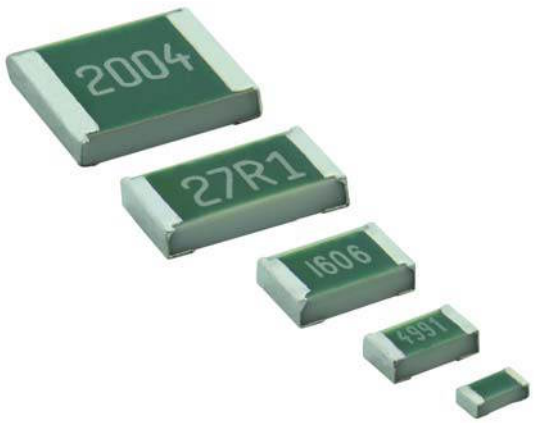
High Stability Thin Film Flat Chip Resistors



TNPW e3 precision thin film flat chip resistors are the perfect choice for most fields of modern electronics where highest reliability and stability is of major concern. Typical applications include test and measuring equipment, medical equipment, industrial, and automotive.

FEATURES

- 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 (sizes 0402 to 1206)
- Single lot date code (optional)
- Sulfur resistance verified according to ASTM B 809
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

AUTOMOTIVE GRADE

RoHS COMPLIANT

HALOGEN FREE

APPLICATIONS

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

TECHNICAL SPECIFICATIONS

DESCRIPTION	TNPW0402 e3	TNPW0603 e3	TNPW0805 e3	TNPW1206 e3	TNPW1210 e3 (1)
Imperial size	0402	0603	0805	1206	1210
Metric size code	RR1005M	RR1608M	RR2012M	RR3216M	RR3225M
Resistance range	10 Ω to 100 kΩ	4.7 Ω to 332 kΩ	4.7 Ω to 1 MΩ	4.7 Ω to 2 MΩ	10 Ω to 3.01 MΩ
Resistance tolerance	± 1 %; ± 0.5 %; ± 0.1 %				
Temperature coefficient	± 50 ppm/K; ± 25 ppm/K; ± 15 ppm/K; ± 10 ppm/K				
Rated dissipation, P_{70} (2)	0.063 W	0.1 W	0.125 W	0.25 W	0.33 W
Operating voltage, $U_{max.}$ AC_{RMS} or DC	50 V	75 V	150 V	200 V	200 V
Permissible film temperature, $\vartheta_{F\,max.}$ (2)	155 °C				
Operating temperature range	-55 °C to 125 °C (155 °C)				
Insulation voltage:					
1 min; U_{ins}	75 V	100 V	200 V	300 V	300 V
Continuous	75 V	75 V	75 V	75 V	75 V
Failure rate: $FIT_{observed}$	≤ 0.1 x 10^{-9}/h				

Notes

(1) The detail specification EN 140401-801 does not cover this product size.

(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 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. 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.

MAXIMUM RESISTANCE CHANGE AT RATED DISSIPATION		
OPERATION MODE		**STANDARD**
Rated dissipation, P_{70}	**TNPW0402 e3**	0.063 W
	TNPW0603 e3	0.1 W
	TNPW0805 e3	0.125 W
	TNPW1206 e3	0.25 W
	TNPW1210 e3	0.33 W
Permissible film temperature, $\vartheta_{F\ max.}$		125 °C
Max. resistance change at P_{70} for resistance range, $\lvert\Delta R/R\rvert_{max.}$, after:	**TNPW0402 e3**	10 Ω to 100 kΩ
	TNPW0603 e3	4.7 Ω to 332 kΩ
	TNPW0805 e3	4.7 Ω to 1 MΩ
	TNPW1206 e3	4.7 Ω to 2 MΩ
	TNPW1210 e3	10 Ω to 3.01 MΩ
	1000 h	≤ 0.05 %
	8000 h	≤ 0.10 %
	225 000 h	≤ 0.30 %

