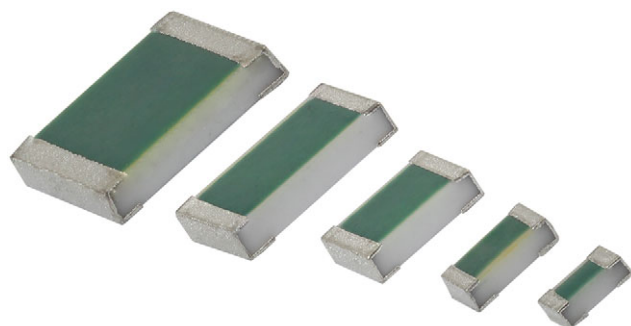


# Lead (Pb)-Bearing High Stability Thin Film Chip Resistors

**HALOGEN  
FREE**


TNPW high stability thin film chip resistors are the perfect choice for most fields of modern electronics where lead (Pb)-bearing terminations are mandatory and reliability and stability are of major concern.

## FEATURES

- SnPb termination plating, Pb content > 6 %
- AEC-Q200 qualified
- Single lot date code available
- Excellent overall stability at different environmental conditions  $\leq 0.05$  % (1000 h rated power at 70 °C)
- Low temperature coefficient and tight tolerances ( $\pm 0.1$  %;  $\pm 10$  ppm/K)
- Material categorization: for definitions of compliance please see [www.vishay.com/doc?99912](http://www.vishay.com/doc?99912)

## APPLICATIONS

- Military
- Avionics

## TECHNICAL SPECIFICATIONS

| DESCRIPTION                                                      | TNPW0402                                                       | TNPW0603                      | TNPW0805                    | TNPW1206                    | TNPW1210                       |
|------------------------------------------------------------------|----------------------------------------------------------------|-------------------------------|-----------------------------|-----------------------------|--------------------------------|
| Imperial size                                                    | 0402                                                           | 0603                          | 0805                        | 1206                        | 1210                           |
| Metric size code                                                 | RR1005M                                                        | RR1608M                       | RR2012M                     | RR3216M                     | RR3225M                        |
| Resistance range                                                 | 10 $\Omega$ to 100 k $\Omega$                                  | 10 $\Omega$ to 332 k $\Omega$ | 10 $\Omega$ to 1 M $\Omega$ | 10 $\Omega$ to 2 M $\Omega$ | 10 $\Omega$ to 3.01 M $\Omega$ |
| Resistance tolerance                                             | $\pm 1$ %; $\pm 0.5$ %; $\pm 0.1$ %                            |                               |                             |                             |                                |
| Temperature coefficient                                          | $\pm 50$ ppm/K; $\pm 25$ ppm/K; $\pm 15$ ppm/K; $\pm 10$ ppm/K |                               |                             |                             |                                |
| Rated dissipation, $P_{70}$ <sup>(1)</sup>                       | 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, $\vartheta_{F max}$ <sup>(1)</sup> | 155 °C                                                         |                               |                             |                             |                                |
| Operating temperature range                                      | -55 °C to 125 °C (155 °C)                                      |                               |                             |                             |                                |
| Internal thermal resistance (typical) <sup>(1)</sup>             | 90 K/W                                                         | 63 K/W                        | 38 K/W                      | 32 K/W                      | -                              |
| Insulation voltage:<br>$U_{ins}$ 1 min                           | 75 V                                                           | 100 V                         | 200 V                       | 300 V                       | 300 V                          |
| Failure rate: FIT <sub>observed</sub>                            | $\leq 0.3 \times 10^{-9}/h$                                    |                               |                             |                             |                                |

### Note

<sup>(1)</sup> Please refer to APPLICATION INFORMATION below

## APPLICATION INFORMATION

When the resistor dissipates power, a temperature rise above the ambient temperature occurs, dependent on the thermal resistance of the assembled resistor together with the printed circuit board. The rated dissipation applies only if the permitted film temperature is not exceeded.

Please consider the application note “Thermal Management in Surface-Mounted Resistor Applications” ([www.vishay.com/doc?28844](http://www.vishay.com/doc?28844)) for information on the general nature of thermal resistance.

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.

