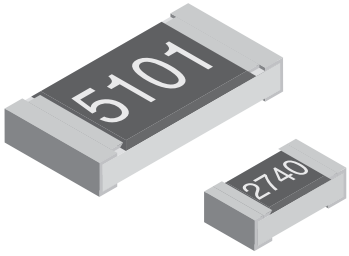
High Stability Thin Film Flat Chip Resistors



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

- Low temperature coefficient and tight tolerances (± 0.1 %; ± 10 ppm/K)
- Superior moisture resistivity ≤ 0.25 % (85 °C; 56 days; 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)
- Waste gas resistant
- 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

STANDARD ELECTRICAL SPECIFICATIONS

DESCRIPTION	TNPW0402 e3	TNPW0603 e3	TNPW0805 e3	TNPW1206 e3	TNPW1210 e3 (1)	TNPW2010 e3	TNPW2512 e3 (1)
Metric size	RR 1005M	RR 1608M	RR 2012M	RR 3216M	RR 3225M	RR 5025M	RR 6332M
Resistance range	10 Ω to 100 kΩ	10 Ω to 332 kΩ	10 Ω to 1 MΩ	10 Ω to 2 MΩ	10 Ω to 3.01 MΩ	10 Ω to 4.99 MΩ	10 Ω to 8.87 MΩ
Resistance tolerance	± 1 %; ± 0.5 %; ± 0.1 %						
Temperature coefficent	± 50 ppm/K; ± 25 ppm/K; ± 15 ppm/K; ± 10 ppm/K					± 50 ppm/K; ± 25 ppm/K	
Rated dissipation, P_{70} (2)	0.063 W	0.1 W	0.125 W	0.25 W	0.33 W	0.4 W	0.5 W
Operating voltage, $U_{max.}$ AC/DC	50 V	75 V	150 V	200 V	200 V	300 V	300 V
Permissible film temperature, ϑ_F max.	155 °C						
Operating temperature range	- 55 °C to 125 °C (155 °C)						
Thermal resistance (3)	870 K/W	550 K/W	440 K/W	220 K/W	170 K/W	140 K/W	110 K/W
Max. resistance change at P_{70}; $\Delta R/R$:	10 Ω to 100 kΩ	10 Ω to 332 kΩ	10 Ω to 1 MΩ	10 Ω to 2 MΩ	10 Ω to 3.01 MΩ	10 Ω to 4.99 MΩ	10 Ω to 8.87 MΩ
1000 h	≤ 0.05 %	≤ 0.05 %	≤ 0.05 %	≤ 0.05 %	≤ 0.05 %	≤ 0.05 %	≤ 0.05 %
8000 h	≤ 0.10 %	≤ 0.10 %	≤ 0.10 %	≤ 0.10 %	≤ 0.10 %	≤ 0.10 %	≤ 0.10 %
225 000 h	≤ 0.30 %	≤ 0.30 %	≤ 0.30 %	≤ 0.30 %	≤ 0.30 %	≤ 0.30 %	≤ 0.30 %
Insulation voltage:							
U_{ins} 1 min	75 V	100 V	200 V	300 V	300 V	300 V	300 V
Continuous	75 V	75 V	75 V	75 V	75 V	75 V	75 V
Failure rate: $FIT_{observed}$	≤ 0.1 x 10^{-9}/h	≤ 0.1 x 10^{-9}/h	≤ 0.1 x 10^{-9}/h	≤ 0.1 x 10^{-9}/h	≤ 0.1 x 10^{-9}/h	≤ 0.1 x 10^{-9}/h	≤ 0.1 x 10^{-9}/h

Notes

- TNPW 0402 without marking.

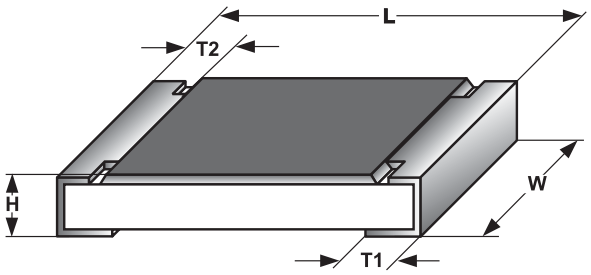
(1) Size not specified in EN 140401-801.

