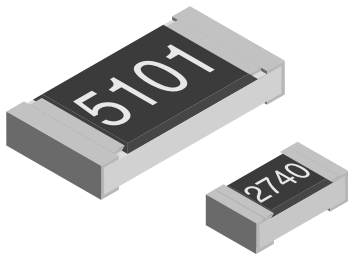
High Stability Thin Film Flat Chip Resistor
≤ 0.05 % (1000 h rated power at 70 °C)



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 automotive, telecommunication, industrial, medical equipment, precision test and measuring equipment.

FEATURES

- Superior moisture resistivity ≤ 0.25 % (85 °C; 56 days; 85 % RH)
- Lead (Pb)-free solder contacts, RoHS compliant
- AEC-Q200 compliant (sizes 0402 to 1206)
- Low temperature coefficient and tight tolerances (± 0.1 %; ± 10 ppm/K)
- Waste gas resistant

RoHS COMPLIANT

APPLICATIONS

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

STANDARD ELECTRICAL SPECIFICATIONS

DESCRIPTION	TNPW0402	TNPW0603	TNPW0805	TNPW1206	TNPW1210 (1)	TNPW2010	TNPW2512 (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	
Climatic category (LCT/UCT/days)	55/125/56	55/125/56	55/125/56	55/125/56	55/125/56	55/125/56	55/125/56
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
Maximum permissible film temperature	155 °C	155 °C	155 °C	155 °C	155 °C	155 °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
$FIT_{observed}$	≤ 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
Weight/1000 pieces	0.65 g	2 g	5.5 g	10 g	16 g	28 g	39 g

Notes

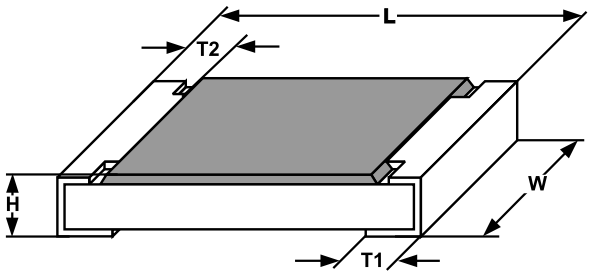
(1) Size not specified in EN 140401-801

(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.

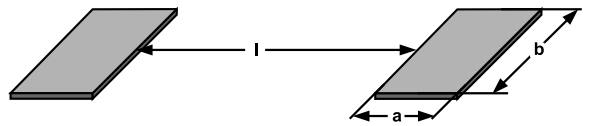
(3) Measuring conditions in accordance with EN 140401-801

- TNPW 0402 without marking

DIMENSIONS



SIZE		DIMENSIONS in millimeters				
INCH	METRIC	L	W	H	T1	T2
0402	1005	1.0 ± 0.05	0.5 ± 0.05	0.35 ± 0.05	0.2 ± 0.10	
0603	1608	1.6 ± 0.10	0.85 ± 0.10	0.45 ± 0.10	0.3 ± 0.20	
0805	2012	2.0 ± 0.15	1.25 ± 0.15	0.45 ± 0.10	0.4 ± 0.20	
1206	3216	3.2 ± 0.15	1.6 ± 0.15	0.55 ± 0.10	0.5 ± 0.25	
1210	3225	3.2 ± 0.15	2.45 ± 0.15	0.60 ± 0.15	0.5 ± 0.25	
2010	5025	5.0 ± 0.15	2.5 ± 0.15	0.60 ± 0.15	0.6 ± 0.25	
2512	6332	6.3 ± 0.20	3.1 ± 0.15	0.60 ± 0.15	0.6 ± 0.25	



