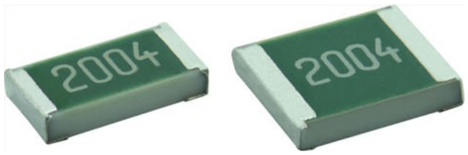
High Voltage Thin Film Flat Chip Resistors



TNPV e3 precision thin film flat chip resistors are the perfect choice for most fields of modern electronics where the highest reliability and stability at high operating voltages is of major concern. Typical applications include industrial and automotive inverters, voltage measurement systems as implemented in battery management systems, and test and measuring equipment.

FEATURES

- High operating voltage $U_{max.}$ up to 1000 V
- Low voltage coefficient < 1 ppm/V
- Excellent overall stability at different environmental conditions ≤ 0.05 % (1000 h rated power at 70 °C)
- Superior moisture resistivity (85 °C; 85 % RH)
- AEC-Q200 qualification under preparation
- Sulfur resistance verified according to ASTM B 809
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

RoHS COMPLIANT
HALOGEN FREE

APPLICATIONS

- Industrial and automotive inverters
- Battery management system
- Test and measuring equipment

TECHNICAL SPECIFICATIONS		
DESCRIPTION	**TNPV1206 e3**	**TNPV1210 e3**
Imperial size	1206	1210 (1)
Metric size code	RR3216M	RR3225M (1)
Resistance range	160 kΩ to 2 MΩ	121 kΩ 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	
Voltage coefficient $\|c\|$	< 1 ppm/V	
Rated dissipation, P_{70} (2)	0.25 W	0.33 W
Maximum operating voltage, $U_{max.}$ AC_{RMS} or DC (3)	700 V	1000 V
Permissible film temperature, $\vartheta_{F\ max.}$ (2)	155 °C	
Operating temperature range	-55 °C to 125 °C (155 °C)	

Notes

(1) Size not specified in EN 140401-801.
(2) Please refer to APPLICATION INFORMATION below.
(3) Application-specific safety requirements may set limitations to the applicability of the specified voltage.

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.

MAXIMUM RESISTANCE CHANGE AT RATED DISSIPATION

OPERATION MODE		STANDARD
Rated dissipation, P_{70}	TNPV1206 e3	0.25 W
	TNPV1210 e3	0.33 W
Applied maximum film temperature, ϑ_F max.		125 °C
Max. resistance change at P_{70} for resistance range $\Delta R/R$, after:	TNPV1206 e3	160 kΩ to 2 MΩ
	TNPV1210 e3	121 kΩ to 3.01 MΩ
	1000 h	≤ 0.05 %
	8000 h	≤ 0.10 %
	225 000 h	≤ 0.30 %

TEMPERATURE COEFFICIENT AND RESISTANCE RANGE

TYPE/SIZE	TCR	TOLERANCE	RESISTANCE	E-SERIES
TNPV1206 e3	± 50 ppm/K	± 1 %	160 kΩ to 2.0 MΩ	E24; E96
	± 25 ppm/K	± 0.5 %		E24; E192
		± 0.1 %		
	± 15 ppm/K	± 0.1 %		
	± 10 ppm/K	± 0.1 %		
TNPV1210 e3	± 50 ppm/K	± 1 %	121 kΩ to 3.01 MΩ	E24; E96
	± 25 ppm/K	± 0.5 %		E24; E192
		± 0.1 %	121 kΩ to 2.13 MΩ	
	± 15 ppm/K	± 0.1 %		
	± 10 ppm/K	± 0.1 %		

PACKAGING

TYPE/SIZE	CODE	QUANTITY	PACKAGING STYLE	WIDTH	PITCH	REEL DIAMETER
TNPV1206 e3 TNPV1210 e3	E52 = EN	1000 [(1)]	Paper tape acc. IEC 60286-3 Type 1a	8 mm	4 mm	180 mm / 7"
	ET1 = EA	5000				
	ET6 = EC	20 000				330 mm / 13"

Note

(1) 1000 pieces packaging is available only for precision resistors with tolerance ± 0.1 %.