**TEMPERATURE COEFFICIENT AND RESISTANCE RANGE**

| TYPE     | TCR            | TOLERANCE   | RESISTANCE                     | E-SERIES  |
|----------|----------------|-------------|--------------------------------|-----------|
| TNPW0402 | $\pm 50$ ppm/K | $\pm 1$ %   | 10 $\Omega$ to 100 k $\Omega$  | E24; E96  |
|          | $\pm 25$ ppm/K | $\pm 0.5$ % | 47 $\Omega$ to 100 k $\Omega$  | E24; E192 |
|          |                | $\pm 0.1$ % |                                |           |
|          | $\pm 15$ ppm/K | $\pm 0.1$ % |                                |           |
|          | $\pm 10$ ppm/K | $\pm 0.1$ % |                                |           |
| TNPW0603 | $\pm 50$ ppm/K | $\pm 1$ %   | 10 $\Omega$ to 332 k $\Omega$  | E24; E96  |
|          | $\pm 25$ ppm/K | $\pm 0.5$ % | 47 $\Omega$ to 332 k $\Omega$  | E24; E192 |
|          |                | $\pm 0.1$ % |                                |           |
|          | $\pm 15$ ppm/K | $\pm 0.1$ % |                                |           |
|          | $\pm 10$ ppm/K | $\pm 0.1$ % |                                |           |
| TNPW0805 | $\pm 50$ ppm/K | $\pm 1$ %   | 10 $\Omega$ to 1.0 M $\Omega$  | E24; E96  |
|          | $\pm 25$ ppm/K | $\pm 0.5$ % | 47 $\Omega$ to 1.0 M $\Omega$  | E24; E192 |
|          |                | $\pm 0.1$ % |                                |           |
|          | $\pm 15$ ppm/K | $\pm 0.1$ % |                                |           |
|          | $\pm 10$ ppm/K | $\pm 0.1$ % |                                |           |
| TNPW1206 | $\pm 50$ ppm/K | $\pm 1$ %   | 10 $\Omega$ to 2.0 M $\Omega$  | E24; E96  |
|          | $\pm 25$ ppm/K | $\pm 0.5$ % | 47 $\Omega$ to 2.0 M $\Omega$  | E24; E192 |
|          |                | $\pm 0.1$ % |                                |           |
|          | $\pm 15$ ppm/K | $\pm 0.1$ % |                                |           |
|          | $\pm 10$ ppm/K | $\pm 0.1$ % |                                |           |
| TNPW1210 | $\pm 50$ ppm/K | $\pm 1$ %   | 10 $\Omega$ to 3.01 M $\Omega$ | E24; E96  |
|          | $\pm 25$ ppm/K | $\pm 0.5$ % | 47 $\Omega$ to 2.13 M $\Omega$ | E24; E192 |
|          |                | $\pm 0.1$ % |                                |           |
|          | $\pm 15$ ppm/K | $\pm 0.1$ % |                                |           |
|          | $\pm 10$ ppm/K | $\pm 0.1$ % |                                |           |

**PACKAGING**

| TYPE                             | CODE                    | QUANTITY | PACKAGING<br>STYLE                           | WIDTH | PITCH | REEL<br>DIAMETER |
|----------------------------------|-------------------------|----------|----------------------------------------------|-------|-------|------------------|
| TNPW0402                         | TP1 = TP <sup>(1)</sup> | 1000     | Paper tape according<br>IEC 60286-3, Type 1a | 8 mm  | 2 mm  | 180 mm/7"        |
|                                  | RT7 = TD                | 10 000   |                                              | 8 mm  | 2 mm  | 180 mm/7"        |
| TNPW0603                         | R52 = CN <sup>(1)</sup> | 1000     |                                              | 8 mm  | 4 mm  | 180 mm/7"        |
| TNPW0805<br>TNPW1206<br>TNPW1210 | RT1 = TA                | 5000     |                                              | 8 mm  | 4 mm  | 180 mm/7"        |

**Note**

<sup>(1)</sup> 1000 pieces packaging quantity is only available for precision resistors with tolerance  $\pm 0.1$  %