TEMPERATURE COEFFICIENT AND RESISTANCE RANGE				
TYPE	**TCR**	**TOLERANCE**	**RESISTANCE**	**E-SERIES**
TNPW0402 e3	± 50 ppm/K	± 1 %	10 Ω to 100 kΩ	E24; E96
		± 0.5 %	10 Ω to 100 kΩ	E24; E192
		± 0.1 %	47 Ω to 100 kΩ	
	± 25 ppm/K	± 1 %	10 Ω to 100 kΩ	E24; E96
		± 0.5 %	10 Ω to 100 kΩ	E24; E192
		± 0.1 %	47 Ω to 100 kΩ	
	± 15 ppm/K	± 0.1 %		
	± 10 ppm/K	± 0.1 %		
TNPW0603 e3	± 50 ppm/K	± 1 %	4.7 Ω to 332 kΩ	E24; E96
		± 0.5 %	4.7 Ω to 332 kΩ	E24; E192
		± 0.1 %		
	± 25 ppm/K	± 1 %	4.7 Ω to 332 kΩ	E24; E96
		± 0.5 %	4.7 Ω to 332 kΩ	E24; E192
		± 0.1 %		
	± 15 ppm/K	± 0.1 %	47 Ω to 332 kΩ	
	± 10 ppm/K	± 0.1 %		
TNPW0805 e3	± 50 ppm/K	± 1 %	4.7 Ω to 1 MΩ	E24; E96
		± 0.5 %	4.7 Ω to 1 MΩ	E24; E192
		± 0.1 %		
	± 25 ppm/K	± 1 %	4.7 Ω to 1 MΩ	E24; E96
		± 0.5 %	4.7 Ω to 1 MΩ	E24; E192
		± 0.1 %		
	± 15 ppm/K	± 0.1 %	47 Ω to 1 MΩ	
	± 10 ppm/K	± 0.1 %		
TNPW1206 e3	± 50 ppm/K	± 1 %	4.7 Ω to 2 MΩ	E24; E96
		± 0.5 %	4.7 Ω to 2 MΩ	E24; E192
		± 0.1 %		
	± 25 ppm/K	± 1 %	4.7 Ω to 2 MΩ	E24; E96
		± 0.5 %	4.7 Ω to 2 MΩ	E24; E192
		± 0.1 %		
	± 15 ppm/K	± 0.1 %	47 Ω to 2 MΩ	
	± 10 ppm/K	± 0.1 %		
TNPW1210 e3	± 50 ppm/K	± 1 %	10 Ω to 3.01 MΩ	E24; E96
		± 0.5 %	10 Ω to 3.01 MΩ	E24; E192
		± 0.1 %	47 Ω to 2.13 MΩ	
	± 25 ppm/K	± 1 %	10 Ω to 3.01 MΩ	E24; E96
		± 0.5 %	10 Ω to 3.01 MΩ	E24; E192
		± 0.1 %	47 Ω to 2.13 MΩ	
	± 15 ppm/K	± 0.1 %		
	± 10 ppm/K	± 0.1 %		

PACKAGING

TYPE	CODE	QUANTITY	CARRIER TAPE	WIDTH	PITCH	REEL DIAMETER
TNPW0402 e3	EP1 = EP	1000 (1)	Paper tape acc. IEC 60286-3 Type 1a	8 mm	2 mm	180 mm/7"
TNPW0402 e3	ET7 = ED	10 000			2 mm	180 mm/7"
TNPW0603 e3 TNPW0805 e3 TNPW1206 e3 TNPW1210 e3	E52 = EN	1000 (1)			4 mm	180 mm/7"
	ET1 = EA	5000				
	ET6 = EC	20 000			4 mm	330 mm/13"

Note

(1) 1000 pieces packaging is available only for precision resistors with tolerance ± 0.1 % and temperature coefficient ≤ ± 25 ppm/K.

