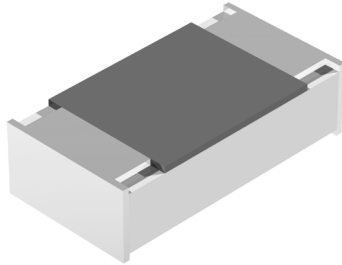


Trimmable Flat Chip Resistors



TCT 0603, TCU 0805 and TCA 1206 trimmable flat chip resistors are best suited whenever stable circuit adjustment is required and potentiometers will be either too expensive, too unstable or too large. The trimming is done directly on the printed-circuit board (PCB) using a state of the art laser trimming system e.g. with YAG or CO₂ laser source. Typical applications include any type of electronic sensors, oscillators or electronic circuits which have to be trimmed to certain functional parameters after PCB assembly.

FEATURES

- Designed for state of the art laser trimming
- Enables economical functional circuit adjustment
- Low TC ± 50 ppm/K available
- Excellent overall stability
- Wide ohmic range: 10 Ω to 1 M Ω
- Pure Sn termination on Ni barrier layer
- Compatible with lead (Pb)-free and lead containing soldering processes
- Lead (Pb)-free and RoHS compliant



APPLICATIONS

- Electronic sensors
- Oscillators
- Electronic circuits

METRIC SIZE

METRIC:	0603	0805	1206
INCH:	RR 1608M	RR 2012M	RR 3216M

TECHNICAL SPECIFICATIONS

DESCRIPTION	TCT 0603		TCU 0805		TCA 1206
Metric size	RR 1608M		RR 2012M		RR 3216M
Resistance range	10 Ω to 1 M Ω		10 Ω to 1 M Ω		10 Ω to 1 M Ω
Resistance tolerance	+ 0/- 30 %; + 0/- 20 %; + 0/- 10 %				+ 0/- 20 %
Temperature coefficient	± 100 ppm/K; ± 50 ppm/K				± 100 ppm/K
Operation mode	standard	power	standard	power	standard
Climatic category	55/125/56	55/155/56	55/125/56	55/155/56	55/125/56
Rated dissipation, P ₇₀ ¹⁾	0.1 W	0.125 W	0.125 W	0.2 W	0.25 W
Operating voltage, U _{max} AC/DC	75 V		150 V		200 V
Film temperature	125 °C	155 °C	125 °C	155 °C	125 °C
Max. resistance change at P ₇₀ for resistance range, $\Delta R/R$ max., after:	10 Ω to 1 M Ω		10 Ω to 1 M Ω		10 Ω to 1 M Ω
1000 h	≤ 0.25 %	≤ 0.5 %	≤ 0.25 %	≤ 0.5 %	≤ 0.25 %
8000 h	≤ 0.5 %	≤ 1.0 %	≤ 0.5 %	≤ 1.0 %	≤ 0.5 %
225000 h	≤ 1.5 %	-	≤ 1.5 %	-	≤ 1.5 %
Specified lifetime	225000 h	8000 h	225000 h	8000 h	225000 h
Insulation voltage:					
1 minute; U _{ins}	100 V		200 V		300 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

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.
2. All given figures are valid for the untrimmed resistor.



12NC INFORMATION

- The resistors have a 12-digit numeric code starting with 2312.
- The subsequent 4 digits indicate the resistor type, specification and packing; see the 12NC 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

12NC Example

The 12 NC of a TCT 0603 resistor, value 47 kΩ and TC 50 with + 0/- 20 % tolerance, supplied in cardboard tape of 5000 units per reel is: 2312 300 64703.

12NC - resistor type and packing				
DESCRIPTION			ORDERING CODE 2312	
			CARDBOARD TAPE ON REEL	
TYPE	T.C.	TOL.	P5	PW
TCT 0603	± 100 ppm/K	+ 0/- 30 %	300 1....	305 1....
		+ 0/- 20 %	300 2....	305 2....
		+ 0/- 10 %	300 3....	305 3....
	± 50 ppm/K	+ 0/- 30 %	300 5....	305 5....
		+ 0/- 20 %	300 6....	305 6....
		+ 0/- 10 %	300 7....	305 7....
TCU 0805	± 100 ppm/K	+ 0/- 30 %	320 1....	325 1....
		+ 0/- 20 %	320 2....	325 2....
		+ 0/- 10 %	320 3....	325 3....
	± 50 ppm/K	+ 0/- 30 %	320 5....	325 5....
		+ 0/- 20 %	320 6....	325 6....
		+ 0/- 10 %	320 7....	325 7....
TCA 1206	± 100 ppm/K	+ 0/- 20 %	340 2....	345 2....

