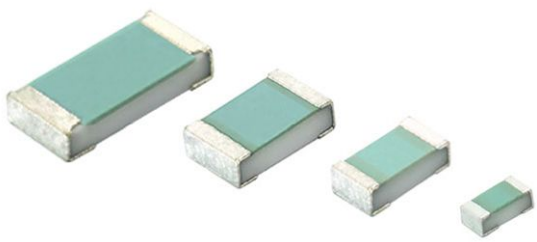
Precision Thin Film Chip Resistors



Thin film flat chip resistors combine the proven reliability of the professional products with an advanced level of precision and stability. Therefore they are perfectly suited for applications in the fields of test and measurement equipment together with industrial and medical electronics.

FEATURES

- IECQ-CECC approved to EN 140401-801
- Low TCR: ± 10 ppm/K to ± 25 ppm/K
- Precision tolerance of resistance: ± 0.1 % and ± 0.25 %
- Superior overall stability: class 0.1 and 0.25
- Sulfur resistance verified according to ASTM B 809
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

RoHS COMPLIANT

APPLICATIONS

- Industrial equipment
- Test and measuring equipment
- Telecommunication
- Medical equipment

TECHNICAL SPECIFICATIONS				
DESCRIPTION	**MCS 0402**	**MCT 0603**	**MCU 0805**	**MCA 1206**
Imperial size	0402	0603	0805	1206
Metric size code	RR1005M	RR1608M	RR2012M	RR3216M
Resistance range	100 Ω to 221 kΩ	39 Ω to 511 kΩ	39 Ω to 1.5 MΩ	39 Ω to 2 MΩ
Resistance tolerance	± 0.25 %; ± 0.1 %			
Temperature coefficient	± 25 ppm/K; ± 15 ppm/K; ± 10 ppm/K			
Rated dissipation, P_{70} (1)	0.063 W	0.100 W	0.125 W	0.250 W
Operating voltage, $U_{max.}$ AC_{RMS}/DC	50 V	75 V	150 V	200 V
Permissible film temperature, $\vartheta_{F\ max.}$ (1)	125 °C			
Operating temperature range	-55 °C to 125 °C			
Internal thermal resistance (1)	90 K/W	63 K/W	38 K/W	32 K/W
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		PRECISION	STANDARD
Rated dissipation, P_{70}	**MCS 0402**	0.016 W	0.063 W
	MCT 0603	0.032 W	0.100 W
	MCU 0805	0.050 W	0.125 W
	MCA 1206	0.100 W	0.250 W
Operating voltage, $U_{max.}$ AC_{RMS}/DC	**MCS 0402**	12.5 V	50 V
	MCT 0603	25 V	75 V
	MCU 0805	35 V	150 V
	MCA 1206	50 V	200 V
Operating temperature range		-10 °C to 85 °C	-55 °C to 125 °C
Permissible film temperature, $\vartheta_{F\ max.}$		85 °C	125 °C
Max. resistance change at P_{70} for resistance range, $\lvert\Delta R/R\rvert$ after:	**MCS 0402**	100 Ω to 221 kΩ	100 Ω to 221 kΩ
	MCT 0603	39 Ω to 511 kΩ	39 Ω to 511 kΩ
	MCU 0805	39 Ω to 1.5 MΩ	39 Ω to 1.5 MΩ
	MCA 1206	39 Ω to 2 MΩ	39 Ω to 2 MΩ
	1000 h	≤ 0.05 %	≤ 0.1 %
	8000 h	≤ 0.1 %	≤ 0.25 %
	225 000 h	≤ 0.25 %	≤ 0.5 %

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 (1)

