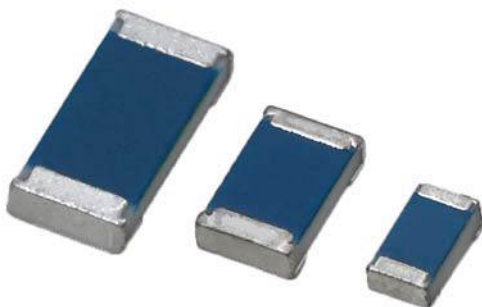


Ultra Precision Thin Film Chip Resistors



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 (± 2 ppm/K; ± 0.02 %)
- Sulfur resistance verified according to ASTM B 809
- Superior moisture resistivity (85 °C; 85 % RH)
- Excellent overall stability at different environmental conditions ≤ 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

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 Ω to 100 k Ω	100 Ω to 332 k Ω	100 Ω to 511 k Ω
Resistance tolerance	± 0.1 %; ± 0.05 %; ± 0.02 %		
Temperature coefficient	± 10 ppm/K; ± 5 ppm/K; ± 2 ppm/K ⁽¹⁾		
Rated dissipation, P_{70} ⁽²⁾	0.1 W	0.125 W	0.25 W
Operating voltage, U_{max} AC _{RMS} /DC	75 V	150 V	200 V
Permissible film temperature, $\vartheta_{F max}$ ⁽²⁾	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	≤ 0.05 %	≤ 0.05 %	≤ 0.05 %
8000 h	≤ 0.10 %	≤ 0.10 %	≤ 0.10 %
225 000 h	≤ 0.30 %	≤ 0.30 %	≤ 0.30 %
Insulation voltage:			
1 min; U_{ins}	100 V	200 V	300 V
Continuous	75 V	75 V	75 V
FIT _{observed}	$\leq 0.1 \times 10^{-9}$ /h	$\leq 0.1 \times 10^{-9}$ /h	$\leq 0.1 \times 10^{-9}$ /h

Notes

- (1) Temperature coefficient ± 2 ppm/K (-10 °C / 85 °C) is available on request between 500 Ω and 20 k Ω .
(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

TEMPERATURE COEFFICIENT AND TOLERANCE 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 %		
		± 0.05 %		
		± 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	
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	

PACKAGING

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

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
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	RESISTANCE	TOLERANCE	TCR	PACKAGING	LEAD (Pb)-FREE
TNPU0603	Examples: 1K32 = 1320 Ω	± 0.1 %	T-13 = ± 10 ppm/K	ET1 E52	e3 = Pure tin termination finish
TNPU0805		± 0.02 %	T-16 = ± 5 ppm/K		
TNPU1206		± 0.05 %	T-20 = ± 2 ppm/K		

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_2O_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 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 vapour 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 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 ⁽²⁾, 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)

