

## Ultra Precision Thin Film Chip Resistors



TNPU e3 ultra 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 ( $\pm 2$  ppm/K;  $\pm 0.02$  %)
- Sulfur resistance verified according to ASTM B 809
- Superior moisture resistivity (85 °C; 85 % RH)
- Excellent overall stability at different environmental conditions  $\leq 0.05$  % (1000 h rated power at 70 °C)
- AEC-Q200 qualified
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)

 AUTOMOTIVE  
GRADE

**RoHS**  
COMPLIANT

### APPLICATIONS

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

TECHNICAL SPECIFICATIONS			
DESCRIPTION	TNPU0603 e3	TNPU0805 e3	TNPU1206 e3
Imperial size	0603	0805	1206
Metric size code	RR1608M	RR2012M	RR3216M
Resistance range	100 $\Omega$ to 100 k $\Omega$	100 $\Omega$ to 332 k $\Omega$	100 $\Omega$ to 511 k $\Omega$
Resistance tolerance	$\pm 0.1$ %; $\pm 0.05$ %; $\pm 0.02$ %		
Temperature coefficient	$\pm 10$ ppm/K; $\pm 5$ ppm/K; $\pm 2$ ppm/K <sup>(1)</sup>		
Rated dissipation, $P_{70}$ <sup>(2)</sup>	0.1 W	0.125 W	0.25 W
Operating voltage, $U_{max}$ AC <sub>RMS</sub> /DC	75 V	150 V	200 V
Permissible film temperature, $\vartheta_{F max}$ <sup>(2)</sup>	125 °C	125 °C	125 °C
Operating temperature range	-55 °C to 125 °C	-55 °C to 125 °C	-55 °C to 125 °C
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:			
1 min; $U_{ins}$	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

### Notes

- (1) Temperature coefficient  $\pm 2$  ppm/K (-10 °C / 85 °C) is available on request between 500  $\Omega$  and 20 k $\Omega$ .  
 (2) Please refer to APPLICATION INFORMATION, see next page.



**APPLICATION INFORMATION**

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. 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.

These resistors do not feature a lifetime limitation when operated within the limits of rated dissipation, permissible operating voltage and permissible film temperature. However, the resistance typically increases due to the resistor's film temperature over operating time, generally known as drift. The drift may exceed the stability requirements of an individual application circuit and thereby limits the functional lifetime. The designer may estimate the performance of the particular resistor application or set certain load and temperature limits in order to maintain a desired stability.

TEMPERATURE COEFFICIENT AND RESISTANCE RANGE				
TYPE / SIZE	TCR	TOLERANCE	RESISTANCE	E-SERIES
TNPU0603 e3	± 10 ppm/K	± 0.05 %	100 Ω to 100 kΩ	E24; E192
	± 5 ppm/K	± 0.1 %		
		± 0.02 %		
TNPU0805 e3	± 10 ppm/K	± 0.05 %	100 Ω to 332 kΩ	
	± 5 ppm/K	± 0.1 %	100 Ω to 200 kΩ	
		± 0.05 %		
TNPU1206 e3	± 10 ppm/K	± 0.05 %	100 Ω to 511 kΩ	
	± 5 ppm/K	± 0.1 %	100 Ω to 200 kΩ	
		± 0.05 %		

PACKAGING						
TYPE / SIZE	CODE	QUANTITY	PACKAGING STYLE	WIDTH	PITCH	REEL DIAMETER
TNPU0603 e3 TNPU0805 e3 TNPU1206 e3	E52 = EN	1000	Tape and reel cardboard tape acc. IEC 60286-3 Type 1a	8 mm	4 mm	180 mm / 7"
	ET1 = EA	5000				