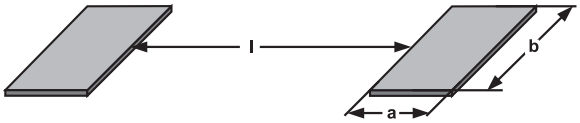
(2) Rated voltage $\sqrt{P \times R}$. The power dissipation on the resistor generates a temperature rise against the local ambient, depending on the heat flow support of the printed-circuit board (thermal resistance). Using advanced temperature level may require special considerations towards the choice of circuit board and solder material. The rated dissipation applies only if the permitted film temperature is not exceeded.

(3) Measuring conditions in accordance with EN 140401-801.

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DIMENSIONS





DIMENSIONS AND MASS

TYPE	L (mm)	W (mm)	H (mm)	T1/T2 (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
TNPW2010 e3	5.0 ± 0.15	2.5 ± 0.15	0.60 ± 0.15	0.6 ± 0.25	28
TNPW2512 e3	6.3 ± 0.20	3.1 ± 0.15	0.60 ± 0.15	0.6 ± 0.25	39

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
TNPW2010 e3	1.0	2.5	3.9	1.2	2.5	3.9
TNPW2512 e3	1.0	3.2	5.2	1.2	3.2	5.2

TEMPERATURE COEFFICIENT AND RESISTANCE RANGE

TYPE	TCR	TOLERANCE	RESISTANCE	E-SERIES
TNPW0402 e3	± 50 ppm/K	± 1 %	10R to 100K	24; 96
		± 0.5 %	10R to 100K	24; 192
		± 0.1 %	47R to 100K	
	± 25 ppm/K	± 1 %	10R to 100K	24; 96
		± 0.5 %	10R to 100K	24; 192
		± 0.1 %	47R to 100K	
	± 15 ppm/K	± 0.1 %		
	± 10 ppm/K	± 0.1 %		
TNPW0603 e3	± 50 ppm/K	± 1 %	10R to 332K	24; 96
		± 0.5 %	10R to 332K	24; 192
		± 0.1 %		
	± 25 ppm/K	± 1 %	10R to 332K	24; 96
		± 0.5 %	10R to 332K	24; 192
		± 0.1 %		
	± 15 ppm/K	± 0.1 %	47R to 332K	
	± 10 ppm/K	± 0.1 %		
TNPW0805 e3	± 50 ppm/K	± 1 %	10R to 1M0	24; 96
		± 0.5 %	10R to 1M0	24; 192
		± 0.1 %		
	± 25 ppm/K	± 1 %	10R to 1M0	24; 96
		± 0.5 %	10R to 1M0	24; 192
		± 0.1 %		
	± 15 ppm/K	± 0.1 %	47R to 1M0	
	± 10 ppm/K	± 0.1 %		
TNPW1206 e3	± 50 ppm/K	± 1 %	10R to 2M0	24; 96
		± 0.5 %	10R to 2M0	24; 192
		± 0.1 %		
	± 25 ppm/K	± 1 %	10R to 2M0	24; 96
		± 0.5 %	10R to 2M0	24; 192
		± 0.1 %		
	± 15 ppm/K	± 0.1 %	47R to 2M0	
	± 10 ppm/K	± 0.1 %		

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TEMPERATURE COEFFICIENT AND RESISTANCE RANGE

TYPE	TCR	TOLERANCE	RESISTANCE	E-SERIES
TNPW1210 e3	± 50 ppm/K	± 1 %	10R to 3M01	24; 96
		± 0.5 %	10R to 3M01	24; 192
		± 0.1 %	47R to 2M13	
	± 25 ppm/K	± 1 %	10R to 3M01	24; 96
		± 0.5 %	10R to 3M01	24; 192
		± 0.1 %	47R to 2M13	
	± 15 ppm/K	± 0.1 %		
	± 10 ppm/K	± 0.1 %		
TNPW2010 e3	± 50 ppm/K	± 1 %	10R to 4M99	24; 96
		± 0.5 %	10R to 4M99	24; 192
		± 0.1 %	47R to 1M0	
	± 25 ppm/K	± 1 %	10R to 4M99	24; 96
		± 0.5 %	10R to 4M99	24; 192
		± 0.1 %	47R to 1M0	
TNPW2512 e3	± 50 ppm/K	± 1 %	10R to 8M87	24; 96
		± 0.5 %	10R to 8M87	24; 192
		± 0.1 %	47R to 1M0	
	± 25 ppm/K	± 1 %	10R to 8M87	24; 96
		± 0.5 %	10R to 8M87	24; 192
		± 0.1 %	47R to 1M0	