PART NUMBER AND PRODUCT DESCRIPTION

Part Number: TNPV12061M24DEEA

T	N	P	V	1	2	0	6	1	M	2	4	D	E	E	A		

TYPE/SIZE	RESISTANCE	TOLERANCE	TCR	PACKAGING	SPECIAL
TNPV1206 **TNPV1210**	**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** **EN**	Up to 2 digits Blank = standard

Product Description: TNPV1206 1M24 0.5 % T-9 ET1 e3

TNPV1206	**1M24**	**0.5 %**	**T-9**	**ET1**	**e3**
TYPE/SIZE	RESISTANCE	TOLERANCE	TCR	PACKAGING	LEAD (Pb)-FREE
TNPV1206 **TNPV1210**	Examples: **1M24** = 1.24 MΩ **560K** = 560 kΩ	**± 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** **E52**	**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 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 cutting a meander groove in the resistive layer without damaging the ceramics. The resistor elements are covered by a unique 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 paper tape in accordance with **IEC 60286-3** [(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 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 lists 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)

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

For products with ultra precision specification see the datasheet:

- TNPU e3 - Ultra Precision Thin Film Flat Chip Resistors (www.vishay.com/doc?28779)

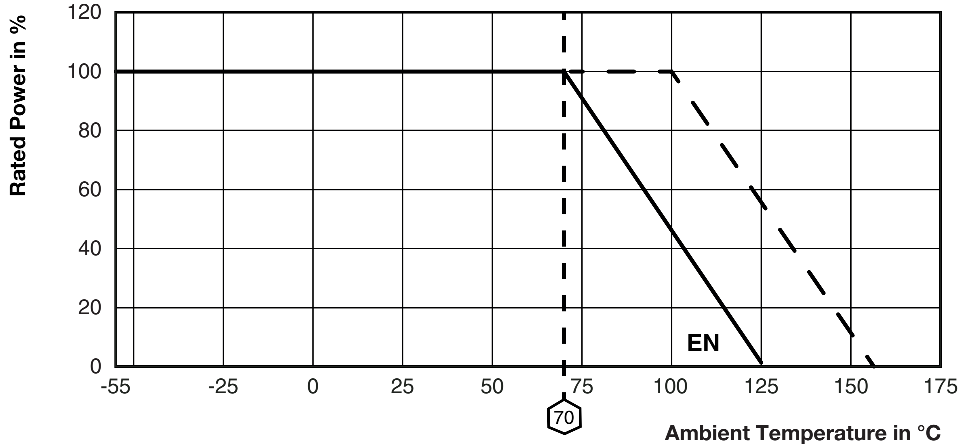
For products with high stability specification see the datasheet:

- TNPW e3 - High Stability Thin Film Flat Chip Resistors (www.vishay.com/doc?28758)

