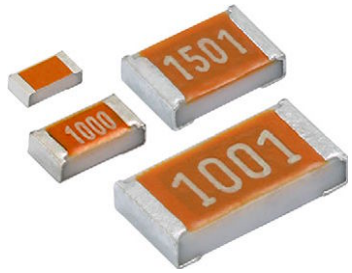
# SMD PTC - Nickel Thin Film Linear Thermistors




## FEATURES

- Alumina substrate base with nickel based PTC thin film element
- 0402, 0603, 0805, and 1206 sizes available
- Available in tape and reel packaging
- Standard $R_{25}$ tolerances: ± 0.5 %, ± 1 %, ± 5 %
- Operation range -55 °C to +150 °C
- High stability over the entire temperature range
- cULus recognized, file E148885 (UL category XGPU2 / XGPU8)
- AEC-Q200 qualified (grade 1), except TFPT0402
- Material categorization: for definitions of compliance please see www.vishay.com/doc?99912

Pb Available

e3 RoHS* Available

HALOGEN FREE

**Note**

* This datasheet provides information about parts that are RoHS-compliant and / or parts that are non RoHS-compliant. For example, parts with lead (Pb) terminations are not RoHS-compliant. Please see the information / tables in this datasheet for details

## ADDITIONAL RESOURCES

Design Tools

## APPLICATIONS

Temperature compensation and sensing in

- Automotive
- Motor drives
- Lighting LED drivers
- Test and measuring equipment
- Air-flow sensor

## QUICK REFERENCE DATA

| PARAMETER | VALUE | | | | UNIT |
|---|---|---|---|---|---|
| DESCRIPTION | TFPT0402 | TFPT0603 | TFPT0805 | TFPT1206 | |
| Resistance value at 25 °C (2) | 5 | 100 to 1K | 100 to 5K | 100 to 10K | Ω |
| Tolerance on $R_{25}$-value (2) | ± 25 | ± 0.5; ± 1; ± 5 | | | % |
| TCR at 25 °C | 4110 | | | | ppm/K |
| Tolerance on TCR at 25 °C (1) | ± 400 | | | | |
| Operating temperature range:<br>at rated power<br>at zero dissipation (4) | <br>-55 to +70<br>-55 to +150 | | | | °C |
| Dissipation factor δ (for information only) (5) | 0.8 | 1.8 | 2.3 | 4 | mW/K |
| Maximum rated power at 70 °C ($P_{70}$) (5) | 100 (6) | 75 | 100 | 125 | mW |
| Maximum working voltage RCWV (3) | 1.2 | 30 | 40 | 50 | V |
| Climatic category (LCT/UCT/days) | 55/150/56 | | | | - |
| Weight | 0.65 | 2 | 5.5 | 10 | mg |
| Failure rate $FIT_{observed}$ | ≤ 0.1 x $10^{-9}$/h | | | | |

**Notes**

(1) Contact Vishay if closer TCR lot tolerance is desired
(2) Other $R_{25}$-values and tolerances are available upon request
(3) Rated continuous working voltage is maximum working voltage or $\sqrt{P_{70} \times R}$ whichever is less
(4) Zero power or zero dissipation is considered as measuring power max. 1 % of rated power $P_{70}$
(5) Please refer to APPLICATION INFORMATION
(6) Power levels are depending on way of mounting and substrates used. Higher power up to 200 mW at 25 °C ($P_{25}$) can be tolerated on uniform layer TFPT0402 5R

## 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 of 150 °C is not exceeded.

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

The TFPT0402 uniform layer linear thermistor with low resistance value can be used as an air-flow sensor in a controlled power mode where nickel film temperature changes can be related to air-flow speed.

## STANDARD RESISTANCE VALUES at 25 °C in Ω

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 100 | 180 | 330 | 560 | 1.0K | 1.8K | 3.3K | 5.0K | 8.2K |
| 120 | 220 | 390 | 680 | 1.2K | 2.2K | 3.9K | 5.6K | 10.0K |
| 150 | 270 | 470 | 820 | 1.5K | 2.7K | 4.7K | 6.8K | |

**Note**

- Rated continuous working voltage is maximum working voltage or $\sqrt{P_{70} \times R}$ whichever is less

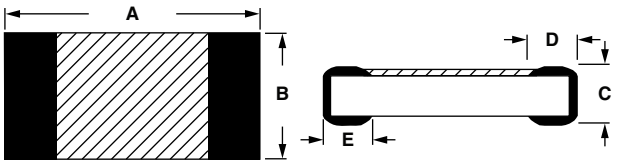
## GLOBAL PART NUMBER INFORMATION

**Global Part Numbering: TFPT1206L1002FM (preferred part number format)**

| T | F | P | T | 1 | 2 | 0 | 6 | L | 1 | 0 | 0 | 2 | F | M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

