

0805 surface mount resistors

Order code	Manufacturer code	Description
71-2100	n/a	100R 0805 0.1% 15PPM RESISTOR (RC)
71-2102	n/a	102R 0805 0.1% 15 PPM RESISTOR
71-2104	n/a	105R 0805 0.1% 15 PPM RESISTOR (RC)
71-2106	n/a	107R 0805 0.1% 15PPM RESISTOR
71-2114	n/a	118R 0805 0.1% 15 PPM RESISTOR
71-2116	n/a	121R 0805 0.1% 15 PPM RESISTOR
71-2128	n/a	140R 0805 0.1% 15PPM RESISTOR
71-2134	n/a	150R 0805 0.1% 15PPM RESISTOR
71-2138	n/a	158R 0805 0.1% 15 PPM RESISTOR
71-2148	n/a	178R 0805 0.1% 15PPM RESISTOR
71-2150	n/a	182R 0805 0.1% 15 PPM RESISTOR
71-2158	n/a	200R 0805 0.1% 15PPM RESISTOR (RC)
71-2160	n/a	205R 0805 0.1% 15 PPM RESISTOR
71-2162	n/a	220R 0805 0.1% 15 PPM RESISTOR
71-2164	n/a	221R 0805 0.1% 15 PPM RESISTOR
71-2166	n/a	226R 0805 0.1% 15 PPM RESISTOR
71-2168	n/a	232R 0805 0.1% 15 PPM RESISTOR
71-2180	n/a	267R 0805 0.1% 15 PPM RESISTOR
71-2182	n/a	270R 0805 0.1% 15 PPM RESISTOR
71-2184	n/a	274R 0805 0.1% 15 PPM RESISTOR
71-2192	n/a	301R 0805 0.1% 15 PPM RE4SISTOR
71-2204	n/a	348R 0805 0.1% 15 PPM RESISTOR
71-2210	n/a	374R 0805 0.1% 15 PPM RESISTOR (RC)
71-2214	n/a	392R 0805 0.1% 15 PPM RESISTOR
71-2230	n/a	475R 0805 0.1% 15 PPM RESISTOR
71-2234	n/a	499R 0805 0.1% 15 PPM RESISTOR
71-2236	n/a	511R 0805 0.1% 15 P-PM RESISTOR
71-2248	n/a	590R 0805 0.1% 15PPM RESISTOR
71-2250	n/a	604R 0805 0.1% 15PPM RESISTOR
71-2260	n/a	680R 0805 0.1% 15PPM RESISTOR (RC)
71-2296	n/a	1K 0805 0.1% 15PPM RESISTOR (RC)
71-2298	n/a	1K02 0805 0.1% 15PPM RESISTOR
71-2300	n/a	1K05 0805 0.1% 15PPM RESISTOR
71-2304	n/a	1K1 0805 0.1% 15PPM RESISTOR
71-2306	n/a	1K13 0805 0.1% 15PPM RESISTOR
71-2310	n/a	1K18 0805 0.1% 15PPM RESISTOR
71-2312	n/a	1K21 0805 0.1% 15PPM RESISTOR
71-2318	n/a	1K3 0805 0.1% 15PPM RESISTOR
71-2328	n/a	1K47 0805 0.1% 15PPM RESISTOR
71-2332	n/a	1K54 0805 0.1% 15PPM RESISTOR
71-2340	n/a	1K69 0805 0.1% 15PPM RESISTOR
71-2346	n/a	1K8 0805 0.1% 15PPM RESISTOR
71-2348	n/a	1K82 0805 0.1% 15PPM RESISTOR
71-2356	n/a	2K 0805 0.1% 15PPM RESISTOR
71-2364	n/a	2K2 0805 0.1% 15PPM RESISTOR
71-2376	n/a	2K49 0805 0.1% 15PPM RESISTOR

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The enclosed information is believed to be correct, Information may change 'without notice' due to product improvement. Users should ensure that the product is suitable for their use. E. & O. E.	Revision A 04/07/2003

