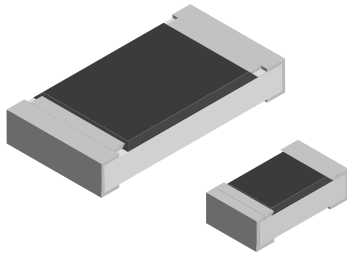


## High Precision Thin Film Chip Resistors ± 0.05 %; ± 5 ppm/K



TNPU e3 High Precision Thin Film Flat Chip Resistors combine the proven reliability of TNPW e3 products with a most advanced level of precision and stability. This unique combination makes the product perfectly suited for all applications with outstanding requirements towards size, reliable precision and stability.

### FEATURES

- Low temperature coefficient and tight tolerances ( $\pm 0.05\%$ ;  $\pm 5$  ppm/K)
- Superior moisture resistivity  $\leq 0.25\%$  (85 °C; 56 days; 85 % RH)
- Waste gas resistant
- AEC-Q200 qualified
- Compliant to RoHS directive 2002/95/EC
- Find out more about Vishay's Automotive Grade Product requirements at: [www.vishay.com/applications](http://www.vishay.com/applications)



### APPLICATIONS

- Industrial equipment
- Telecommunication
- Medical equipment
- Instrumentation
- Test and measuring equipment
- Automotive

STANDARD ELECTRICAL SPECIFICATIONS			
	TNPU0603 e3	TNPU0805 e3	TNPU1206 e3
Metric size	RR 1608M	RR 2012M	RR 3216M
Resistance range	100 $\Omega$ to 100 k $\Omega$	100 $\Omega$ to 332 k $\Omega$	100 $\Omega$ to 511 k $\Omega$
Resistance tolerance	$\pm 0.1\%$ ; $\pm 0.05\%$		
Temperature coefficient	$\pm 10$ ppm/K; $\pm 5$ ppm/K		
Climatic category (LCT/UCT/days)	55/125/56	55/125/56	55/125/56
Rated dissipation, $P_{70}$ <sup>(1)</sup>	0.1 W	0.125 W	0.25 W
Operating voltage, $U_{max}$ . AC/DC	75 V	150 V	200 V
Maximum permissible film temperature	125 °C	125 °C	125 °C
Thermal resistance <sup>(2)</sup>	550 K/W	440 K/W	220 K/W
Max. resistance change at $P_{70}$ ; $ \Delta R/R $			
1000 h	$\leq 0.05\%$	$\leq 0.05\%$	$\leq 0.05\%$
8000 h	$\leq 0.10\%$	$\leq 0.10\%$	$\leq 0.10\%$
225 000 h	$\leq 0.30\%$	$\leq 0.30\%$	$\leq 0.30\%$
Insulation voltage:			
$U_{ins}$ 1 min	100 V	200 V	300 V
Continuous	75 V	75 V	75 V
FIT <sub>observed</sub>	$\leq 0.1 \times 10^{-9}/h$	$\leq 0.1 \times 10^{-9}/h$	$\leq 0.1 \times 10^{-9}/h$
Weight/1000 pieces	2 g	5.5 g	10 g

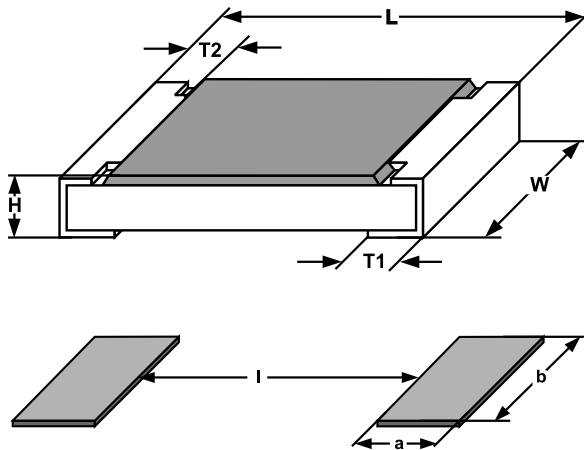
**Notes**

<sup>(1)</sup> Rated voltage  $\sqrt{P \times R}$ . 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.

<sup>(2)</sup> Measuring conditions in accordance with EN 140401-801.



