

# APPROVAL SHEET

Thin Film High Precision Chip Resistors

## **WF Series**

Size **2512, 2010, 1210, 1206, 0805, 0603, 0402, 0201**

Tolerance  **$\pm 1\%$ ,  $\pm 0.5\%$ ,  $\pm 0.25\%$ ,  $\pm 0.1\%$ ,  $\pm 0.05\%$**

TCR  **$\pm 50\text{ppm}$ ,  $\pm 25\text{ppm}$ ,  $\pm 15\text{ppm}$ ,  $\pm 10\text{ppm}$ ,  $\pm 5\text{ppm}$**

RoHS Compliant

\*Contents in this sheet are subject to change without prior notice.

## FEATURES

1. SMD metal film resistor
2. High reliability and stability of 0.1% per customer request
3. Full product range from 0201 ~ 2512 size
4. Full TCR range from 50 ~ 5ppm
5. Low current noise
6.  $\pm 0.05\%$  is available upon the customer request.
7. RoHS compliant with complete lead free

## APPLICATION

- Medical equipments
- Testing & Measuring instruments
- Communication devices Base station, AP Router,
- Power supply & Server
- High end audio system

## DESCRIPTION

The resistors are constructed in a high grade ceramic body (aluminum oxide). Internal metal electrodes are added at each end and connected by a resistive layer that is applied to the top surface of the substrate. The composition of the resistive layer is adjusted to give the approximate resistance required and the value is trimmed to nominated value within tolerance which controlled by laser trimming of this resistive layer.

The resistive layer is covered with a protective coat. Finally, the two external end terminations are added. For environmental soldering issue, the outer layer of these end terminations is a Lead-free solder .

