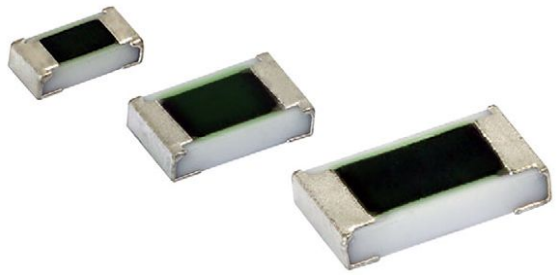
Trimmable Thick Film Flat Chip Resistors



FEATURES

- Designed for state of the art laser trimming
- Enables economical functional circuit adjustment
- Low TCR ± 50 ppm/K available
- Excellent stability ≤ ± 0.25 % (1000 h rated power at 70 °C)
- Wide ohmic range: 10 Ω to 1 MΩ
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

RoHS COMPLIANT

APPLICATIONS

- Electronic sensors
- Oscillators
- Electronic circuits

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 CO_2 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.

TECHNICAL SPECIFICATIONS

DESCRIPTION	TCT 0603	TCU 0805	TCA 1206
Imperial size	0603	0805	1206
Metric size code	RR1608M	RR2012M	RR3216M
Resistance range	10 Ω to 1 MΩ	10 Ω to 1 MΩ	10 Ω to 1 MΩ
Resistance tolerance	0 % / -30 %; 0 % / -20 %; 0 % / -10 %	0 % / -30 %; 0 % / -20 %; 0 % / -10 %	0 % / -20 %
Temperature coefficient	± 100 ppm/K; ± 50 ppm/K	± 100 ppm/K; ± 50 ppm/K	± 100 ppm/K
Rated dissipation, P_{70} (1)	0.125 W	0.200 W	0.250 W
Operating voltage, $U_{max.}$ AC_{RMS}/DC	75 V	150 V	200 V
Permissible film temperature, $\vartheta_{F\ max.}$ (1)	155 °C		
Operating temperature range (1)	-55 °C to 155 °C		
Permissible voltage against ambient (insulation): 1 min; U_{ins}	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}	TCT 0603	0.100 W	0.125 W
	TCU 0805	0.125 W	0.200 W
	TCA 1206	0.250 W	-
Operating temperature range		-55 °C to 125 °C	-55 °C to 155 °C
Permissible film temperature, ϑ_F max.		125 °C	155 °C
Max. resistance change at P_{70} for resistance range, $\lvert\Delta R/R\rvert$ after:	TCT 0603	10 Ω to 1 MΩ	
	TCU 0805	10 Ω to 1 MΩ	
	TCA 1206	10 Ω to 1 MΩ	
	1000 h	≤ 0.25 %	≤ 0.5 %
	8000 h	≤ 0.5 %	≤ 1.0 %
	225 000 h	≤ 1.5 %	-

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

TYPE / SIZE	TCR	TOLERANCE	RESISTANCE	E-SERIES
TCT 0603	± 100 ppm/K	0 % / -30 %	10 Ω to 1 MΩ	E24
		0 % / -20 %	**10 Ω to 1 MΩ**	
		0 % / -10 %	10 Ω to 1 MΩ	
	± 50 ppm/K	0 % / -30 %	100 Ω to 1 MΩ	
		0 % / -20 %	**100 Ω to 1 MΩ**	
		0 % / -10 %	100 Ω to 1 MΩ	
TCU 0805	± 100 ppm/K	0 % / -30 %	10 Ω to 1 MΩ	
		0 % / -20 %	**10 Ω to 1 MΩ**	
		0 % / -10 %	10 Ω to 1 MΩ	
	± 50 ppm/K	0 % / -30 %	100 Ω to 1 MΩ	
		0 % / -20 %	**100 Ω to 1 MΩ**	
		0 % / -10 %	100 Ω to 1 MΩ	
TCA 1206	± 100 ppm/K	0 % / -20 %	10 Ω to 1 MΩ	

Note

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

PACKAGING

TYPE / SIZE	CODE	QUANTITY	PACKAGING STYLE	WIDTH	PITCH	PACKAGING DIMENSIONS
TCT 0603	P5	5000	Paper tape acc. IEC 60286-3, Type 1a	8 mm	4 mm	Ø 180 mm/7"
	PW	20 000				Ø 330 mm/13"
TCU 0805	P5	5000		8 mm	4 mm	Ø 180 mm/7"
	PW	20 000				Ø 330 mm/13"
TCA 1206	P5	5000		8 mm	4 mm	Ø 180 mm/7"

PART NUMBER AND PRODUCT DESCRIPTION

Part Number: TCT06030C4702XP500

T	C	T	0	6	0	3	0	C	4	7	0	2	X	P	5	0	0

TYPE / SIZE	VERSION	TCR	RESISTANCE	TOLERANCE	PACKAGING
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** = $*10^{4}$	**W** = +0 %/ -30 % **X** = +0 %/ -20 % **Y** = +0 %/ -10 %	**P5** **PW**

Product Description: TCT 0603-50 -20 % P5 47K

TCT	0603	-50	-20 %	P5	47K
TYPE	SIZE	TCR (1)	TOLERANCE	PACKAGING	RESISTANCE
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** = 1 MΩ

Notes

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

(1) A temperature coefficient ± 100 ppm/K is marked -00.