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Order code	Manufacturer code	Description
71-2378	n/a	2K55 0805 0.1% 15PPM RESISTOR
71-2384	n/a	2K7 0805 0.1% 15PPM RESISTOR
71-2394	n/a	3K01 0805 0.1% 15PPM RESISTOR
71-2402	n/a	3K3 0805 0.1% 15PPM RESISTOR
71-2404	n/a	3K32 0805 0.1% 15PPM RESISTOR
71-2406	n/a	3K4 0805 0.1% 15PPM RESISTOR
71-2418	n/a	3K9 0805 0.1% 15PPM RESISTOR
71-2434	n/a	4K64 0805 0.1% 15PPM RESISTOR (RC)
71-2436	n/a	4K7 0805 0.1% 15PPM RESISTOR
71-2438	n/a	4K75 0805 0.1% 15PPM RESISTOR
71-2440	n/a	4K87 0805 0.1% 15PPM RESISTOR
71-2442	n/a	4K99 0805 0.1% 15PPM RESISTOR (RC)
71-2444	n/a	5K11 0805 0.1% 15PPM RESISTOR (RC)
71-2450	n/a	5K49 0805 0.1% 15PPM RESISTOR (RC)
71-2456	n/a	5K76 0805 0.1% 15PPM RESISTOR
71-2458	n/a	5K9 0805 0.1% 15PPM RESISTOR
71-2462	n/a	6K19 0805 0.1% 15PPM RESISTOR
71-2468	n/a	6K65 0805 0.1% 15PPM RESISTOR
71-2470	n/a	6K8 0805 0.1% 15PPM RESISTOR
71-2486	n/a	8K06 0805 0.1% 15PPM RESISTOR
71-2488	n/a	8K25 0805 0.1% 15PPM RESISTOR
71-2496	n/a	9K09 0805 0.1% 15PPM RESISTOR (RC)
71-2500	n/a	9K53 0805 0.1% 15PPM RESISTOR
71-2504	n/a	10K 0805 0.1% 15PPM RESISTOR (RC)
71-2506	n/a	10K2 0805 0.1% 15PPM RESISTOR (RC)
71-2510	n/a	10K7 0805 0.1% 15PPM RESISTOR (RC)
71-2512	n/a	11K 0805 0.1% 15PPM RESISTOR
71-2516	n/a	11K5 0805 0.1% 15PPM RESISTOR
71-2520	n/a	12K 0805 0.1% 15PPM RESISTOR (RC)
71-2522	n/a	12K1 0805 0.1% 15PPM RESISTOR
71-2526	n/a	12K7 0805 0.1% 15PPM RESISTOR
71-2530	n/a	13K3 0805 0.1% 15PPM RESISTOR (RC)
71-2538	n/a	14K7 0805 0.1% 15PPM RESISTOR (RC)
71-2540	n/a	15K 0805 0.1% 15PPM RESISTOR (RC)
71-2556	n/a	18K 0805 0.1% 15PPM RESISTOR
71-2558	n/a	18K2 0805 0.1% 15PPM RESISTOR
71-2566	n/a	20K 0805 0.1% 15PPM RESISTOR (RC)
71-2568	n/a	20K5 0805 0.1% 15PPM RESISTOR
71-2572	n/a	21K5 0805 0.1% 15PPM RESISTOR
71-2574	n/a	22K 0805 0.1% 15PPM RESISTOR (RC)
71-2576	n/a	22K1 0805 0.1% 15PPM RESISTOR
71-2582	n/a	23K7 0805 0.1% 15PPM RESISTOR
71-2586	n/a	24K9 0805 0.1% 15PPM RESISTOR
71-2592	n/a	26K7 0805 0.1% 15PPM RESISTOR
71-2596	n/a	27K4 0805 0.1% 15PPM RESISTOR
71-2600	n/a	28K7 0805 0.1% 15PPM RESISTOR