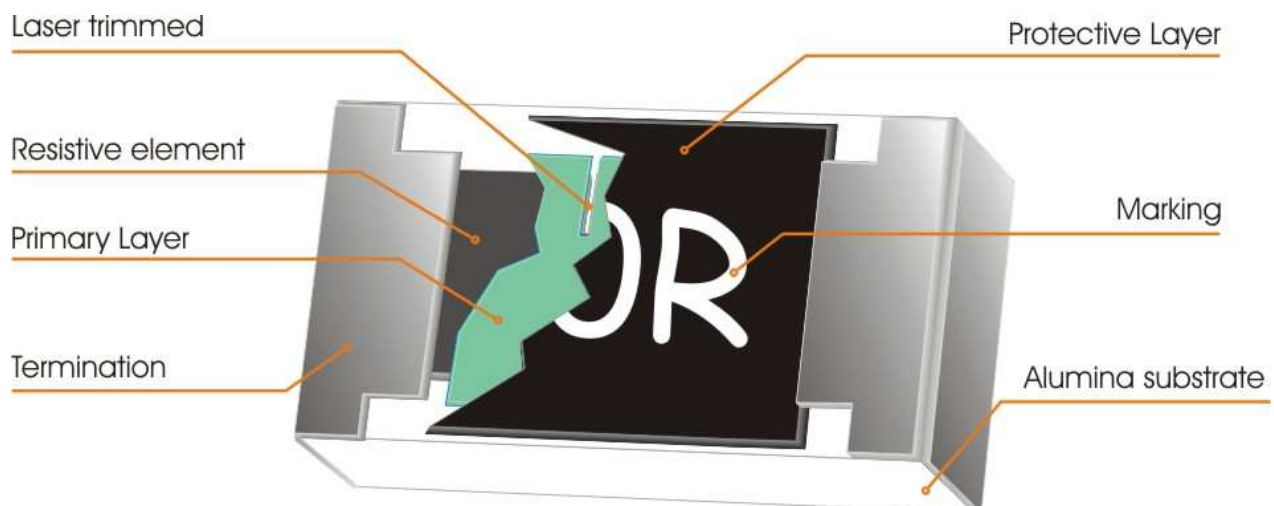


Fig 1. Construction of Chip-R

**QUICK REFERENCE DATA**

| TYPE           | Operation temperature | Rated power                | MWV *1       | MOV *2       | DWV *3       | TCR ppm/C | Resistance Range ( E24+E192) & Tolerance |          |          |          |          |
|----------------|-----------------------|----------------------------|--------------|--------------|--------------|-----------|--|----------|----------|----------|----------|
|                |                       |                            |              |              |              |           | ±0.05%                                   | ±0.1%    | ±0.25%   | ±0.5%    | ±1%      |
| WF02<br>(0201) | -55 °C /<br>+125°C    | 1/20W (±<br>0.5%)          | 15V          | 30V          | 30V          | ±50       | -  | 100-1K   | -        | 47-10K   | -        |
|                |                       | 1/30W (±<br>0.1%)          |              |              |              | ±25       | -  | 100-1K   | -        | 47-5K    | -        |
| WF04<br>(0402) | -55 °C /<br>+155°C    | 1/16W                      | 25V          | 50V          | 50V          | ±50       | 10-100K                                  | 10-100K  | 10-100K  | 10-100K  | 10-100K  |
|                |                       |                            |              |              |              | ±25       | 10-100K                                  | 10-100K  | 10-100K  | 10-100K  | 10-100K  |
|                |                       |                            |              |              |              | ±15       | 25-20K                                   | 25-20K   | 25-20K   | -        | -        |
|                |                       |                            |              |              |              | ±10       | 25-20K                                   | 25-20K   | 25-20K   | -        | -        |
|                |                       |                            |              |              |              | ±5        | 25-8K                                    | 25-8K    | 25-8K    | -        | -        |
| WF06<br>(0603) | -55 °C /<br>+155°C    | 1/16W<br>1/10W<br>Hi-power | 50V<br>75V   | 100V<br>150V | 100V<br>150V | ±50       | 4.7-680K                                 | 4.7-680K | 4.7-680K | 4.7-680K | 4.7-680K |
|                |                       |                            |              |              |              | ±25       | 4.7-680K                                 | 4.7-680K | 4.7-680K | 4.7-680K | 4.7-680K |
|                |                       |                            |              |              |              | ±15       | 25-100K                                  | 25-100K  | 25-100K  | -        | -        |
|                |                       |                            |              |              |              | ±10       | 25-100K                                  | 25-100K  | 25-100K  | -        | -        |
|                |                       |                            |              |              |              | ±5        | 25-40K                                   | 25-40K   | 25-40K   | -        | -        |
| WF08<br>(0805) | -55 °C /<br>+155°C    | 1/10W<br>1/8W<br>Hi-power  | 100V<br>150V | 200V<br>300V | 200V<br>300V | ±50       | 4.7-1M                                   | 4.7-1M   | 4.7-1M   | 4.7-1M   | 4.7-1M   |
|                |                       |                            |              |              |              | ±25       | 4.7-1M                                   | 4.7-1M   | 4.7-1M   | 4.7-1M   | 4.7-1M   |
|                |                       |                            |              |              |              | ±15       | 25-200K                                  | 25-200K  | 25-200K  | -        | -        |
|                |                       |                            |              |              |              | ±10       | 25-200K                                  | 25-200K  | 25-200K  | -        | -        |
|                |                       |                            |              |              |              | ±5        | 25-80K                                   | 25-80K   | 25-80K   | -        | -        |
| WF12<br>(1206) | -55 °C /<br>+155°C    | 1/8W<br>1/4W<br>Hi-power   | 200V         | 400V         | 400V         | ±50       | 4.7-1M                                   | 4.7-1M   | 4.7-1M   | 4.7-1M   | 4.7-1M   |
|                |                       |                            |              |              |              | ±25       | 4.7-1M                                   | 4.7-1M   | 4.7-1M   | 4.7-1M   | 4.7-1M   |
|                |                       |                            |              |              |              | ±15       | 25-300K                                  | 25-300K  | 25-300K  | -        | -        |
|                |                       |                            |              |              |              | ±10       | 25-300K                                  | 25-300K  | 25-300K  | -        | -        |
|                |                       |                            |              |              |              | ±5        | 25-120K                                  | 25-120K  | 25-120K  | -        | -        |
| WF10<br>(1210) | -55 °C /<br>+155°C    | 1/4W<br>2/5W<br>Hi-power   | 200V         | 400V         | 400V         | ±50       | 10-1M                                    | 10-1M    | 10-1M    | 10-1M    | 10-1M    |
|                |                       |                            |              |              |              | ±25       | 10-1M                                    | 10-1M    | 10-1M    | 10-1M    | 10-1M    |
| WF20<br>(2010) | -55 °C /<br>+155°C    | 1/2W<br>3/4W<br>Hi-power   | 200V         | 400V         | 400V         | ±50       | 10-1.5M                                  | 10-1.5M  | 10-1.5M  | 10-1.5M  | 10-1.5M  |
|                |                       |                            |              |              |              | ±25       | 10-1.5M                                  | 10-1.5M  | 10-1.5M  | 10-1.5M  | 10-1.5M  |
| WF25<br>(2512) | -55 °C /<br>+155°C    | 3/4W<br>1W<br>Hi-power     | 200V         | 400V         | 400V         | ±50       | 10-1.5M                                  | 10-1.5M  | 10-1.5M  | 10-1.5M  | 10-1.5M  |
|                |                       |                            |              |              |              | ±25       | 10-1.5M                                  | 10-1.5M  | 10-1.5M  | 10-1.5M  | 10-1.5M  |

