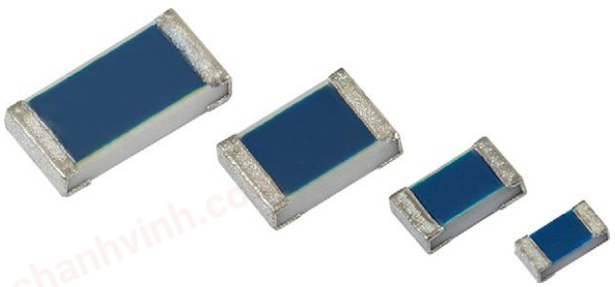
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Ultra Precision Thin Film Chip Resistors



FEATURES

- Low temperature coefficients and tight tolerances
- Sulfur resistance verified according to ASTM B 809
- Superior moisture resistivity (85 °C; 85 % RH)
- Excellent overall stability at different environmental conditions, e.g. ≤ 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

AUTOMOTIVE GRADE

Pb-free

RoHS COMPLIANT

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.

APPLICATIONS

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

TECHNICAL SPECIFICATIONS

DESCRIPTION	TNPU0402 e3	TNPU0603 e3	TNPU0805 e3	TNPU1206 e3
Imperial size	0402	0603	0805	1206
Metric size code	RR1005M	RR1608M	RR2012M	RR3216M
Resistance range	100 Ω to 100 kΩ	100 Ω to 100 kΩ	100 Ω to 332 kΩ	100 Ω to 511 kΩ
Resistance tolerance	± 0.1 %; ± 0.05 %	± 0.1 %; ± 0.05 %; ± 0.02 %		
Temperature coefficient	± 10 ppm/K; ± 5 ppm/K	± 10 ppm/K; ± 5 ppm/K; ± 2 ppm/K		
Rated dissipation, P_{70} (1)	0.063 W	0.1 W	0.125 W	0.25 W
Operating voltage, $U_{max.}$ AC_{RMS}/DC	50 V	75 V	150 V	200 V
Permissible film temperature, $\vartheta_{F\ max.}$ (1)	125 °C			
Operating temperature range	-55 °C to 125 °C			
Internal thermal resistance (1)	90 K/W	63 K/W	38 K/W	32 K/W
Permissible voltage against ambient (insulation): 1 min; U_{ins}	75 V	100 V	200 V	300 V
$FIT_{observed}$	≤ 0.1 x 10^{-9}/h			

Note

(1) Please refer to APPLICATION INFORMATION, see 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.

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.

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.

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MAXIMUM RESISTANCE CHANGE AT RATED DISSIPATION		
OPERATION MODE		**STANDARD**
Rated dissipation, P_{70}	**TNPU0402 e3**	0.063 W
	TNPU0603 e3	0.100 W
	TNPU0805 e3	0.125 W
	TNPU1206 e3	0.250 W
Operating temperature range		-55 °C to 125 °C
Permissible film temperature, $\vartheta_{F\ max.}$		125 °C
Max. resistance change at P_{70} for resistance range, $\lvert\Delta R/R\rvert$ after:	**TNPU0402 e3**	100 Ω to 100 kΩ
	TNPU0603 e3	100 Ω to 100 kΩ
	TNPU0805 e3	100 Ω to 332 kΩ
	TNPU1206 e3	100 Ω to 511 kΩ
	1000 h	≤ 0.05 %
	8000 h	≤ 0.1 %
	225 000 h	≤ 0.3 %

TEMPERATURE COEFFICIENT AND RESISTANCE RANGE				
TYPE / SIZE	**TCR**	**TOLERANCE**	**RESISTANCE**	**E-SERIES**
TNPU0402 e3	± 10 ppm/K	± 0.05 %	100 Ω to 100 kΩ	E24; E192
	± 5 ppm/K	± 0.1 %		
		± 0.05 %		
TNPU0603 e3	± 10 ppm/K	± 0.05 %	100 Ω to 100 kΩ	
	± 5 ppm/K	± 0.1 %		
		± 0.05 %		
		± 0.02 %		
	± 2 ppm/K	± 0.1 %	500 Ω to 20 kΩ	
		± 0.05 %		
		± 0.02 %		
TNPU0805 e3	± 10 ppm/K	± 0.05 %	100 Ω to 332 kΩ	
	± 5 ppm/K	± 0.1 %		
		± 0.05 %		
		± 0.02 %	100 Ω to 200 kΩ	
	± 2 ppm/K	± 0.1 %	500 Ω to 20 kΩ	
		± 0.05 %		
		± 0.02 %		
TNPU1206 e3	± 10 ppm/K	± 0.05 %	100 Ω to 511 kΩ	
	± 5 ppm/K	± 0.1 %		
		± 0.05 %		
		± 0.02 %	100 Ω to 200 kΩ	
	± 2 ppm/K	± 0.1 %	500 Ω to 20 kΩ	
		± 0.05 %		
		± 0.02 %		

