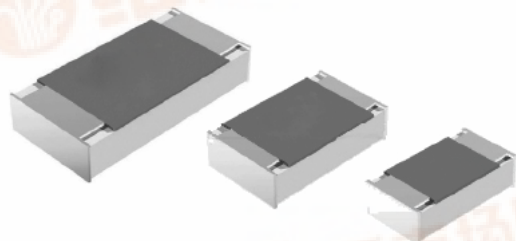


Trimable Flat Chip Resistors



TCT 0603, TCU 0805 and TCA 1206 trimable 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 TCR ± 50 ppm/K available
- Excellent stability $\leq \pm 0.25$ % (1000 h rated power at 70 °C)
- Wide ohmic range: 10 Ω to 1 M Ω
- Lead (Pb)-free solder contacts
- Compliant to RoHS directive 2002/95/EC



RoHS
COMPLIANT

APPLICATIONS

- Electronic sensors
- Oscillators
- Electronic circuits

METRIC SIZE

INCH:	0603	0805	1206
METRIC:	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 MΩ		10 Ω to 1 MΩ		10 Ω to 1 MΩ
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 (LCT/UCT/days)	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 MΩ		10 Ω to 1 MΩ		10 Ω to 1 MΩ
1000 h	≤ 0.25 %	≤ 0.5 %	≤ 0.25 %	≤ 0.5 %	≤ 0.25 %
8000 h	≤ 0.5 %	≤ 1.0 %	≤ 0.5 %	≤ 1.0 %	≤ 0.5 %
225 000 h	≤ 1.5 %	-	≤ 1.5 %	-	≤ 1.5 %
Insulation voltage:					
1 min; U_{ins}	100 V		200 V		300 V
Continuous	75 V		75 V		75 V
Failure rate: FIT _{observed}	≤ 0.1 x 10 ⁻⁹ /h				

Notes

⁽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

- 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.

PART NUMBER AND PRODUCT DESCRIPTION (1)																	
PART NUMBER: TCT06030C4702XP500																	
T	C	T	0	6	0	3	0	C	4	7	0	2	X	P	5	0	0
MODEL/SIZE		SPECIAL CHARACTER			TCR			VALUE				TOLERANCE		PACKAGING		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		TCR (2)		TOLERANCE		PACKAGING		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 = 1 MΩ							

Notes

⁽¹⁾ Products can be ordered using either the PRODUCT DESCRIPTION or the PART NUMBER

⁽²⁾ A temperature coefficient ± 100 ppm/K is marked -00

TEMPERATURE COEFFICIENT AND RESISTANCE RANGE				
DESCRIPTION		RESISTANCE VALUE ⁽³⁾		
TCR	TOLERANCE	TCT 0603	TCU 0805	TCA 1206
± 100 ppm/K	+ 0/- 30 %	10 Ω to 1 M Ω	10 Ω to 1 M Ω	—
	+ 0/- 20 %	10 Ω to 1 MΩ	10 Ω to 1 MΩ	10 Ω to 1 M Ω
	+ 0/- 10 %	10 Ω to 1 M Ω	10 Ω to 1 M Ω	—
± 50 ppm/K	+ 0/- 30 %	100 Ω to 1 M Ω	100 Ω to 1 M Ω	—
	+ 0/- 20 %	100 Ω to 1 MΩ	100 Ω to 1 MΩ	—
	+ 0/- 10 %	100 Ω to 1 M Ω	100 Ω to 1 M Ω	—

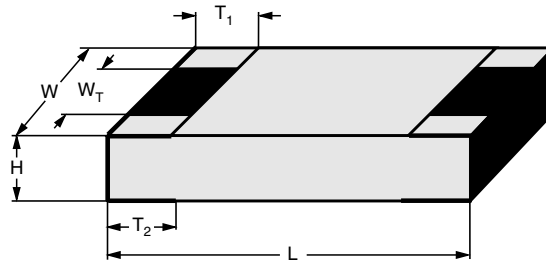
Note

⁽³⁾ Resistance values to be selected from E12 (preferred) or E24 series

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

PACKAGING		
MODEL	REEL	
	PIECES/PAPER TAPE ON REEL	CODE
TCT 0603	5000	P5
	20 000	PW
TCU 0805	5000	P5
	20 000	PW
TCA 1206	5000	P5