DESCRIPTION

Production is strictly controlled and follows an extensive set of instructions established for reproducibility. A newly developed cermet layer is deposited onto a high-grade ceramic substrate (Al_2O_3) 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 matte 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 **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 vapor 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

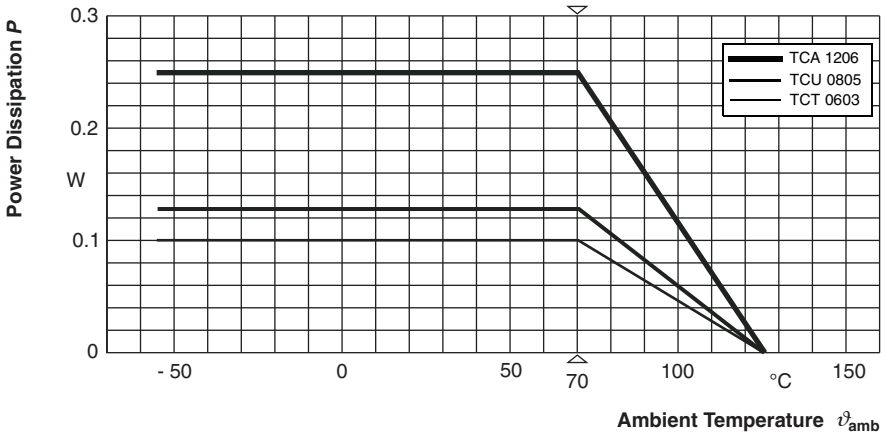
The resistors are tested in accordance with **EN 140401-802** which refers to **EN 60115-1**, **EN 60115-8**, and the variety of environmental test procedures of the **IEC 60068** (1) series.

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.

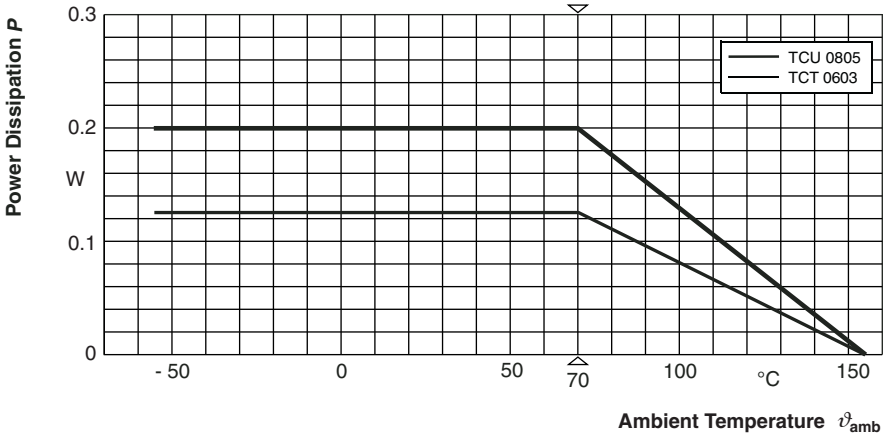
Notes

(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.

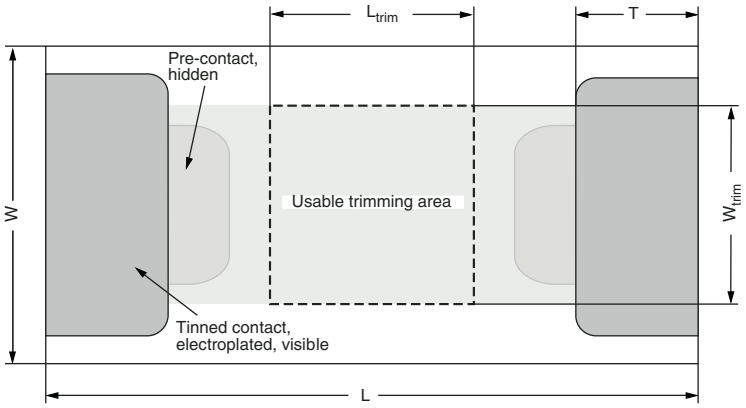
FUNCTIONAL PERFORMANCE



Derating - Standard Operation



Derating - Power Operation



Permissible Trimming Area

DIMENSIONS OF THE PERMISSIBLE TRIMMING AREA in millimeters					
TYPE / SIZE	**L**	**W**	**T**	**L_{trim}**	**W_{trim}**
TCT 0603	1.55 ± 0.05	0.85 ± 0.1	0.3 + 0.15 / - 0.2	0.5	0.5
TCU 0805	2.0 ± 0.1	1.25 ± 0.15	0.4 + 0.1 / - 0.2	0.8	0.8
TCA 1206	3.2 + 0.1/- 0.2	1.6 ± 0.15	0.5 ± 0.25	1.4	1.0

Note

- Please consider the application note “Using Laser Trimmable Resistors” at the link www.vishay.com/doc?28893 for information on the trimming process and achievable trimming factors.