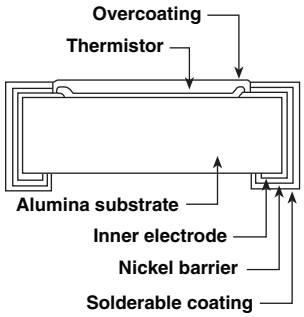
| GLOBAL MODEL | CHARACTERISTIC | RESISTANCE VALUE | TOLERANCE CODE | PACKAGING |
|---|---|---|---|---|
| **TFPT0402**<br>**TFPT0603**<br>**TFPT0805**<br>**TFPT1206** | **L** = linear<br>**U** = uniform linear (0402) | **1002** = 10K<br>**0050** = 5R (0402) | **D** = ± 0.5 %<br>**F** = ± 1 %<br>**J** = ± 5 %<br>**V** = ± 25 % (0402) | **L** = lead (Pb)-free, T/R (10 000 pcs) 0402<br>**M** = lead (Pb)-free, T/R (5000 pcs)<br>**V** = lead (Pb)-free, T/R (1000 pcs)<br>**Z** = tin / lead, T/R (5000 pcs)<br>**Y** = tin / lead, T/R (1000 pcs) |

## DIMENSIONS in millimeters




| PART NUMBER | A | B | C | D | E |
|---|---|---|---|---|---|
| TFPT 0402 | 1.00 ± 0.05 | 0.50 ± 0.05 | 0.35 ± 0.07 | 0.20 ± 0.10 | 0.20 ± 0.10 |
| TFPT 0603 | 1.55 ± 0.10 | 0.80 ± 0.10 | 0.45 ± 0.10 | 0.30 ± 0.20 | 0.30 ± 0.20 |
| TFPT 0805 | 2.00 ± 0.15 | 1.25 ± 0.15 | 0.45 ± 0.10 | 0.40 ± 0.20 | 0.40 ± 0.20 |
| TFPT 1206 | 3.05 ± 0.15 | 1.50 ± 0.15 | 0.55 ± 0.10 | 0.50 ± 0.25 | 0.50 ± 0.25 |

## CONSTRUCTION




## TESTS AND REQUIREMENTS (except TFPT0402)

| TEST | CONDITIONS [1] | REQUIREMENTS MAX. $\lvert\Delta R_{25}/R_{25}\rvert$ |
|---|---|---|
| High temperature exposure (storage) | AEC-Q200, 1000 h at 150 °C | 0.25 % |
| Temperature cycling | AEC-Q200, 1000 cycles -55 °C / +125 °C | 0.25 % |
| Biased humidity | 1000 h, 1 mA biased at 85 °C / 85 % RH | 0.25 % |
| | 1000 h, 1 mA biased at 40 °C / 95 % RH | 0.25 % |
| Operational life | 1000 h, $P_{70}$ max biased at 85 °C | 0.25 % |
| Mechanical shock and vibration | MIL-STD 202, method 213 - 204 | 0.50 % |
| Resistance to soldering heat | MIL-STD 202, method 210, solder bath dipping 10 s at 260°C | 0.25 % |
| ESD [2] | AEC-Q200-002, HBM (CD) 0.5 kV (0603), 1.0 kV (0805), 1.0 kV (1206) | 0.25 % |
| Board flex | AEC-Q200-005, 2 mm during 60 s | 0.25 % |
| Terminal strength | AEC-Q200-006, shear test 17.7 N during 60 s | 0.25 % |

**Notes**

[1] Environmental performance specifications use test procedures as outlined in MIL-R23648D, MIL-STD 202 and AEC-Q200

