

Temperature Dependent Nickel Thin Film Chip Resistor (RTD)



FEATURES

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



LINKS TO ADDITIONAL RESOURCES



APPLICATIONS

- Temperature compensation and sensing in
- Automotive
 - Motor drives
 - Lighting LED drivers
 - Test and measuring equipment

| QUICK REFERENCE DATA | | | | |
|---|------------------------------------|-----------|------------|--------------------|
| PARAMETER | VALUE | | | UNIT |
| DESCRIPTION | TFPT0603 | TFPT0805 | TFPT1206 | |
| Resistance value at $25\text{ }^{\circ}\text{C}$ ⁽¹⁾ | 100 to 1K | 100 to 5K | 100 to 10K | Ω |
| Tolerance on R_{25} -value | $\pm 0.5; \pm 1; \pm 5$ | | | % |
| TCR at $25\text{ }^{\circ}\text{C}$ | 4110 | | | ppm/K |
| Tolerance on TCR at $25\text{ }^{\circ}\text{C}$ ⁽²⁾ | ± 400 | | | |
| Operating temperature range: at rated power | -55 to $+70$ | | | $^{\circ}\text{C}$ |
| at derated power ⁽³⁾ | -55 to $+150$ | | | |
| Storage temperature range | -55 to $+150$ | | | $^{\circ}\text{C}$ |
| Dissipation factor δ (for information only) ⁽⁴⁾ | 1.8 | 2.3 | 4 | mW/K |
| Maximum rated power at $70\text{ }^{\circ}\text{C}$ (P_{70}) ^(3/4) | 75 | 100 | 125 | mW |
| Maximum working voltage RCWV ⁽⁵⁾ | 30 | 40 | 50 | V |
| Weight | 2 | 5.5 | 10 | mg |
| Failure rate FIT _{observed} | $\leq 0.1 \times 10^{-9}/\text{h}$ | | | |

Notes

- (1) Other R_{25} -values are available upon request
- (2) Contact Vishay if closer TCR lot tolerance is desired
- (3) Derated power curve can be found in section "Power Derating". Power applied at maximum temperature should not let increase the film temperature by more than 1 K ($1\text{ }^{\circ}\text{C}$)
- (4) Valid for sensor element only in low dissipative mode. For dissipative mounting, please refer to APPLICATION INFORMATION
- (5) Rated continuous working voltage is maximum working voltage or $\sqrt{P_{70} \times R}$ whichever is less

APPLICATION INFORMATION

When the TFPT dissipates power, a temperature rise above the ambient temperature occurs, dependent on the thermal resistance of the assembled thermistor together with the mounting substrate. The (de)-rated power dissipation applies only if the long term permitted film temperature of $150\text{ }^{\circ}\text{C}$ is not exceeded by more than $1\text{ }^{\circ}\text{C}$. Typically the thermal resistance (R_{thFA}) of a FR4 mounted TFPT0603 is around 250 K/W .

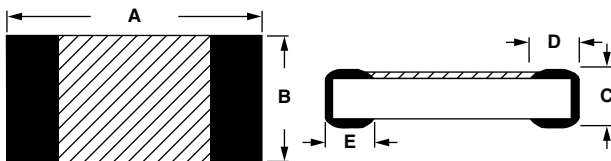
Please consider the application note "Thermal Management in Surface-Mounted Resistor Applications" (www.vishay.com/doc?28844) for information on the general nature of thermal resistance.

| 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 | |

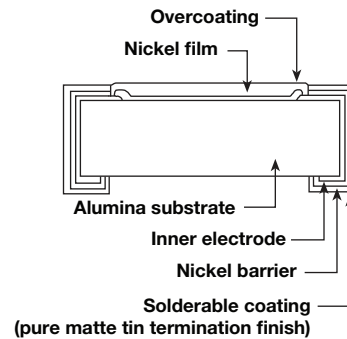
| GLOBAL PART NUMBER INFORMATION | | | | |
|---|----------------|--|---------------------------------------|--|
| Global Part Numbering: TFPT1206L1002FM (preferred part number format) | | | | |
| T | F | P | T | 1 2 0 6 L 1 0 0 2 F M |
| GLOBAL MODEL | CHARACTERISTIC | RESISTANCE VALUE | TOLERANCE CODE | PACKAGING (1) |
| TFPT0603 TFPT0805 TFPT1206 | L = linear | 1002 = 10K 1001 = 1K 1000 = 100R | D = ± 0.5 % F = ± 1 % J = ± 5 % | M = paper tape on reel, code ET1 (5000 pcs) V = paper tape on reel, code E52 (1000 pcs) |

