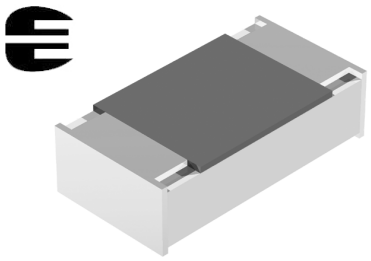
Precision Flat Chip Resistors



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 measuring equipment together with industrial and medical electronics. The latest member of this product family size 0402 follows the ongoing trend of miniaturisation and enables precision applications in micro circuit designs.

FEATURES

- Approved according to EN 140401-801
- Thin-film technology
- Low TC: ± 10 to ±25 ppm/K
- Precision tolerance of value: ± 0.1 and ±0.25 %
- Superior overall stability: class 0.1 and 0.25
- Green product, supports lead-free soldering

APPLICATIONS

- Automotive
- Test and measuring equipment
- Medical equipment
- Industrial equipment.

METRIC SIZE				
INCH:	0402	0603	0805	1206
METRIC:	RR 1005M	RR 1608M	RR 2012M	RR 3216M

TECHNICAL SPECIFICATIONS

DESCRIPTION	MCS 0402		MCT 0603		MCU 0805		MCA 1206	
Metric size	RR 1005M		RR 1608M		RR 2012M		RR 3216M	
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 %						±0.1 %	
Temperature coefficient	±25 ppm/K; ± 15 ppm/K; ± 10 ppm/K							
Operation mode	precision	standard	precision	standard	precision	standard	precision	standard
Climatic category (LCT/UCT/days)	10/85/56	55/125/56	10/85/56	55/125/56	10/85/56	55/125/56	10/85/56	55/125/56
Rated dissipation, P_{70} (1)	0.016 W	0.063 W	0.032 W	0.1 W	0.050 W	0.125 W	0.1 W	0.25 W
Operating voltage, U_{max} AC/DC	12.5 V	50 V	25 V	75 V	35 V	150 V	50 V	200 V
Film temperature	85 °C	125 °C	85 °C	125 °C	85 °C	125 °C	85 °C	125 °C
Max. resistance change at P_{70}	100 Ω to 221 kΩ		39 Ω to 511 kΩ		39 Ω to 1.5 MΩ		39 Ω to 2 MΩ	
1 000 h	≤0.1 %	≤ 0.2 %	≤0.1 %	≤ 0.2 %	≤ 0.1 %	≤ 0.2 %	≤ 0.05 %	≤ 0.1 %
8 000 h	≤0.2 %	≤ 0.4 %	≤0.2 %	≤ 0.4 %	≤ 0.2 %	≤ 0.4 %	≤ 0.1 %	≤ 0.25 %
225 000 h	≤ 0.5 %	≤ 1.0 %	≤ 0.5 %	≤ 1.0 %	≤ 0.5 %	≤ 1.0 %	≤ 0.25 %	≤ 0.5 %
Specified lifetime	225 000 h		225 000 h		225 000 h		225 000 h	
Insulation voltage :								
1 minute; U_{ins}	75 V		100 V		200 V		300 V	
continuous	75 V		75 V		75 V		75 V	
Failure rate	≤ 2 x 10^{-9}/h		≤ 2 x 10^{-9}/h		≤ 2 x 10^{-9}/h		≤ 2 x 10^{-9}/h	

Note

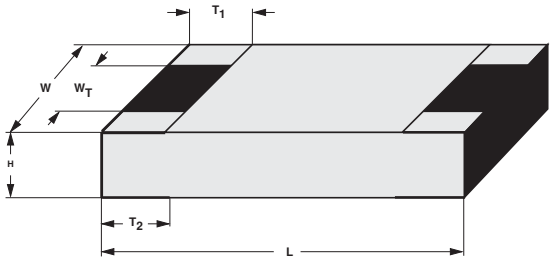
1. The power dissipation on the resistor generates a temperature rise against the local ambient, depending on the heat flow support of the printed-circuit board (thermal resistance). The rated dissipation applies only if the permitted film temperature is not exceeded.