Note

(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

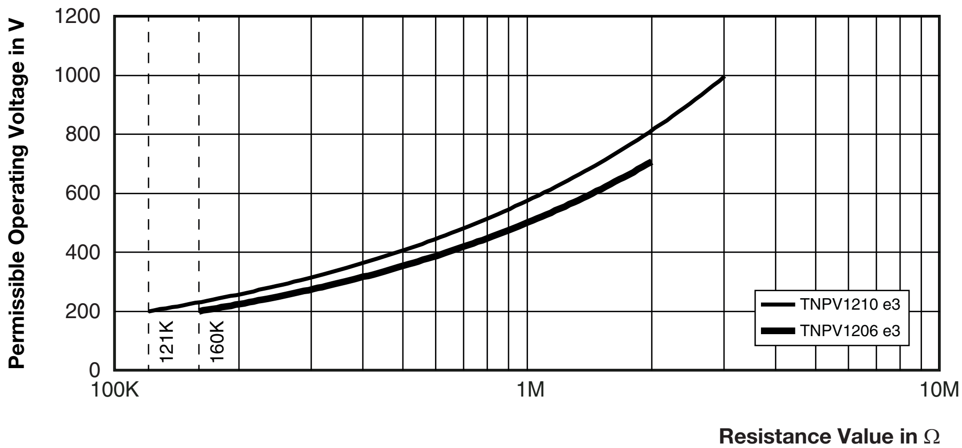
FUNCTIONAL PERFORMANCE



Derating

Note

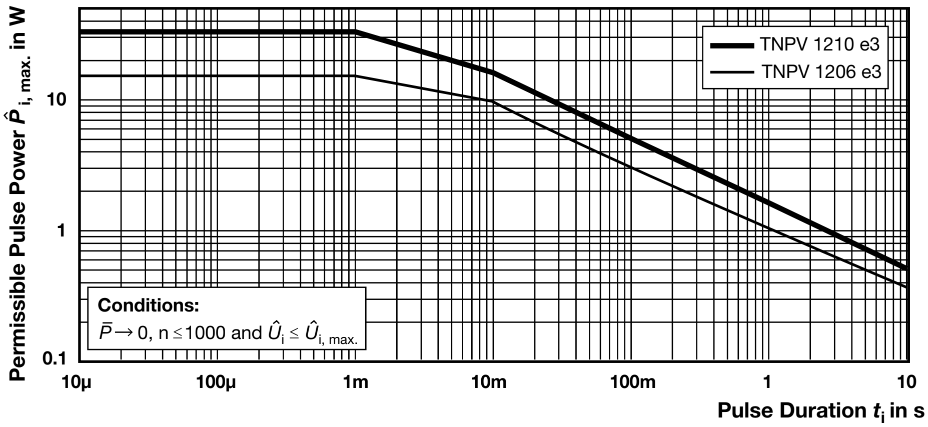
- The solid line is based on IEC/EN reference test conditions which is considered as standard mode. However, above that the maximum permissible film temperature is 155 °C (dashed line).



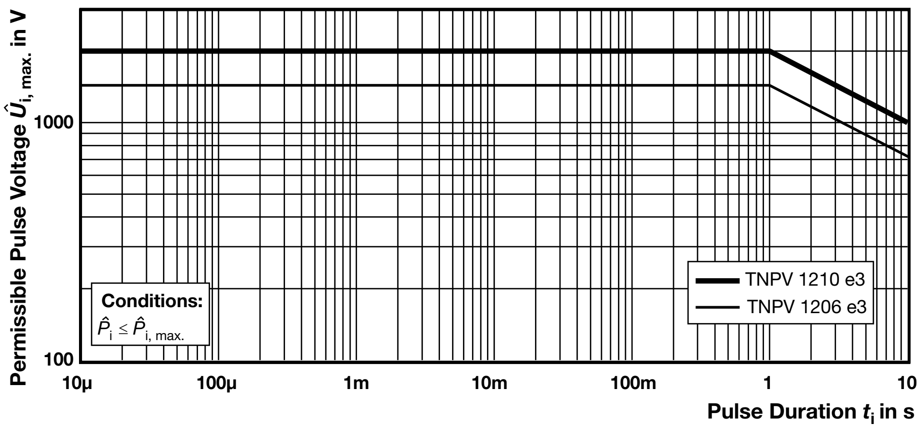
Nominal Operating Voltage

Note

- The permissible operating voltage $U_{max.}$ equals the rated voltage $\sqrt{P_{70} \times R}$. For ambient temperatures above 70 °C power derating must be considered.



Maximum Pulse Load $\hat{P}_{i,\ max.}$ Single Pulses



Maximum Pulse Voltage $\hat{U}_{i,\ max.}$

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, where upon 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