TYPE / SIZE	TCR	TOLERANCE	RESISTANCE	E-SERIES
MCS 0402	± 25 ppm/K	± 0.25 %	100 Ω to 221 kΩ	E24; E192
		± 0.1 %	**100 Ω to 221 kΩ**	
	± 15 ppm/K	± 0.25 %	100 Ω to 150 kΩ	
		± 0.1 %	**100 Ω to 150 kΩ**	
	± 10 ppm/K	± 0.25 %	100 Ω to 130 kΩ	
		± 0.1 %	**100 Ω to 130 kΩ**	
MCT 0603	± 25 ppm/K	± 0.25 %	39 Ω to 511 kΩ	
		± 0.1 %	**47 Ω to 511 kΩ**	
	± 15 ppm/K	± 0.25 %	39 Ω to 332 kΩ	
		± 0.1 %	**47 Ω to 332 kΩ**	
	± 10 ppm/K	± 0.25 %	39 Ω to 221 kΩ	
		± 0.1 %	**47 Ω to 221 kΩ**	
MCU 0805	± 25 ppm/K	± 0.25 %	39 Ω to 1.5 MΩ	
		± 0.1 %	**47 Ω to 1.5 MΩ**	
	± 15 ppm/K	± 0.25 %	39 Ω to 1 MΩ	
		± 0.1 %	**47 Ω to 1 MΩ**	
	± 10 ppm/K	± 0.25 %	39 Ω to 511 kΩ	
		± 0.1 %	**47 Ω to 511 kΩ**	
MCA 1206	± 25 ppm/K	± 0.25 %	39 Ω to 2 MΩ	
		± 0.1 %	**47 Ω to 2 MΩ**	
	± 15 ppm/K	± 0.25 %	39 Ω to 1.5 MΩ	
		± 0.1 %	**47 Ω to 1.5 MΩ**	
	± 10 ppm/K	± 0.25 %	39 Ω to 1 MΩ	
		± 0.1 %	**47 Ω to 1 MΩ**	

Notes

- Resistance ranges printed in bold are preferred TCR / tolerance combinations with optimized availability

(1) For the approved IECQ-CECC resistance range, please refer to www.vishay.com/doc?28945

PACKAGING

TYPE / SIZE	CODE	QUANTITY	PACKAGING STYLE	WIDTH	PITCH	PACKAGING DIMENSIONS
MCS 0402	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	P1	1000			4 mm	Ø 180 mm/7"
	P5	5000				
	PW	20 000				Ø 330 mm/13"
MCU 0805	P1	1000				Ø 180 mm/7"
	P5	5000				
	PW	20 000				Ø 330 mm/13"
MCA 1206	P1	1000				Ø180 mm/7"
	P5	5000				

PART NUMBER AND PRODUCT DESCRIPTION

Part Number: MCT06030D4641BPW00

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

TYPE / SIZE	VERSION	TCR	RESISTANCE	TOLERANCE	PACKAGING
MCS0402 **MCT0603** **MCU0805** **MCA1206**	**0** = neutral	**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** = $*10^{3}$ **4** = $*10^{4}$	**B** = ± 0.1 % **C** = ± 0.25 %	**E1** **E5** **E0** **P1** **P5** **PW**

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

MCT	0603	-25	0.1 %	PW	4K64
TYPE	SIZE	TCR	TOLERANCE	PACKAGING	RESISTANCE
MCS **MCT** **MCU** **MCA**	**0402** **0603** **0805** **1206**	± **10** ppm/K ± **15** ppm/K ± **25** ppm/K	± **0.1 %** ± **0.25 %**	**E1** **E5** **E0** **P1** **P5** **PW**	**4K64** = 4.64 kΩ **50R1** = 50.1 Ω

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 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 fine trimming the resistive layer without damaging the ceramics. A further conditioning is applied in order to stabilize the trimming result. The resistor elements are covered by a 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. 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 and for automatic soldering using wave, reflow or vapor phase. 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

Where applicable, 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.

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.

RELATED PRODUCTS

Resistors are available with established reliability in accordance with EN 140401-801 version E. Please refer to the special datasheet (www.vishay.com/doc?28744) for information on failure rate level, available resistance ranges and order codes.

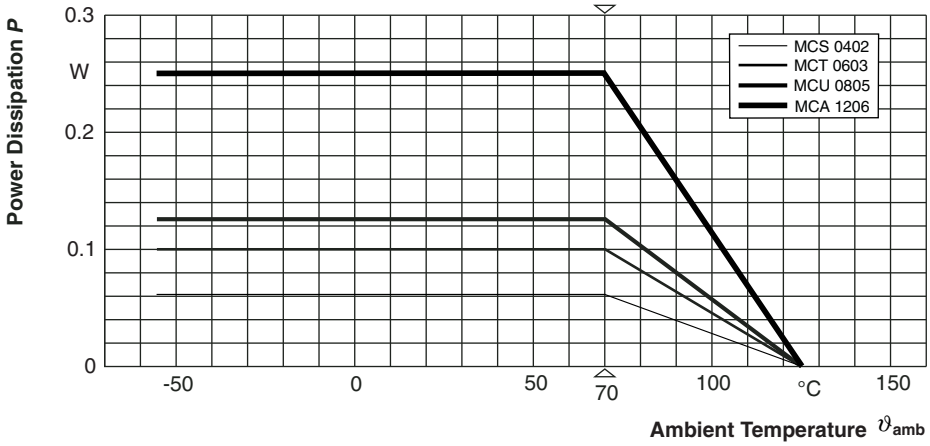
For more information about products with higher rated power and higher operation temperature please refer to the Professional Thin Film Chip Resistor datasheet (www.vishay.com/doc?28705).