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

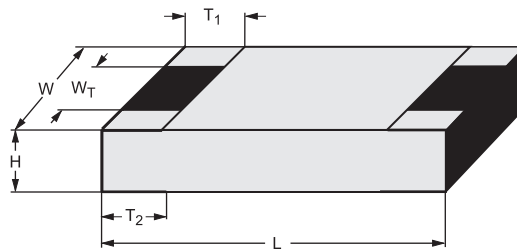
PART NUMBER AND PRODUCT DESCRIPTION ¹⁾						
PART NUMBER ²⁾ : TCT06030C4702XP500						
T	C	T	0	6	0	3
0	C	4	7	0	2	X
P	5	0	0			
MODEL/SIZE	SPECIAL CHARACTER	TC	VALUE	TOLERANCE	PACKING ³⁾	SPECIAL
TCT0603 TCU0805 TCA1206	0 = neutral	C = ± 50 ppm/K B = ± 100 ppm/K	3 digit value 1 digit multiplier Multiplier 9 = *10 ⁻¹ 0 = *10 ⁰ 1 = *10 ¹ 2 = *10 ² 3 = *10 ³ 4 = *10 ⁴ 5 = *10 ⁵	W = + 0/- 30 % X = + 0/- 20 % Y = + 0/- 10 %	P5 PW	up to 2 digits 00 = standard
PRODUCT DESCRIPTION: TCT 0603-50 -20% P5 47K						
TCT	0603	- 50	- 20 %	P5		47K
MODEL	SIZE	TC	TOLERANCE	PACKING ³⁾		RESISTANCE VALUE
TCT TCU TCA	0603 0805 1206	± 50 ppm/K ± 100 ppm/K	- 10 % = + 0/- 10 % - 20 % = + 0/- 20 % - 30 % = + 0/- 30 %	P5 PW		47K = 47 KΩ 1M = MΩ

Note

- Products can be ordered using either the PRODUCT DESCRIPTION or the 12NC.
- The PART NUMBER is shown to facilitate the introduction of a unified part numbering system. Currently, this PART NUMBER is applicable in the Americas only.
- Please refer to table PACKING, page 122.

PACKING		
MODEL	REEL	
	PIECES/PAPER TAPE ON REEL	CODE
OCT0603	5000	P5
	20000	PW
OCU0805	5000	P5
	20000	PW

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)
TCT 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
TCU 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
TCA 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	TCT 0603	TCU 0805	TCA 1206
± 100 ppm/K	+ 0/- 30 %	10 Ω to 1 MΩ	10 Ω to 1 MΩ	–
	+ 0/- 20 %	10 Ω to 1 MΩ	10 Ω to 1 MΩ	10 Ω to 1 MΩ
	+ 0/- 10 %	10 Ω to 1 MΩ	10 Ω to 1 MΩ	–
± 50 ppm/K	+ 0/- 30 %	100 Ω to 1 MΩ	100 Ω to 1 MΩ	–
	+ 0/- 20 %	100 Ω to 1 MΩ	100 Ω to 1 MΩ	–
	+ 0/- 10 %	100 Ω to 1 MΩ	100 Ω to 1 MΩ	–

Note

1. Resistance values to be selected from E12 (preferred) or E24 series.

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 newly developed cermet layer is deposited onto a super-high-grade (96 % Al_2O_3) ceramic substrate and conditioned to achieve the desired temperature coefficient. Pre-contacts are built on both sides of the substrate. The resistor elements are covered by glass for superior 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 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. They are suitable 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 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 compliance 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)