**PART NUMBER AND PRODUCT DESCRIPTION**

Part Number: TNPW12061K32DETA

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

| TYPE / SIZE                                              | RESISTANCE                                               | TOLERANCE                                             | TCR                                                                                  | PACKAGING            | SPECIAL                                          |
|----------------------------------------------------------|----------------------------------------------------------|-------------------------------------------------------|--------------------------------------------------------------------------------------|----------------------|--------------------------------------------------|
| TNPW0402<br>TNPW0603<br>TNPW0805<br>TNPW1206<br>TNPW1210 | R = decimal<br>K = thousand<br>M = million<br>(4 digits) | B = $\pm 0.1\%$<br>D = $\pm 0.5\%$<br>F = $\pm 1.0\%$ | H = $\pm 50$ ppm/K<br>E = $\pm 25$ ppm/K<br>X = $\pm 15$ ppm/K<br>Y = $\pm 10$ ppm/K | TP<br>TD<br>CN<br>TA | Blank = standard<br>OH = single lot<br>date code |

Product Description: TNPW-1206 1.32K 0.5 % T-9 RT1

| TNPW-1206                                                     | 1.32K                                                   | 0.5 %                                     | T-9                                                                                            | RT1                      |                                                       |
|---------------------------------------------------------------|---------------------------------------------------------|-------------------------------------------|------------------------------------------------------------------------------------------------|--------------------------|-------------------------------------------------------|
| TYPE / SIZE                                                   | RESISTANCE                                              | TOLERANCE                                 | TCR                                                                                            | PACKAGING                | SPECIAL                                               |
| TNPW-0402<br>TNPW-0603<br>TNPW-0805<br>TNPW-1206<br>TNPW-1210 | Examples:<br>1K32 = 1320 $\Omega$<br>360 = 360 $\Omega$ | $\pm 0.1\%$<br>$\pm 0.5\%$<br>$\pm 1.0\%$ | T-2 = $\pm 50$ ppm/K<br>T-9 = $\pm 25$ ppm/K<br>T-10 = $\pm 15$ ppm/K<br>T-13 = $\pm 10$ ppm/K | TP1<br>RT7<br>R52<br>RT1 | Blank = standard<br>BV20545 =<br>single lot date code |

**Notes**

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



## DESCRIPTION

The 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 ceramic body ( $\text{Al}_2\text{O}_3$ ) and conditioned to achieve the desired temperature coefficient. A special laser is used to achieve the target value by smoothly cutting an appropriate groove in the resistive layer without damaging the ceramics. The resistor elements are covered by a protective coating designed for electrical, mechanical and climatic protection. The terminations receive a final tin-lead (SnPb) on nickel plating. The result of the determined production is verified by an extensive testing procedure performed on 100 % of the individual resistors. Only accepted products are placed into the tape in accordance with **IEC 60286-3, Type 1a**.

## 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** <sup>(1)</sup>. Solderability is specified for 2 years after production. The permitted storage time is 20 years.

The terminations are plated with SnPb solder, controlled for a minimum lead Pb content of 6 % for compliance with the respective requirements of Bellcore, MIL and ESCC specifications.

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.

## RELATED PRODUCTS

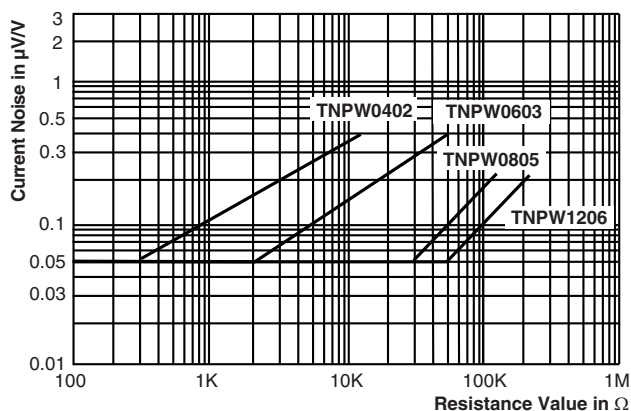
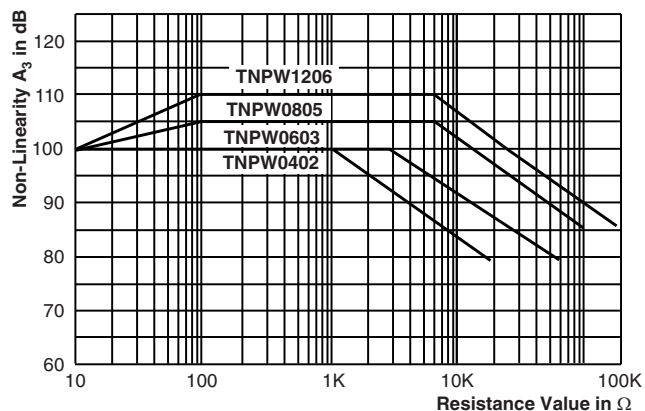
For ordering TNPW with lead free terminations please refer to latest edition of data sheet TNPW e3, ([www.vishay.com/doc?28758](http://www.vishay.com/doc?28758)).