Precision chip resistor arrays may be used in voltage divider applications or precision amplifiers where close matching between multiple resistors is necessary. Please refer to the ACAS 0612 - Precision datasheet (www.vishay.com/doc?28751).

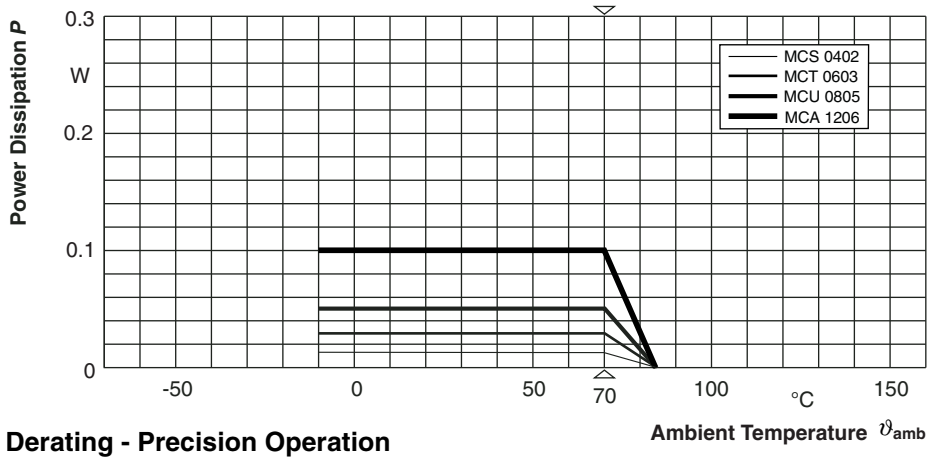
Notes

(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

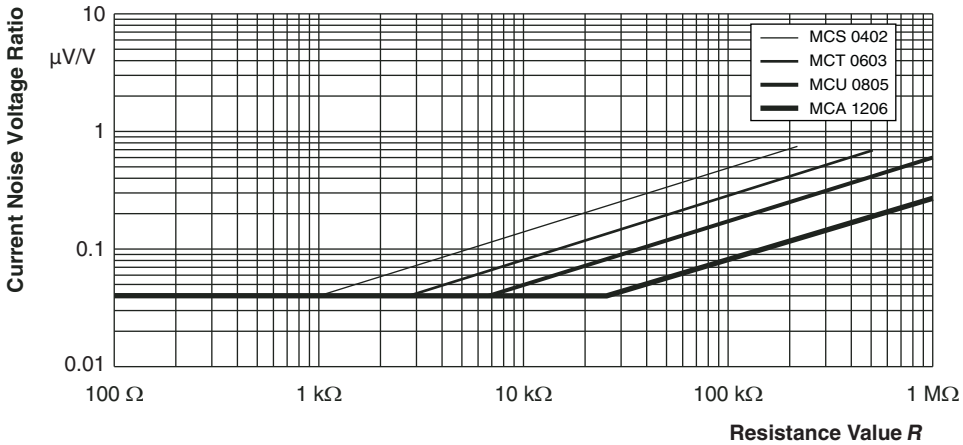
FUNCTIONAL PERFORMANCE



Derating - Standard Operation



Derating - Precision Operation



In accordance with IEC 60195

Current Noise Voltage Ratio

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 140401-801, 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 0.1	STABILITY CLASS 0.25
			Stability for product types:		
			MCS 0402	100 Ω to 10 kΩ	> 10 kΩ to 221 kΩ
			MCT 0603	100 Ω to 10 kΩ	39 Ω to < 100 Ω; > 10 kΩ to 511 kΩ
			MCU 0805	100 Ω to 47.5 kΩ	39 Ω to < 100 Ω; > 47.5 kΩ to 1.5 MΩ
			MCA 1206	47 Ω to 332 kΩ	39 Ω to < 47 Ω; > 332 kΩ to 2 MΩ
4.5	-	Resistance	-	± 0.1 % R; ± 0.25 % R	
4.8	-	Temperature coefficient	At (20 / - 10 / 20) °C and (20 / 85 / 20) °C	± 25 ppm/K; ± 15 ppm/K; ± 10 ppm/K	-
			At (20 / - 55 / 20) °C and (20 / 125 / 20) °C	-	± 25 ppm/K; ± 15 ppm/K; ± 10 ppm/K
4.25.1	-	Endurance at 70 °C: precision 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	± (0.05 % R + 0.02 Ω)	
			70 °C; 8000 h	± (0.1 % R + 0.02 Ω)	
		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	± (0.1 % R + 0.02 Ω)	
			70 °C; 8000 h	± (0.25 % R + 0.05 Ω)	
4.25.3	-	Endurance at upper category temperature	85 °C; 1000 h	± (0.1 % R + 0.02 Ω)	± (0.2 % R + 0.02 Ω)
			125 °C; 1000 h	± (0.2 % R + 0.02 Ω)	± (0.25 % R + 0.05 Ω)
4.24	78 (Cab)	Damp heat, steady state	(40 ± 2) °C; 56 days; (93 ± 3) % RH	± (0.1 % R + 0.02 Ω)	± (0.25 % R + 0.05 Ω)

TEST PROCEDURES AND REQUIREMENTS

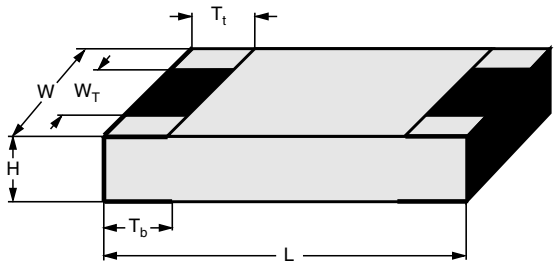
EN 60115-1 CLAUSE	IEC 60068-2 [1] TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE (ΔR)	
