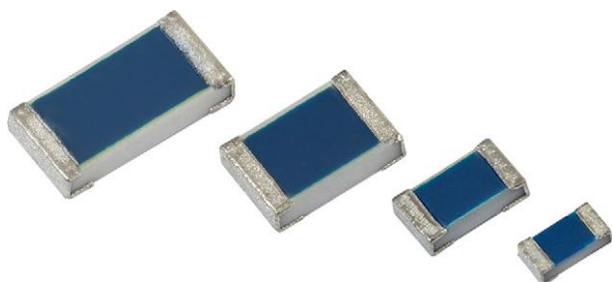


Ultra Precision Thin Film Chip Resistors



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 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. $\leq 0.05\%$ (1000 h rated power at 70 °C)
- AEC-Q200 qualified
- Material categorization: for definitions of compliance please see www.vishay.com/doc299912


RoHS
COMPLIANT

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 k Ω	100 Ω to 100 k Ω	100 Ω to 332 k Ω	100 Ω to 511 k Ω
Resistance tolerance	$\pm 0.1\%$; $\pm 0.05\%$	$\pm 0.1\%$; $\pm 0.05\%$; $\pm 0.02\%$		
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}	$\leq 0.1 \times 10^{-9}/h$			

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/doc228844) 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.

**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, $ \Delta R/R $ after:	TNPU0402 e3	100 Ω to 100 k Ω
	TNPU0603 e3	100 Ω to 100 k Ω
	TNPU0805 e3	100 Ω to 332 k Ω
	TNPU1206 e3	100 Ω to 511 k Ω
	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 %		