TNPS .... ESCC high-reliability thin film chip resistors are the premium choice for design and manufacture of equipment, where mature technology and proven reliability are of utmost importance.

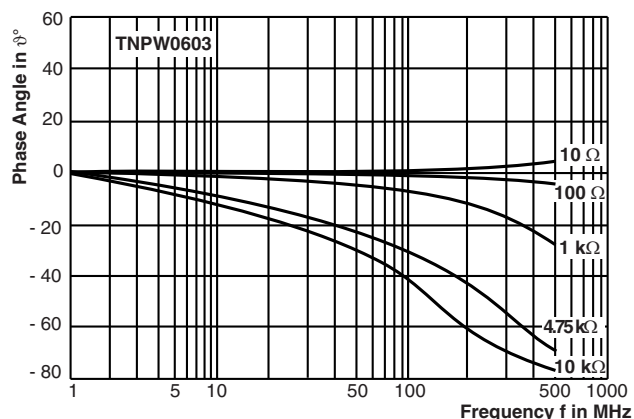
([www.vishay.com/doc?28789](http://www.vishay.com/doc?28789))



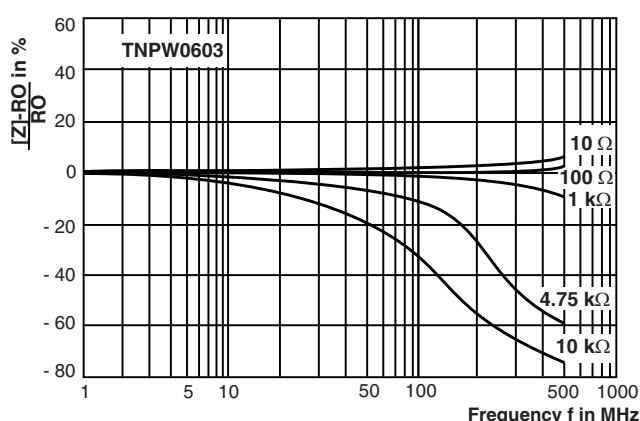
## FUNCTIONAL PERFORMANCE



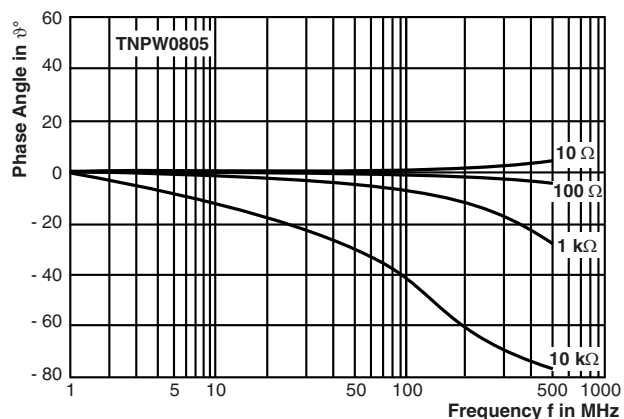
### Non-Linearity



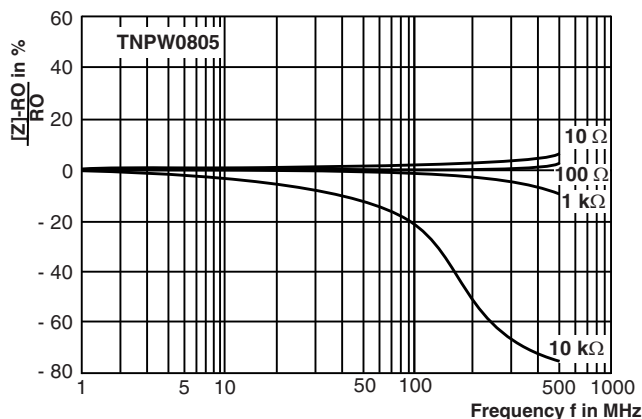