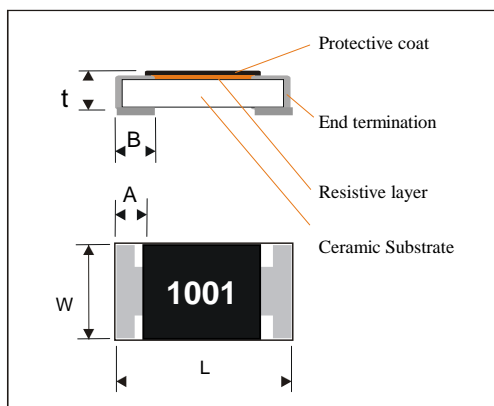
1. This is the maximum voltage that may be continuously supplied to the resistor element, see "IEC publication 60115-8" ! Max. Operation Voltage : So called RCWV (Rated Continuous Working Voltage) is determined by

$$RCWV = \sqrt{\text{Rated Power} \times \text{Resistance Value}} \text{ or Max. RCWV listed above, whichever is lower.}$$

2. \*1 MWV = Max. Working Voltage; \*2 MOV = Max. Overload Voltage; \*3 DWV = Dielectric Withstand Voltage

**DIMENSIONS:( unit:mm)**

| Type | SIZE | L           | W           | t           | A           | B           |
|------|------|-------------|-------------|-------------|-------------|-------------|
| WF25 | 2512 | 6.35 ± 0.10 | 3.20 ± 0.15 | 0.55 ± 0.10 | 0.60 ± 0.20 | 0.50 ± 0.20 |
| WF20 | 2010 | 5.00 ± 0.10 | 2.50 ± 0.15 | 0.55 ± 0.10 | 0.60 ± 0.20 | 0.50 ± 0.20 |
| WF10 | 1210 | 3.10 ± 0.10 | 2.60 ± 0.15 | 0.55 ± 0.10 | 0.50 ± 0.20 | 0.50 ± 0.20 |
| WF12 | 1206 | 3.10 ± 0.10 | 1.60 ± 0.10 | 0.60 ± 0.15 | 0.45 ± 0.20 | 0.45 ± 0.20 |
| WF08 | 0805 | 2.00 ± 0.10 | 1.25 ± 0.10 | 0.50 ± 0.15 | 0.25 ± 0.20 | 0.40 ± 0.20 |
| WF06 | 0603 | 1.55 ± 0.10 | 0.80 ± 0.10 | 0.45 ± 0.15 | 0.25 ± 0.15 | 0.30 ± 0.15 |
| WF04 | 0402 | 1.00 ± 0.05 | 0.50 ± 0.05 | 0.35 ± 0.05 | 0.20 ± 0.10 | 0.25 ± 0.10 |
| WF02 | 0201 | 0.60 ± 0.03 | 0.30 ± 0.03 | 0.23 ± 0.03 | 0.10 ± 0.05 | 0.15 ± 0.05 |