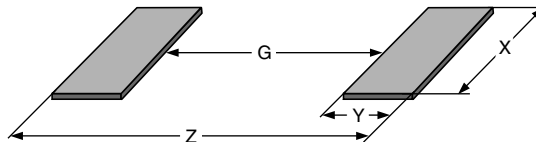
DIMENSIONS



DIMENSIONS AND MASS

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	0.45 + 0.1/- 0.05	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	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

Note

- The rated dissipation applies only if the permitted film temperature is not exceeded. Furthermore, a high level of ambient temperature or of power dissipation may raise the temperature of the solder joint, hence special solder alloys or board materials may be required to maintain the reliability of the assembly.

Specified power rating above 125 °C requires dedicated heat-sink pads, which depend on board materials.

The given solder pad dimensions reflect the considerations for board design and assembly as outlined e.g. in standards IEC 61188-5-x, or in publication IPC-7351. They do not guarantee any supposed thermal properties, particularly as these are also strongly influenced by many other parameters.

Still, the given solder pad dimensions will be found adequate for most general applications, e.g. those referring to “standard operation mode”. Please note however that applications for “power operation mode” require special considerations for the design of solder pads and adjacent conductor areas.

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 (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 **IEC 60286-3** ⁽³⁾.

ASSEMBLY

The resistors are suitable for processing on automatic SMD assembly systems. They are suitable for automatic soldering using wave, reflow or vapour phase as shown in **IEC 61760-1** ⁽³⁾. 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, 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 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.

All products comply with the **GADSL** ⁽¹⁾ and the **CEFIC-EECA-EICTA** ⁽²⁾ list of legal restrictions on hazardous substances. This includes full compliance with the following directives:

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

APPROVALS

The resistors are tested in accordance with **EN 140401-802** which refers to **EN 60115-1** and **EN 140400**. The detail specification refers to the climatic category 55/125/56, which relates to the "Standard operation mode" of this datasheet.