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** **TNPW2010** **TNPW2512**	**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	**EA** **EC** **ED** **EG** **EN** **EY**	Up to 2 digits Blank = Standard

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** **TNPW2010** **TNPW2512**	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	**ET1** **ET6** **ET7** **E67** **E52** **E75**	**e3** = Pure tin termination finish

Note

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

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PACKAGING						
TYPE	CODE	QUANTITY	CARRIER TAPE	WIDTH	PITCH	REEL DIAMETER
TNPW0402 e3	ET7 = ED	10 000	Paper tape acc. IEC 60286-3 Type I	8 mm	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"
TNPW2010 e3	E75 = EY	1000	Blister tape acc. IEC 60286-3 Type II	12 mm	4 mm	180 mm / 7"
TNPW2512 e3	E75 = EY	1000				
	E67 = EG	2000				

Note

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

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. This includes pulse load 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 **EN 60286-3**.

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**. 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, 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 **GADSL** (2) and the **CEFIC-EECA-EICTA** (3) list of legal restrictions on hazardous substances. This includes 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)
- 2002/96/EC 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 data sheet TNPW, document number 31006.

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, document number 28789.

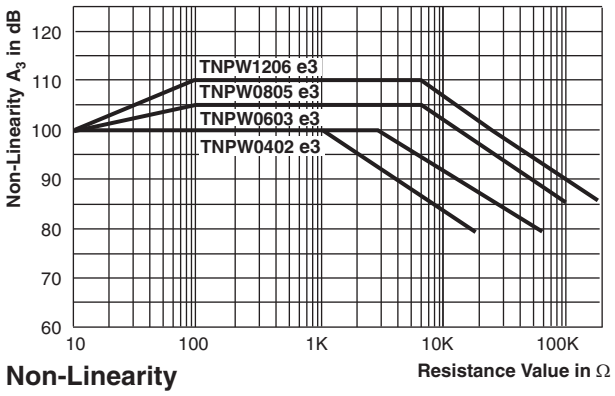
Notes

(2) Global Automotive Declarable Substance List, see www.gadsl.org.

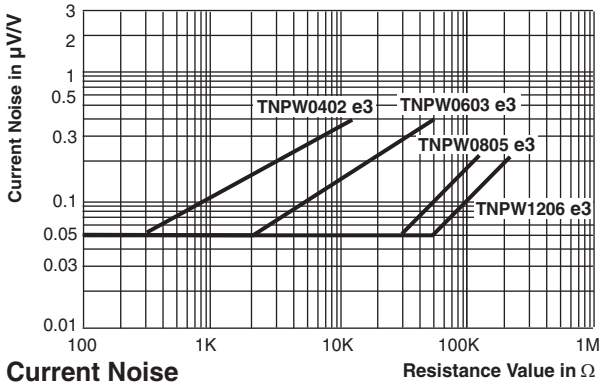
(3) CEFIC (European Chemical Industry Council), EECA (European Electronic Component Manufacturers Association), EICTA (European trade organisation representing the information and communications technology and consumer electronics), see www.eicta.org → issue → environment policy → chemicals → chemicals for electronics.

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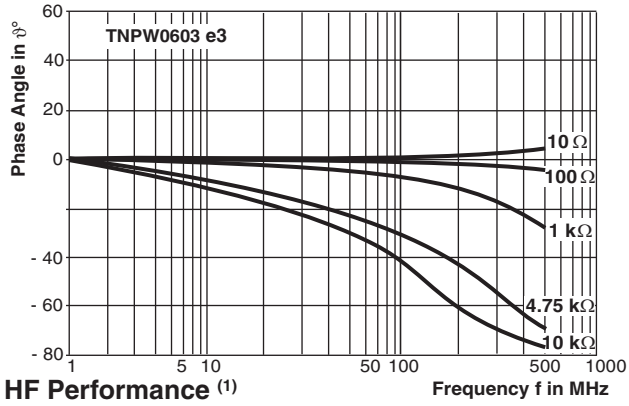
FUNCTIONAL PERFORMANCE