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Order code	Manufacturer code	Description
71-2604	n/a	30K1 0805 0.1% 15PPM RESISTOR
71-2608	n/a	31K6 0805 0.1% 15PPM RESISTOR
71-2612	n/a	33K 0805 0.1% 15PPM RESISTOR (RC)
71-2614	n/a	33K2 0805 0.1% 15PPM RESISTOR
71-2628	n/a	39K 0805 0.1% 15PPM RESISTOR
71-2630	n/a	39K2 0805 0.1% 15PPM RESISTOR
71-2632	n/a	40K2 0805 0.1% 15PPM RESISTOR
71-2646	n/a	47K 0805 0.1% 15PPM RESISTOR (RC)
71-2648	n/a	47K5 0805 0.1% 15PPM RESISTOR
71-2650	n/a	48K7 0805 0.1% 15PPM RESISTOR (RC)
71-2652	n/a	49K9 0805 0.1% 15PPM RESISTOR (RC)
71-2654	n/a	51K1 0805 0.1% 15PPM RESISTOR
71-2660	n/a	54K9 0805 0.1% 15PPM RESISTOR
71-2662	n/a	56K 0805 0.1% 15PPM RESISTOR
71-2666	n/a	57K6 0805 0.1% 15PPM RESISTOR (RC)
71-2670	n/a	60K4 0805 0.1% 15PPM RESISTOR
71-2680	n/a	68K1 0805 0.1% 15PPM RESISTOR
71-2686	n/a	73K2 0805 0.1% 15PPM RESISTOR (RC)
71-2694	n/a	80K6 0805 0.1% 15PPM RESISTOR (RC)
71-2696	n/a	82K 0805 0.1% 15PPM RESISTOR
71-2698	n/a	82K5 0805 0.1% 15PPM RESISTOR
71-2714	n/a	100K 0805 0.1% 15PPM RESISTOR

DATA SHEET

MCT 0603; MCU 0805; MCA 1206
Precision flat chip resistors

Product specification
File under BCcomponents, BC08

2001 Jun 08

Precision flat chip resistors MCT 0603; MCU 0805; MCA 1206

FEATURES

- 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
- Case sizes:
 - Imperial: 0603; 0805; 1206
 - Metric: RR 1608M; RR 2012M; RR 3216M.

APPLICATIONS

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

DESCRIPTION

MCT 0603, MCT 0805 and MCA 1206 Precision 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.

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_2O_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 **IEC 60286-3**.

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 tested in accordance with **CECC 40401-801** which refers to **EN 140000 (IEC 60115-1)** and **EN 140400 (IEC 60115-8)**.

BCcomponents 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 BCcomponents BEYSCHLAG manufacturing process.

On request, resistors are available with established reliability in accordance with **CECC 40401-801 Version E**.

Precision flat chip resistors MCT 0603; MCU 0805; MCA 1206

QUICK REFERENCE DATA

DESCRIPTION	MCT 0603		MCU 0805		MCA 1206
Metric size	RR 1608M		RR 2012M		RR 3216M
Resistance range	47 Ω to 150 k Ω		47 Ω to 221 k Ω		47 Ω to 332 k Ω
Resistance tolerance	$\pm 0,25\%$; $\pm 0,1\%$				$\pm 0,1\%$
Temperature coefficient	± 25 ppm/K; ± 15 ppm/K; ± 10 ppm/K				± 25 ppm/K
Operation mode	precision	standard	precision	standard	standard
Climatic category (LCT/UCT/days)	10/85/56	55/125/56	10/85/56	55/125/56	55/125/56
Rated dissipation, P_{70}	0,032 W	0,1 W	0,050 W	0,125 W	0,125 W
Operating voltage, U_{\max} AC/DC	25 V	75 V	35 V	150 V	150 V
Film temperature	85 $^{\circ}$ C	125 $^{\circ}$ C	85 $^{\circ}$ C	125 $^{\circ}$ C	125 $^{\circ}$ C
Max. resistance change at P_{70} for resistance range, $\Delta R/R$ max., after:	100 Ω to 18 k Ω		100 Ω to 33 k Ω		47 Ω to 332 k Ω
1 000 h	$\leq 0,1\%$	$\leq 0,25\%$	$\leq 0,1\%$	$\leq 0,25\%$	$\leq 0,1\%$
8 000 h	$\leq 0,25\%$	$\leq 0,5\%$	$\leq 0,25\%$	$\leq 0,5\%$	$\leq 0,25\%$
225 000 h	$\leq 0,5\%$	$\leq 1,0\%$	$\leq 0,5\%$	$\leq 1,0\%$	$\leq 0,5\%$
Specified lifetime	225 000 h		225 000 h		225 000 h
Permissible voltage against ambient:					
1 minute	100 V		200 V		200 V
continuous	75 V		75 V		75 V
Failure rate	$\leq 2 \times 10^{-9}/h$		$\leq 2 \times 10^{-9}/h$		$\leq 2 \times 10^{-9}/h$