## MARKING

- **3-digits marking for 0603 size**

WF has same marking rule as WR.

- **3-digits marking ( $\pm 1\%$  : 0603)**

| Nominal resistance |         | Description   |         |      |         |      |         |      |         |      |         |      |         |      |         |
|--------------------|---------|---|---------|------|---------|------|---------|------|---------|------|---------|------|---------|------|---------|
| 1.E-24 series      |         | As 0603 WR06X $\pm 5\%$ .   |         |      |         |      |         |      |         |      |         |      |         |      |         |
| 2.E-96 series      |         | The 1st two digit codes are referring to the CODE on the table, the 3rd code is the index of resistance value :<br>$Y=10^{-2}$ , $X=10^{-1}$ , $A=10^0$ , $B=10^1$ , $C=10^2$ , $D=10^3$ , $E=10^4$ , $F=10^5$<br>EX : 17.8 $\Omega$ =25X, 178 $\Omega$ =25A, 1K78 =25B<br>17K8=25C, 178K=25D, 1M78=25E |         |      |         |      |         |      |         |      |         |      |         |      |         |
| 3. Remark          |         | There is no marking for the items are not under E-24 and E-96 series  |         |      |         |      |         |      |         |      |         |      |         |      |         |
| CODE               | R_value | CODE  | R_value | CODE | R_value | CODE | R_value | CODE | R_value | CODE | R_value | CODE | R_value | CODE | R_value |
| 01                 | 100     | 13  | 133     | 25   | 178     | 37   | 237     | 49   | 316     | 61   | 422     | 73   | 562     | 85   | 750     |
| 02                 | 102     | 14  | 137     | 26   | 182     | 38   | 243     | 50   | 324     | 62   | 432     | 74   | 576     | 86   | 768     |
| 03                 | 105     | 15  | 140     | 27   | 187     | 39   | 249     | 51   | 332     | 63   | 442     | 75   | 590     | 87   | 787     |
| 04                 | 107     | 16  | 143     | 28   | 191     | 40   | 255     | 52   | 340     | 64   | 453     | 76   | 604     | 88   | 806     |
| 05                 | 110     | 17  | 147     | 29   | 196     | 41   | 261     | 53   | 348     | 65   | 464     | 77   | 619     | 89   | 825     |
| 06                 | 113     | 18  | 150     | 30   | 200     | 42   | 267     | 54   | 357     | 66   | 475     | 78   | 634     | 90   | 845     |
| 07                 | 115     | 19  | 154     | 31   | 205     | 43   | 274     | 55   | 365     | 67   | 487     | 79   | 649     | 91   | 866     |
| 08                 | 118     | 20  | 158     | 32   | 210     | 44   | 280     | 56   | 374     | 68   | 499     | 80   | 665     | 92   | 887     |
| 09                 | 121     | 21  | 162     | 33   | 215     | 45   | 287     | 57   | 383     | 69   | 511     | 81   | 681     | 93   | 909     |
| 10                 | 124     | 22  | 165     | 34   | 221     | 46   | 294     | 58   | 392     | 70   | 523     | 82   | 698     | 94   | 931     |
| 11                 | 127     | 23  | 169     | 35   | 226     | 47   | 301     | 59   | 402     | 71   | 536     | 83   | 715     | 95   | 953     |
| 12                 | 130     | 24  | 174     | 36   | 232     | 48   | 309     | 60   | 412     | 72   | 549     | 84   | 732     | 96   | 976     |

- **4-digits marking for 2512, 2010, 1210, 1206, 0805 size**

For E24/E96 series, each resistor is marked with a four digits code on the protective coating to designate the nominal resistance value. For non E24/E96 series, no marking is applied!

