

# APPROVAL SHEET

**WR12, WR08, WR06, WR04**

**$\pm 1\%$ ,  $\pm 5\%$**

Thick Film General Purpose Chip Resistors

Size 1206, 0805, 0603, 0402

RoHS 2 compliant & Halogen free

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

## FEATURE

1. High reliability and stability
2. Reduced size of final equipment
3. Lower assembly costs
4. Higher component and equipment reliability
5. RoHS 2 compliant and Halogen free products

## APPLICATION

- Consumer electrical equipment
- EDP, Computer application
- Telecom application

## 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 paste that is applied to the top surface of the substrate. The composition of the paste is adjusted to give the approximate resistance required and the value is trimmed to within tolerance by laser cutting of this resistive layer.

The resistive layer is covered with a protective coat. Finally, the two external end terminations are added. For ease of soldering the outer layer of these end terminations is a Tin (lead free) alloy.

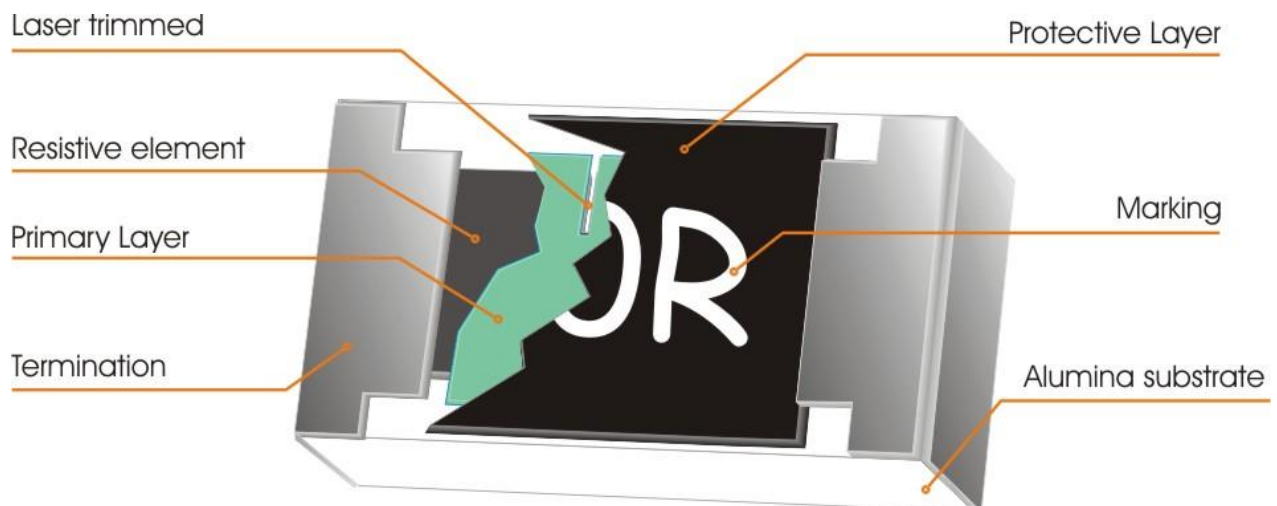


Fig 1. Construction of Chip-R

**QUICK REFERENCE DATA**

| Item                                         | General Specification                                       |            |                |            |                |            |                |            |
|----------------------------------------------|-------------------------------------------------------------|------------|----------------|------------|----------------|------------|----------------|------------|
| Series No.                                   | WR12                                                        |            | WR08           |            | WR06           |            | WR04           |            |
| Size code                                    | 1206(3216)                                                  |            | 0805(2012)     |            | 0603(1608)     |            | 0402(1005)     |            |
| Resistance Range                             | 1Ω~10MΩ (±5% tolerance), Jumper<br>1Ω~10MΩ (±1% tolerance), |            |                |            |                |            |                |            |
| Resistance Tolerance                         | ±1%<br>E96/E24                                              | ±5%<br>E24 | ±1%<br>E96/E24 | ±5%<br>E24 | ±1%<br>E96/E24 | ±5%<br>E24 | ±1%<br>E96/E24 | ±5%<br>E24 |
| TCR (ppm/°C)<br>10MΩ ≥R > 10Ω<br>R≤10Ω       | ≤ ± 100<br>-200~+400                                        |            |                |            |                |            |                |            |
| Max. dissipation<br>@ T <sub>amb</sub> =70°C | 1/4 W                                                       |            | 1/8 W          |            | 1/10 W         |            | 1/16 W         |            |
| Max. Operation<br>Voltage (DC or RMS)        | 200V                                                        |            | 150V           |            | 75V            |            | 50V            |            |
| Max. Overload<br>Voltage (DC or RMS)         | 400V                                                        |            | 300V           |            | 150V           |            | 100V           |            |
| Climatic category                            | 55/155/56                                                   |            |                |            |                |            |                |            |