Precision flat chip resistors MCT 0603; MCU 0805; MCA 1206

Table 1 Temperature coefficient and resistance range

DESCRIPTION		RESISTANCE VALUE ⁽¹⁾		
T.C.	TOLERANCE	MCT 0603	MCU 0805	MCA 1206
±25 ppm/K	±0,25%	47 Ω to 150 kΩ	47 Ω to 221 kΩ	–
	±0,1%	100 Ω to 150 kΩ	47 Ω to 221 kΩ	47 Ω to 332 kΩ
±15 ppm/K	±0,25%	47 Ω to 150 kΩ	47 Ω to 100 kΩ	–
	±0,1%	100 Ω to 100 kΩ	100 Ω to 100 kΩ	–
±10 ppm/K ⁽²⁾	±0,25%	47 Ω to 20 kΩ	47 Ω to 36 kΩ	–
	±0,1%	100 Ω to 20 kΩ	100 Ω to 36 kΩ	–

Notes

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.

Precision flat chip resistors MCT 0603; MCU 0805; MCA 1206

ORDERING INFORMATION

Components may be ordered by using either a simple clear text ordering code, see "Type description and ordering code" or 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 Table 2.
- 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 Table 3.

Table 2 12NC ordering code indicating resistor type and packaging

DESCRIPTION			ORDERING CODE 2312		
			CARDBOARD TAPE ON REEL		
TYPE	T.C.	TOL.	P1 1000 units	P5 5000 units	PW 20000 units
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	±0,1%	381 7....	396 7....	386 7....

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

Table 3 Last digit of 12NC indicating resistance decade

RESISTANCE DECADE	LAST DIGIT
10 to 99,9 Ω	9
100 to 999 Ω	1
1 to 9,99 kΩ	2
10 to 99,9 kΩ	3
100 to 999 kΩ	4