### Example

| RESISTANCE       | 10 $\Omega$ | 12 $\Omega$ | 100 $\Omega$ | 6800 $\Omega$ | 47000 $\Omega$ |
|------------------|-------------|-------------|--------------|---------------|----------------|
| 4-digits marking | 10R0        | 12R0        | 1000         | 6801          | 4702           |

- **No marking code for 0402/ 0201 size**

## FUNCTIONAL DESCRIPTION

### Product characterization

Standard values of nominal resistance are taken from the E192 & E24 series for resistors with a tolerance of  $\pm 1\%$ ,  $\pm 0.5\%$ ,  $\pm 0.25\%$ ,  $\pm 0.1\%$ ,  $\pm 0.05\%$ . The values of the E24/E192 series are in accordance with "IEC publication 60063".

### Derating

The power that the resistor can dissipate depends on the operating temperature; see Fig.2

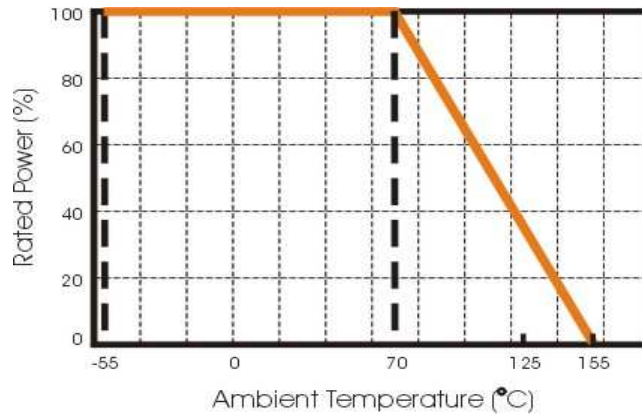
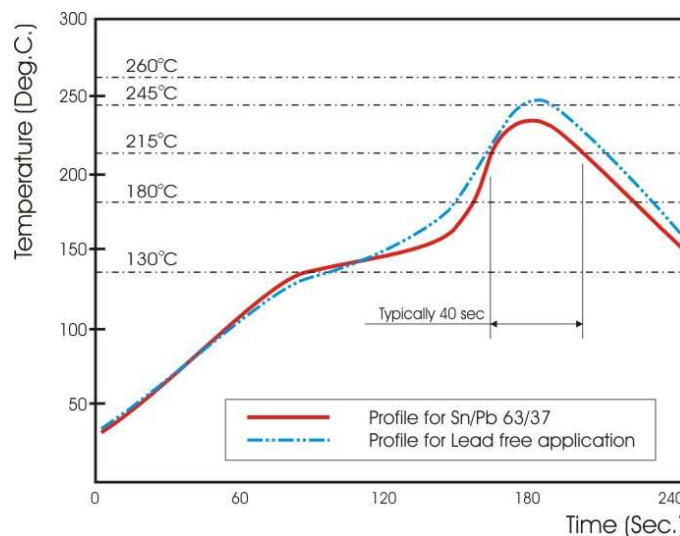


Fig.2 Maximum dissipation in percentage of rated power As a function of the ambient temperature

## SOLDERING CONDITION

The robust construction of chip resistors allows them to be completely immersed in a solder bath of 260°C for 10 seconds. Therefore, it is possible to mount Surface Mount Resistors on one side of a PCB and other discrete components on the reverse (mixed PCBs).

Surface Mount Resistors are tested for solderability at 235°C during 2 seconds within lead-free solder bath. The test condition for no leaching is 260°C for 30 seconds. Typical examples of soldering processes that provide reliable joints without any damage are given in Fig 3.