### Current Noise



### HF Performance

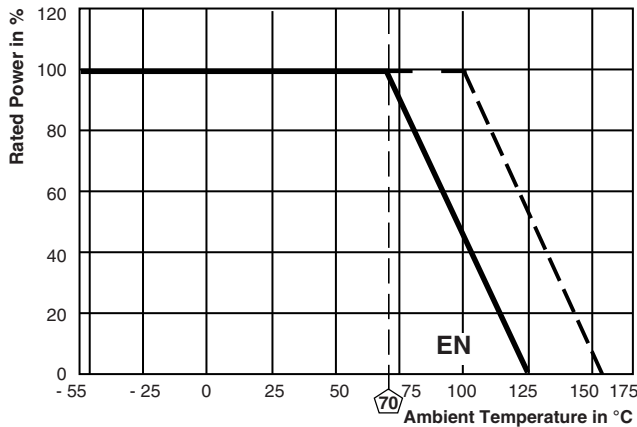


### HF Performance



### HF Performance

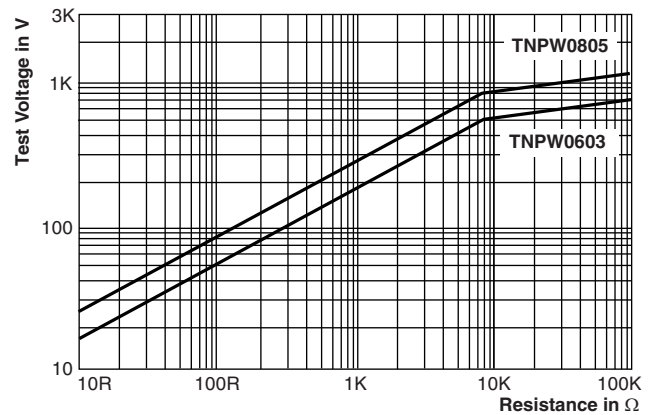
### HF Performance



### Derating

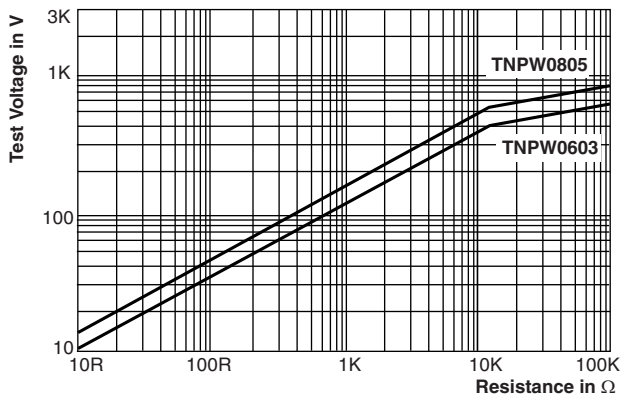
#### Note

- 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)



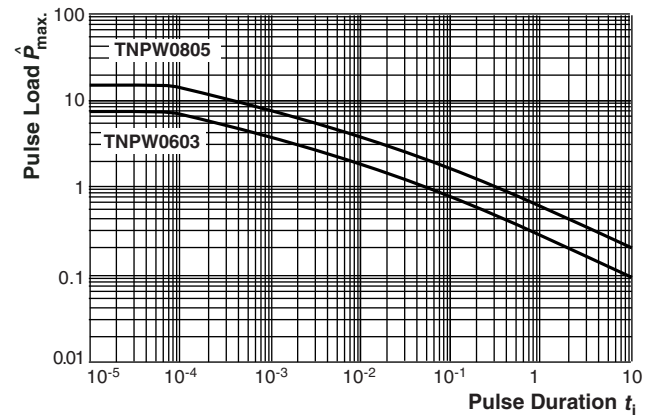
### Single-Pulse High Voltage Overload Test

1.2/50 μs EN 140000 4.27



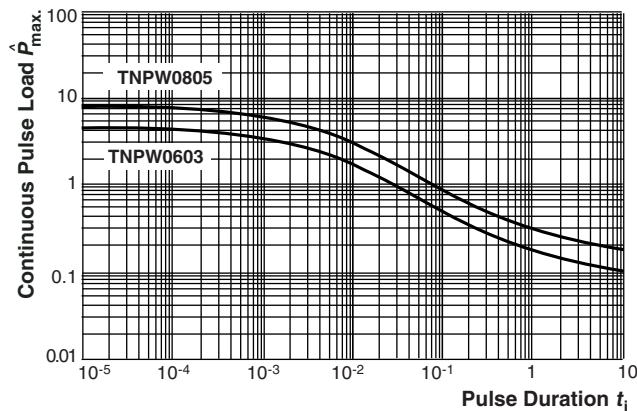
### Single-Pulse High Voltage Overload Test