ORDERING INFORMATION - type description and ordering code							
M	**C**	**T**	**0603**	**-25**	**0.1 %**	**P5**	**47 K**
FILM TYPE	PRODUCT CODE	SIZE CODE	IMPERIAL SIZE	TEMPERATURE COEFFICIENT	TOLERANCE	PACKAGING	RESISTANCE VALUE
M = Metal film or cermet	C = Flat chip	S = 0402 T = 0603 U = 0805 A = 1206	0402 0603 0805 1206	± 10 ppm/K ± 15 ppm/K ± 25 ppm/K	± 0.1 % ± 0.25 %	E1 = 1 000 units(1) E0 = 10 000 units(1) P1 = 1 000 units P5 = 5 000 units PW = 20 000 units	See Temperature coefficient and resistance range table

Note: We recommend that the clear text ordering code is used to minimize the possibility of errors in order handling.

1. E1 and E0 only for MCS 0402.

DIMENSIONS



DIMENSIONS - CHIP resistor types, mass and relevant physical dimensions							
TYPE	**H (mm)**	**L (mm)**	**W (mm)**	**W_T (mm)**	**T_1 (mm)**	**T_2 (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

TEMPERATURE COEFFICIENT AND RESISTANCE RANGE					
DESCRIPTION		**RESISTANCE VALUE (1)**			
T.C.	**TOLERANCE**	**MCS 0402**	**MCT 0603**	**MCU 0805**	**MCA 1206**
±25 ppm/K	± 0.25 %	**100 Ω to 221 kΩ**	**39 Ω to 511 kΩ**	**39 Ω to 1.5 MΩ**	**39 Ω to 2 MΩ**
	± 0.1 %	**150 Ω to 221 kΩ**	**47 Ω to 511 kΩ**	**47 Ω to 1.5 MΩ**	**47 Ω to 2 MΩ**
±15 ppm/K	± 0.25 %	100 Ω to 150 kΩ	39 Ω to 332 kΩ	39 Ω to 1 MΩ	39 Ω to 1.5 MΩ
	± 0.1 %	**150 Ω to 150 kΩ**	**47 Ω to 332 kΩ**	**47 Ω to 1 MΩ**	**47 Ω to 1.5 MΩ**
±10 ppm/K(2)	± 0.25 %	100 Ω to 130 kΩ	39 Ω to 221 kΩ	39 Ω to 511 kΩ	39 Ω to 1 MΩ
	± 0.1 %	**150 Ω to 130 kΩ**	**47 Ω to 221 kΩ**	**47 Ω to 511 kΩ**	**47 Ω to 1 MΩ**

Note

1. Resistance values to be selected from E96 and E192 series, other values are available on request.
2. TC 10 is specified over the temperature range from - 10 °C to 85 °C.

Resistance ranges printed in bold are preferred T.C./tolerance combinations with optimized availability.

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 super high grade (96 % Al_20_3) ceramic substrate 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 blue protective coating designed for electrical, mechanical and climatic protection. The terminations receive a final pure 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. Only accepted products are laid directly into the paper tape in accordance with **EN 60286-3**.

ASSEMBLY

The resistors are suitable for processing on automatic SMD assembly systems and for automatic soldering using wave, reflow or vapour phase. The encapsulation is resistant to all cleaning solvents commonly used in the electronics industry, including alcohols, esters and aqueous solutions. The resistors are lead (Pb)-free, the pure tin plating provides compatibility with lead (Pb)-free and lead-containing soldering processes. The immunity of the plating against tin whisker growth has been proven under extensive testing. All products comply with the CEFIC-EECA-EICTA list of legal restrictions on hazardous substances.