## CATALOGUE NUMBERS

The resistors have a catalogue number starting with .

| WF06             | R                      | xxxx   | B                | T                         | L                          |
|------------------|------------------------|--|------------------|---------------------------|----------------------------|
| <b>Size code</b> | <b>Type code</b>       | <b>Resistance code</b>                           | <b>Tolerance</b> | <b>Packaging code</b>     | <b>Termination code</b>    |
| WF25: 2512       | T: TCR 50              | E192+E24:  | F : ±1.0%        | T : 7" RL                 | L = Sn base<br>(lead free) |
| WF20: 2010       | Q: TCR 50<br>Hi-power  | 3 significant digits followed by no.<br>of zeros | D : ±0.5%        | A : 7" RL<br>15,000pcs/RL |                            |
| WF10: 1210       | U: TCR 25              | 102Ω =1020                                       | C: ±0.25%        |                           |                            |
| WF12: 1206       | R: TCR 25:<br>Hi-power | 37.4KΩ =3742                                     | B : ±0.1%        |                           |                            |
| WF08: 0805       | F: TCR 15              | 220Ω =2200                                       | A : ±0.05%       |                           |                            |
| WF06: 0603       | W: TCR 10              |  |                  |                           |                            |
| WF04: 0402       | Z: TCR 5               |  |                  |                           |                            |
| WF02: 0201       |                        |  |                  |                           |                            |

1. Reeled tape packaging: 8mm width paper taping.

5,000pcs/reel for WF10, WF12, WF08, WF06; 10,000pcs/reel for WF04; 15,000pcs/reel for WF02

2. Reeled tape packaging : 12mm width plastic taping, 4,000pcs/reel for WF25, WF20

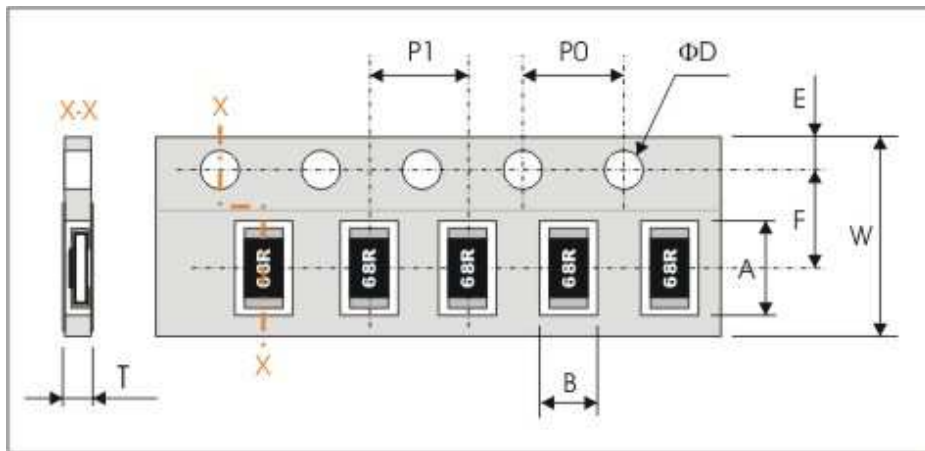
**TEST AND REQUIREMENTS(JIS C 5201-1 : 1998)**