**DIMENSIONS**



SIZE		DIMENSIONS in millimeters				
INCH	METRIC	L	W	H	T1	T2
0603	1608	1.6 ± 0.10	0.85 ± 0.10	0.45 ± 0.10	0.3 ± 0.20	
0805	2012	2.0 ± 0.15	1.25 ± 0.15	0.45 ± 0.10	0.4 ± 0.20	
1206	3216	3.2 ± 0.15	1.6 ± 0.15	0.55 ± 0.10	0.5 ± 0.25	

SIZE		SOLDER PAD DIMENSIONS in millimeters					
		REFLOW SOLDERING			WAVE SOLDERING		
INCH	METRIC	a	b	l	a	b	l
0603	1608	0.5	0.9	1.0	0.9	0.9	1.0
0805	2012	0.7	1.3	1.2	0.9	1.3	1.3
1206	3216	0.9	1.7	2.0	1.1	1.7	2.3

TEMPERATURE COEFFICIENT AND RESISTANCE RANGE				
TYPE	TCR	TOLERANCE	RESISTANCE VALUE	E-SERIES
TNPU0603 e3	± 10 ppm/K	± 0.05 %	100 Ω to 100 kΩ	E24 to E192
	± 5 ppm/K	± 0.1 % ± 0.05 %		
TNPU0805 e3	± 10 ppm/K	± 0.05 %	100 Ω to 332 kΩ	
	± 5 ppm/K	± 0.1 % ± 0.05 %		
TNPU1206 e3	± 10 ppm/K	± 0.05 %	100 Ω to 511 kΩ	
	± 5 ppm/K	± 0.1 % ± 0.05 %		

PART NUMBER AND PRODUCT DESCRIPTION																	
Part Number: TNPU12061K32AZE00																	
T	N	P	U	1	2	0	6	1	K	3	2	A	Z	E	A	0	0
MODEL	VALUE	TOLERANCE	TCR	PACKAGING <sup>(1)</sup>	SPECIAL												
TNPU0603 TNPU0805 TNPU1206	R = Decimal K = Thousand M = Million (4 digits)	B = ± 0.1 % A = ± 0.05 %	Y = ± 10 ppm/K Z = ± 5 ppm/K	EA EN	Up to 2 digits 00 = Standard												
Product Description: TNPU1206 1K32 0.05 % T-16 ET1 e3																	
TNPU1206	1K32	0.05 %	T-16	ET1	e3												
MODEL	RESISTANCE VALUE	TOLERANCE	TCR	PACKAGING <sup>(1)</sup>	LEAD (Pb)-FREE												
TNPU0603 TNPU0805 TNPU1206	Examples: 1K32 = 1320 Ω	± 0.05 % ± 0.1 %	T-13 = ± 10 ppm/K T-16 = ± 5 ppm/K	ET1 E52	e3 = Pure tin termination finish												

**Notes**

- Products can be ordered using either the PRODUCT DESCRIPTION or the PART NUMBER.
- (1) Please refer to PACKAGING table.



PACKAGING							
MODEL	TAPE WIDTH [mm]	PITCH [mm]	REEL DIAMETER [mm/inch]	PIECES PER REEL	PACKAGING CODE FOR PRODUCT DESCRIPTION	PACKAGING CODE FOR PART NUMBER	TYPE OF CARRIER TAPE
TNPU0603 e3 TNPU0805 e3 TNPU1206 e3	8	4	180/7	1000	E52	EN	Paper
				5000	ET1	EA	

## 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 high grade  $\text{Al}_2\text{O}_3$  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 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 on 100 % of the individual chip resistors. Only accepted products are laid directly into the tape in accordance with **IEC 60286-3** <sup>(3)</sup>.

## 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**. 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. The immunity of the plating against tin whisker growth has been proven under extensive testing.

All products comply with the **GADSL** <sup>(1)</sup> and the **CEFIC-EECA-EICTA** <sup>(2)</sup> 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)

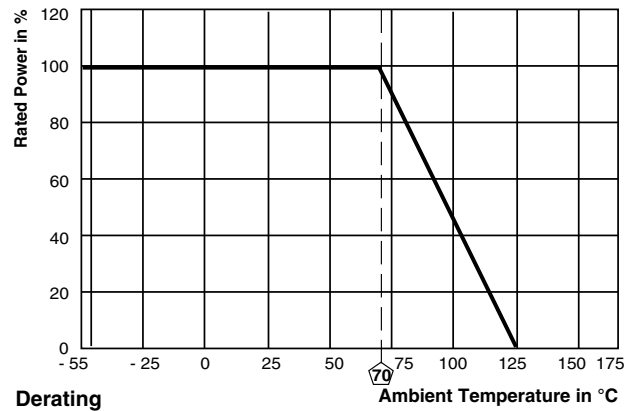
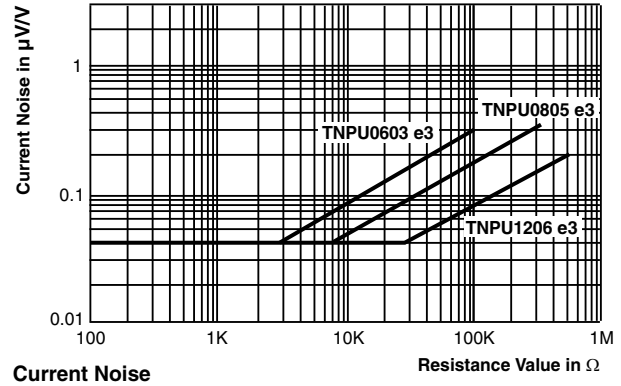
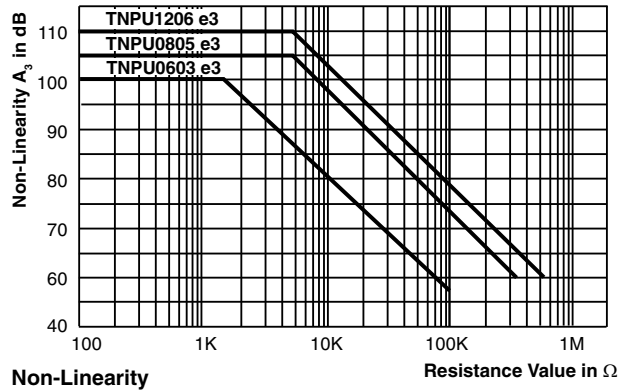
Solderability is specified for 2 years after production or re-qualification. The permitted storage time is 20 years.