PART NUMBER AND PRODUCT DESCRIPTION

Part Number: TNPW12061K32DEEA

T	N	P	W	1	2	0	6	1	K	3	2	D	E	E	A		

TYPE/SIZE	RESISTANCE	TOLERANCE	TCR	PACKAGING	SPECIAL
TNPW0402 **TNPW0603** **TNPW0805** **TNPW1206** **TNPW1210**	**R** = Decimal **K** = Thousand **M** = Million (4 digits)	**B** = ± 0.1 % **D** = ± 0.5 % **F** = ± 1.0 %	**H** = ± 50 ppm/K **E** = ± 25 ppm/K **X** = ± 15 ppm/K **Y** = ± 10 ppm/K	**EP** **EA** **EC** **ED** **EN**	Up to 2 digits Blank = Standard 0H = Single lot date code

Product Description: TNPW1206 1K32 0.5 % T-9 ET1 e3

TNPW1206	**1K32**	**0.5 %**	**T-9**	**ET1**	**e3**
TYPE/SIZE	RESISTANCE	TOLERANCE	TCR	PACKAGING	LEAD (Pb)-FREE
TNPW0402 **TNPW0603** **TNPW0805** **TNPW1206** **TNPW1210**	Examples: **54R1** = 54.1 Ω **1K32** = 1320 Ω	**± 0.1 %** **± 0.5 %** **± 1.0 %**	**T-2** = ± 50 ppm/K **T-9** = ± 25 ppm/K **T-10** = ± 15 ppm/K **T-13** = ± 10 ppm/K	**EP1** **ET1** **ET6** **ET7** **E52**	**e3** = Pure tin termination finish BV 20545 = Single lot date code

Note

- The product 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 special 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 tin on nickel plating.
The result of the determined production is verified by an extensive testing procedure and optical inspection performed on 100 % of the individual chip resistors. This includes full screening for the elimination of products with a potential risk of early life failures according to EN 140401-801, 2.1.2.2. 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 Life Vehicle 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)

The resistors are Halogen-free according to JEDEC JS709A definition.

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

RELATED PRODUCTS

The TNPW with SnPb termination plating is designed for those applications, where lead bearing terminations are mandatory. For ordering TNPW with SnPb terminations please refer to latest edition of datasheet TNPW (www.vishay.com/doc?31006).

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 (www.vishay.com/doc?28779).

TNPS .... ESCC high-reliability thin film chip resistors are the premium choice for design and manufacture of equipment, where matured technology and proven reliability are of utmost importance. They are regularly used in communication and research satellites and fit equally well into aircraft and military electronic systems.

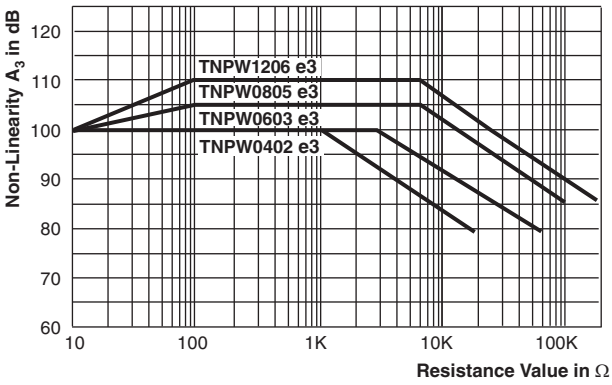
Approval of the TNPS .... ESCC products is granted by the European Space Components Coordination and registered in the ESCC Qualified Parts List, REP005 (www.vishay.com/doc?28789).

TNPV e3 High Voltage Thin Film Flat Chip Resistors are designed for most fields of modern electronics where precision, reliability and stability at high operating voltage are primary concerns (www.vishay.com/doc?28881).

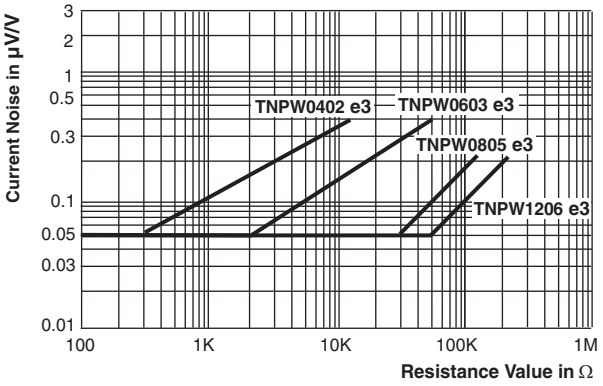
Notes

(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.