[2] TFPTs are ESD sensitive

## AGENCY APPROVALS (except TFPT0402)

- cUL certificate
- ULus certificate

**Note**

- Agency approval documents, please see: www.vishay.com/ppg?33017&documents

### AVERAGE RATIO $R/R_{25}$ TFPT ALL SIZES AND VALUES

| TEMP. | $R/R_{25}$ | TEMP. | $R/R_{25}$ | TEMP. | $R/R_{25}$ | TEMP. | $R/R_{25}$ | TEMP. | $R/R_{25}$ | TEMP. | $R/R_{25}$ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | -20 | 0.825 | 20 | 0.980 | 60 | 1.150 | 100 | 1.337 | 140 | 1.541 |
| | | -19 | 0.828 | 21 | 0.984 | 61 | 1.155 | 101 | 1.342 | 141 | 1.547 |
| | | -18 | 0.832 | 22 | 0.988 | 62 | 1.159 | 102 | 1.347 | 142 | 1.552 |
| | | -17 | 0.836 | 23 | 0.992 | 63 | 1.164 | 103 | 1.352 | 143 | 1.557 |
| | | -16 | 0.839 | 24 | 0.996 | 64 | 1.168 | 104 | 1.357 | 144 | 1.563 |
| -55 | 0.702 | -15 | 0.843 | **25** | **1.000** | 65 | 1.173 | 105 | 1.362 | 145 | 1.568 |
| -54 | 0.705 | -14 | 0.847 | 26 | 1.004 | 66 | 1.177 | 106 | 1.367 | 146 | 1.574 |
| -53 | 0.708 | -13 | 0.851 | 27 | 1.008 | 67 | 1.182 | 107 | 1.372 | 147 | 1.579 |
| -52 | 0.712 | -12 | 0.854 | 28 | 1.012 | 68 | 1.186 | 108 | 1.377 | 148 | 1.584 |
| -51 | 0.715 | -11 | 0.858 | 29 | 1.017 | 69 | 1.191 | 109 | 1.382 | 149 | 1.590 |
| -50 | 0.719 | -10 | 0.862 | 30 | 1.021 | 70 | 1.196 | 110 | 1.387 | 150 | 1.595 |
| -49 | 0.722 | -9 | 0.866 | 31 | 1.025 | 71 | 1.200 | 111 | 1.392 | | |
| -48 | 0.725 | -8 | 0.869 | 32 | 1.029 | 72 | 1.205 | 112 | 1.397 | | |
| -47 | 0.729 | -7 | 0.873 | 33 | 1.033 | 73 | 1.209 | 113 | 1.402 | | |
| -46 | 0.732 | -6 | 0.877 | 34 | 1.037 | 74 | 1.214 | 114 | 1.407 | | |
| -45 | 0.736 | -5 | 0.881 | 35 | 1.042 | 75 | 1.219 | 115 | 1.412 | | |
| -44 | 0.739 | -4 | 0.885 | 36 | 1.046 | 76 | 1.223 | 116 | 1.417 | | |
| -43 | 0.743 | -3 | 0.889 | 37 | 1.050 | 77 | 1.228 | 117 | 1.422 | | |
| -42 | 0.746 | -2 | 0.892 | 38 | 1.054 | 78 | 1.232 | 118 | 1.427 | | |
| -41 | 0.749 | -1 | 0.896 | 39 | 1.059 | 79 | 1.237 | 119 | 1.432 | | |
| -40 | 0.753 | 0 | 0.900 | 40 | 1.063 | 80 | 1.242 | 120 | 1.437 | | |
| -39 | 0.756 | 1 | 0.904 | 41 | 1.067 | 81 | 1.246 | 121 | 1.442 | | |
| -38 | 0.760 | 2 | 0.908 | 42 | 1.071 | 82 | 1.251 | 122 | 1.448 | | |
| -37 | 0.763 | 3 | 0.912 | 43 | 1.076 | 83 | 1.256 | 123 | 1.453 | | |
| -36 | 0.767 | 4 | 0.916 | 44 | 1.080 | 84 | 1.261 | 124 | 1.458 | | |
| -35 | 0.771 | 5 | 0.920 | 45 | 1.084 | 85 | 1.265 | 125 | 1.463 | | |
| -34 | 0.774 | 6 | 0.924 | 46 | 1.089 | 86 | 1.270 | 126 | 1.468 | | |
| -33 | 0.778 | 7 | 0.927 | 47 | 1.093 | 87 | 1.275 | 127 | 1.473 | | |
| -32 | 0.781 | 8 | 0.931 | 48 | 1.097 | 88 | 1.280 | 128 | 1.478 | | |
| -31 | 0.785 | 9 | 0.935 | 49 | 1.102 | 89 | 1.284 | 129 | 1.484 | | |
| -30 | 0.788 | 10 | 0.939 | 50 | 1.106 | 90 | 1.289 | 130 | 1.489 | | |
| -29 | 0.792 | 11 | 0.943 | 51 | 1.110 | 91 | 1.294 | 131 | 1.494 | | |
| -28 | 0.796 | 12 | 0.947 | 52 | 1.115 | 92 | 1.299 | 132 | 1.499 | | |
| -27 | 0.799 | 13 | 0.951 | 53 | 1.119 | 93 | 1.303 | 133 | 1.505 | | |
| -26 | 0.803 | 14 | 0.955 | 54 | 1.124 | 94 | 1.308 | 134 | 1.510 | | |
| -25 | 0.806 | 15 | 0.959 | 55 | 1.128 | 95 | 1.313 | 135 | 1.515 | | |
| -24 | 0.810 | 16 | 0.963 | 56 | 1.133 | 96 | 1.318 | 136 | 1.520 | | |
| -23 | 0.814 | 17 | 0.967 | 57 | 1.137 | 97 | 1.323 | 137 | 1.526 | | |
| -22 | 0.817 | 18 | 0.971 | 58 | 1.141 | 98 | 1.328 | 138 | 1.531 | | |
| -21 | 0.821 | 19 | 0.975 | 59 | 1.146 | 99 | 1.333 | 139 | 1.536 | | |