				STABILITY CLASS 0.1	STABILITY CLASS 0.25
			Stability for product types:		
			MCS 0402	100 Ω to 10 kΩ	> 10 kΩ to 221 kΩ
			MCT 0603	100 Ω to 10 kΩ	39 Ω to < 100 Ω; > 10 kΩ to 511 kΩ
			MCU 0805	100 Ω to 47.5 kΩ	39 Ω to < 100 Ω; > 47.5 kΩ to 1.5 MΩ
			MCA 1206	47 Ω to 332 kΩ	39 Ω to < 47 Ω; > 332 kΩ to 2 MΩ
4.23		Climatic sequence: standard operation mode:		± (0.1 % R + 0.02 Ω)	± (0.25 % R + 0.05 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)	Cold	-55 °C; 2 h	± (0.05 % R + 0.01 Ω)	
4.19	14 (Na)	Rapid change of temperature	30 min at LCT and 30 min at UCT; LCT = -10 °C; UCT = 85 °C; 5 cycles	± (0.05 % R + 0.01 Ω) no visible damage	
			LCT = -55 °C; UCT = 125 °C; 1000 cycles	± (0.25 % R + 0.05 Ω) no visible damage	
4.13	-	Short time overload: precision 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)	
		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	± (0.5 % R + 0.05 Ω) no visible damage	
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) no visible damage	

TEST PROCEDURES AND REQUIREMENTS					
EN 60115-1 CLAUSE	IEC 60068-2 [1] TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE (ΔR)	
				STABILITY CLASS 0.1	STABILITY CLASS 0.25
			Stability for product types:		
			MCS 0402	100 Ω to 10 kΩ	> 10 kΩ to 221 kΩ
			MCT 0603	100 Ω to 10 kΩ	39 Ω to < 100 Ω; > 10 kΩ to 511 kΩ
			MCU 0805	100 Ω to 47.5 kΩ	39 Ω to < 100 Ω; > 47.5 kΩ to 1.5 MΩ
			MCA 1206	47 Ω to 332 kΩ	39 Ω to < 47 Ω; > 332 kΩ to 2 MΩ
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: 500 V MCT 0603: 1000 V MCU 0805: 1500 V MCA 1206: 2000 V	± (0.5 % R + 0.05 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) 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 and MCT 0603; 9 N	No visible damage	
			MCU 0805 and MCA 1206; 45 N	No visible damage	
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	