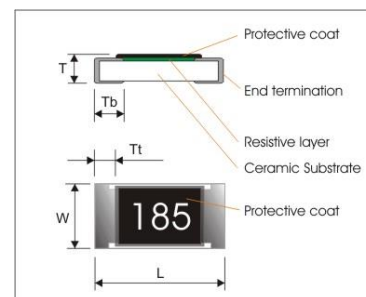
Note :

- 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  

$$RCWV = \sqrt{\text{Rated Power} \times \text{Resistance Value}} \text{ or Max. RCWV listed above, whichever is lower.}$$
- The resistance of Jumper is defined <0.05Ω.

**DIMENSIONS (unit : mm)**

|           | WR12        | WR08        | WR06        | WR04        |
|-----------|-------------|-------------|-------------|-------------|
| <b>L</b>  | 3.10 ± 0.10 | 2.00 ± 0.10 | 1.60 ± 0.10 | 1.00 ± 0.05 |
| <b>W</b>  | 1.60 ± 0.10 | 1.25 ± 0.10 | 0.80 ± 0.10 | 0.50 ± 0.05 |
| <b>T</b>  | 0.60 ± 0.15 | 0.50 ± 0.15 | 0.45 ± 0.15 | 0.35 ± 0.05 |
| <b>Tb</b> | 0.45 ± 0.20 | 0.40 ± 0.20 | 0.30 ± 0.15 | 0.25 ± 0.10 |
| <b>Tt</b> | 0.50 ± 0.20 | 0.40 ± 0.20 | 0.30 ± 0.10 | 0.20 ± 0.10 |



**MARKING**

| Size \ Nr. Of digit of code\tolerance | $\pm 5\%$        | $\pm 1\%$        |
|---------------------------------------|------------------|------------------|
| <b>1206 (3216)</b>                    | 3-digits marking | 4-digits marking |
| <b>0805 (2012)</b>                    | 3-digits marking | 4-digits marking |
| <b>0603 (1608)</b>                    | 3-digits marking | 3-digits marking |
| <b>0402(1005)</b>                     | NO MARKING       |                  |

**3-digits marking** ( $\pm 5\%$  : 1206 & 0805 & 0603 )

Each resistor is marked with a three digits code on the protective coating to designate the nominal resistance value.

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

| Nominal resistance |         |      |         | Description                                                                                                                                                     |         |      |         |      |         |      |         |      |         |      |         |
|--------------------|---------|------|---------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|------|---------|------|---------|------|---------|------|---------|------|---------|
| 1.E-24 series      |         |      |         | As 0603 WR06X ±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 :                                                 |         |      |         |      |         |      |         |      |         |      |         |
|                    |         |      |         | Y=10 <sup>-2</sup> , X=10 <sup>-1</sup> , A=10 <sup>0</sup> , B=10 <sup>1</sup> , C=10 <sup>2</sup> , D=10 <sup>3</sup> , E=10 <sup>4</sup> , F=10 <sup>5</sup> |         |      |         |      |         |      |         |      |         |      |         |
|                    |         |      |         | EX :     17.8Ω=25X , 178Ω=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** ( $\pm 1\%$  : 1206/0805 )

Each resistor is marked with a four digits code on the protective coating to designate the nominal resistance value.