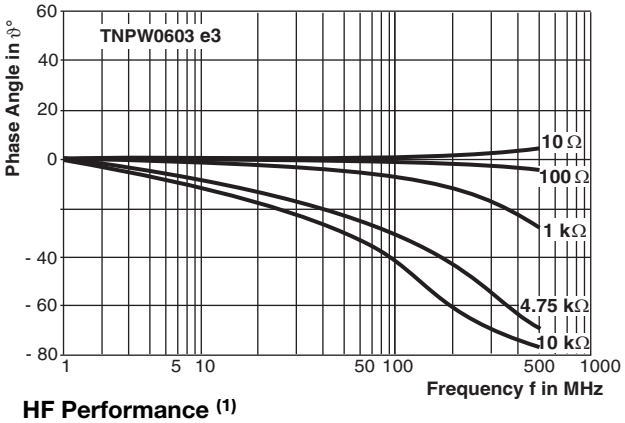
FUNCTIONAL PERFORMANCE



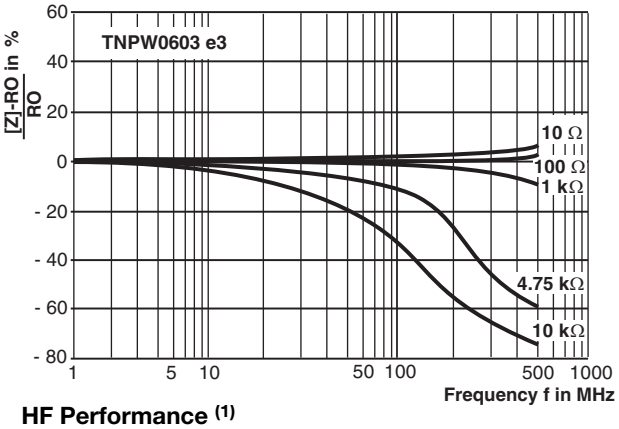
Non-Linearity



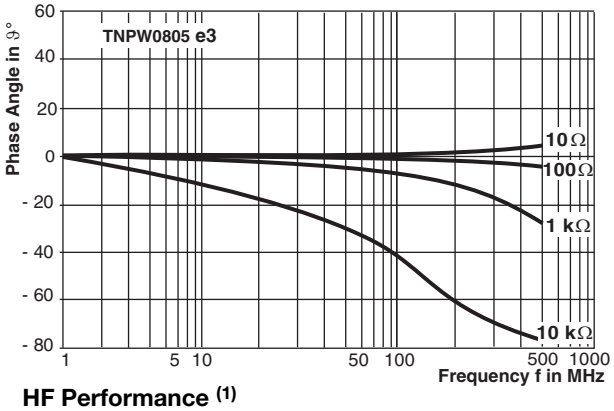
Current Noise



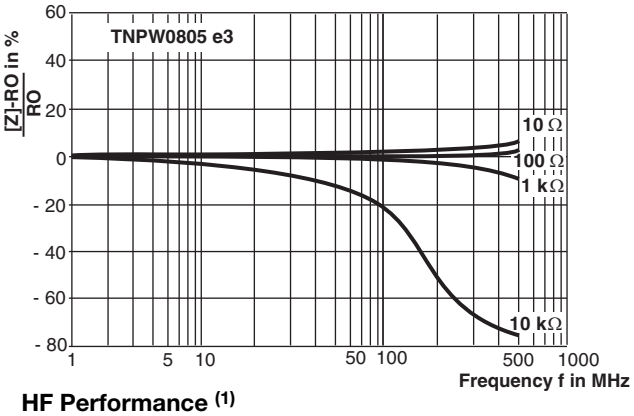
HF Performance (1)



HF Performance (1)



HF Performance (1)