PART NUMBER AND PRODUCT DESCRIPTION																	
Part Number: TNPU12061K32A00																	
T	N	P	U	1	2	0	6	1	K	3	2	A	Z	E	A	0	0
TYPE / SIZE TNPU0603 TNPU0805 TNPU1206			RESISTANCE R = Decimal K = Thousand M = Million (4 digits)			TOLERANCE B = ± 0.1 % A = ± 0.05 % H = ± 0.02 %			TCR Y = ± 10 ppm/K Z = ± 5 ppm/K W = ± 2 ppm/K			PACKAGING EA EN					
Product Description: TNPU1206 1K32 0.05 % T-16 ET1 e3																	
TNPU1206		1K32		0.05 %		T-16		ET1		e3							
TYPE / SIZE TNPU0603 TNPU0805 TNPU1206		RESISTANCE Examples: 1K32 = 1320 Ω		TOLERANCE ± 0.1 % ± 0.02 % ± 0.05 %		TCR T-13 = ± 10 ppm/K T-16 = ± 5 ppm/K T-20 = ± 2 ppm/K		PACKAGING ET1 E52		LEAD (Pb)-FREE e3 = Pure tin termination finish							

**Note**

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



## 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 Al<sub>2</sub>O<sub>3</sub> 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 Type 1a** <sup>(1)</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** <sup>(1)</sup>. 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 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 **IEC 62474**, Material Declaration for Products of and for the Electrotechnical Industry.

The dedicated database <sup>(2)</sup>, that list declarable substances, ensures full compliance with the following directives:

- 2000/53/EC End of Vehicle life Directive (ELV) and Annex II (ELV II)
- 2011/65/EU Restriction of the use of Hazardous Substances directive (RoHS)
- 2012/19/EU 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.

## RELATED PRODUCTS

For products with precision specification see the datasheet:

- TNPW e3 - High Stability Thin Film Flat Chip Resistors ([www.vishay.com/doc?28758](http://www.vishay.com/doc?28758))

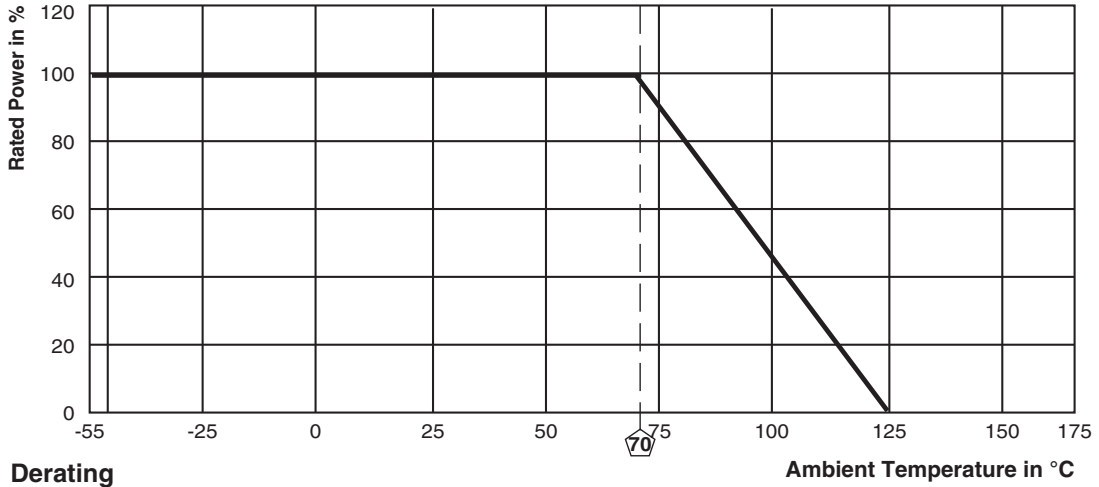
## Notes

<sup>(1)</sup> The quoted IEC standards are also released as EN standards with the same number and identical contents