SOLDER PAD DIMENSIONS in millimeters							
SIZE		REFLOW SOLDERING			WAVE SOLDERING		
INCH	METRIC	a	b	l	a	b	l
0402	1005	0.4	0.6	0.5	-	-	-
0603	1608	0.5	0.9	1.0	0.9	0.9	1.0
0805	2012	0.7	1.3	1.2	0.9	1.3	1.3
1206	3216	0.9	1.7	2.0	1.1	1.7	2.3
1210	3225	0.9	2.5	2.0	1.1	2.5	2.3
2010	5025	1.0	2.5	3.9	1.2	2.5	3.9
2512	6332	1.0	3.2	5.2	1.2	3.2	5.2

TEMPERATURE COEFFICIENT AND RESISTANCE RANGE

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

TEMPERATURE COEFFICIENT AND RESISTANCE RANGE

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

PART NUMBER AND PRODUCT DESCRIPTION

Products can be ordered using either the Product Description or the Part Number.
For ordering TNPW with SnPb contacts please refer to latest edition of data sheet TNPW lead bearing.

PART NUMBER: (LEAD (Pb)-FREE) TNPW12061K32DEEA

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

MODEL	VALUE	TOLERANCE	TCR	PACKAGING (1)	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** **EF** **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
MODEL	RESISTANCE VALUE	TOLERANCE	TCR	PACKAGING (1)	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** **E02** **E67** **E52** **E75**	**e3** = Pure Tin Termination Finish

Note

(1) Please refer to PACKAGING table

PACKAGING							
MODEL	TAPE WIDTH [mm]	PITCH [mm]	REEL DIAMETER [mm/inch]	PIECES PER REEL	PACKAGING CODE FOR PRODUCT DESCRIPTION	PACKAGING CODE FOR PART NUMBER	TYPE OF CARRIER TAPE
TNPW0402	8	2	180/7	10 000	ET7	ED	Paper
TNPW0603 TNPW0805 TNPW1206 TNPW1210	8	4	180/7	1000	E52 (1)	EN (1)	Paper
TNPW0603 TNPW0805 TNPW1206 TNPW1210	8	4	180/7	5000	ET1	EA	Paper
TNPW0603 TNPW0805 TNPW1206 TNPW1210	8	4	330/13	20 000	ET6	EC	Paper
TNPW2010	12	4	180/7	1000	E75	EY	Blister
				4000	E02	EF	Blister
TNPW2512	12	4	180/7	1000	E75	EY	Blister
				2000	E67	EG	Blister

Note

(1) E52/EN 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**. Excellent solderability is proven, even after extended storage in excess of 10 years. 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 puretin 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)
- 2002/95/EC Restriction of the use of Hazardous Substances Directive (RoHS)
- 2002/96/EC Waste Electrical and Electronic Equipment Directive (WEEE)

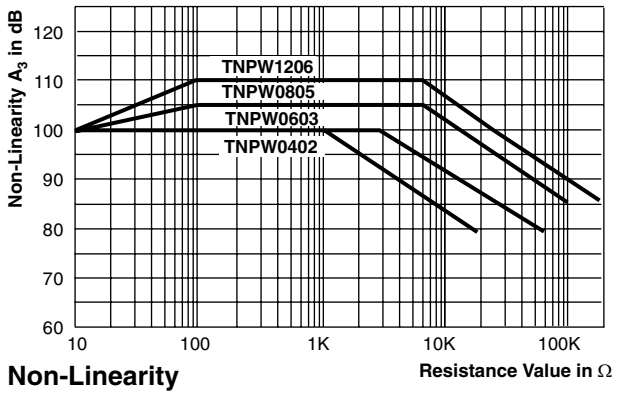
Solderability is specified for 2 years after production or re-qualification. The permitted storage time is 20 years.