10/700 μs EN 140000 4.27



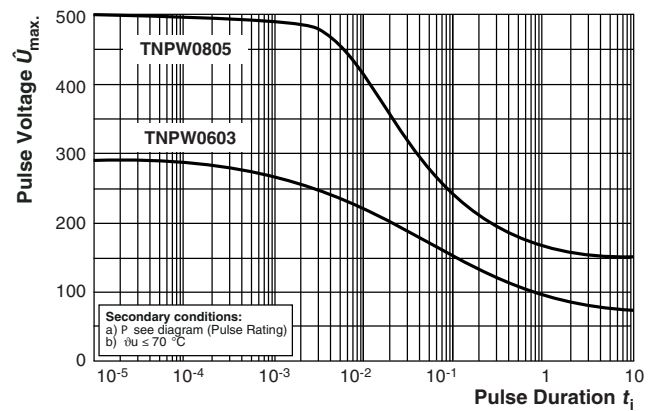
Maximum pulse load, single pulse; applicable if  $\bar{P} \rightarrow 0$  and  $n \leq 1000$  and  $\dot{U} \leq \dot{U}_{max}$ ; for permissible resistance change equivalent to 8000 h operation in standard operation mode

### Single Pulse



Maximum pulse load, continuous pulses; applicable if  $\bar{P} \leq P_{(i_{amb})}$  and  $\dot{U} \leq \dot{U}_{max}$ ; for permissible resistance change equivalent to 8000 h operation in standard operation mode

### Continuous Pulse



Maximum pulse voltage, single and continuous pulses; applicable if  $P \leq P_{max}$ ; for permissible resistance change equivalent to 8000 h operation in standard operation mode

### Pulse Voltage

**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).

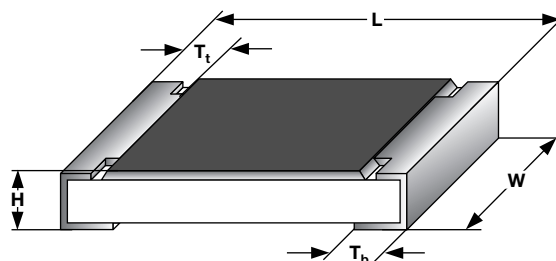
The components are mounted for testing on printed circuit boards in accordance with EN 60115-8, 2.4.2, unless otherwise specified.

