

# SMD PTC - Nickel Thin Film Linear Thermistors



## 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](http://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 $25\text{ }^{\circ}\text{C}$ <sup>(1)</sup>                   | 100 to 1K                          | 100 to 5K | 100 to 10K | $\Omega$           |
| 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 $25\text{ }^{\circ}\text{C}$ <sup>(2)</sup>                   | $\pm 400$                          |           |            |                    |
| Operating temperature range:<br>at rated power                                    | $-55$ to $+70$                     |           |            | $^{\circ}\text{C}$ |
| at derated power <sup>(3)</sup>   | $-55$ to $+150$                    |           |            |                    |
| Storage temperature range   | $-55$ to $+150$                    |           |            | $^{\circ}\text{C}$ |
| Dissipation factor $\delta$ (for information only) <sup>(4)</sup>                 | 1.8                                | 2.3       | 4          | mW/K               |
| Maximum rated power at $70\text{ }^{\circ}\text{C}$ ( $P_{70}$ ) <sup>(3/4)</sup> | 75                                 | 100       | 125        | mW                 |
| Maximum working voltage RCWV <sup>(5)</sup>                                       | 30                                 | 40        | 50         | V                  |
| Weight  | 2                                  | 5.5       | 10         | mg                 |
| Failure rate FIT <sub>observed</sub>  | $\leq 0.1 \times 10^{-9}/\text{h}$ |           |            |                    |

### 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  $1\text{ K}$  ( $1\text{ }^{\circ}\text{C}$ )
- (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  $250\text{ K/W}$ .

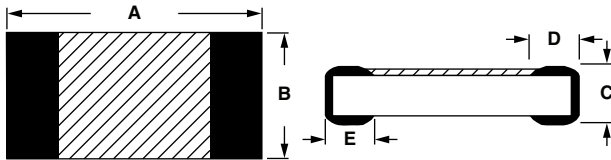
Please consider the application note "Thermal Management in Surface-Mounted Resistor Applications" ([www.vishay.com/doc?28844](http://www.vishay.com/doc?28844)) for information on the general nature of thermal resistance.

| 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 |       |  |

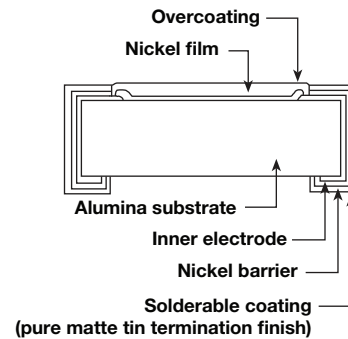
| GLOBAL PART NUMBER INFORMATION  |                |  |                                       |  |   |   |   |   |   |   |   |   |   |   |
|---|----------------|--|---------------------------------------|--|---|---|---|---|---|---|---|---|---|---|
| Global Part Numbering: TFPT1206L1002FM (preferred part 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<br>TFPT0805<br>TFPT1206                                      | L = linear     | 1002 = 10K<br>1001 = 1K<br>1000 = 100R | D = ± 0.5 %<br>F = ± 1 %<br>J = ± 5 % | M = paper tape on reel, code ET1 (5000 pcs)<br>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<br>± 0.10 | 0.80<br>± 0.10 | 0.45<br>± 0.10 | 0.30<br>± 0.20 | 0.30<br>± 0.20 |
| TFPT 0805   | 2.00<br>± 0.15 | 1.25<br>± 0.15 | 0.45<br>± 0.10 | 0.40<br>± 0.20 | 0.40<br>± 0.20 |
| TFPT 1206   | 3.05<br>± 0.15 | 1.50<br>± 0.15 | 0.55<br>± 0.10 | 0.50<br>± 0.25 | 0.50<br>± 0.25 |

**CONSTRUCTION**


| TESTS AND REQUIREMENTS              |  |   |
|-------------------------------------|--|---|
| TEST                                | CONDITIONS (1)   | REQUIREMENTS<br>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) 0.5 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 (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](http://www.vishay.com/ppg?33017&documents)

| AVERAGE RATIO R/R <sub>25</sub> TFPT ALL SIZES AND VALUES |                   |       |                   |           |                   |       |                   |       |                   |       |                   |
|---|-------------------|-------|-------------------|-----------|-------------------|-------|-------------------|-------|-------------------|-------|-------------------|
| TEMP.   | R/R <sub>25</sub> | TEMP. | R/R <sub>25</sub> | TEMP.     | R/R <sub>25</sub> | TEMP. | R/R <sub>25</sub> | TEMP. | R/R <sub>25</sub> | TEMP. | R/R <sub>25</sub> |
|   |                   | -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             | <b>25</b> | <b>1.000</b>      | 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 % |

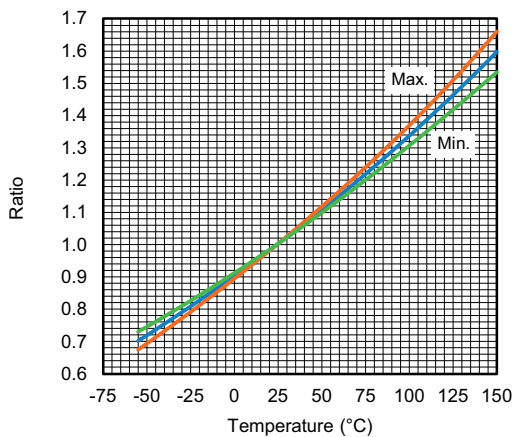
**RATIO TOLERANCE EXAMPLES:**

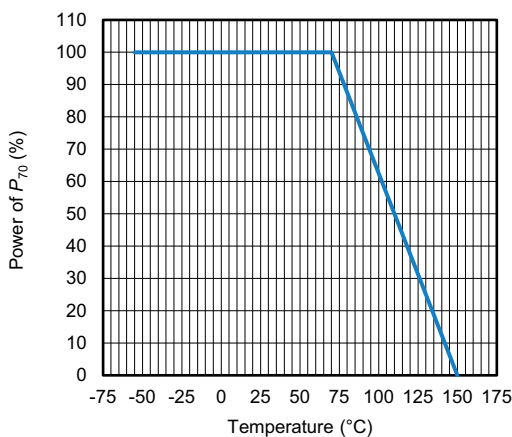
At 40 °C, ratio = 1.063 ± 0.5 % (0.005)  
so, ratio = 1.058 to 1.068

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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