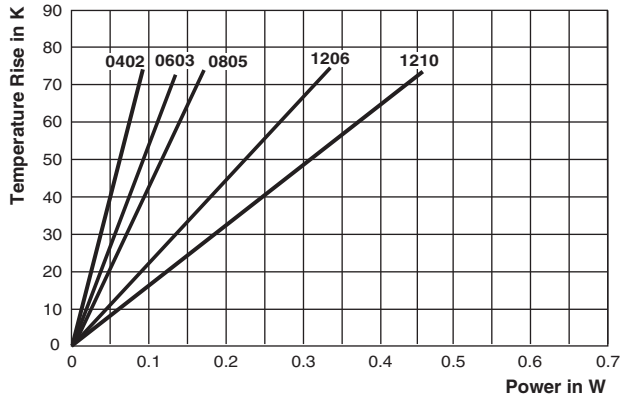


HF Performance (1)

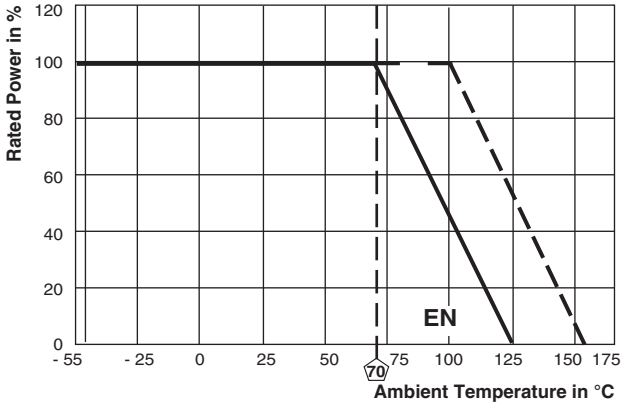
Note

(1) Typical figures. HF-characteristic also depends on termination and circuit design.