## RATIO FORMULA

$R_T = R_{25}$ x (9.0014 x $10^{-1}$ + 3.87235 x $10^{-3}$ (°C)$^{-1}$ x $T$ + 4.86825 x $10^{-6}$ (°C)$^{-2}$ x $T^2$ + 1.37559 x $10^{-9}$ (°C)$^{-3}$ x $T^3$)
$T_{(°C)}$ = 28.54 x $(R_T/R_{25})^3$ - 158.5 x $(R_T/R_{25})^2$ + 474.8 x $(R_T/R_{25})$ - 319.85)

| RATIO TOLERANCES | | |
|---|---|---|
| LOW TEMP. | HIGH TEMP. | TOL. |
| -55 °C | +150 °C | ± 4 % |
| -40 °C | +125 °C | ± 3 % |
| -20 °C | +85 °C | ± 2 % |
| 0 °C | +55 °C | ± 1 % |
| +12 °C | +40 °C | ± 0.5 % |

## RATIO TOLERANCE EXAMPLES:

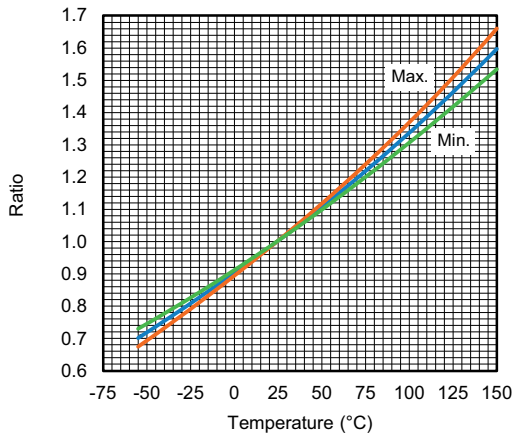
At 40 °C, ratio = 1.063 ± 0.5 % (0.005)
so, ratio = 1.058 to 1.068

At 125 °C, ratio = 1.460 ± 3 % (0.044)
so, ratio = 1.416 to 1.504

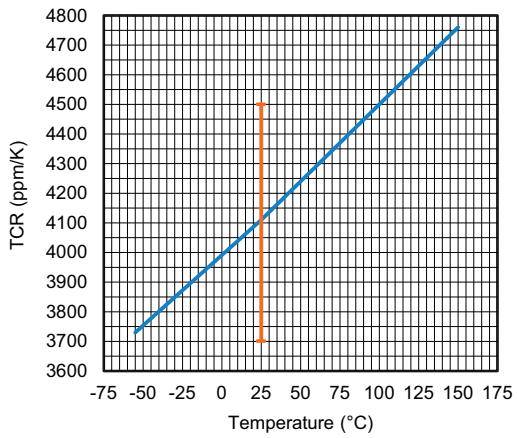
At intermediate temperatures, the ratios can be gradually adapted, for example at 105 °C the ratio tolerance will be ± 2.5 %.

For total resistance tolerance, the specific $R_{25}$ tolerance needs to be multiplied with the ratio tolerance, for example a 100R 1 % at 25 °C will have a maximum resistance at 125 °C of 100R x 1.463 x 1.03 x 1.01 = 152.2 Ω.

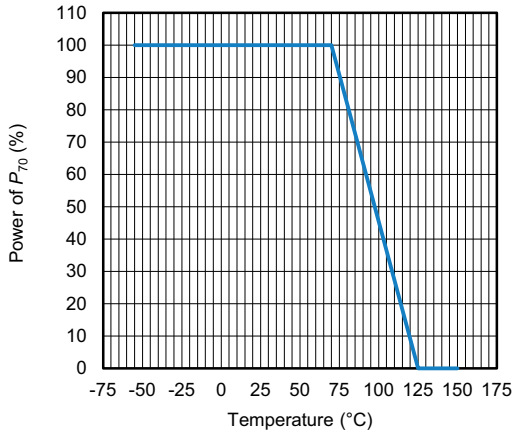
## RATIO $R_T/R_{25}$




## TCR TYPICAL VALUE




## POWER DERATING




**Note**

- Zero power is considered as measuring power max. 1 % of rated power $P_{70}$

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