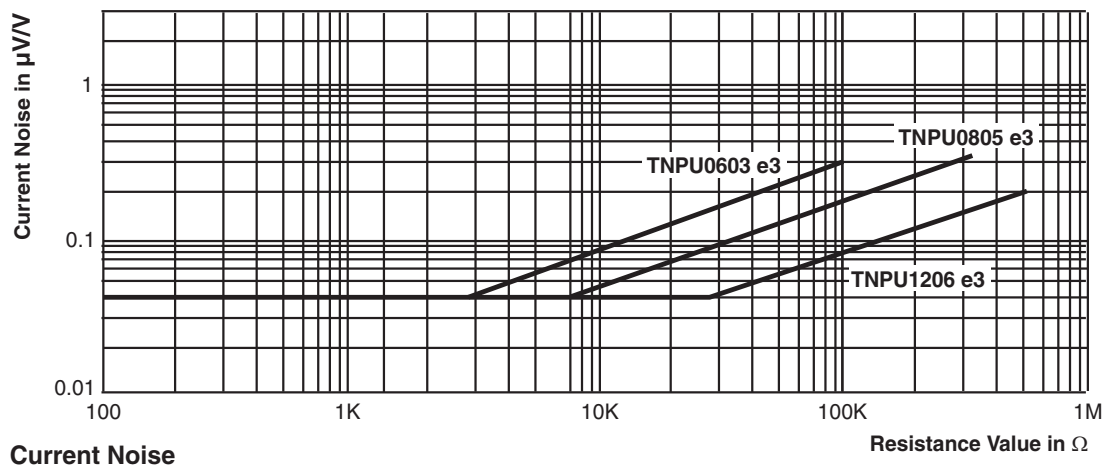
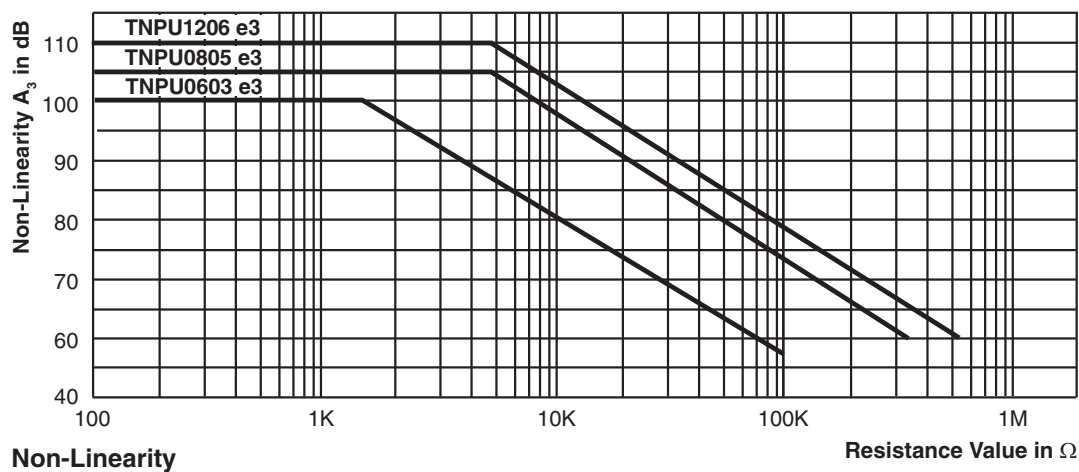
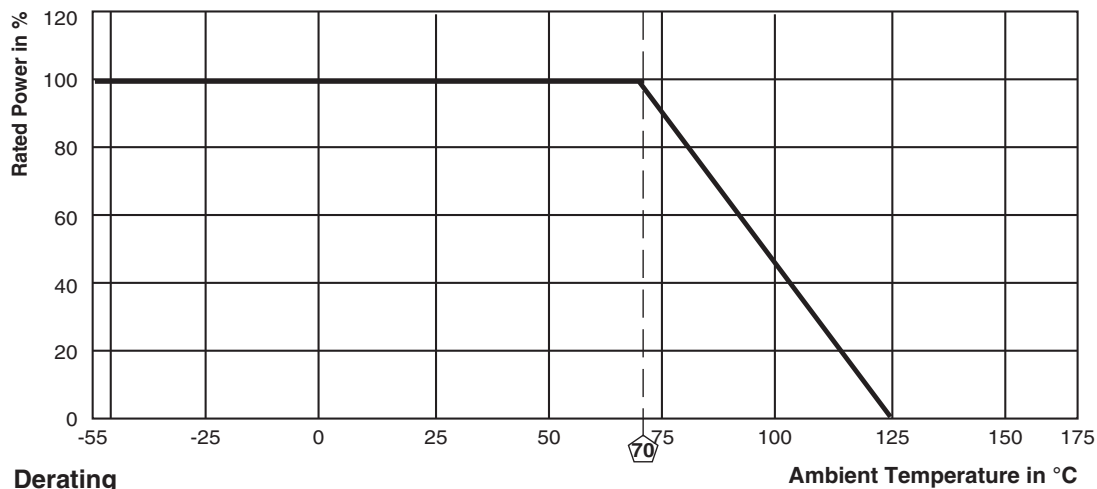
Notes

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

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



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: 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.