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

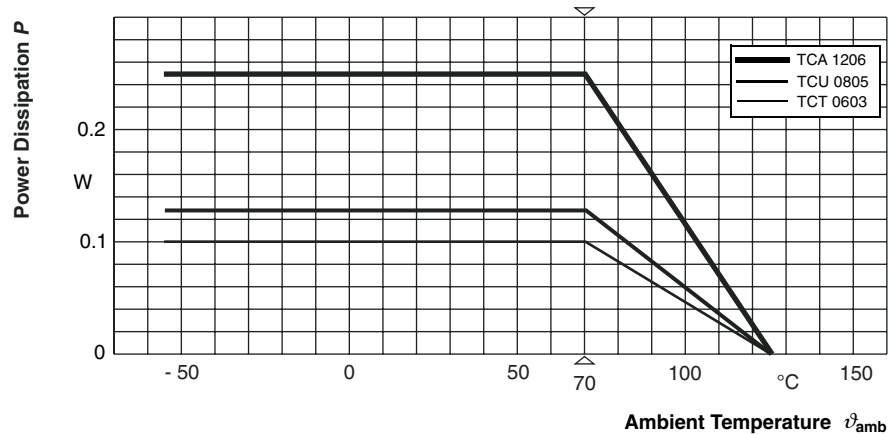
Notes

⁽¹⁾ Global Automotive Declarable Substance List, see www.gadsl.org

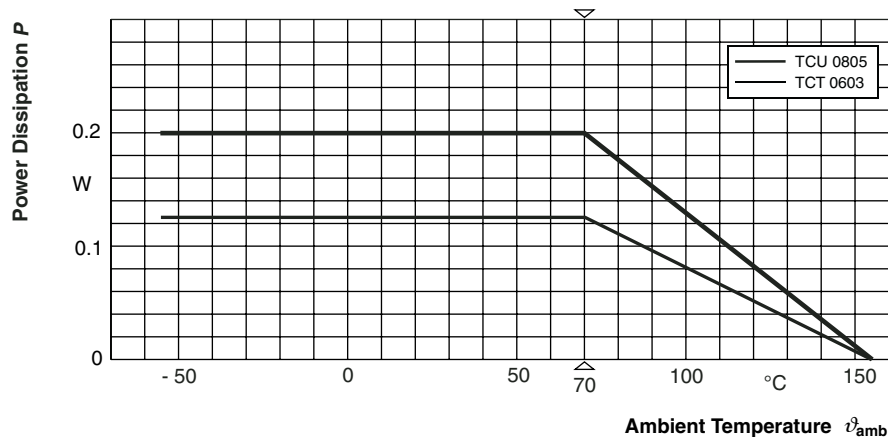
⁽²⁾ CEFIC (European Chemical Industry Council), EECA (European Electronic Component Manufacturers Association), EICTA (European trade organisation representing the information and communications technology and consumer electronics), see www.eicta.org/index.php?id=995
→ issue → environment policy → chemicals → chemicals for electronics

⁽³⁾ The quoted IEC standards marked with an asterisk (*) are also released as EN standards with the same number and identical contents

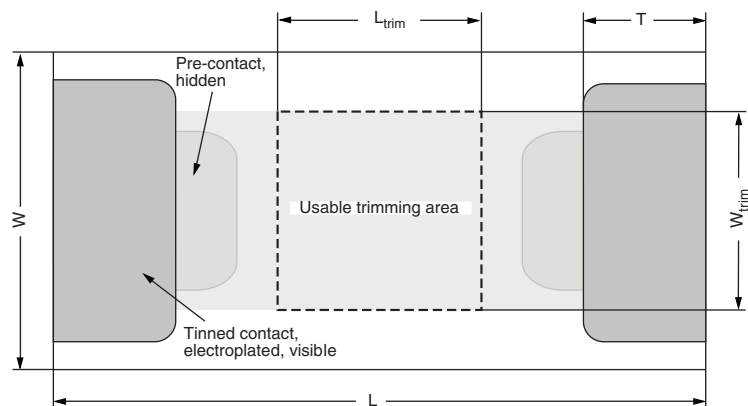
FUNCTIONAL PERFORMANCE



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 140400, sectional specification (includes schedule for qualification approval)

EN 140401-802, 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 140401-802. However, some additional tests and a number of improvements against those minimum requirements have been included.

TEST PROCEDURES AND REQUIREMENTS ⁽¹⁾				
EN 60115-1 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE (ΔR)
			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
4.5	-	Resistance		+ 0/- 30 % R; + 0/- 20 % R; + 0/- 10 % R
4.8.4.2	-	Temperature coefficient	At (20/- 55/20) °C and (20/125/20) °C	$\pm$ 100 ppm/K; $\pm$ 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	$\pm$ (0.25 % R + 0.05 Ω) $\pm$ (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	$\pm$ (0.5 % R + 0.05 Ω) $\pm$ (1 % R + 0.05 Ω)
4.25.3	-	Endurance at upper category temperature	125 °C; 1000 h 155 °C; 1000 h	$\pm$ (0.25 % R + 0.05 Ω) $\pm$ (0.5 % R + 0.05 Ω)