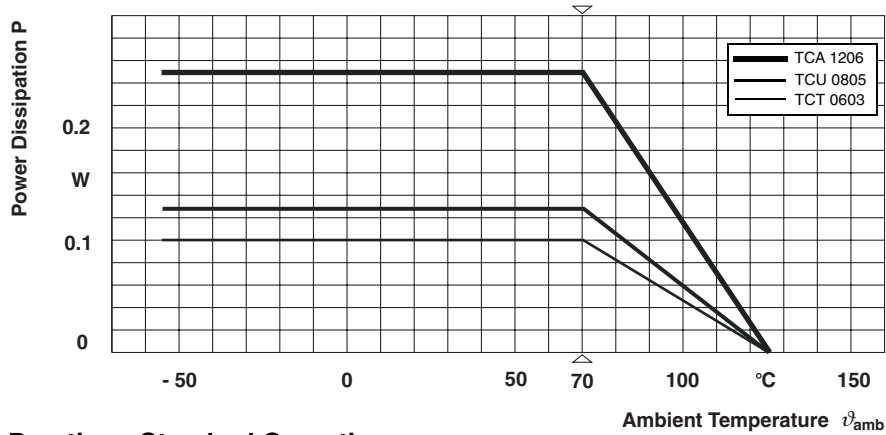
Solderability is specified for 2 years after production or requalification. The permitted storage time is 20 years.

APPROVALS

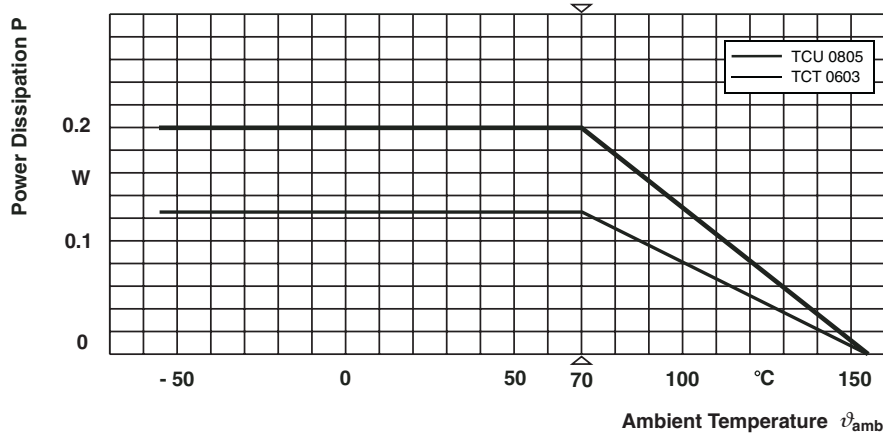
The resistors are tested in accordance with **EN 140 401-802** (superseding **CECC 40 401-802**) which refers to **EN 60115-1** and **EN 140 400**.

Vishay BEYSCHLAG has achieved "**Approval of Manufacturer**" in accordance with **EN 100114-1**.

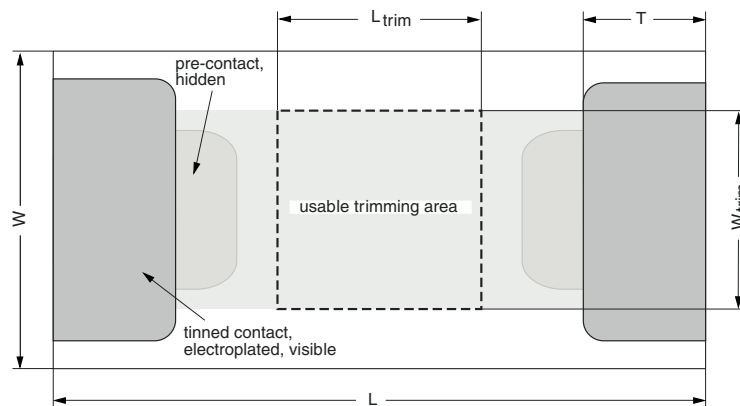
FUNCTIONAL PERFORMANCE



Derating - Standard Operation



Derating - Power Operation



Permissible Trimming Area

DIMENSIONS OF THE PERMISSIBLE TRIMMING AREA in millimeters					
TYPE	L	W	T	L_{trim}	W_{trim}
TCT 0603	1.6	0.8	0.3	0.5	0.5
TCU 0805	2.0	1.2	0.3	0.8	0.8
TCA 1206	3.2	1.6	0.4	1.4	1.0



TESTS 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 140 401-802, 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 1060 mbar).