Note

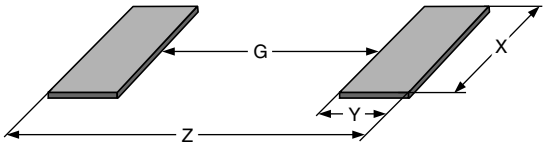
[1] The quoted IEC standards are also released as EN standards with the same number and identical contents

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	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	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	0.45 + 0.1 / - 0.05	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	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	-	-	-	-	0.35	0.55	0.55	1.45
MCT 0603	0.55	1.10	1.10	2.75	0.65	0.70	0.95	2.05
MCU 0805	0.80	1.25	1.50	3.30	0.90	0.90	1.40	2.70
MCA 1206	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

HISTORICAL 12NC INFORMATION

- The resistors had a 12-digit numeric code starting with 2312.
- The subsequent 4 digits indicated the resistor type, specification and packaging; see the 12NC table.
- The remaining 4 digits indicated the resistance value:
  - The first 3 digits indicated the resistance value.
  - The last digit indicated the resistance decade in accordance with the 12NC Indicating Resistance Decade table.

Last Digit of 12NC Indicating Resistance Decade

RESISTANCE DECADE	LAST DIGIT
10 Ω to 99.9 Ω	9
100 Ω to 999 Ω	1
1 kΩ to 9.99 kΩ	2
10 kΩ to 99.9 kΩ	3
100 kΩ to 999 kΩ	4
1 MΩ to 9.99 MΩ	5

Historical 12NC example

The 12NC of a MCT 0603 resistor, value 47 kΩ and TCR 25 with ± 0.1 % tolerance, supplied in cardboard tape of 5000 units per reel was: 2312 216 74703.

HISTORICAL 12NC - Resistors type and packaging

DESCRIPTION			2312...				
			CARDBOARD TAPE ON REEL				
TYPE	TCR	TOL.	P1 1000 UNITS	P5 5000 UNITS	PW 20 000 UNITS	E1 1000 UNITS	E0 10 000 UNITS
MCS 0402	± 25 ppm/K	± 0.25 %	-	-	-	261 6....	276 6....
		± 0.1 %	-	-	-	261 7....	276 7....
	± 15 ppm/K	± 0.25 %	-	-	-	262 6....	277 6....
		± 0.1 %	-	-	-	262 7....	277 7....
	± 10 ppm/K	± 0.25 %	-	-	-	263 6....	278 6....
		± 0.1 %	-	-	-	263 7....	278 7....
MCT 0603	± 25 ppm/K	± 0.25 %	201 6....	216 6....	206 6....	-	-
		± 0.1 %	201 7....	216 7....	206 7....	-	-
	± 15 ppm/K	± 0.25 %	202 6....	217 6....	207 6....	-	-
		± 0.1 %	202 7....	217 7....	207 7....	-	-
	± 10 ppm/K	± 0.25 %	203 6....	218 6....	208 6....	-	-
		± 0.1 %	203 7....	218 7....	208 7....	-	-
MCU 0805	± 25 ppm/K	± 0.25 %	241 6....	256 6....	246 6....	-	-
		± 0.1 %	241 7....	256 7....	246 7....	-	-
	± 15 ppm/K	± 0.25 %	242 6....	257 6....	247 6....	-	-
		± 0.1 %	242 7....	257 7....	247 7....	-	-
	± 10 ppm/K	± 0.25 %	243 6....	258 6....	248 6....	-	-
		± 0.1 %	243 7....	258 7....	248 7....	-	-
MCA 1206	± 25 ppm/K	± 0.25 %	381 6....	396 6....	386 6....	-	-
		± 0.1 %	381 7....	396 7....	386 7....	-	-
	± 15 ppm/K	± 0.25 %	382 6....	397 6....	387 6....	-	-
		± 0.1 %	382 7....	397 7....	387 7....	-	-
	± 10 ppm/K	± 0.25 %	383 6....	398 6....	388 6....	-	-
		± 0.1 %	383 7....	398 7....	388 7....	-	-

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