary. Please refer to the ACAS AT - Precision datasheet (www.vishay.com/doc?28770).

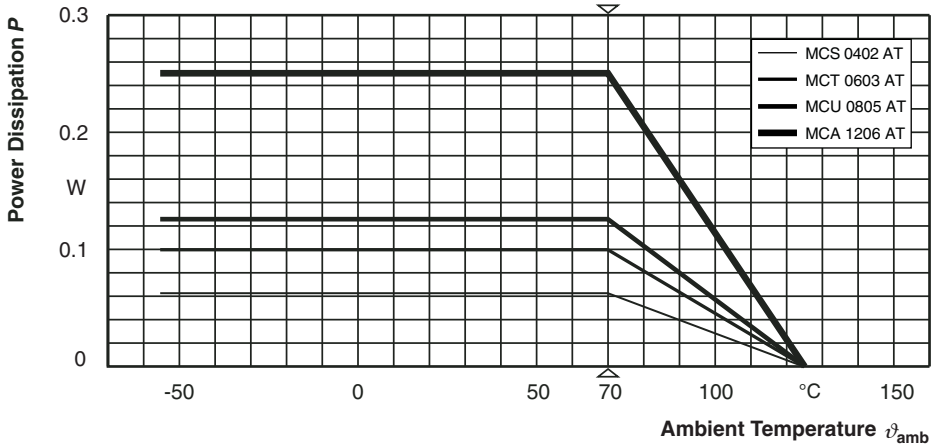
MC AT Precision is also available with gold termination for conductive gluing. Please refer to the datasheet (www.vishay.com/doc?28877).

For high power and high temperature applications MCW 0406 AT wide terminal thin film chip resistors offer extremely high power ratings in compact 0406 case size and extraordinary temperature cycling robustness.
Please refer to the datasheets for
precision (www.vishay.com/doc?28847) and
professional (www.vishay.com/doc?28796) specification.

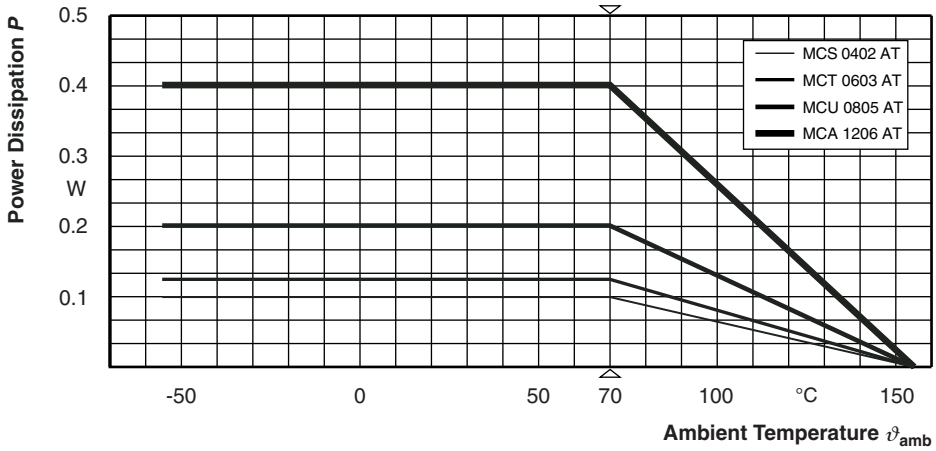
Notes

(1) The quoted IEC standards are also released as EN standards with the same number and identical contents.
(2) The IEC 62474 list of declarable substances is maintained in a dedicated database, which is available at http://std.iec.ch/iec62474.
(3) The Global Automotive Declarable Substance List (GADSL) is maintained by the American Chemistry Council and available at www.gadsl.org.
(4) The SVHC list is maintained by the European Chemical Agency (ECHA) and available at http://echa.europa.eu/candidate-list-table.

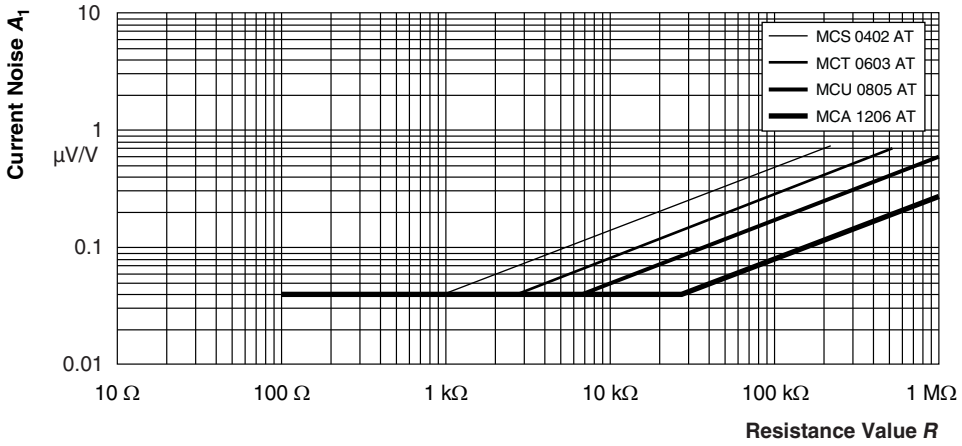
FUNCTIONAL PERFORMANCE



Derating - Standard Operation



Derating - Power Operation



Current noise A_1 in accordance with IEC 60195

Current Noise

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 140401-801, detail specification

IEC 60068-2-xx, test methods

The components are approved under the IECQ-CECC quality assessment system for electronic components.