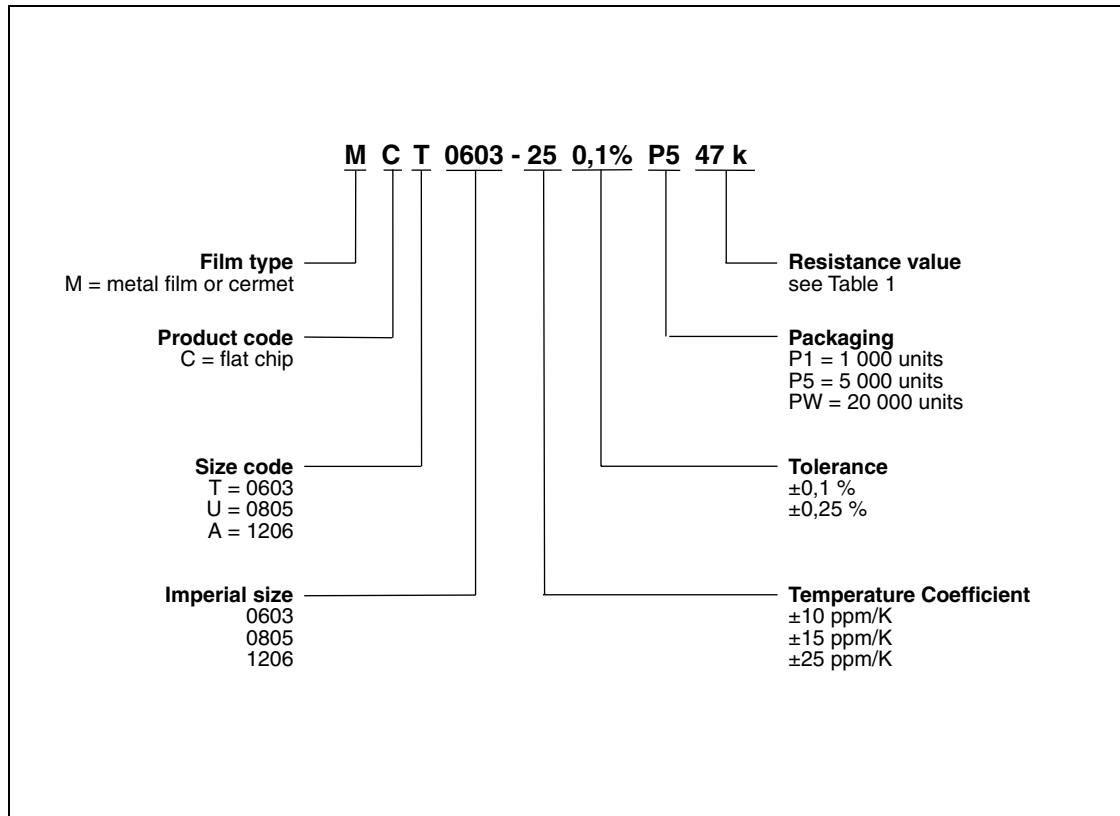
ORDERING EXAMPLE

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.

Precision flat chip resistors MCT 0603; MCU 0805; MCA 1206

Type description and ordering code

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



Precision flat chip resistors MCT 0603; MCU 0805; MCA 1206

FUNCTIONAL DESCRIPTION

Derating

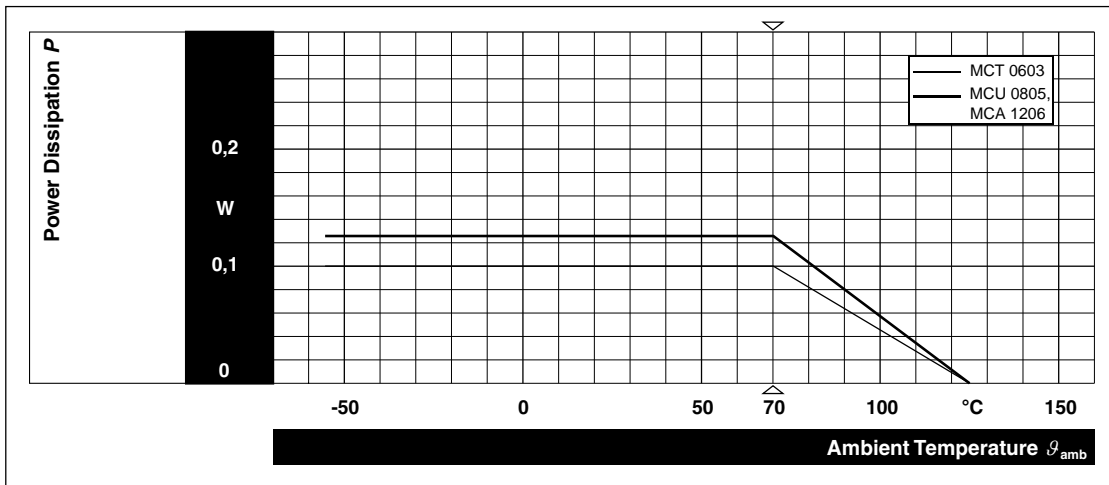


Fig.1 Derating, standard operation.

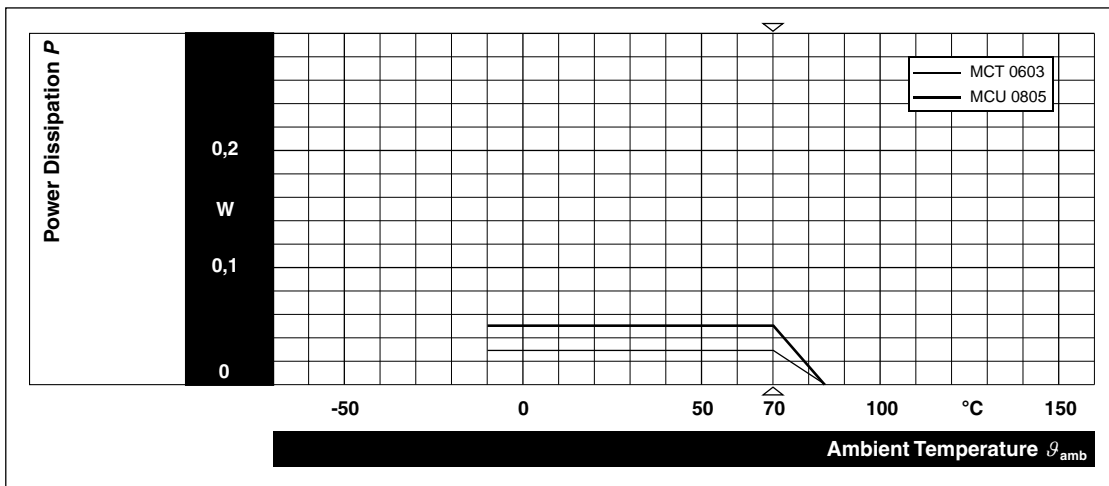


Fig.2 Derating, precision operation.