| TEST  | PROCEDURE   | REQUIREMENT   |
|---|---|---|
|   |   | Resistor  |
| DC resistance<br><b>Clause 4.5</b>                                | DC resistance values measured at the test voltages specified below :<br><10Ω@0.1V, <100Ω@0.3V, <1KΩ@1.0V,<br><10KΩ@3V, <100KΩ@10V, <1MΩ@25V, <10MΩ@30V  | Within the specified tolerance  |
| Temperature Coefficient of Resistance(T.C.R)<br><b>Clause 4.8</b> | Natural resistance change per change in degree centigrade.<br>$\frac{R_2 - R_1}{R_1(t_2 - t_1)} \times 10^6 \text{ (ppm/}^\circ\text{C)}$<br>R <sub>1</sub> : Resistance at reference temperature<br>R <sub>2</sub> : Resistance at test temperature<br>t <sub>1</sub> : 20°C+5°C-1°C<br>t <sub>2</sub> : 125°C+5°C-1°C | Refer to<br>"QUICK REFERENCE DATA"  |
| Short time overload (S.T.O.L)<br><b>Clause 4.13</b>               | Permanent resistance change after a 5second application of a voltage 2.5 times RCWV or the maximum overload voltage specified in the above list, whichever is less.   | For TCR50/25,<br>ΔR/R max. ±(0.2%+0.05Ω)<br>For TCR15/10/5,<br>ΔR/R max. ±(0.1%+0.05Ω)                      |
| Resistance to soldering heat(R.S.H)<br><b>Clause 4.18</b>         | Un-mounted chips completely immersed for 10±1second in a SAC solder bath at 260°C±5°C   | no visible damage<br>Δ R/R max. ±(0.1%+0.05Ω)   |
| Solderability<br><b>Clause 4.17</b>                               | Un-mounted chips completely immersed for 2±0.5 second in a SAC solder bath at 235°C±5°C   | good tinning (>95% covered)<br>no visible damage  |
| Temperature cycling<br><b>Clause 4.19</b>                         | 30 minutes at -55°C±3°C, 2~3 minutes at 20°C+5°C-1°C, 30 minutes at +155°C±3°C, 2~3 minutes at 20°C+5°C-1°C, total 5 continuous cycles  | no visible damage<br>For TCR50/25,<br>ΔR/R max. ±(0.2%+0.05Ω)<br>For TCR15/10/5,<br>ΔR/R max. ±(0.1%+0.05Ω) |
| Load life (endurance)<br><b>Clause 4.25</b>                       | 1000 +48/-0 hours, loaded with RCWV or Vmax in chamber controller 70±2°C, 1.5 hours on and 0.5 hours off  | For TCR50/25,<br>ΔR/R max. ±(0.5%+0.05Ω)<br>For TCR15/10/5,<br>ΔR/R max. ±(0.25%+0.05Ω)                     |
| Load life in Humidity<br><b>Clause 4.24</b>                       | 1000 +48/-0 hours, loaded with RCWV or Vmax in humidity chamber controller at 40°C±2°C and 90~95% relative humidity, 1.5hours on and 0.5 hours off  | For TCR50/25,<br>ΔR/R max. ±(0.5%+0.05Ω)<br>For TCR15/10/5,<br>ΔR/R max. ±(0.25%+0.05Ω)                     |
| Bending strength<br><b>Clause 4.33</b>                            | Resistors mounted on a 90mm glass epoxy resin PCB(FR4); bending : 3 mm, once for 10 seconds.  | ΔR/R max. ±(0.1%+0.05Ω)   |
| Adhesion<br><b>Clause 4.32</b>                                    | Pressurizing force: 5N, Test time: 10±1sec.   | No remarkable damage or removal of the terminations.  |
| Insulation Resistance<br><b>Clause 4.6</b>                        | Apply the maximum overload voltage (DC) for 1minute   | R ≥ 10GΩ  |
| Dielectric Withstand Voltage<br><b>Clause 4.7</b>                 | Apply the maximum overload voltage (AC) for 1 minute  | No breakdown or flashover   |