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PACKAGING

TYPE / SIZE	CODE	QUANTITY	PACKAGING STYLE	WIDTH	PITCH	PACKAGING DIMENSIONS
TNPU0402 e3	EP1 = EP	1000	Paper tape according IEC 60286-3, type 1a	8 mm	2 mm	Ø 180 mm / 7"
	ET2 = EI	5000				
TNPU0603 e3 **TNPU0805 e3** **TNPU1206 e3**	E52 = EN	1000			4 mm	
	ET1 = EA	5000				

PART NUMBER AND PRODUCT DESCRIPTION

Part Number: TNPU12061K32AZEA00

T	N	P	U	1	2	0	6	1	K	3	2	A	Z	E	A	0	0

TYPE / SIZE	RESISTANCE	TOLERANCE	TCR	PACKAGING
TNPU0402 **TNPU0603** **TNPU0805** **TNPU1206**	**R** = decimal **K** = thousand **M** = million (4 digits)	**B** = ± 0.1 % **A** = ± 0.05 % **H** = ± 0.02 %	**Y** = ± 10 ppm/K **Z** = ± 5 ppm/K **W** = ± 2 ppm/K	**EP** **EI** **EN** **EA**

Product Description: TNPU1206 1K32 0.05 % T-16 ET1 e3

TNPU1206	1K32	0.05 %	T-16	ET1	e3
TYPE / SIZE	RESISTANCE	TOLERANCE	TCR	PACKAGING	LEAD (Pb)-FREE
TNPU0402 **TNPU0603** **TNPU0805** **TNPU1206**	**1K32** = 1320 Ω	**± 0.02 %** **± 0.05 %** **± 0.1 %**	**T-13** = ± 10 ppm/K **T-16** = ± 5 ppm/K **T-20** = ± 2 ppm/K	**EP1** **ET2** **E52** **ET1**	**e3** = pure tin termination finish

Note

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

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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 ceramic substrate (Al_2O_3) 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 matte 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** [(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. 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.

RELATED PRODUCTS

For products with precision specification see the datasheet:

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

Notes

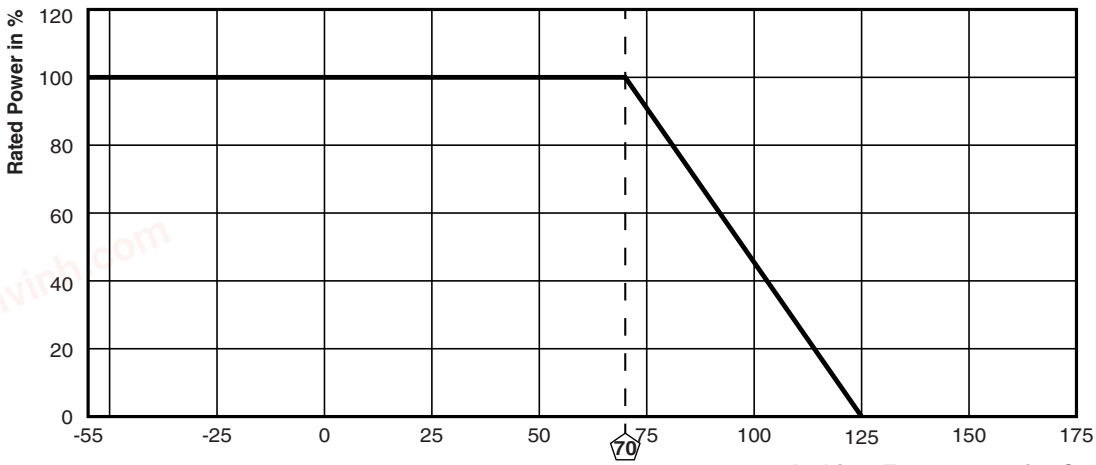
(1) The quoted IEC standards are also released as EN standards with the same number and identical contents
(2) The IEC 62474 list of declarable substances is maintained in a dedicated database, which is available at http://std.iec.ch/iec62474
(3) The Global Automotive Declarable Substance List (GADSL) 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