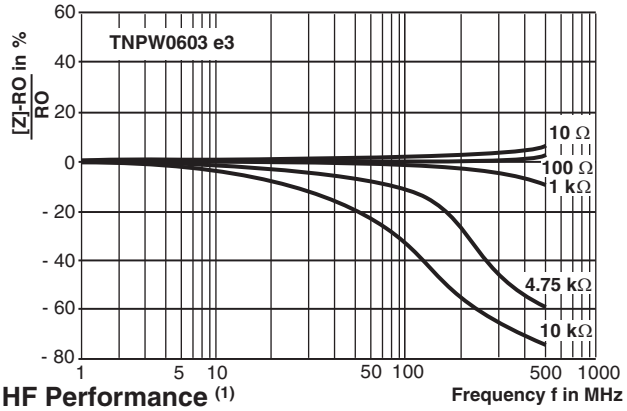
Non-Linearity



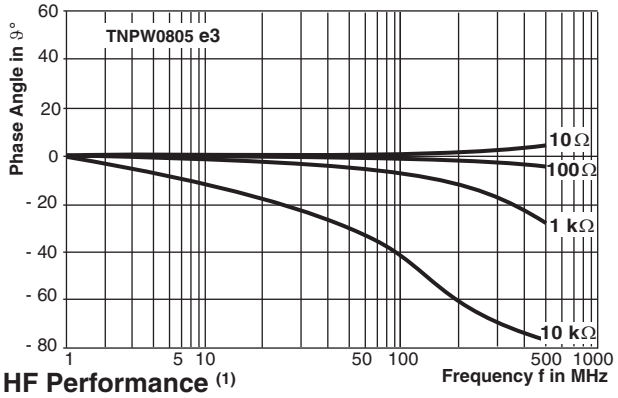
Current Noise



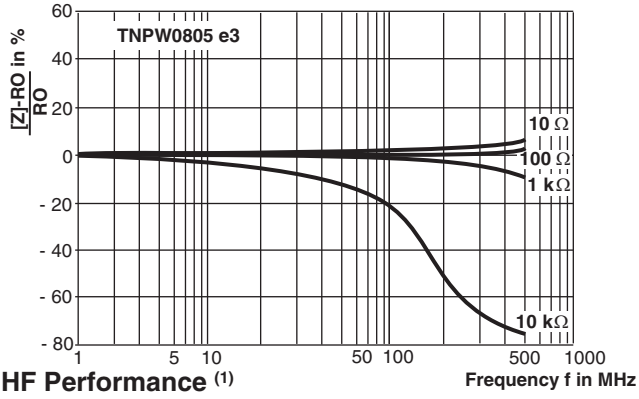
HF Performance (1)



HF Performance (1)



HF Performance (1)

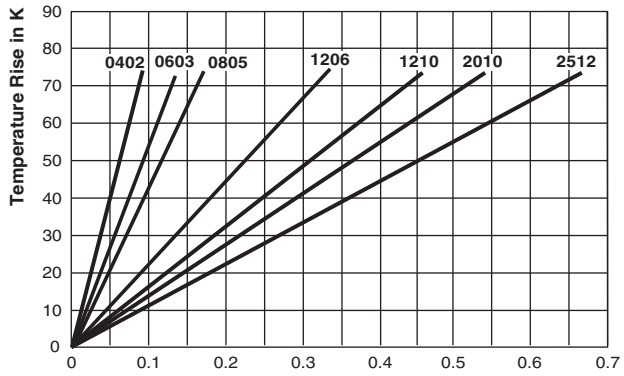


HF Performance (1)