## PACKAGING

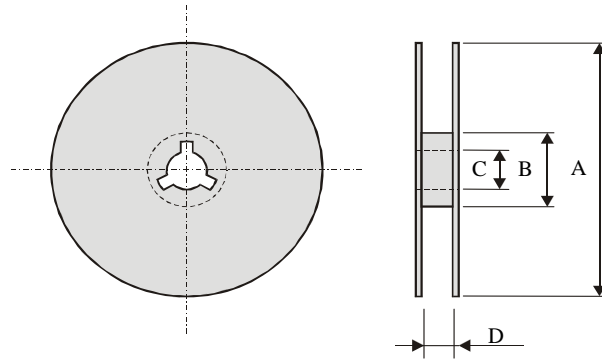
Tape specifications (unit :mm)



| Series No. | A         | B         | W          | F         | E         |
|------------|-----------|-----------|------------|-----------|-----------|
| WF25       | 6.90±0.20 | 3.60±0.20 | 12.00±0.30 | 5.50±0.10 | 1.75±0.10 |
| WF20       | 5.50±0.20 | 2.80±0.20 | 12.00±0.30 | 5.50±0.10 | 1.75±0.10 |
| WF10       | 3.60±0.20 | 3.00±0.20 | 8.00±0.30  | 3.50±0.20 | 1.75±0.10 |
| WF12       | 3.60±0.20 | 2.00±0.20 | 8.00±0.30  | 3.50±0.20 | 1.75±0.10 |
| WF08       | 2.40±0.20 | 1.65±0.20 | 8.00±0.30  | 3.50±0.20 | 1.75±0.10 |
| WF06       | 1.90±0.20 | 1.10±0.20 | 8.00±0.30  | 3.50±0.20 | 1.75±0.10 |
| WF04       | 1.20±0.10 | 0.7±0.10  | 8.00±0.30  | 3.50±0.05 | 1.75±0.10 |
| WF02       | 0.67±0.05 | 0.37±0.05 | 8.00±0.20  | 3.50±0.20 | 1.75±0.10 |

| Series No. | P1        | P0        | ΦD                                    | T         |
|------------|-----------|-----------|---------------------------------------|-----------|
| WF25       | 4.00±0.10 | 4.00±0.10 | Φ1.50 <sup>+0.1</sup> <sub>-0.0</sub> | MAX1.2    |
| WF20       | 4.00±0.10 | 4.00±0.10 | Φ1.50 <sup>+0.1</sup> <sub>-0.0</sub> | MAX1.2    |
| WF10       | 4.00±0.10 | 4.00±0.10 | Φ1.50 <sup>+0.1</sup> <sub>-0.0</sub> | Max. 1.0  |
| WF12       | 4.00±0.10 | 4.00±0.10 | Φ1.50 <sup>+0.1</sup> <sub>-0.0</sub> | Max. 1.0  |
| WF08       | 4.00±0.10 | 4.00±0.10 | Φ1.50 <sup>+0.1</sup> <sub>-0.0</sub> | Max. 1.0  |
| WF06       | 4.00±0.10 | 4.00±0.10 | Φ1.50 <sup>+0.1</sup> <sub>-0.0</sub> | 0.65±0.05 |
| WF04       | 2.00±0.10 | 4.00±0.10 | Φ1.50 <sup>+0.1</sup> <sub>-0.0</sub> | 0.40±0.05 |
| WF02       | 2.00±0.05 | 4.00±0.10 | Φ1.50 <sup>+0.1</sup> <sub>-0.0</sub> | 0.45±0.05 |

Remark: Plastic tape for WF25, WF20; Paper tape for WF10, WF12, WF08, WF06, WF04, WF02.



| Symbol      | A                    | B                   | C              | D             |
|-------------|----------------------|---------------------|----------------|---------------|
| (unit : mm) | $\Phi 178.0 \pm 2.0$ | $\Phi 60.0 \pm 1.0$ | $13.0 \pm 0.2$ | $9.0 \pm 0.5$ |

**Taping quantity**

- Chip resistors 4,000 pcs per reel ( WF25, WF20 )
- Chip resistors 5,000 pcs per reel ( WF10, WF12, WF08, WF06 )
- Chip resistors 10,000 pcs per reel ( WF04 )
- Chip resistors 15,000 pcs per reel ( WF02 )
-