**Example**

| RESISTANCE                                        | 10 $\Omega$ | 12 $\Omega$ | 100 $\Omega$ | 6800 $\Omega$ | 47000 $\Omega$ |
|---------------------------------------------------|-------------|-------------|--------------|---------------|----------------|
| 3-digits marking ( 1206 & 0805 & 0603 $\pm 5\%$ ) | 100         | 120         | 101          | 682           | 473            |
| 4-digits marking                                  | 10R0        | 12R0        | 1000         | 6801          | 4702           |

## FUNCTIONAL DESCRIPTION

### Product characterization

Standard values of nominal resistance are taken from the E24 series for resistors with a tolerance of  $\pm 5\%$ , and E96 series for resistors with a tolerance of  $\pm 1\%$ . The values of the E24/E96 series are in accordance with "IEC publication 60063"

### Derating

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

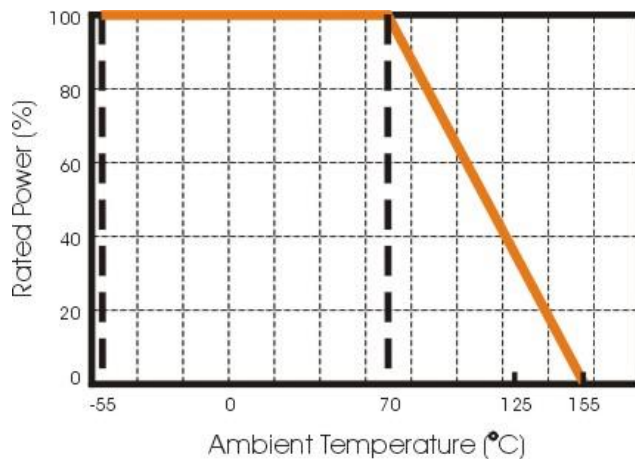


Figure 2 Maximum dissipation in percentage of rated power as a function of the ambient temperature for WR12, WR08, WR06, WR04

## MOUNTING

Due to their rectangular shapes and small tolerances, Surface Mountable Resistors are suitable for handling by automatic placement systems.

Chip placement can be on ceramic substrates and printed-circuit boards (PCBs).

Electrical connection to the circuit is by individual soldering condition.

### Storage and Handling Conditions:

1. Products are recommended to be used up within two years since operation date as ensured shelf life. Check solderability in case shelf life extension is needed.
2. To store products with following condition:
  - Temperature :5 to 40°C
  - Humidity :20 to 70% relative humidity
3. Caution:
  - a. Don't store products in a corrosive environment such as sulfide, chloride gas, or acid.  
It may cause oxidation of electrode, which easily be resulted in poor soldering
  - b. To store products on the shelf and avoid exposure to moisture.
  - c. Don't expose products to excessive shock, vibration, direct sunlight and so on

## SOLDERING CONDITION follows J-STD-020D

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. 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.