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 140401-802, detail specification

IEC 60068-2-xx, test methods

The parameters stated in the Test Procedures and Requirements table are based on the required tests and permitted limits of EN 140401-802. 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 (1)

EN 60115-1 CLAUSE	IEC 60068-2 (2) TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE (ΔR)
			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 % R; +0 % / -20 % R; +0 % / -10 % R
4.8	-	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)
4.25.3	-	Endurance at upper category temperature	125 °C; 1000 h 155 °C; 1000 h	± (0.25 % R + 0.05 Ω) ± (0.5 % R + 0.05 Ω)
4.24	78 (Cab)	Damp heat, steady state	(40 ± 2) °C; 56 days; (93 ± 3) % RH	± (0.25 % R + 0.05 Ω)

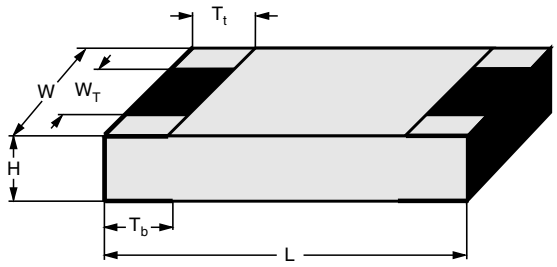
TEST PROCEDURES AND REQUIREMENTS [1]				
EN 60115-1 CLAUSE	**IEC 60068-2 [2] TEST METHOD**	**TEST**	**PROCEDURE**	**REQUIREMENTS PERMISSIBLE CHANGE (ΔR)**
			Stability for product types:	
			TCT 0603	**10 Ω to 1 MΩ**
			TCU 0805	**10 Ω to 1 MΩ**
			TCA 1206	**10 Ω to 1 MΩ**
4.23		Climatic sequence: standard operation mode:		± (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	± (0.25 % R + 0.05 Ω)
4.19	14 (Na)	Rapid change of temperature	30 min at LCT and 30 min at UCT; LCT = -55 °C; UCT = 125 °C; 5 cycles	± (0.25 % R + 0.05 Ω) no visible damage
			LCT = -55 °C; UCT = 125 °C; 1000 cycles	± (0.5 % R + 0.05 Ω) 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	± (0.25 % R + 0.05 Ω)
		Short time overload: power operation mode		± (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	± (0.25 % R + 0.05 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	
4.18	58 (Td)	Resistance to soldering heat	Solder bath method; (260 ± 5) °C; (10 ± 1) s	± (0.25 % R + 0.05 Ω); 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)	TCT 0603: 9 N	No visible damage
			TCU 0805 and TCA 1206: 45 N	
4.33	21 (Ue_1)	Substrate bending	Depth 2 mm, 3 times	± (0.25 % R + 0.05 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 60695-2-2 [2], needle flame test; 10 s	No burning after 30 s

Notes

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

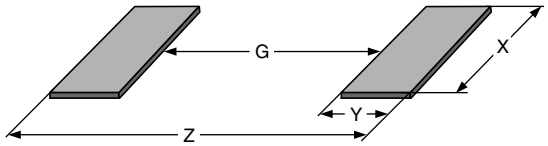
[2] The quoted IEC standards are also released as EN standards with the same number and identical contents.

DIMENSIONS



DIMENSIONS AND MASS							
TYPE / SIZE	H (mm)	L (mm)	W (mm)	W_T (mm)	T_t (mm)	T_b (mm)	MASS (mg)
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

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)
TCT 0603	0.55	1.10	1.10	2.75	0.65	0.70	0.95	2.05
TCU 0805	0.80	1.25	1.50	3.30	0.90	0.90	1.40	2.70
TCA 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.

12NC INFORMATION FOR HISTORICAL CODING REFERENCE ONLY

- The resistors have a 12 digit numeric code starting with 2312.
- The subsequent 4 digits indicate the resistor type, specification and packaging; 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 12NC of a TCT 0603 resistor, value 47 kΩ and TCR 50 with +0 % / -20 % tolerance, supplied in cardboard tape of 5000 units per reel is: 2312 300 64703.

12NC - Resistor type and packaging

DESCRIPTION			CODE 2312	
			CARDBOARD TAPE ON REEL	
TYPE	**TCR**	**TOL.**	**P5 5000 UNITS**	**PW 20 000 UNITS**
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....

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