**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: TNPU12061K32AZE00

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



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

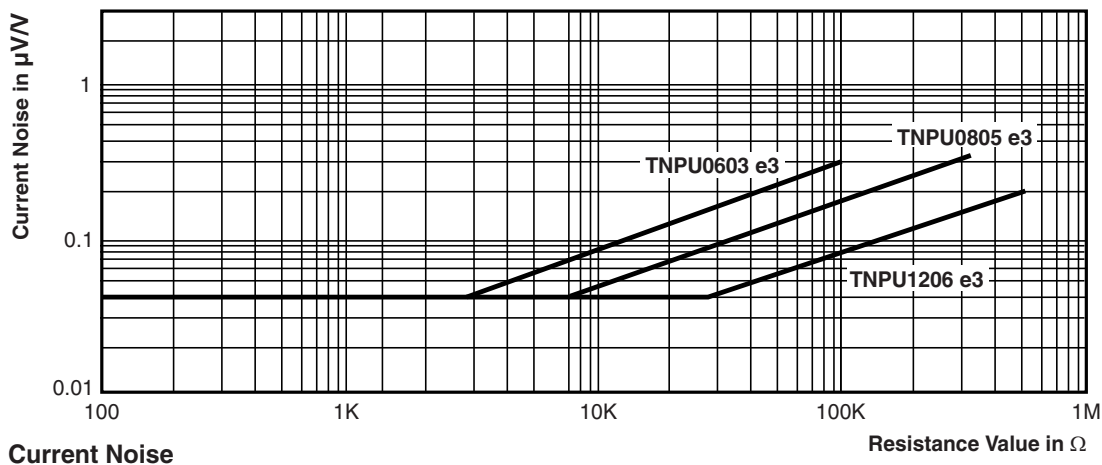
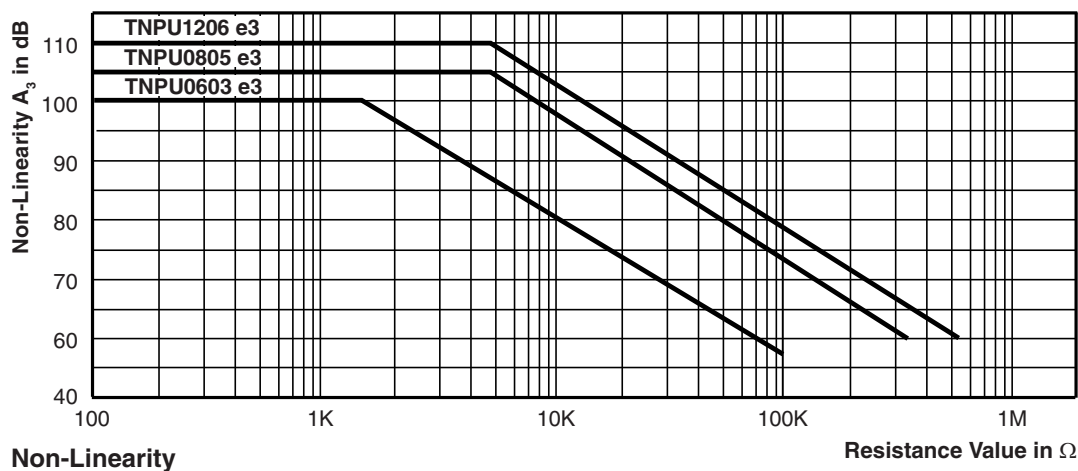
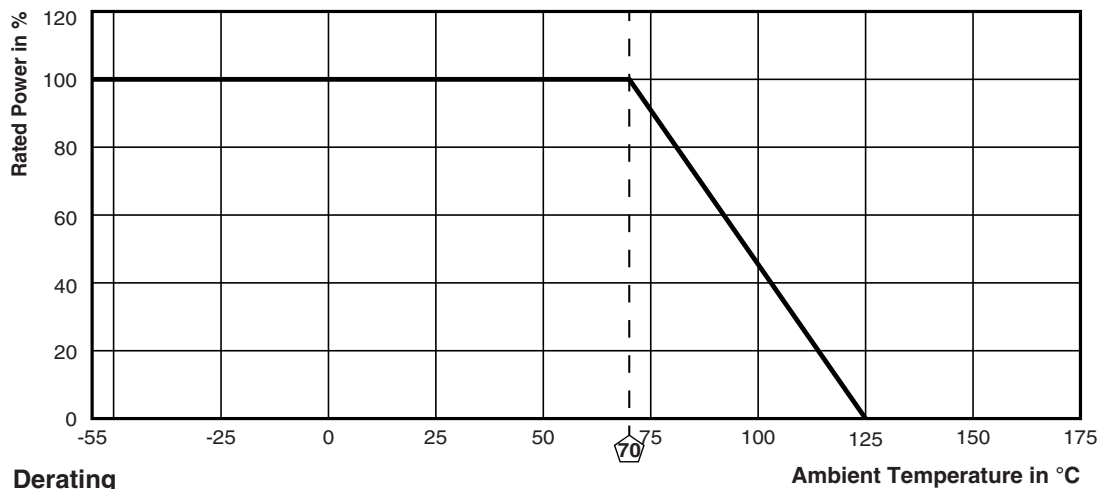
⁽²⁾ The IEC 62474 list of declarable substances is maintained in a dedicated database, which is available at <http://std.iec.ch/iec62474>