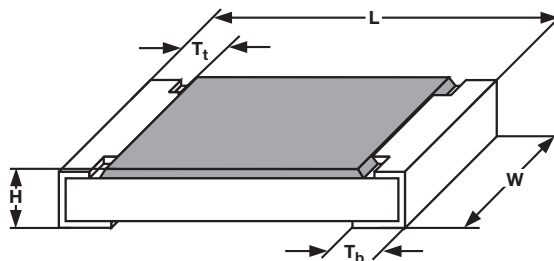
TEST PROCEDURES AND REQUIREMENTS				
EN 60115-1 CLAUSE	IEC 60068-2 ⁽¹⁾ TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE (ΔR)
			Stability for product types:	
			TNPU0603 e3	
			TNPU0805 e3	
			TNPU1206 e3	
4.5	-	Resistance		$\pm 0.1 \%$; $\pm 0.05 \%$; $\pm 0.02 \%$
4.8.4.2	-	Temperature coefficient	At (20 / -55 / 20) °C and (20 / 125 / 20) °C	$\pm 10 \text{ ppm/K}$; $\pm 5 \text{ ppm/K}$
			At (20 / -10 / 20) °C and (20 / 85 / 20) °C	$\pm 2 \text{ ppm/K}$
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 (Ba) 30 (Db) 1 (Aa) 13 (M) 30 (Db) -	Climatic sequence:	UCT; 16 h 55 °C; 24 h; > 90 % RH; 5 cycle LCT; 2 h 8.5 kPa; 2 h; (25 $\pm$ 10) °C 55 °C; 24 h; > 90 % RH; 5 cycles $U = \sqrt{P_{70} \times R} \leq U_{\max.}$; 1 min LCT = -55 °C UCT = 125 °C	$\pm (0.1 \% R + 0.02 \Omega)$
4.23.2		Dry heat		
4.23.3		Damp heat, cyclic		
4.23.4		Cold		
4.23.5		Low air pressure		
4.23.6		Damp heat, cyclic		
4.23.7		D.c. load		

TEST PROCEDURES AND REQUIREMENTS				
EN 60115-1 CLAUSE	IEC 60068-2 ⁽¹⁾ TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE (ΔR)
			Stability for product types:	
			TNPU0603 e3	
			TNPU0805 e3	
			TNPU1206 e3	
-	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 ≤ 1.5 mm or ≤ 200 m/s ² ; 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	Good tinning (≥ 95 % covered); no visible damage
			Solder bath method; SnAg3Cu0,5 or SnAg3,5; non-activated flux (235 $\pm$ 3) °C; (2 $\pm$ 0.2) s	
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 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	$\pm (0.05 \% R + 0.01 \Omega)$ 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

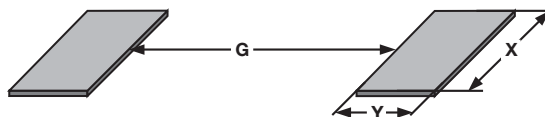
⁽¹⁾ The quoted IEC standards are also released as EN standards with the same number and identical contents.

DIMENSIONS



DIMENSIONS AND MASS						
TYPE	H (mm)	L (mm)	W (mm)	T _t (mm)	T _b (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



RECOMMENDED SOLDER PAD DIMENSIONS						
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



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.

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.

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.

Vishay Intertechnology, Inc. hereby certifies that all its products that are identified as Halogen-Free follow Halogen-Free requirements as per JEDEC JS709A standards. Please note that some Vishay documentation may still make reference to the IEC 61249-2-21 definition. We confirm that all the products identified as being compliant to IEC 61249-2-21 conform to JEDEC JS709A standards.