This includes full compatibility with the following directives:

- 2000/53/EC End of Vehicle life Directive (ELV)
- 2000/53/EC Annex II to End of Vehicle Life Directive (ELV II)
- 2002/95/EC Restriction of the use of Hazardous Substances Directive (RoHS)
- 2002/96/EC Waste Electrical and Electronic Equipment Directive (WEEE)

Solderability is specified for 2 years after production or re-qualification. The permitted storage time is 20 years.

APPROVALS

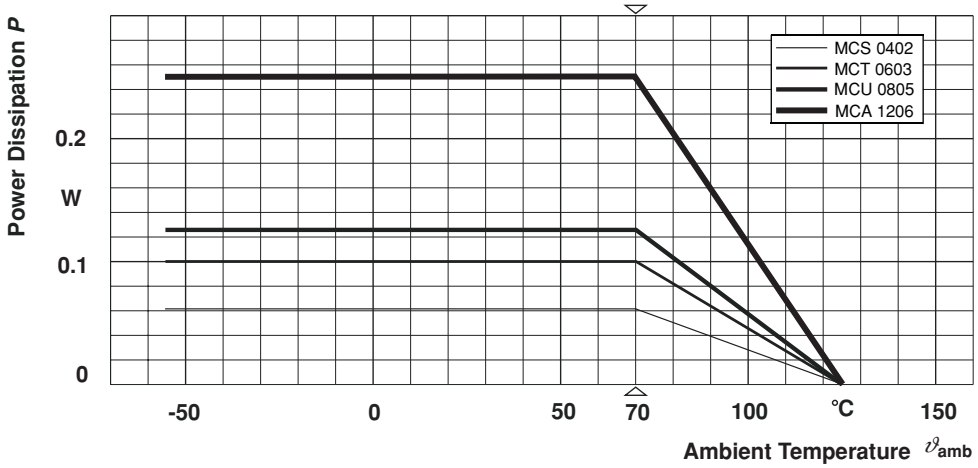
The resistors are tested in accordance with **EN 140401-801** (superseding **CECC 40401-801)** which refers to **EN 60115-1 and EN 140400.** Approval of conformity is indicated by the CECC logo on the package label.

Vishay BEYSCHLAG has achieved **"Approval of Manufacturer"** in accordance with **EN 100114-1**. The release certificate for **"Technology Approval Schedule"** in accordance with **CECC 240001** based on **EN 100114-6** is granted for the Vishay BEYSCHLAG manufacturing process.

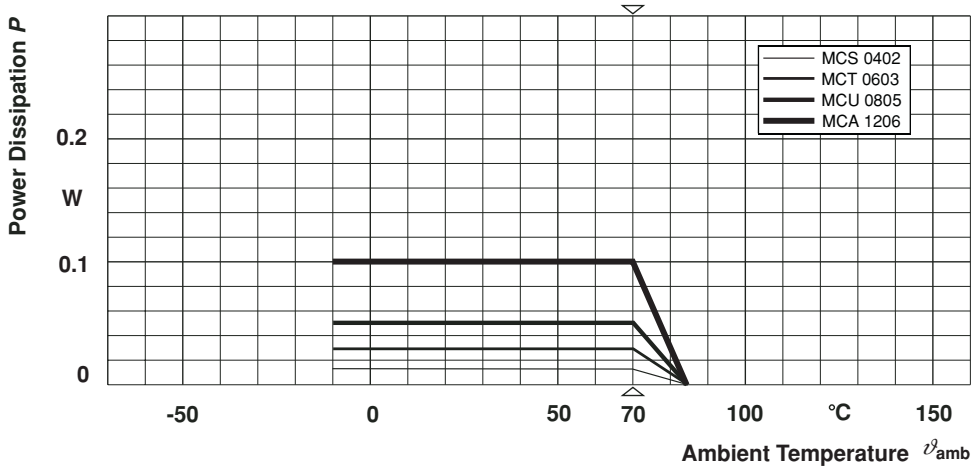
SPECIALS

On request, resistors are available with established reliability in accordance with **EN 140 401-801 Version E**. Please refer to the special data sheet for information on failure rate level, available resistance ranges and order codes.