⁽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>



FUNCTIONAL PERFORMANCE



**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.

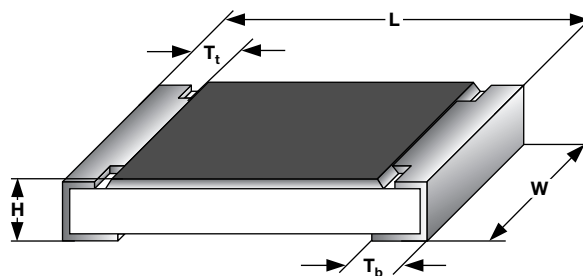
TEST PROCEDURES AND REQUIREMENTS				
EN 60115-1 CLAUSE	IEC 60068-2 (1) TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE (ΔR)
			Stability for product types:	
			TNPU0402 e3	100 Ω to 100 k Ω
			TNPU0603 e3	100 Ω to 100 k Ω
			TNPU0805 e3	100 Ω to 332 k Ω
			TNPU1206 e3	100 Ω to 511 k Ω
4.5	-	Resistance		$\pm 0.1 \%$; $\pm 0.05 \%$; $\pm 0.02 \%$
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	$\pm (0.05 \% R + 0.01 \Omega)$ $\pm (0.1 \% R + 0.02 \Omega)$
4.25.3	-	Endurance at upper category temperature	125 °C; 1000 h 125 °C; 8000 h	$\pm (0.05 \% R + 0.01 \Omega)$ $\pm (0.1 \% R + 0.02 \Omega)$
4.24	78 (Cab)	Damp heat, steady state	(40 $\pm$ 2) °C; 56 days; (93 $\pm$ 3) % RH	$\pm (0.1 \% R + 0.01 \Omega)$
4.23	2 (Bb) 30 (Db) 1 (Ab) 13 (M) 30 (Db) -	Climatic sequence:		$\pm (0.1 \% R + 0.02 \Omega)$
4.23.2		Dry heat	UCT; 16 h	
4.23.3		Damp heat, cyclic	55 °C; 24 h; > 90 % RH; 5 cycle	
4.23.4		Cold	LCT; 2 h	
4.23.5		Low air pressure	8.5 kPa; 2 h; (25 $\pm$ 10) °C	
4.23.6		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	$\pm (0.05 \% R + 0.01 \Omega)$

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 k Ω
			TNPU0603 e3	100 Ω to 100 k Ω
			TNPU0805 e3	100 Ω to 332 k Ω
			TNPU1206 e3	100 Ω to 511 k 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	$\pm (0.1 \% R + 0.01 \Omega)$
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 ≤ 1.5 mm or ≤ 200 m/s ² ; 6 h	$\pm (0.05 \% R + 0.01 \Omega)$ no visible damage
4.17	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 (≥ 95 % covered); no visible damage
4.18	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 ₃)	Shear (adhesion)	RR 1005M and RR 1608M; 9 N RR 2012M and RR 3216M; 45 N	No visible damage
4.33	21 (Ue ₁)	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
4.39	-	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	$\pm (0.1 R + 0.02 \Omega)$
4.37	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) TNPU0402: 400 V TNPU0603: 1000 V TNPU0805: 1500 V TNPU1206: 2000 V	$\pm (0.5 R + 0.05 \Omega)$

Note

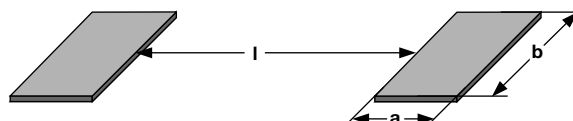
(1) The quoted IEC standards are also released as EN standards with the same number and identical contents

DIMENSIONS



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



Disclaimer

ALL PRODUCT, PRODUCT SPECIFICATIONS AND DATA ARE SUBJECT TO CHANGE WITHOUT NOTICE TO IMPROVE RELIABILITY, FUNCTION OR DESIGN OR OTHERWISE.

Vishay Intertechnology, Inc., its affiliates, agents, and employees, and all persons acting on its or their behalf (collectively, "Vishay"), disclaim any and all liability for any errors, inaccuracies or incompleteness contained in any datasheet or in any other disclosure relating to any product.

Vishay makes no warranty, representation or guarantee regarding the suitability of the products for any particular purpose or the continuing production of any product. To the maximum extent permitted by applicable law, Vishay disclaims (i) any and all liability arising out of the application or use of any product, (ii) any and all liability, including without limitation special, consequential or incidental damages, and (iii) any and all implied warranties, including warranties of fitness for particular purpose, non-infringement and merchantability.

Statements regarding the suitability of products for certain types of applications are based on Vishay's knowledge of typical requirements that are often placed on Vishay products in generic applications. Such statements are not binding statements about the suitability of products for a particular application. It is the customer's responsibility to validate that a particular product with the properties described in the product specification is suitable for use in a particular application. Parameters provided in datasheets and / or specifications may vary in different applications and performance may vary over time. All operating parameters, including typical parameters, must be validated for each customer application by the customer's technical experts. Product specifications do not expand or otherwise modify Vishay's terms and conditions of purchase, including but not limited to the warranty expressed therein.