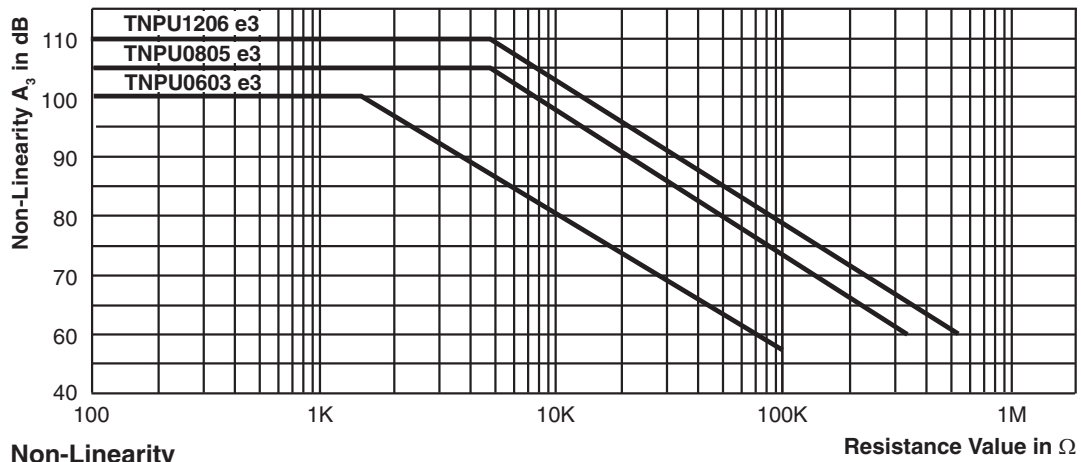
<sup>(2)</sup> IEC 62474 database can be found at <http://std.iec.ch/iec62474>.



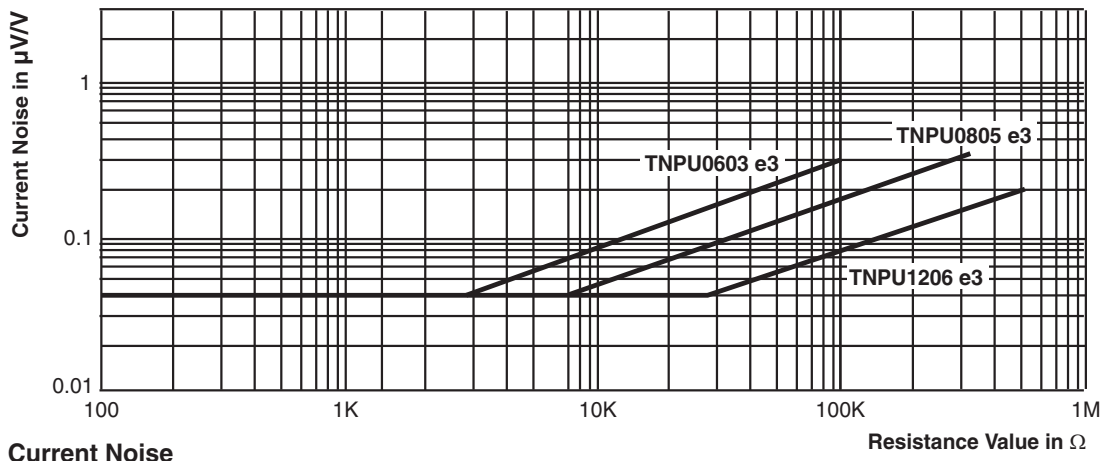
**FUNCTIONAL PERFORMANCE**



**Derating**



**Non-Linearity**



**Current Noise**



**TEST 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 140401-801, 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 140401-801. 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: 45 % 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.

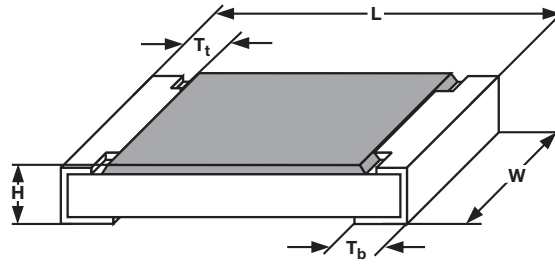
TEST PROCEDURES AND REQUIREMENTS				
EN 60115-1 CLAUSE	IEC 60068-2 (1) TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE (ΔR)
			<b>Stability for product types:</b> TNPU0603 e3 TNPU0805 e3 TNPU1206 e3	
4.5	-	Resistance		± 0.1 %; ± 0.05 %; ± 0.02 %
4.8.4.2	-	Temperature coefficient	At (20 / -55 / 20) °C and (20 / 125 / 20) °C	± 10 ppm/K; ± 5 ppm/K
			At (20 / -10 / 20) °C and (20 / 85 / 20) °C	± 2 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 125 °C; 8000 h	± (0.05 % R + 0.01 Ω) ± (0.1 % R + 0.02 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; 5 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	± (0.1 % R + 0.02 Ω)
4.23.6	30 (Db)	Damp heat, cyclic	55 °C; 24 h; > 90 % 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	