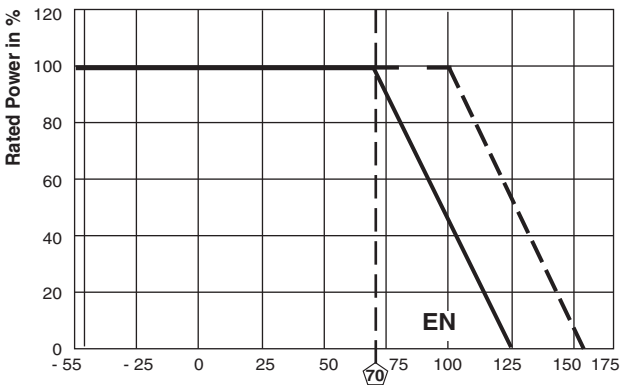
Note

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

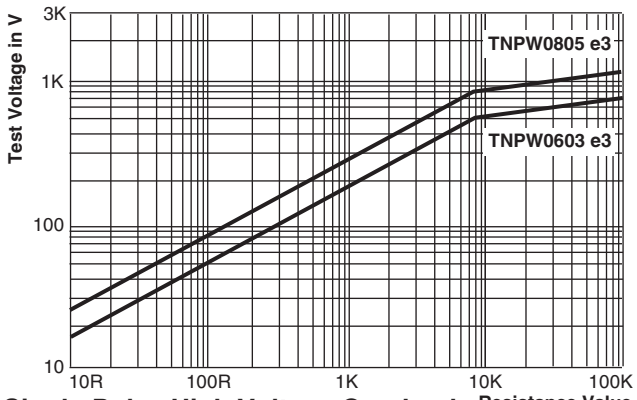
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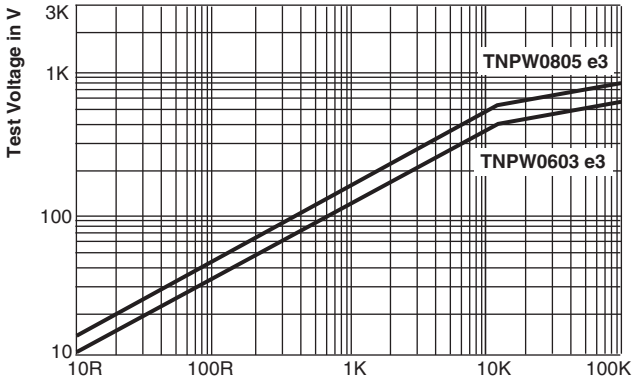
Temperature Rise



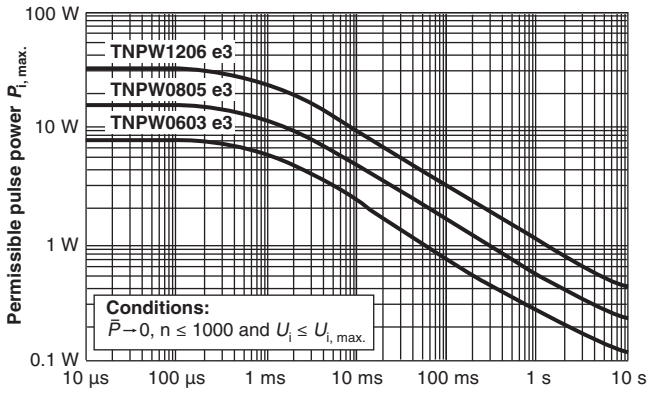
Derating



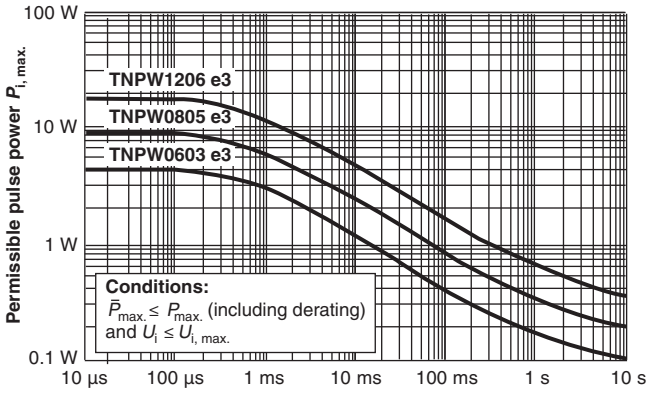
Single-Pulse High Voltage Overload
Test 1.2/50 µs EN140000 4.27