Precision flat chip resistors MCT 0603; MCU 0805; MCA 1206

Current noise

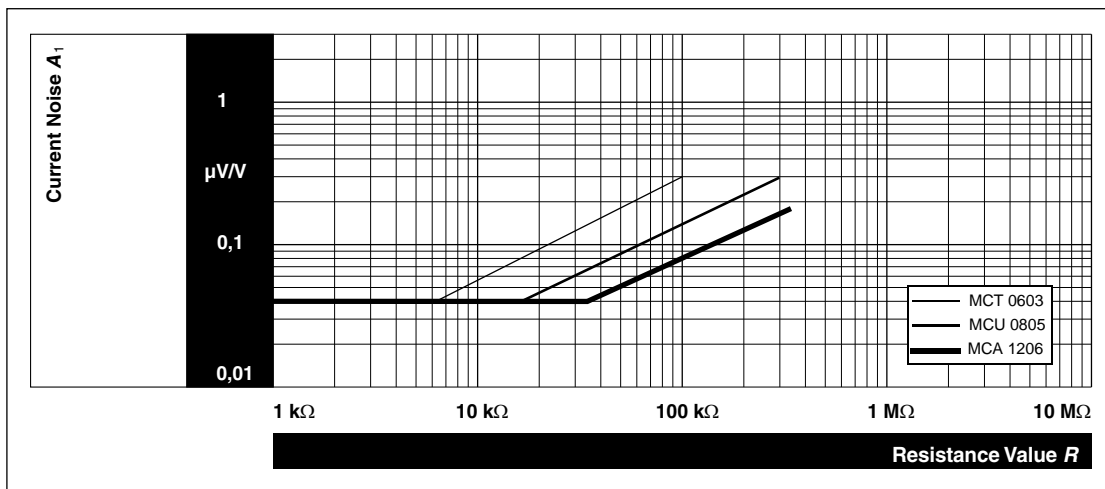
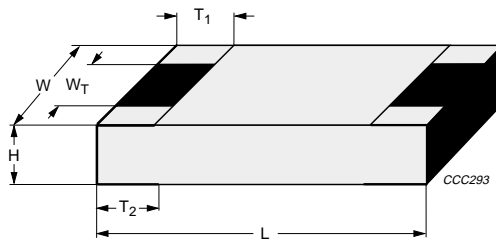


Fig.3 Current noise A_1 in accordance with IEC 60195.

Precision flat chip resistors MCT 0603; MCU 0805; MCA 1206

MECHANICAL DATA

Outlines



For dimensions see Table 4.

Fig.4 Outlines.

Table 4 Chip resistor types, mass and relevant physical dimensions; see Fig.4

TYPE	H (mm)	L (mm)	W (mm)	W _T (mm)	T ₁ (mm)	T ₂ (mm)	MASS (mg)
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	1,5
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	3,2
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	10,0

Precision flat chip resistors MCT 0603; MCU 0805; MCA 1206

TESTS AND REQUIREMENTS

Essentially all tests are carried out in accordance with the following specifications:

EN 140000 / IEC 60115-1, Generic specification (includes tests)

EN 140400 / IEC 60115-1, Sectional specification (includes schedule for qualification approval)

CECC 40401-801, Detail specification (includes schedule for conformance inspection)

Most of the components are approved in accordance with the European CECC-system, where applicable. Table 5 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).

For testing the components are mounted on a test board in accordance with IEC 60115-1, 4.31 unless otherwise specified.

In Table 5 the tests and requirements are listed with reference to the relevant clauses of IEC 60115-1 and IEC 60068-2; a short description of the test procedure is also given.