## Notes

<sup>(1)</sup> Global Automotive Declarable Substance List, see [www.gadsl.org](http://www.gadsl.org).

<sup>(2)</sup> 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](http://www.eicta.org) → issue → environment policy → chemicals → chemicals for electronics.

<sup>(3)</sup> The quoted IEC standards are also released as EN standards with the same number and identical contents.



## 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 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:  $15^{\circ}\text{C}$  to  $35^{\circ}\text{C}$
- 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 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
			<b>Stability for product types:</b> TNPU0603 e3 TNPU0805 e3 TNPU1206 e3	
4.5	-	Resistance		± 0.1 %; ± 0.05 %
4.8.4.2	-	Temperature coefficient	At (20/- 55/20) °C and (20/125/20) °C	± 10 ppm/K; ± 5 ppm/K
4.25.1	-	Endurance at 70 °C	$U = \sqrt{P_{70} \times R}$ 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	± (0.05 % R + 0.01 Ω) ± (0.1 % R + 0.02 Ω)
4.25.3	-	Endurance at upper category temperature	125 °C; 1000 h	± (0.05 % R + 0.01 Ω)
4.24	78 (Cab)	Damp heat, steady state	(40 ± 2) °C; 56 days; (93 ± 3) % RH	± (0.1 % R + 0.01 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	
4.23.7	-	D.c. load	$U = \sqrt{P_{70} \times R} \leq U_{max.}$ ; 1 min LCT = - 55 °C UCT = 125 °C	
-	1 (Aa)	Cold	- 55 °C; 2 h	± (0.05 % R + 0.01 Ω)
4.19	14 (Na)	Rapid change of temperature	30 min at LCT and 30 min at UCT; LCT = - 55 °C; UCT = 125 °C; 1000 cycles	± (0.1 % R + 0.01 Ω)
4.13	-	Short time overload	$U = 2.5 \times \sqrt{P_{70} \times R}$ or $U = 2 \times U_{max.}$ ; whichever is the less severe; 5 s	± (0.05 % R + 0.01 Ω)



TEST PROCEDURES AND REQUIREMENTS				
EN 60115-1 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE
			<b>Stability for product types:</b> TNPU0603 e3 TNPU0805 e3 TNPU1206 e3	
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 <sup>2</sup> ; 6 h	$\pm (0.05\% R + 0.01 \Omega)$ 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 Solder bath method; SnAg3Cu0,5 or SnAg3,5; non-activated flux (235 $\pm$ 3) °C; (2 $\pm$ 0.2) s	Good tinning ( $\geq 95\%$ covered); no visible damage
4.18.2	58 (Td)	Resistance to soldering heat	Solder bath method; (260 $\pm$ 5) °C; (10 $\pm$ 1) s	$\pm (0.02\% R + 0.01 \Omega)$
4.29	45 (XA)	Component solvent resistance	Isopropyl alcohol + 50 °C; method 2	No visible damage
4.32	21 (Ue <sub>3</sub> )	Shear (adhesion)	RR 1005M and RR 1608M; 9 N RR 2012M and RR 3216M; 45 N	No visible damage
4.33	21 (Ue <sub>1</sub> )	Substrate bending	Depth 2 mm, 3 times	$\pm (0.05\% R + 0.01 \Omega)$ 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 60695-11-5, needle flame test; 10 s	No burning after 30 s
	-	Damp heat	(85 $\pm$ 5) °C; 56 days (85 $\pm$ 5) % RH	$\pm (0.25 R + 0.05 \Omega)$



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## Material Category Policy

**Vishay Intertechnology, Inc. hereby certifies that all its products that are identified as RoHS-Compliant fulfill the definitions and restrictions defined under Directive 2011/65/EU of The European Parliament and of the Council of June 8, 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (EEE) - recast, unless otherwise specified as non-compliant.**

**Please note that some Vishay documentation may still make reference to RoHS Directive 2002/95/EC. We confirm that all the products identified as being compliant to Directive 2002/95/EC conform to Directive 2011/65/EU.**