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

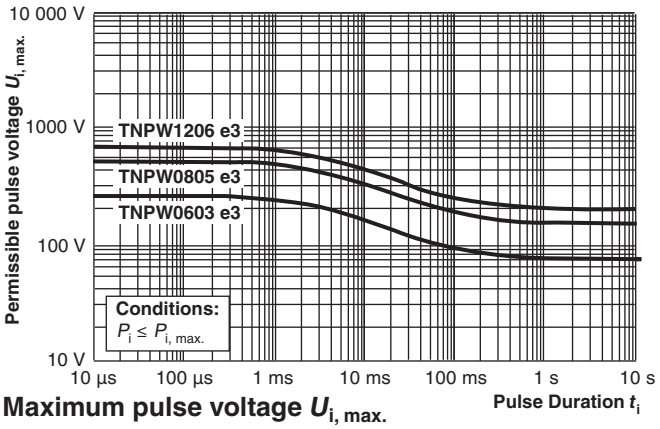


Maximum pulse load $P_{i, max.}$ for single pulses



Maximum pulse load $P_{i, max.}$ for continuous pulses

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TEST AND REQUIREMENTS

All tests are carried out in accordance with the following specifications:
IEC 60115-1, generic specification (includes tests)
EN 140400, sectional specification (includes schedule for qualification approval)
EN 140401-801, detail specification (includes schedule for conformance inspection)

The testing also covers most of the requirements specified by EIA/IS-703 and JIS-C-5202. The tests are carried out under standard atmospheric conditions in accordance with IEC 60068-1, 5.3. Climatic category LCT/UCT/56 (rated temperature range: Lower category temperature, upper category temperature; damp heat, long term, 56 days) is valid. Unless otherwise specified the following values apply:
Temperature: 15 °C to 35 °C
Relative humidity: 45 % to 75 %
Air pressure: 86 kPa to 106 kPa (860 mbar to 1060 mbar).

The components are mounted for testing on boards in accordance with EN 60115-1, 4.31 unless otherwise specified. The parameters stated in the Test Procedures and Requirements table are based on the required tests and permitted limits of EN 140401-801.

TEST PROCEDURES AND REQUIREMENTS

EN 60115-1 CLAUSE	IEC 60068-2 TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE
			Stability for product types:	
			TNPW0402 e3	
			TNPW0603 e3	
			TNPW0805 e3	
			TNPW1206 e3	
			TNPW1210 e3	
			TNPW2010 e3	
			TNPW2512 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)

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TEST PROCEDURES AND REQUIREMENTS				
EN 60115-1 CLAUSE	**IEC 60068-2 TEST METHOD**	**TEST**	**PROCEDURE**	**REQUIREMENTS PERMISSIBLE CHANGE**
			Stability for product types:	
			TNPW0402 e3	
			TNPW0603 e3	
			TNPW0805 e3	
			TNPW1206 e3	
			TNPW1210 e3	
			TNPW2010 e3	
			TNPW2512 e3	
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:		± (0.1 % R + 0.02 Ω)
4.23.2	2 (Bb)	Dry heat	UCT; 16 h	
4.23.3	30 (Db)	Damp	55 °C; 24 h; > 90 % RH; 1 cycle	
4.23.4	1 (Ab)	Cold	LCT; 2 h	
4.23.5	13 (M)	Low air	8.5 kPa; 2 h; 25 ± 10 °C	
4.23.6	30 (Db)	Damp heat, cyclic	55 °C; 5 days; > 95 to 100 % RH; 5 cycles	
4.23.7	-	DC load	$U = \sqrt{P_{70} \times R} \leq U_{max.}$; 1 min LCT = - 55 °C UCT = 125 °C	
-	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 + 0.05 Ω) no visible damage
4.37	-	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

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TEST PROCEDURES AND REQUIREMENTS				
EN 60115-1 CLAUSE	**IEC 60068-2 TEST METHOD**	**TEST**	**PROCEDURE**	**REQUIREMENTS PERMISSIBLE CHANGE**
			Stability for product types:	
			TNPW0402 e3	
			TNPW0603 e3	
			TNPW0805 e3	
			TNPW1206 e3	
			TNPW1210 e3	
			TNPW2010 e3	
			TNPW2512 e3	
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)	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, needle flame test; 10 s	No burning after 30 s
-	-	Damp heat	(85 ± 5) °C; 56 days (85 ± 5) % RH	± (0.25 R + 0.05 Ω)

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