Hyperlinks included in this datasheet may direct users to third-party websites. These links are provided as a convenience and for informational purposes only. Inclusion of these hyperlinks does not constitute an endorsement or an approval by Vishay of any of the products, services or opinions of the corporation, organization or individual associated with the third-party website. Vishay disclaims any and all liability and bears no responsibility for the accuracy, legality or content of the third-party website or for that of subsequent links.

Except as expressly indicated in writing, Vishay products are not designed for use in medical, life-saving, or life-sustaining applications or for any other application in which the failure of the Vishay product could result in personal injury or death. Customers using or selling Vishay products not expressly indicated for use in such applications do so at their own risk. Please contact authorized Vishay personnel to obtain written terms and conditions regarding products designed for such applications.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted by this document or by any conduct of Vishay. Product names and markings noted herein may be trademarks of their respective owners.

Mouser Electronics

Authorized Distributor

Click to View Pricing, Inventory, Delivery & Lifecycle Information:

[Vishay:](#)

TNPU0603102KBZEA00	TNPU060399R8BZEA00	TNPU0805333KAYEA00	TNPU080599R8AYEA00
TNPU1206512KBZEA00	TNPU120699R8BZEA00	TNPU1206500RAZEN00	TNPU0603500RAZEN00
TNPU04021K00AZEP00	TNPU040220K0BZEP00	TNPU0402100KBZEP00	TNPU04022K00AZEP00
TNPU040249K9BZEP00	TNPU0402100KAYEP00	TNPU04021K00AYEP00	TNPU04021K00BZEP00
TNPU040249K9AYEP00	TNPU0402100KAZEP00	TNPU0402100RAYEP00	TNPU040210K0BZEP00
TNPU040249K9AZEP00	TNPU040220K0AYEP00	TNPU04022K00AYEP00	TNPU04022K00BZEP00
TNPU040220K0AZEP00	TNPU0402100RAZEP00	TNPU040210K0AYEP00	TNPU0402100RBZEP00
TNPU040210K0AZEP00	TNPU04024K99AYEP00	TNPU04024K99AZEP00	TNPU04024K99BZEP00
TNPU06032K00AWEN00	TNPU1206500RAWEN00	TNPU080510K0AWEN00	TNPU12061K00AWEN00
TNPU0603500RAWEN00	TNPU08051K00AWEN00	TNPU120610K0AWEN00	TNPU120620K0AWEN00
TNPU12064K99AWEN00	TNPU080520K0AWEN00	TNPU08052K00AWEN00	TNPU08054K99AWEN00
TNPU06034K99AWEN00	TNPU12062K00AWEN00	TNPU0805500RAWEN00	TNPU06031K00AWEN00
TNPU060320K0AWEN00	TNPU060310K0AWEN00	TNPU08052K49BZEN00	TNPU06034K70AZEN00
TNPU060333K0BZEN00	TNPU060322K0BZEN00	TNPU0805500RAZEN00	TNPU06034K70BZEN00
TNPU04024K70BZEP00	TNPU12061K50BZEN00	TNPU1206200RBZEN00	TNPU12062K49BZEN00
TNPU12064K70BZEN00	TNPU06031K50BZEN00	TNPU0603100KHZEN00	TNPU040215K0BZEP00
TNPU04021K50BZEP00	TNPU0402200RBZEP00	TNPU04022K49BZEP00	TNPU080550K0AZEN00
TNPU080550K0HZEN00	TNPU08055K00AZEN00	TNPU120615K0BZEN00	TNPU1206470KBZEN00
TNPU12065K00AZEN00	TNPU06037K50BZEN00	TNPU080512K1BZEN00	TNPU08051K50BZEN00
TNPU0805200RBZEN00	TNPU08052K21BZEN00	TNPU08054K70BZEN00	TNPU080515K0BZEN00
TNPU0603200RBZEN00	TNPU060322K1BZEN00	TNPU0603250RAZEN00	TNPU060350K0HZEN00
TNPU06035K11BZEN00			