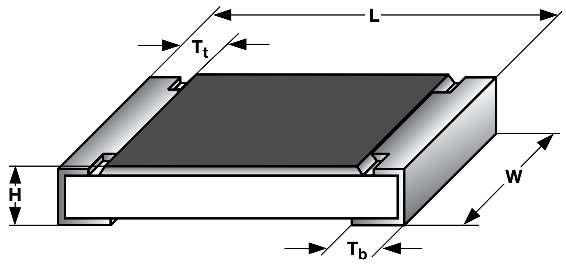
EN 60115-1 CLAUSE	IEC 60068-2 (1) TEST METHOD	TEST	PROCEDURE	REQUIREMENTS PERMISSIBLE CHANGE (ΔR)
			Stability for product type:	
			TNPV1206 e3 **TNPV1210 e3**	
4.5	-	Resistance	-	± 1 %; ± 0.5 %; ± 0.1 %
4.8.4.2	-	Temperature coefficient	At (20 / -55 / 20) °C and (20 / 125 / 20) °C	± 50 ppm/K; ± 25 ppm/K; ± 15 ppm/K; ± 10 ppm/K
4.25.1	-	Endurance at 70 °C	$U = U_{max.}$; 1.5 h on; 0.5 h off; 70 °C; 1000 h 70 °C; 8000 h	 ± (0.05 % R) ± (0.1 % R)
4.25.3	-	Endurance at upper category temperature	125 °C; 1000 h 155 °C; 1000 h	± (0.05 % R) ± (0.1 % R)
4.24	78 (Cab)	Damp heat, steady state	(40 ± 2) °C; 56 days; (93 ± 3) % RH; $U = 0.1 \times U_{max.}$	± (0.1 % R)
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)
4.13	-	Short time overload	$U = 2 \times U_{max.}$; 5 s	± (0.05 % R)
4.27	-	Single pulse high voltage overload	Severity no. 4: $U = 2 \times U_{max.}$; 10 pulses 10 µs/700 µs	± (0.1 % R)
4.39	-	Periodic electric overload	$U = 2 \times U_{max.}$; 0.1 s on; 2.5 s off; 1000 cycles	± (0.1 % R)
4.22	6 (Fc)	Vibration	Endurance by sweeping; 10 Hz to 2000 Hz; no resonance; amplitude ≤ 1.5 mm or ≤ 200 m/s²; 7.5 h	± (0.05 % R)

TEST PROCEDURES AND REQUIREMENTS				
EN 60115-1 CLAUSE	**IEC 60068-2 (1) TEST METHOD**	**TEST**	**PROCEDURE**	**REQUIREMENTS PERMISSIBLE CHANGE (ΔR)**
			Stability for product type:	
			TNPV1206 e3 TNPV1210 e3	
4.38	-	Electrostatic discharge (Human Body Model)	IEC 61340-3-1 (1); 3 pos. + 3 neg. discharges TNPV1206e3: 6 kV TNPV1210e3: 8 kV	± (0.5 % *R*)
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*)
			Reflow method 2 (IR/forced gas convection); (260 ± 5) °C; (10 ± 1) s	
4.29	45 (XA)	Component solvent resistance	Isopropyl alcohol; 50 °C; method 2	No visible damage
4.30	45 (XA)	Solvent resistance of marking	Isopropyl alcohol; 50 °C; method 1, toothbrush	No visible damage
4.32	21 (Ue_3)	Shear (adhesion)	45 N	No visible damage
4.33	21 (Ue_1)	Substrate bending	Depth 2 mm, 3 times	± (0.05 % *R*) no visible damage, no open circuit in bent position
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 ± 2) °C; (85 ± 5) % RH; $U = 0.3 \times U_{max.}$; 1000 h	± (0.25 % *R*)

Note

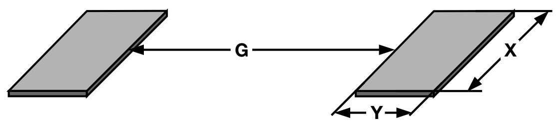
(1) The quoted IEC standards are also released as EN standards with the same number and identical contents.

DIMENSIONS



DIMENSIONS AND MASS					
TYPE	H (mm)	L (mm)	W (mm)	T_t/T_b(mm)	MASS (mg)
TNPV1206 e3	0.55 ± 0.10	3.2 ± 0.15	1.6 ± 0.15	0.5 ± 0.25	10
TNPV1210 e3	0.60 ± 0.15	3.2 ± 0.15	2.45 ± 0.15	0.5 ± 0.25	16

SOLDER PAD DIMENSIONS



RECOMMENDED SOLDER PAD DIMENSIONS						
TYPE	REFLOW SOLDERING			WAVE SOLDERING		
	Y (mm)	X (mm)	G (mm)	Y (mm)	X (mm)	G (mm)
TNPV1206 e3	0.9	1.7	2.0	1.1	1.7	2.3
TNPV1210 e3	0.9	2.5	2.0	1.1	2.5	2.3

Note

- Utilization of the full specified operating voltage may require special considerations on the creepage and clearance distance between conductors at different potential levels.

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Телефон: 8 (812) 309-75-97 (многоканальный)
Факс: 8 (812) 320-03-32
Электронная почта: ocean@oceanchips.ru
Web: http://oceanchips.ru/
Адрес: 198099, г. Санкт-Петербург, ул. Калинина, д. 2, корп. 4, лит. А