Notes

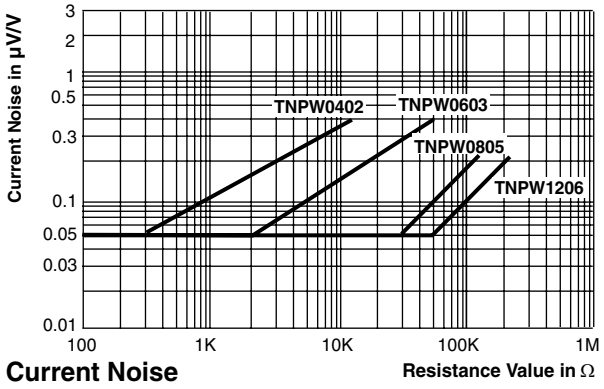
(2) Global Automotive Declarable Substance List, see www.gadsl.org

(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

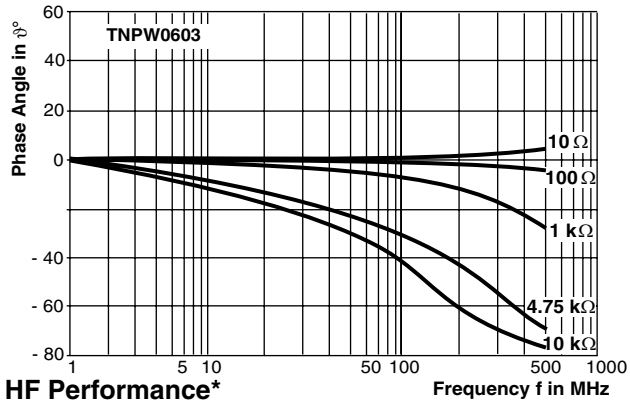
FUNCTIONAL PERFORMANCE



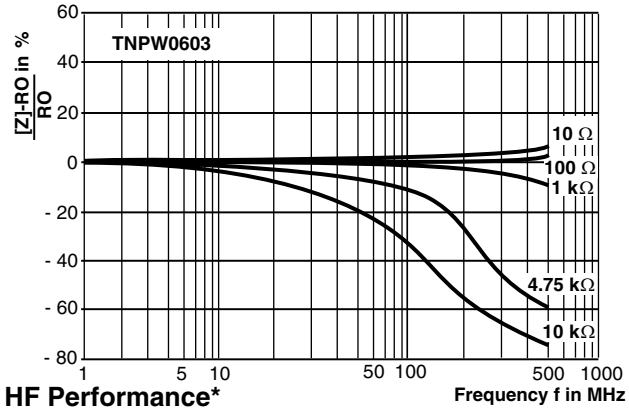
Non-Linearity



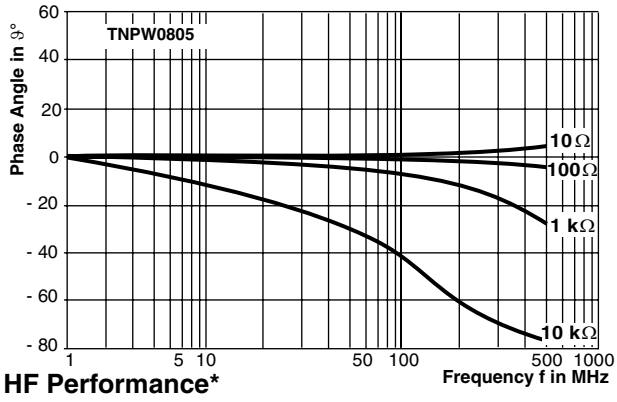
Current Noise