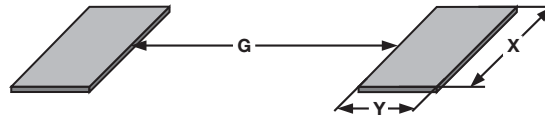
TEST PROCEDURES AND REQUIREMENTS				
EN 60115-1 CLAUSE	IEC 60068-2 (1) TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE ( $\Delta R$ )
			<b>Stability for product types:</b> <b>TNPU0603 e3</b> <b>TNPU0805 e3</b> <b>TNPU1206 e3</b>	
-	1 (Aa)	Cold	-55 °C; 2 h	$\pm (0.05 \% R + 0.01 \Omega)$
4.19	14 (Na)	Rapid change of temperature	30 min at LCT and 30 min at UCT; LCT = -55 °C; UCT = 125 °C; 1000 cycles	$\pm (0.1 \% R + 0.01 \Omega)$
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	$\pm (0.05 \% R + 0.01 \Omega)$
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 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 (1), needle flame test; 10 s	No burning after 30 s
4.37	-	Periodic electric overload: Standard operation mode	$U = \sqrt{15 \times P_{70} \times R}$ or $U = 2 \times U_{max.}$ ; whichever is the less severe; 0.1 s on; 2.5 s off; 1000 cycles	$\pm (0.1 R + 0.02 \Omega)$
4.39	67 (Cy)	Damp heat, steady state, accelerated	(85 $\pm$ 5) °C; 56 days (85 $\pm$ 5) % RH	$\pm (0.25 R + 0.05 \Omega)$
4.38	-	Electro static discharge (Human Body Model)	IEC 61340-3-1 (1); 3 pos. + 3 neg. (equivalent to MIL-STD-883, method 3015) TNPU0603: 1000 V TNPU0805: 1500 V TNPU1206: 2000 V	$\pm (0.5 R + 0.05 \Omega)$

**Note**

(1) The quoted IEC standards are also released as EN standards with the same number and identical contents.

**DIMENSIONS**


<b>DIMENSIONS AND MASS</b>						
TYPE	H (mm)	L (mm)	W (mm)	T <sub>t</sub> (mm)	T <sub>b</sub> (mm)	MASS (mg)
TNPU0603 e3	0.45 ± 0.10	1.6 ± 0.10	0.85 ± 0.10	0.3 ± 0.20	0.3 ± 0.20	2
TNPU0805 e3	0.45 ± 0.10	2.0 ± 0.15	1.25 ± 0.15	0.4 ± 0.20	0.4 ± 0.20	5.5
TNPU1206 e3	0.55 ± 0.10	3.2 ± 0.15	1.6 ± 0.15	0.5 ± 0.25	0.5 ± 0.25	10

**SOLDER PAD DIMENSIONS**


<b>RECOMMENDED SOLDER PAD DIMENSIONS</b>						
TYPE	REFLOW SOLDERING			WAVE SOLDERING		
	Y (mm)	X (mm)	G (mm)	Y (mm)	X (mm)	G (mm)
TNPU0603 e3	0.5	0.9	1.0	0.9	0.9	1.0
TNPU0805 e3	0.7	1.3	1.2	0.9	1.3	1.3
TNPU1206 e3	0.9	1.7	2.0	1.1	1.7	2.3



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## Material Category Policy

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