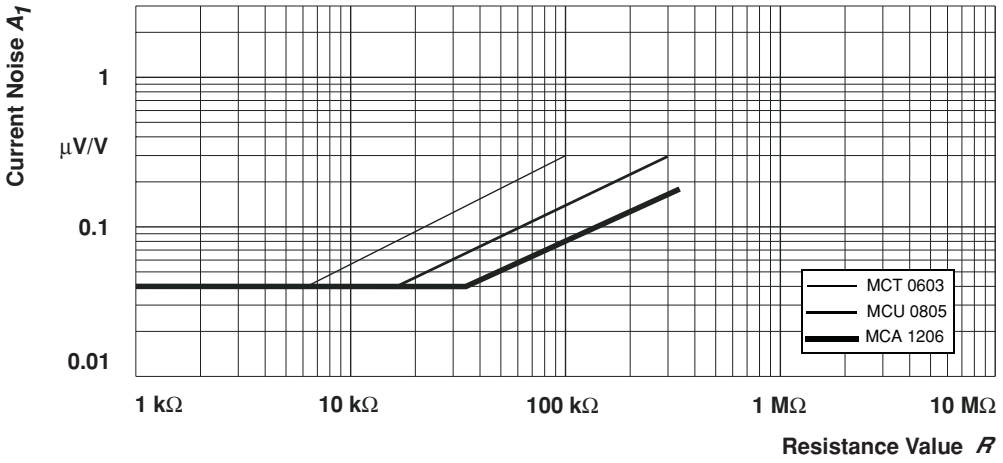
FUNCTIONAL PERFORMANCE



Derating - Standard Operation



Derating - Precision Operation



Current Noise A_1

In accordance with IEC 60195

TEST AND REQUIREMENTS

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

EN 60115-1, Generic specification (includes tests)

EN 140 400, Sectional specification (includes schedule for qualification approval)

EN 140 401-801, Detail specification (includes schedule for conformance inspection)

The components are approved in accordance with the European CECC-system, where applicable. The following table contains only the most important tests. For the full test schedule refer to the documents listed above. The testing also covers most of the requirements specified by EIA/IS-703 and JIS-C-5202.

The tests are carried out in accordance with IEC 60068 and under standard atmospheric conditions in accordance with IEC 60068-1, 5.3. Climatic category LCT/UCT/56 (rated temperature range: Lower Category Temperature, Upper Category Temperature; damp heat, long term, 56 days) is valid. Unless otherwise specified the following values apply:

Temperature: 15 °C to 35 °C

Relative humidity: 45 % to 75 %

Air pressure: 86 kPa to 106 kPa (860 mbar to 1 060 mbar).

The components are mounted for testing on boards in accordance with EN 60115-1, 4.31 unless otherwise specified.

The parameters stated in the Test Procedures and Requirements table are based on the required tests and permitted limits of EN 140 401-801. However, some additional tests and a number of improvements against those minimum requirements have been included.

TEST PROCEDURES AND REQUIREMENTS

EN 60115-1 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE	
				STABILITY CLASS 0.1	STABILITY CLASS 0.25
			stability for product types:		
			MCS 0402	470 Ω to 10 kΩ	> 10 kΩ to 52.3 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 %; ± 0.25 %	
4.8.4.2	-	temperature coefficient	at 20 / -10 / 20 °C and 20 / 85 / 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 = Umax; whichever is the less severe; 1.5 h on; 0,5 h off; 70 °C; 1000 h	± (0.1 % R + 0.02 Ω) (1)	
			70 °C; 8000 h	± (0.2 % R + 0.02 Ω) (1)	
	–	endurance at 70 °C: standard operation mode	$U = \sqrt{P_{70} \times R}$ or U = Umax; whichever is the less severe; 1.5 h on; 0.5 h off; 70 °C; 1000 h	± (0.2 % R + 0.02 Ω) (1)	
			70 °C; 8000 h	± (0.4 % R + 0.05 Ω) (1)	