Note

(1) According to IEC 60286-3: 8 mm paper tape on Ø 180 mm / 7" reel

DIMENSIONS in millimeters


| PART NUMBER | A | B | C | D | E |
|-------------|----------------|----------------|----------------|----------------|----------------|
| 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 | | |
|-------------------------------------|--|---|
| TEST | CONDITIONS (1) | REQUIREMENTS MAX. $ \Delta R_{25}/R_{25} $ |
| 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, 10 % of P_{70} max biased at 85 °C | 0.25 % |
| Mechanical shock | MIL-STD 202, method 213 | 0.25 % |
| Mechanical vibration | MIL-STD 202, method 204 | 0.25 % |
| Resistance to soldering heat | MIL-STD 202, method 210, condition K (reflow soldering) | 0.25 % |
| ESD (2) | AEC-Q200-002, HBM (CD) 0.2 kV (0603), 0.5 kV (0805), 0.5 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 (0805, 1206) and 10 N (0603) 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

- C-UL certificate
- UL-US 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

$$R_T = R_{25} \times (9.0014 \times 10^{-1} + 3.87235 \times 10^{-3} (^\circ\text{C})^{-1} \times T + 4.86825 \times 10^{-6} (^\circ\text{C})^{-2} \times T^2 + 1.37559 \times 10^{-9} (^\circ\text{C})^{-3} \times T^3)$$

$$T(^\circ\text{C}) = 28.54 \times (R_T/R_{25})^3 - 158.5 \times (R_T/R_{25})^2 + 474.8 \times (R_T/R_{25}) - 319.85$$

| 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:

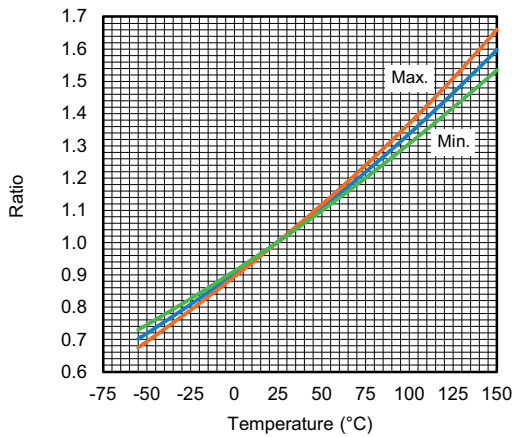
At 40 °C, ratio = 1.063 ± 0.5 % (0.005)
so, ratio = 1.058 to 1.068

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

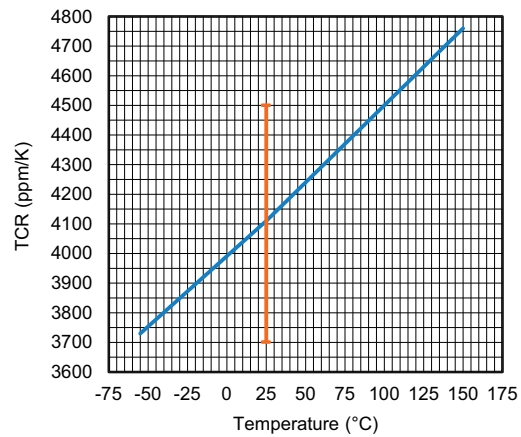
At intermediate temperatures, the ratios can be gradually adapted, for example at 105 °C the ratio tolerance will be ± 2.5 %.

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.

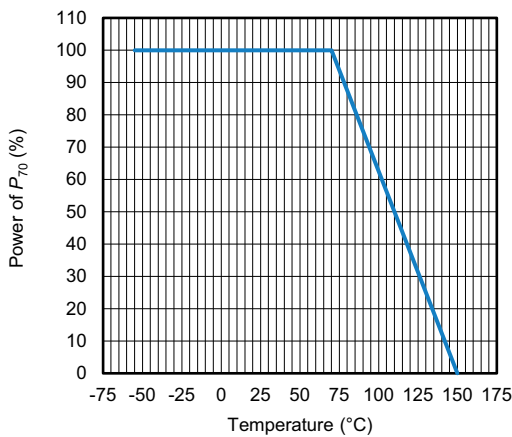
RATIO R_T/R_{25}



TCR TYPICAL VALUE



POWER DERATING



Note

- Zero (0 %) power is considered as measuring power that will generate a maximum film temperature increase of 1 °C



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