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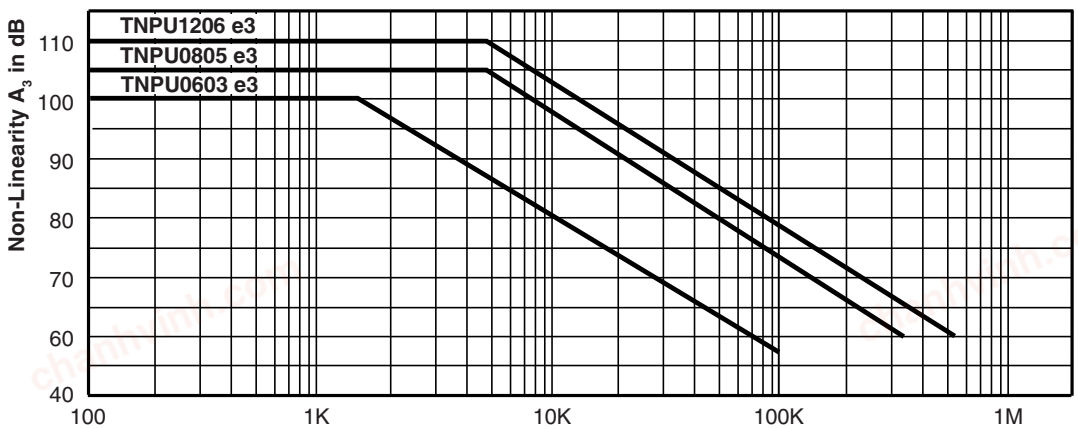
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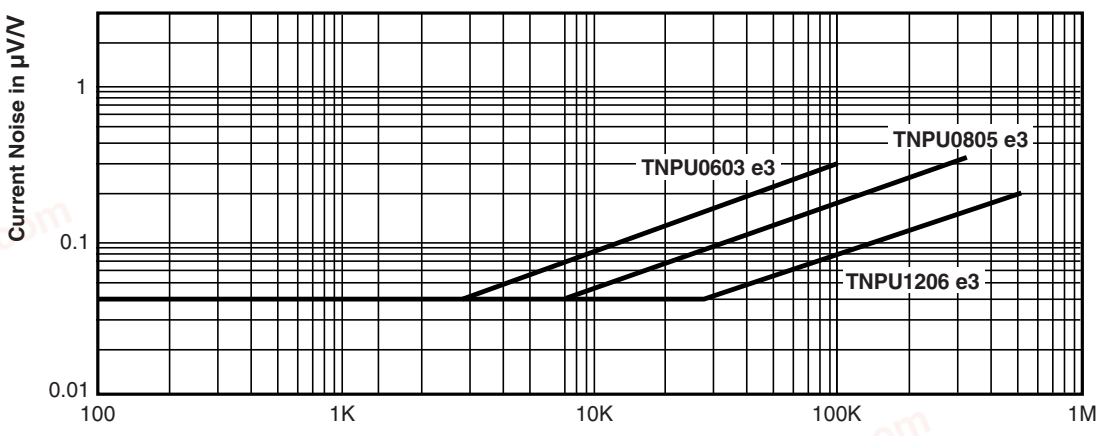
FUNCTIONAL PERFORMANCE



Derating



Non-Linearity



Current Noise

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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: 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