TEST PROCEDURES AND REQUIREMENTS - continued

EN 60115-1 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE	
				STABILITY CLASS 0.1	STABILITY CLASS 0.25
			stability for product types:		
			MCS 0402	470 Ω to 10 kΩ	> 10 kΩ to 52.3 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
4.25.3	-	endurance at upper category temperature	85 °C; 1000h 125 °C; 1000h	± (0.1 %R + 0.02 Ω) ± (0.2 %R + 0.02 Ω)	± (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)
4.23		climatic sequence:			
4.23.2	2 (Ba)	dry heat	UCT; 16 h		
4.23.3	30 (Db)	damp heat, cyclic	55 °C; 24 h; > 90 % RH;1 cycle		
4.23.4	1 (Aa)	cold	LCT; 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; 5 days; > 95 to 100 % RH; 5 cycles LCT = - 55 °C; UCT = 125 °C	±(0.1 %R + 0.02 Ω)	±(0.25 %R + 0.05 Ω)
-	1 (Aa)	cold	- 55 °C; 2h	±(0.05 %R + 0.01 Ω)	
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT and 30 minutes 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; 5s	± (0.05 %R + 0.01 Ω)	
		short time overload; standard operation mode		± (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 10µs/700µs	± (0.5 %R + 0.05 Ω) (2) no visible damage	
4.37	-	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) (2) no visible damage	

TEST PROCEDURES AND REQUIREMENTS - continued

EN 60115-1 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE	
				STABILITY CLASS 0.1	STABILITY CLASS 0.25
			stability for product types:		
			MCS 0402	470 Ω to 10 kΩ	> 10 kΩ to 52.3 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
4.22	6 (Fc)	vibration	endurance by sweeping; 10 to 2000 Hz; no resonance; amplitude ≤ 1.5 mm or ≤ 200 m/s^2; 6 h	± (0.05 %R + 0.01 Ω) no visible damage	
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		
4.18.2	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	RR 1005M and RR 1608M; 9 N	no visible damage	
			RR 2012M and RR 3216M; 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	Urms = U_{ins}; 60 ± 5 s	no flashover or breakdown	
4.35	-	flammability	IEC 60695-2-2, needle flame test; 10 s	no burning after 30 s	
Special requirements for type MCA 1206					
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		
			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		
			70 °C; 1000 h	±(0.1 %R + 0.02 Ω)	
			70 °C; 8000 h	± (0.25 %R + 0.05 Ω)	

Note

1. See 4.25.1 (above): special requirements for type MCA 1206.
2. The pulse load stability of professional MFC resistors applies for precision resistors also. However, severe pulse loads are likely to jeopardise precision stability requirements.

ORDERING INFORMATION

Components may be ordered by using either a simple clear text ordering code, see “Type description and ordering code” or Vishay BCcomponents’ unique 12NC.

Numeric Ordering Code (12NC)

- The resistors have a 12-digit ordering code starting with 2312.
- The subsequent 4 digits indicate the resistor type, specification and packaging; see the 12NC Ordering Code table.
- The remaining 4 digits indicate the resistance value:

  - The first 3 digits indicate the resistance value.

  - The last digit indicates 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

Ordering Example

The ordering code of a MCT 0603 resistor, value 47 kΩ and TC 25 with ± 0.1 % tolerance, supplied in cardboard tape of 5 000 units per reel is: 2312 216 74703.

12NC ORDERING CODE - resistors type and packaging

DESCRIPTION			ORDERING CODE 2312...				
			CARDBOARD TAPE ON REEL				
TYPE	T.C.	TOL.	P1 1 000 UNITS	P5 5 000 UNITS	PW 20 000 UNITS	E1 1 000 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....	-	-

Resistance ranges printed in bold are preferred T.C./tolerance combinations with optimized availability.