FUNCTIONAL PERFORMANCE



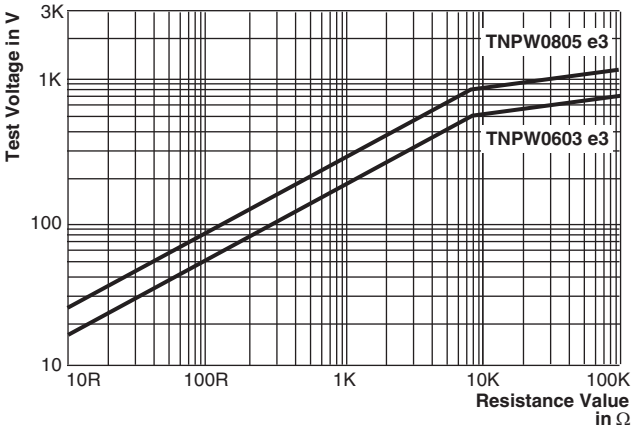
Temperature Rise



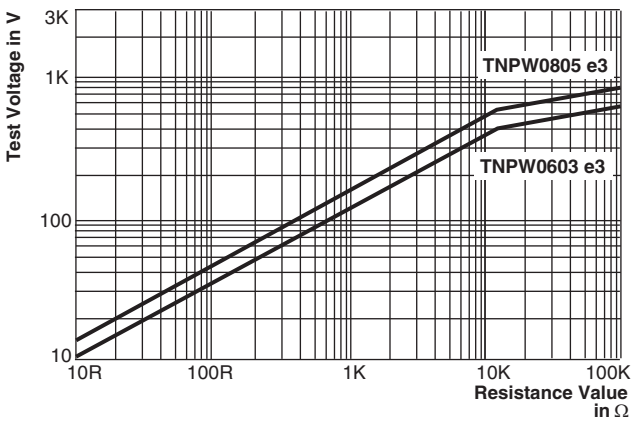
Derating

Note

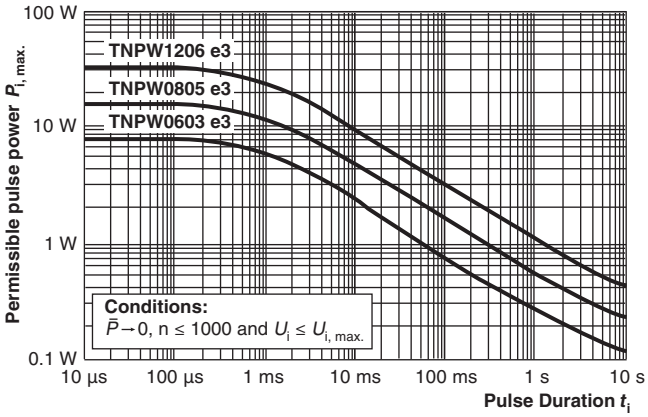
• The solid line is based on IEC/EN reference test conditions which is considered as standard mode. However, above that the maximum permissible film temperature is 155 °C (dashed line).



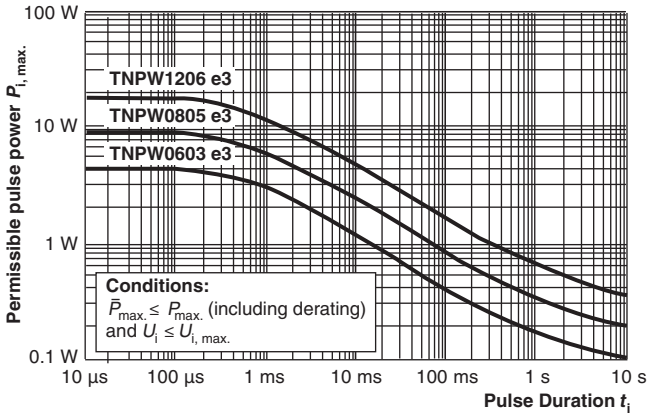
Single-Pulse High Voltage Overload Test 1.2/50 µs EN140000 4.27



Single-Pulse High Voltage Overload Test 10/700 µs EN140000 4.27

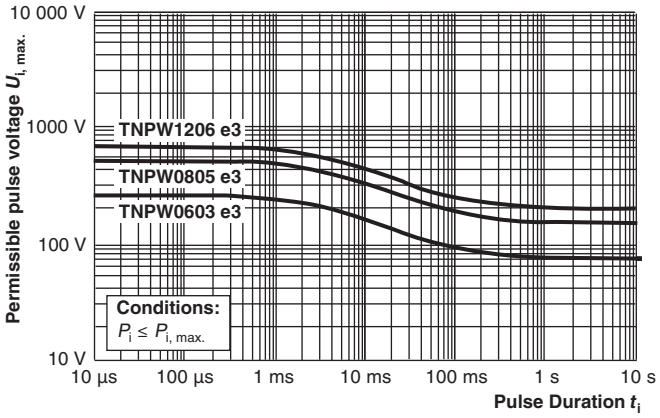


Maximum Pulse Load $P_{i, max.}$ for Single Pulses



Maximum Pulse Load $P_{i, max.}$ for Continuous Pulses

FUNCTIONAL PERFORMANCE



Maximum Pulse Voltage $U_{i, max.}$

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

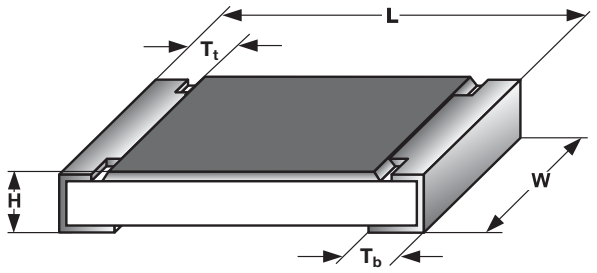
EN 60115-1 CLAUSE	IEC 60068-2 (1) TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE (ΔR)
			Stability for product types:	
			TNPW0402 e3	
			TNPW0603 e3	
			TNPW0805 e3	
			TNPW1206 e3	
			TNPW1210 e3	
4.5	-	Resistance	-	± 1 %; ± 0.5 %; ± 0.1 %
4.8.4.2	-	Temperature coefficient	At (20 / -55 / 20) °C and (20 / 125 / 20) °C	± 50 ppm/K; ± 25 ppm/K; ± 15 ppm/K; ± 10 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 155 °C; 1000 h	± (0.05 % R + 0.01 Ω) ± (0.1 % R + 0.02 Ω)