EN 60115-1 CLAUSE	IEC 60068-2 (1) TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE (ΔR)
			Stability for product types:	
			TNPU0402 e3	100 Ω to 100 kΩ
			TNPU0603 e3	100 Ω to 100 kΩ
			TNPU0805 e3	100 Ω to 332 kΩ
			TNPU1206 e3	100 Ω to 511 kΩ
4.5	-	Resistance		± 0.1 %; ± 0.05 %; ± 0.02 %
4.8	-	Temperature coefficient	At (20 / -55 / 20) °C and (20 / 125 / 20) °C	± 10 ppm/K; ± 5 ppm/K; ± 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 (Bb)	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 (Ab)	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	
-	1 (Aa)	Cold	-55 °C; 2 h	± (0.05 % R + 0.01 Ω)

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TEST PROCEDURES AND REQUIREMENTS				
EN 60115-1 CLAUSE	**IEC 60068-2 (1) TEST METHOD**	**TEST**	**PROCEDURE**	**REQUIREMENTS PERMISSIBLE CHANGE (ΔR)**
			Stability for product types:	
			TNPU0402 e3	100 Ω to 100 kΩ
			TNPU0603 e3	100 Ω to 100 kΩ
			TNPU0805 e3	100 Ω to 332 kΩ
			TNPU1206 e3	100 Ω to 511 kΩ
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)
4.22	6 (Fc)	Vibration	Endurance by sweeping; 10 Hz to 2000 Hz; no resonance; amplitude ≤ 1.5 mm or ≤ 200 m/s^2; 6 h	± (0.05 % R + 0.01 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	± (0.02 % R + 0.01 Ω)
4.29	45 (XA)	Component solvent resistance	Isopropyl alcohol +50 °C; method 2	No visible damage
4.32	21 (Ue_3)	Shear (adhesion)	RR 1005M and 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	± (0.05 % R + 0.01 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 60695-11-5 (1), needle flame test; 10 s	No burning after 30 s
4.39	-	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	± (0.1 R + 0.02 Ω)
4.37	67 (Cy)	Damp heat, steady state, accelerated	(85 ± 5) °C; 56 days (85 ± 5) % RH	± (0.25 R + 0.05 Ω)
4.38	-	Electro static discharge (Human Body Model)	IEC 61340-3-1 (1); 3 pos. + 3 neg. (equivalent to MIL-STD-883, method 3015) TNPU0402: 400 V TNPU0603: 1000 V TNPU0805: 1500 V TNPU1206: 2000 V	± (0.5 R + 0.05 Ω)

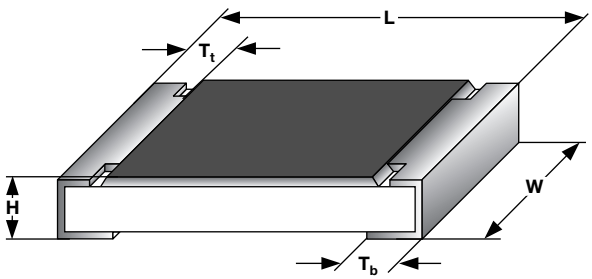
Note

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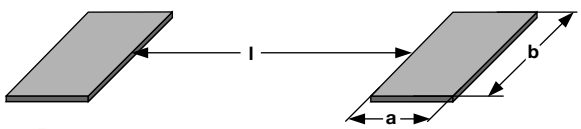
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DIMENSIONS



DIMENSIONS AND MASS					
TYPE / SIZE	L (mm)	W (mm)	H (mm)	T_t / T_b (mm)	MASS (mg)
TNPU0402 e3	1.0 ± 0.05	0.5 ± 0.05	0.35 ± 0.05	0.2 ± 0.10	0.65
TNPU0603 e3	1.6 ± 0.10	0.85 ± 0.10	0.45 ± 0.10	0.3 ± 0.20	2
TNPU0805 e3	2.0 ± 0.15	1.25 ± 0.15	0.45 ± 0.10	0.4 ± 0.20	5.5
TNPU1206 e3	3.2 ± 0.15	1.6 ± 0.15	0.55 ± 0.10	0.5 ± 0.25	10

SOLDER PAD DIMENSIONS



RECOMMENDED SOLDER PAD DIMENSIONS						
TYPE / SIZE	REFLOW SOLDERING			WAVE SOLDERING		
	a (mm)	b (mm)	l (mm)	a (mm)	b (mm)	l (mm)
TNPU0402 e3	0.4	0.6	0.5	-	-	-
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

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

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