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

The requirements stated in the Test Procedures and Requirements table are based on the required tests and permitted limits of EN 140 401-802. However, some additional tests and a number of improvements against those minimum requirements have been included.

TEST PROCEDURES AND REQUIREMENTS¹⁾				
EN 60115-1 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE (ΔR/R)
			stability for product types:	
			TCT 0603	10 Ω to 1 MΩ
			TCU 0805	10 Ω to 1 MΩ
			TCA 1206	10 Ω to 1 MΩ
4.5	–	resistance		+ 0/- 30 %; + 0/- 20 %; + 0/- 10 %
4.8.4.2	–	temperature coefficient	at 20/ - 55/ 20 °C and 20/ 125/ 20 °C	± 100 ppm/K; ± 50 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	± (0.25 % R + 0.05 Ω) ± (0.5 % R + 0.05 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	± (0.5 % R + 0.05 Ω) ± (1 % R + 0.05 Ω)



TEST PROCEDURES AND REQUIREMENTS¹⁾ - continued				
EN 60115-1 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE ($\Delta R/R$)
			stability for product types:	
			TCT 0603	10 Ω to 1 M Ω
			TCU 0805	10 Ω to 1 M Ω
			TCA 1206	10 Ω to 1 M Ω
4.25.3	–	endurance at upper category temperature	125 °C; 1000 h 155 °C; 1000 h	$\pm (0.25 \% R + 0.05 \Omega)$ $\pm (0.5 \% R + 0.05 \Omega)$
4.24	78 (Cab)	damp heat, steady state	(40 \pm 2) °C; 56 days; (93 \pm 3) % RH	$\pm (0.25 \% R + 0.05 \Omega)$
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 \pm 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	$\pm (0.25 \% R + 0.05 \Omega)$
–	1 (Aa)	cold	- 55 °C; 2 h	$\pm (0.25 \% R + 0.05 \Omega)$
4.19	14 (Na)	rapid change of temperature	30 minutes at LCT and 30 minutes at UCT; LCT = - 55 °C; UCT = 125 °C; 5 cycles	$\pm (0.25 \% R + 0.05 \Omega)$ no visible damage
			LCT = - 55 °C; UCT = 125 °C; 1000 cycles	$\pm (0.5 \% R + 0.05 \Omega)$ no visible damage
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	$\pm (0.25 \% R + 0.05 \Omega)$
		short time overload; power operation mode		$\pm (0.5 \% R + 0.05 \Omega)$



TEST PROCEDURES AND REQUIREMENTS ¹⁾ - continued				
EN 60115-1 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE ($\Delta R/R$)
			stability for product types:	
			TCT 0603	10 Ω to 1 M Ω
			TCU 0805	10 Ω to 1 M Ω
			TCA 1206	10 Ω to 1 M Ω
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	$\pm (0.25 \% R + 0.05 \Omega)$; no visible damage
4.17.2	58 (Td)	solderability	solder bath method; SnPb40; non-activated flux (215 \pm 3) °C; (3 \pm 0.3) s	good tinning (≥ 95 % covered); no visible damage
			solder bath method; SnAg3Cu0,5 or SnAg3,5; non-activated flux (235 \pm 3) °C; (2 \pm 0.2) s	
4.18.2	58 (Td)	resistance to soldering heat	solder bath method; (260 \pm 5) °C; (10 \pm 1) s	$\pm (0.25 \% R + 0.05 \Omega)$; no visible damage
4.29	45 (XA)	component solvent resistance	isopropyl alcohol + 50 °C; method 2	no visible damage
4.32	21 (Ue ₃)	shear (adhesion)	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	$\pm (0.25 \% R + 0.05 \Omega)$ no visible damage, no open circuit in bent position
4.7	–	voltage proof	$U_{rms} = U_{ins}$; 60 \pm 5 s	no flashover or breakdown
4.35	–	flammability	IEC 60695-2-2, needle flame test; 10 s	no burning after 30 s

Note

1. All given figures are valid for the untrimmed resistor.



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