The parameters stated in the Test Procedures and Requirements table are based on the required tests and permitted limits of EN 140401-801. 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 (ΔR)
				STABILITY CLASS 0.25 OR BETTER [2]
			Stability for product types:	
			MCS 0402 AT	47 Ω to 221 kΩ
			MCT 0603 AT	47 Ω to 511 kΩ
			MCU 0805 AT	47 Ω to 1 MΩ
			MCA 1206 AT	47 Ω to 1 MΩ
4.5	-	Resistance		± 0.1 % R
4.8	-	Temperature coefficient	At (20 / -55 / 20) °C and (20 / 155 / 20) °C	± 25 ppm/K; ± 15 ppm/K; ± 10 ppm/K
4.25.1	-	Endurance at 70 °C: Standard operation mode	$U = \sqrt{P_{70} \times R}$ or $U = U_{max.}$; whichever is the less severe; 1.5 h on; 0.5 h off; 70 °C; 1000 h 70 °C; 8000 h	± (0.1 % R + 0.02 Ω) ± (0.2 % R + 0.02 Ω)
		Endurance at 70 °C: Power operation mode	$U = \sqrt{P_{70} \times R}$ or $U = U_{max.}$; whichever is the less severe; 1.5 h on; 0.5 h off; 70 °C; 1000 h 70 °C; 8000 h	± (0.2 % R + 0.02 Ω) ± (0.4 % R + 0.05 Ω)
4.25.3	-	Endurance at upper category temperature	125 °C; 1000 h 155 °C; 1000 h	± (0.15 % R + 0.02 Ω) ± (0.3 % R + 0.02 Ω)
4.24	78 (Cab)	Damp heat, steady state	(40 ± 2) °C; 56 days; (93 ± 3) % RH	± (0.1 % R + 0.02 Ω)
4.37	67 (Cy)	Damp heat, steady state, accelerated Standard operation mode	(85 ± 2) °C (85 ± 5) % RH $U = \sqrt{0.1 \times P_{70} \times R}$; $U \leq 0.3 \times U_{max.}$; 1000 h	± (0.5 % R + 0.05 Ω)

TEST PROCEDURES AND REQUIREMENTS				
EN 60115-1 CLAUSE	IEC 60068-2 [1] TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE (ΔR)
				STABILITY CLASS 0.25 OR BETTER [2]
			Stability for product types:	
			MCS 0402 AT	47 Ω to 221 kΩ
			MCT 0603 AT	47 Ω to 511 kΩ
			MCU 0805 AT	47 Ω to 1 MΩ
			MCA 1206 AT	47 Ω to 1 MΩ
4.23		Climatic sequence: Standard operation mode		± (0.25 % R + 0.02 Ω)
4.23.2	2 (Bb)	Dry heat	125 °C; 16 h	
4.23.3	30 (Db)	Damp heat, cyclic	55 °C; 24 h; ≥ 90 % RH; 1 cycle	
4.23.4	1 (Ab)	Cold	-55 °C; 2 h	
4.23.5	13 (M)	Low air pressure	8.5 kPa; 2 h; (25 ± 10) °C	
4.23.6	30 (Db)	Damp heat, cyclic	55 °C; 24 h; ≥ 90 % RH; 5 cycles	
4.23.7	-	DC load	$U = \sqrt{P_{70} \times R} \leq U_{max.}$; 1 min	
-	1 (Aa)	Storage at low temperature	-55 °C; 2 h	± (0.05 % R + 0.01 Ω)
4.19	14 (Na)	Rapid change of temperature	30 min at -55 °C and 30 min at 155 °C; 1000 cycles	± (0.25 % R + 0.02 Ω)
		Extended rapid change of temperature	30 min at -40 °C; 30 min at 125 °C [3]; MCS 0402 AT: 3000 cycles MCT 0603 AT: 2000 cycles MCU 0805 AT: 1500 cycles MCA 1206 AT: 1000 cycles	± (0.25 % R + 0.05 Ω); (≥ 50 % of initial shear force)
4.13	-	Short time overload: Standard operation mode	$U = 2.5 \times \sqrt{P_{70} \times R}$ or $U = 2 \times U_{max.}$; whichever is the less severe; 5 s	± (0.05 % R + 0.01 Ω)
4.27	-	Single pulse high voltage overload: Standard operation mode	Severity no. 4: $U = 10 \times \sqrt{P_{70} \times R}$ or $U = 2 \times U_{max.}$; whichever is the less severe; 10 pulses 10 µs/700 µs	± (0.25 % R + 0.05 Ω)
4.39	-	Periodic electric overload: Standard operation mode	$U = \sqrt{15 \times P_{70} \times R}$ or $U = 2 \times U_{max.}$ whichever is the less severe; 0.1 s on; 2.5 s off; 1000 cycles	± (0.5 % R + 0.05 Ω)
4.38	-	Electro static discharge (human body model)	IEC 61340-3-1 [1]; 3 pos. + 3 neg. (equivalent to MIL-STD-883, method 3015) MCS 0402 AT: 500 V MCT 0603 AT: 1000 V MCU 0805 AT: 1500 V MCA 1206 AT: 2000 V	± (0.5 % R + 0.05 Ω)