HF Performance*



HF Performance*



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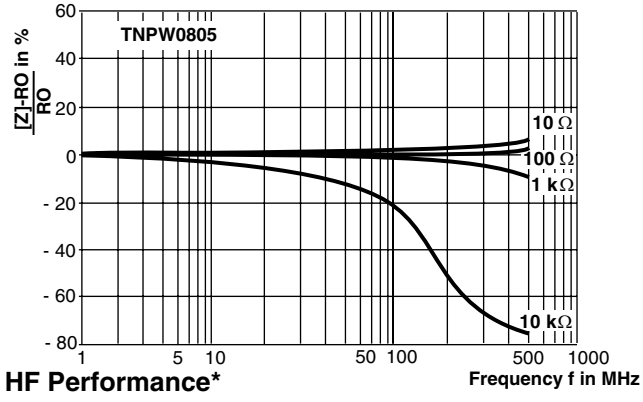
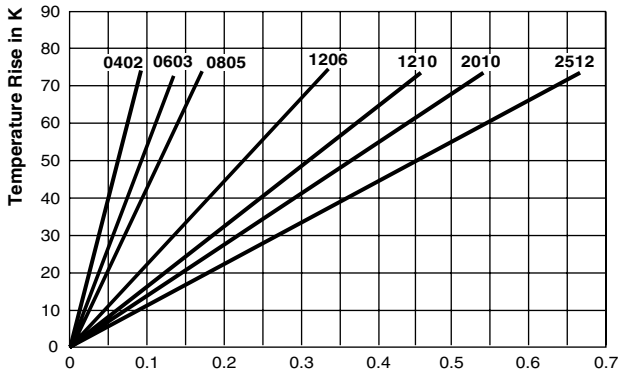
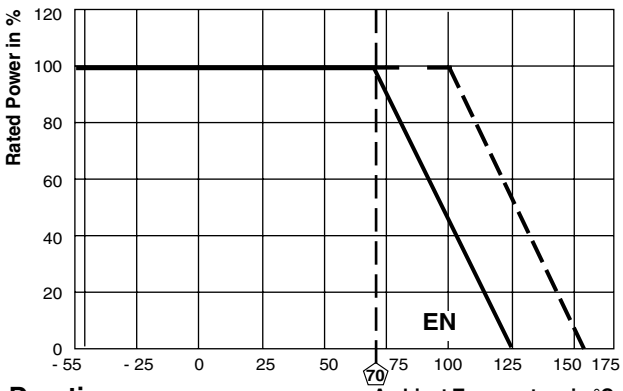


HF Performance*

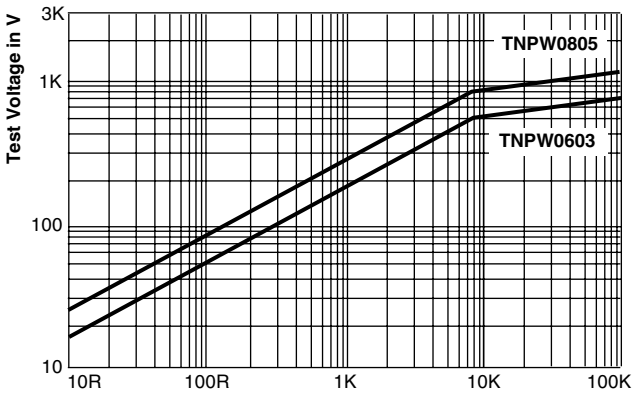
* Typical figures. HF-characteristic also depends on termination and circuit design.