| <b>TEST PROCEDURES AND REQUIREMENTS</b> |                                              |                                                  |                                                                                              |                                                |                                      |                                   |
|-----------------------------------------|----------------------------------------------|--------------------------------------------------|----------------------------------------------------------------------------------------------|------------------------------------------------|--------------------------------------|-----------------------------------|
| EN 60115-1<br>CLAUSE                    | IEC 60068-2 <sup>(1)</sup><br>TEST<br>METHOD | TEST                                             | PROCEDURE                                                                                    | REQUIREMENTS PERMISSIBLE CHANGE ( $\Delta R$ ) |                                      |                                   |
|                                         |                                              |                                                  | Stability for<br>product type:                                                               |                                                |                                      |                                   |
|                                         |                                              |                                                  | TNPW0402<br>TNPW0603<br>TNPW0805<br>TNPW1206<br>TNPW1210                                     | 10 $\Omega$ to < 100 $\Omega$                  | $\geq 100 \Omega$ to 3.01 M $\Omega$ | 10 $\Omega$ to 3.01 M $\Omega$    |
| 6.1                                     | -                                            | Resistance                                       | -                                                                                            | $\pm 0.1 \%$                                   |                                      | $\pm 1 \%$ ; $\pm 0.5 \%$         |
| 6.2                                     | -                                            | Temperature<br>coefficient                       | At (20 / -55 / 20) °C<br>and (20 / 125 / 20) °C                                              | $\pm 25$ ppm/K; $\pm 15$ ppm/K; $\pm 10$ ppm/K |                                      | $\pm 50$ ppm/K;<br>$\pm 25$ ppm/K |
| 7.1                                     | -                                            | Endurance<br>at 70 °C                            | $U = \sqrt{P_{70} \times R}$<br>or $\leq U_{max}$ ;<br>1.5 h on; 0.5 h off;<br>70 °C; 1000 h | $\pm (0.1 \% R + 0.02 \Omega)$                 | $\pm (0.05 \% R + 0.01 \Omega)$      | $\pm (0.25 \% R + 0.05 \Omega)$   |
| 7.3                                     | -                                            | Endurance<br>at upper<br>category<br>temperature | 125 °C; 1000 h                                                                               | $\pm (0.1 \% R + 0.02 \Omega)$                 | $\pm (0.05 \% R + 0.01 \Omega)$      | $\pm (0.5 \% R + 0.05 \Omega)$    |
| 8.1                                     | -                                            | Short time<br>overload                           | $U = 2.5 \times \sqrt{P_{70} \times R}$<br>$\leq 2 \times U_{max}$ ; 2 s                     | $\pm (0.05 \% R + 0.01 \Omega)$                | $\pm (0.02 \% R + 0.01 \Omega)$      | $\pm (0.1 \% R + 0.02 \Omega)$    |
| 10.4                                    | 78 (Cab)                                     | Damp heat,<br>steady state                       | (40 $\pm$ 2) °C;<br>(93 $\pm$ 3) % RH;<br>56 days                                            | $\pm (0.1 \% R + 0.02 \Omega)$                 | $\pm (0.05 \% R + 0.01 \Omega)$      | $\pm (0.5 \% R + 0.05 \Omega)$    |
| 10.1                                    | 14 (Na)                                      | Rapid change<br>of temperature                   | 30 min at - 55 °C;<br>30 min at 125 °C;<br>5 cycles                                          | $\pm (0.05 \% R + 0.01 \Omega)$                | $\pm (0.02 \% R + 0.01 \Omega)$      | $\pm (0.1 \% R + 0.02 \Omega)$    |
| 11.2.4.3                                | 58 (Td)                                      | Resistance to<br>soldering heat                  | Solder bath method;<br>(260 $\pm$ 5) °C;<br>(10 $\pm$ 1) s                                   | $\pm (0.05 \% R + 0.01 \Omega)$                | $\pm (0.02 \% R + 0.01 \Omega)$      | $\pm (0.1 \% R + 0.02 \Omega)$    |
| 12.4                                    | -                                            | Flammability,<br>needle flame<br>test            | IEC 60695-11-5 <sup>(1)</sup> ;<br>10 s                                                      | No burning after 30 s                          |                                      |                                   |

**Note**

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

## DIMENSIONS



| DIMENSIONS AND MASS |             |                   |             |                        |                        |              |
|---------------------|-------------|-------------------|-------------|------------------------|------------------------|--------------|
| TYPE                | H<br>(mm)   | L<br>(mm)         | W<br>(mm)   | T <sub>t</sub><br>(mm) | T <sub>b</sub><br>(mm) | MASS<br>(mg) |
| TNPW0402            | 0.35 ± 0.05 | 1.0 ± 0.05        | 0.5 ± 0.05  | 0.2 ± 0.10             | 0.2 ± 0.10             | 0.65         |
| TNPW0603            | 0.45 ± 0.10 | 1.55 ± 0.05       | 0.85 ± 0.10 | 0.3 ± 0.20             | 0.3 ± 0.20             | 2            |
| TNPW0805            | 0.45 ± 0.10 | 2.0 ± 0.10        | 1.25 ± 0.15 | 0.4 ± 0.20             | 0.4 ± 0.20             | 5.5          |
| TNPW1206            | 0.55 ± 0.10 | 3.2 + 0.1 / - 0.2 | 1.6 ± 0.15  | 0.5 ± 0.25             | 0.5 ± 0.25             | 10           |
| TNPW1210            | 0.60 ± 0.15 | 3.2 + 0.1 / - 0.2 | 2.45 ± 0.15 | 0.5 ± 0.25             | 0.5 ± 0.25             | 16           |

## SOLDERING RECOMMENDATIONS

For recommended solder pad dimensions please refer to [www.vishay.com/doc?28950](http://www.vishay.com/doc?28950).

For recommended soldering profiles please refer to [www.vishay.com/doc?31090](http://www.vishay.com/doc?31090).





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