TEST PROCEDURES AND REQUIREMENTS ⁽¹⁾				
EN 60115-1 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE (ΔR)
			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
4.24	78 (Cab)	Damp heat, steady state	(40 $\pm$ 2) $^{\circ}$ C; 56 days; (93 $\pm$ 3) % RH	$\pm$ (0.25 % R + 0.05 Ω)
4.23	2 (Ba) 30 (Db) 1 (Aa) 13 (M) 30 (Db)	Climatic sequence: dry heat	UCT; 16 h	$\pm$ (0.25 % R + 0.05 Ω)
4.23.2			55 $^{\circ}$ C; 24 h; > 90 % RH; 1 cycle	
4.23.3		damp heat, cyclic	LCT; 2 h	
4.23.4		cold	8.5 kPa; 2 h; 25 $\pm$ 10 $^{\circ}$ C	
4.23.5		low air pressure	55 $^{\circ}$ C; 5 days; > 95 % to 100 % RH; 5 cycles LCT = - 55 $^{\circ}$ C; UCT = 125 $^{\circ}$ C	
4.23.6		damp heat, cyclic		
-	1 (Aa)	Cold	- 55 $^{\circ}$ C; 2 h	$\pm$ (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 $^{\circ}$ C; UCT = 125 $^{\circ}$ C; 5 cycles	$\pm$ (0.25 % R + 0.05 Ω) no visible damage
			LCT = - 55 $^{\circ}$ C; UCT = 125 $^{\circ}$ C; 1000 cycles	$\pm$ (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	$\pm$ (0.25 % R + 0.05 Ω)
		Short time overload; power operation mode		$\pm$ (0.5 % R + 0.05 Ω)
4.22	6 (Fc)	Vibration	Endurance by sweeping; 10 Hz to 2000 Hz; no resonance; amplitude $\leq$ 1.5 mm or $\leq$ 200 m/s ² ; 6 h	$\pm$ (0.25 % R + 0.05 Ω); no visible damage
4.17.2	58 (Td)	Solderability	Solder bath method; SnPb40; non-activated flux (215 $\pm$ 3) $^{\circ}$ C; (3 $\pm$ 0.3) s	Good tinning ($\geq$ 95 % covered); no visible damage
			Solder bath method; SnAg3Cu0.5 or SnAg3.5; non-activated flux (235 $\pm$ 3) $^{\circ}$ C; (2 $\pm$ 0.2) s	
4.18.2	58 (Td)	Resistance to soldering heat	Solder bath method; (260 $\pm$ 5) $^{\circ}$ C; (10 $\pm$ 1) s	$\pm$ (0.25 % R + 0.05 Ω); no visible damage
4.29	45 (XA)	Component solvent resistance	Isopropyl alcohol + 50 $^{\circ}$ C; method 2	No visible damage

TEST PROCEDURES AND REQUIREMENTS ⁽¹⁾

EN 60115-1 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE (ΔR)
			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
4.32	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	$U_{RMS} = U_{ins}; (60 \pm 5) \text{ s}$	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

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 k Ω to 9.99 k Ω	2
10 k Ω to 99.9 k Ω	3
100 k Ω to 999 k Ω	4
1 M Ω to 9.99 M Ω	5

12NC example

The 12NC of a TCT 0603 resistor, value 47 k Ω 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	$\pm 100 \text{ ppm/K}$	+ 0/- 30 %	300 1....	305 1....
		+ 0/- 20 %	300 2....	305 2....
		+ 0/- 10 %	300 3....	305 3....
	$\pm 50 \text{ ppm/K}$	+ 0/- 30 %	300 5....	305 5....
		+ 0/- 20 %	300 6....	305 6....
		+ 0/- 10 %	300 7....	305 7....
TCU 0805	$\pm 100 \text{ ppm/K}$	+ 0/- 30 %	320 1....	325 1....
		+ 0/- 20 %	320 2....	325 2....
		+ 0/- 10 %	320 3....	325 3....
	$\pm 50 \text{ ppm/K}$	+ 0/- 30 %	320 5....	325 5....
		+ 0/- 20 %	320 6....	325 6....
		+ 0/- 10 %	320 7....	325 7....
TCA 1206	$\pm 100 \text{ ppm/K}$	+ 0/- 20 %	340 2....	345 2....



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