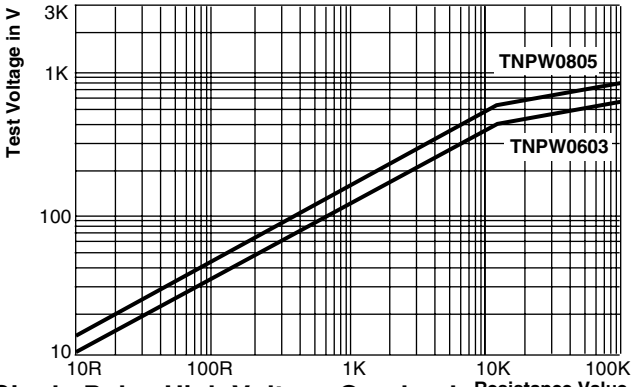
Temperature Rise



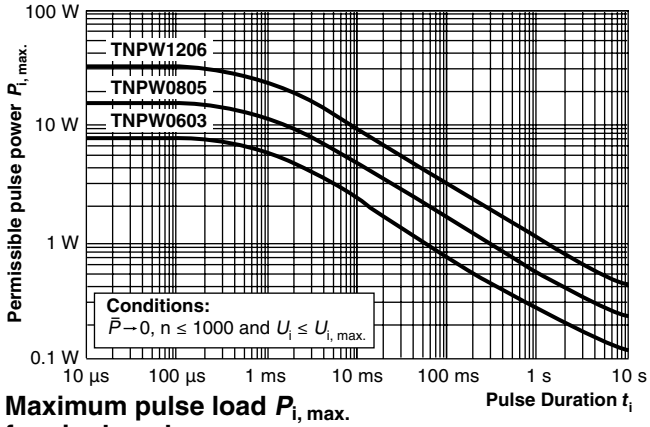
Derating



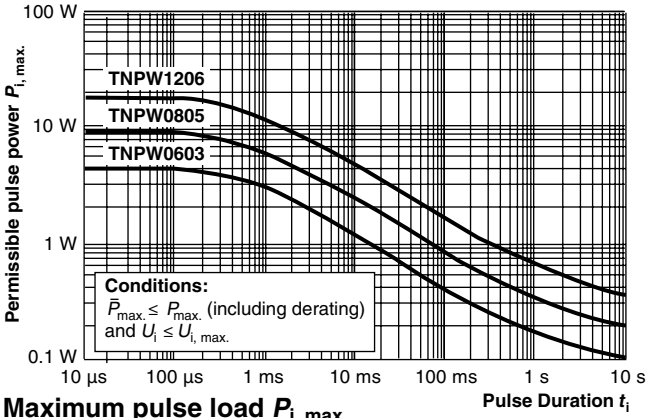
Single-Pulse High Voltage Overload Test 1.2/50 µs EN140000 4.27



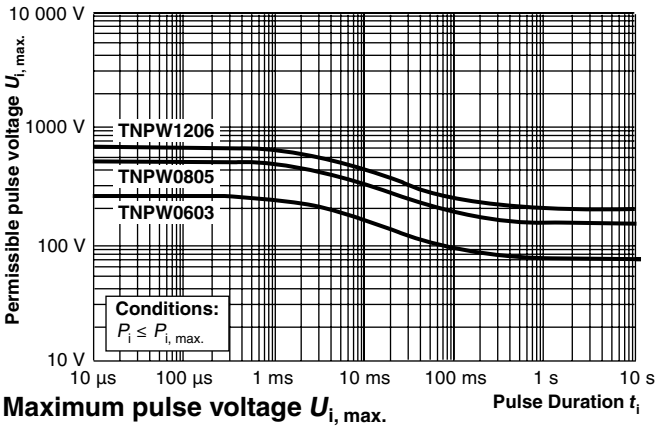
Single-Pulse High Voltage Overload Test 10/700 µs EN140000 4.27



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



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



TEST AND REQUIREMENTS

All tests are carried out in accordance with the following specifications:
EN 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 following table contains only the most important tests. For the full test schedule refer to the documents listed above. The testing also covers most of the requirements specified by EIA/IS-703 and JIS-C-5202. The tests are carried out in accordance with IEC 60068 and 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. However, some additional tests and a number of improvements against those minimum requirements have been included.

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

TEST PROCEDURES AND REQUIREMENTS				
EN 60115-1 CLAUSE	**IEC 60068-2 TEST METHOD**	**TEST**	**PROCEDURE**	**REQUIREMENTS PERMISSIBLE CHANGE**
			Stability for product types:	
			TNPW0402	
			TNPW0603	
			TNPW0805	
			TNPW1206	
			TNPW1210	
			TNPW2010	
			TNPW2512	
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)
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 (Ba)	Dry heat	UCT; 16 h	
4.23.3	30 (Db)	Damp	55 °C; 24 h; > 90 % RH; 1 cycle	
4.23.4	1 (Aa)	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	-	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)
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 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

TEST PROCEDURES AND REQUIREMENTS

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

APPLICABLE SPECIFICATIONS

- CECC40000/40400
- EN140400
- EN 140401-801
- EN 60115-1
- IEC 60286-3

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