Table 5 Test procedures and requirements

IEC 60115-1 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE ($\Delta R/R$)		
				–	STABILITY CLASS 0,1	STABILITY CLASS 0,25
			stability for product types:			
			MCT 0603	–	100 Ω to 18 k Ω	> 18 k Ω
			MCU 0805	–	100 Ω to 33 k Ω	> 33 k Ω
			MCA 1206	47 Ω to 332 k Ω	–	–
4.5	–	resistance		$\pm 0,1\%$	$\pm 0,1\%$; $\pm 0,25\%$	
4.8.4.2	–	temperature coefficient	at 20 / LCT / 20 °C and 20 / UCT / 20 °C	± 25 ppm/K	± 25 ppm/K; ± 15 ppm/K; ± 10 ppm/K	
4.25.1	–	endurance	room temperature; $U = \sqrt{P_{70}} \times R$ or $U = U_{max}$: 1,5 h on; 0,5 h off 70 °C; 1000 h 70 °C; 8000 h	$\pm 0,1\%$ $\pm 0,25\%$	$\pm(0,1\% + 0,02 \Omega)$ $\pm(0,25\% + 0,05 \Omega)$	$\pm 0,25\%$ $\pm 0,5\%$
4.25.3	–	endurance at upper category temperature	125 °C; 1000 h 85 °C; 1000 h	$\pm 0,25\%$ –	– $\pm(0,1\% + 0,02 \Omega)$	$\pm 0,25\%$ –
4.24	3 (Ca)	damp heat, steady state	40 ± 2 °C; 56 days; 93 +2/–3% RH	$\pm 0,25\%$	$\pm(0,1\% + 0,02 \Omega)$	$\pm 0,25\%$

Precision flat chip resistors MCT 0603; MCU 0805; MCA 1206

IEC 60115-1 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE ($\Delta R/R$)		
				–	STABILITY CLASS 0,1	STABILITY CLASS 0,25
4.23		climatic sequence:	stability for product types:			
			MCT 0603	–	100 Ω to 18 k Ω	> 18 k Ω
			MCU 0805	–	100 Ω to 33 k Ω	> 33 k Ω
			MCA 1206	47 Ω to 332 k Ω	–	–
4.23.2	2 (Ba)	dry heat	125 °C; 16 h			
4.23.3	30 (Db)	damp heat, cyclic	55 °C; 24 h; 90 to 100 % RH; 1 cycle			
4.23.4	1 (Aa)	cold	–55 °C; 2 h			
4.23.5	13 (M)	low air pressure	8,5 kPa; 2 h; 15 to 35 °C			
4.23.6	30 (Db)	damp heat, cyclic	55 °C; 5 days; 95 to 100 % RH; 5 cycles	$\pm 0,25\%$ no visible damage	$\pm(0,1\% + 0,02 \Omega)$ no visible damage	$\pm 0,25\%$ no visible damage
–	1 (Aa)	cold	–55 °C; 2 h	–	$\pm(0,05\% + 0,01 \Omega)$	$\pm 0,05\%$
4.13	–	short time overload	room temperature; $U = 2,5 \times \sqrt{P_{70}} \times R$ or $U = 2 \times U_{max}$; 5 s	$\pm 0,1\%$ no visible damage	$\pm(0,05\% + 0,01 \Omega)$ no visible damage	$\pm 0,05\%$ no visible damage
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; 5 cycles	$\pm 0,1\%$ no visible damage	$\pm(0,05\% + 0,01 \Omega)$ no visible damage	$\pm 0,05\%$ no visible damage
4.29	45 (XA)	component solvent resistance	isopropyl alcohol +23 °C; toothbrush method	marking legible; no visible damage		
4.18.2	20 (Tb)	resistance to soldering heat	unmounted components; 260 ± 5 °C; 10 ± 1 s	$\pm 0,1\%$ no visible damage	$\pm(0,05\% + 0,01 \Omega)$ no visible damage	$\pm 0,05\%$ no visible damage
4.17.2	20 (Ta)	solderability	+215 °C; 3 s solder bath method	good tinning ($\geq 95\%$ covered); no visible damage		
4.32	21 (U ₃)	shear (adhesion)	5 N; 10 s	no visible damage		
4.7	–	voltage proof	$U_{rms} = 100$ V; 60 s	no flashover or breakdown		