TEST PROCEDURES AND REQUIREMENTS				
EN 60115-1 CLAUSE	**IEC 60068-2 [1] TEST METHOD**	**TEST**	**PROCEDURE**	**REQUIREMENTS PERMISSIBLE CHANGE (ΔR)**
			Stability for product types:	
			TNPW0402 e3	
			TNPW0603 e3	
			TNPW0805 e3	
			TNPW1206 e3	
			TNPW1210 e3	
4.24	78 (Cab)	Damp heat, steady state	(40 ± 2) °C; 56 days; (93 ± 3) % RH	± (0.1 % R + 0.01 Ω)
-	1 (Ab)	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)
4.27	-	Single pulse high voltage overload	Severity no. 4: $U = 10 \times \sqrt{P_{70} \times R}$ or $U = 2 \times U_{max.}$; whichever is the less severe; 10 pulses 10 µs/700 µs	± (0.5 % R + 0.02 Ω) no visible damage
4.39	-	Periodic electric overload	$U = \sqrt{15 \times P_{70} \times R}$ or $U = 2 \times U_{max.}$; whichever is the less severe; 0.1 s on; 2.5 s off; 1000 cycles	± (0.5 % R + 0.05 Ω) no visible damage
4.22	6 (Fc)	Vibration	Endurance by sweeping; 10 Hz to 2000 Hz; no resonance; amplitude ≤ 1.5 mm or ≤ 200 m/s^2; 7.5 h	± (0.05 % R + 0.01 Ω) no visible damage
4.17.2	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	
4.18.2	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)	RR1005M and RR1608M; 9 N	No visible damage
			RR2012M and RR3216M: 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
4.37	67 (Cy)	Damp heat, steady state accelerated	(85 ± 5) °C; 56 days (85 ± 5) % RH	± (0.25 % R + 0.05 Ω)

Note

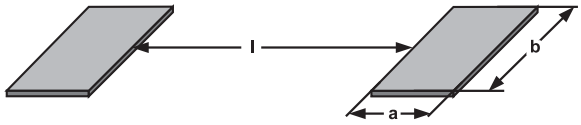
[1] The quoted IEC standards are also released as EN standards with the same number and identical contents.

DIMENSIONS



DIMENSIONS AND MASS					
TYPE	L (mm)	W (mm)	H (mm)	T_t/T_b (mm)	MASS (mg)
TNPW0402 e3	1.0 ± 0.05	0.5 ± 0.05	0.35 ± 0.05	0.2 ± 0.10	0.65
TNPW0603 e3	1.6 ± 0.10	0.85 ± 0.10	0.45 ± 0.10	0.3 ± 0.20	2
TNPW0805 e3	2.0 ± 0.15	1.25 ± 0.15	0.45 ± 0.10	0.4 ± 0.20	5.5
TNPW1206 e3	3.2 ± 0.15	1.6 ± 0.15	0.55 ± 0.10	0.5 ± 0.25	10
TNPW1210 e3	3.2 ± 0.15	2.45 ± 0.15	0.60 ± 0.15	0.5 ± 0.25	16

SOLDER PAD DIMENSIONS



RECOMMENDED SOLDER PAD DIMENSIONS						
TYPE	REFLOW SOLDERING			WAVE SOLDERING		
	a (mm)	b (mm)	l (mm)	a (mm)	b (mm)	l (mm)
TNPW0402 e3	0.4	0.6	0.5	-	-	-
TNPW0603 e3	0.5	0.9	1.0	0.9	0.9	1.0
TNPW0805 e3	0.7	1.3	1.2	0.9	1.3	1.3
TNPW1206 e3	0.9	1.7	2.0	1.1	1.7	2.3
TNPW1210 e3	0.9	2.5	2.0	1.1	2.5	2.3

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