TEST PROCEDURES AND REQUIREMENTS				
EN 60115-1 CLAUSE	IEC 60068-2 [1] TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE (ΔR)
				STABILITY CLASS 0.25 OR BETTER [2]
			Stability for product types:	
			MCS 0402 AT	47 Ω to 221 kΩ
			MCT 0603 AT	47 Ω to 511 kΩ
			MCU 0805 AT	47 Ω to 1 MΩ
			MCA 1206 AT	47 Ω to 1 MΩ
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) no visible damage
4.17	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	58 (Td)	Resistance to soldering heat	Solder bath method; (260 ± 5) °C; (10 ± 1) s	± (0.05 % R + 0.01 Ω)
4.29	45 (XA)	Component solvent resistance	Isopropyl alcohol +50 °C; method 2	No visible damage
4.32	21 (Ue_3)	Shear (adhesion)	MCS 0402 AT and MCT 0603 AT; 9 N	No visible damage
			MCU 0805 AT and MCA 1206 AT; 45 N	
4.33	21 (Ue_1)	Substrate bending	Depth 2 mm, 3 times	± (0.05 % R + 0.01 Ω) no visible damage; no open circuit in bent position
4.7	-	Voltage proof	$U_{RMS} = U_{ins}$; (60 ± 5) s	No flashover or breakdown
4.35	-	Flammability	IEC 60695-11-5 [1], needle flame test; 10 s	No burning after 30 s

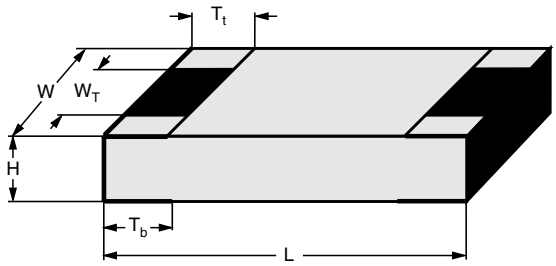
Notes

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

[2] According to the detail specification EN 140401-801 the stability class applies to the category temperatures 85 °C and 125 °C and their respective test conditions.

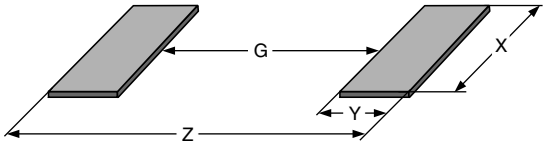
[3] Tested on a 4-layer printed circuit board with SAC micro alloy.

DIMENSIONS



DIMENSIONS AND MASS							
TYPE / SIZE	H (mm)	L (mm)	W (mm)	W_T (mm)	T_t (mm)	T_b (mm)	MASS (mg)
MCS 0402 AT	0.32 ± 0.05	1.0 ± 0.05	0.5 ± 0.05	> 75 % of W	0.2 + 0.1/- 0.15	0.2 ± 0.1	0.6
MCT 0603 AT	0.45 + 0.1/- 0.05	1.55 ± 0.05	0.85 ± 0.1	> 75 % of W	0.3 + 0.15/- 0.2	0.3 + 0.15/- 0.2	1.9
MCU 0805 AT	0.52 ± 0.1	2.0 ± 0.1	1.25 ± 0.15	> 75 % of W	0.4 + 0.1/- 0.2	0.4 + 0.1/- 0.2	4.6
MCA 1206 AT	0.55 ± 0.1	3.2 + 0.1/- 0.2	1.6 ± 0.15	> 75 % of W	0.5 ± 0.25	0.5 ± 0.25	9.2

SOLDER PAD DIMENSIONS



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)
MCS 0402 AT	-	-	-	-	0.35	0.55	0.55	1.45
MCT 0603 AT	0.55	1.10	1.10	2.75	0.65	0.70	0.95	2.05
MCU 0805 AT	0.80	1.25	1.50	3.30	0.90	0.90	1.40	2.70
MCA 1206 AT	1.40	1.50	1.90	4.40	1.50	1.15	1.75	3.80

Notes

- 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.

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

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