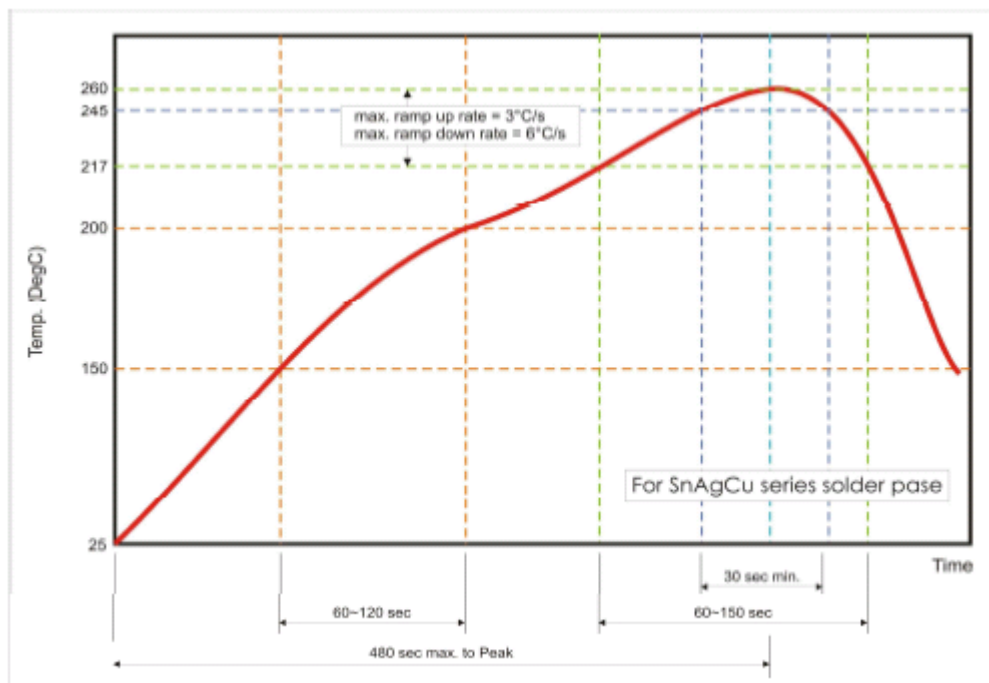


Fig 3. Infrared soldering profile for Chip Resistors

## CATALOGUE NUMBERS

The resistors have a catalogue number starting with

| WR12        | X                | 472_                                                                | J          | T                                 | L                      |
|-------------|------------------|---------------------------------------------------------------------|------------|-----------------------------------|------------------------|
| Size code   | Type code        | Resistance code                                                     | Tolerance  | Packaging code                    | Termination code       |
| WR12 : 1206 | <b>X :</b>       | ±5%, E24: 2 significant digits followed by no. of zeros and a blank | F : ±1%    | T : 7" Reeled taping              | L= Sn base (lead free) |
| WR08 : 0805 | Jumper           |                                                                     | J : ±5%    | Q : 10" Reeled taping             |                        |
| WR06 : 0603 | ±5%, 1Ω ~ 10MΩ   | 4.7Ω =4R7_                                                          | P : Jumper | G : 13" Reeled taping             |                        |
| WR04: 0402  | ±1%, 10Ω ~ 1MΩ   | 10Ω =100_                                                           |            | H : 13" reel 50Kpcs only for 0402 |                        |
|             | <b>W :</b>       | 220Ω =221_                                                          |            | B : Bulk                          |                        |
|             | ±1%, < 10Ω; >1MΩ | Jumper =000_                                                        |            | D : 7" reel 20Kpcs only for 0402  |                        |
|             |                  | ("_" means a blank)                                                 |            | A : 7" reel 15Kpcs only for 0402  |                        |
|             |                  | ±1%, E24+E96: 3 significant digits followed by no. of zeros         |            |                                   |                        |
|             |                  | 102Ω =1020                                                          |            |                                   |                        |
|             |                  | 37.4KΩ =3742                                                        |            |                                   |                        |

WR12, WR08, WR06:

1. Reeled tape packaging : 8mm width paper taping 5000pcs per 7" reel, 10kpcs per 10" reel, 20kpcs per 13" reel.
2. Bulk packaging : 5000pcs per poly-bag

WR04:

1. Reeled tape packaging : 8mm width paper taping 10,000pcs per 7" reel, 20,000pcs per 10" reel. 70,000pcs per 13" reel.
2. Bulk packaging : 10,000pcs per poly-bag

## TEST AND REQUIREMENTS

Essentially all tests are carried out according to the schedule of IEC publication 115-8, category **LCT/UCT/56**(rated temperature range : **Lower Category Temperature, Upper Category Temperature**; damp heat, long term, 56 days). The testing also meets the requirements specified by EIA, EIAJ and JIS.

The tests are carried out in accordance with IEC publication 68, "Recommended basic climatic and mechanical robustness testing procedure for electronic components" and under standard atmospheric conditions according to IEC 60068-1, subclause 5.3. Unless otherwise specified, the following value supplied :

Temperature: 15°C to 35°C.

Relative humidity: 45% to 75%.

Air pressure: 86kPa to 106 kPa (860 mbar to 1060 mbar).

All soldering tests are performed with mildly activated flux.

| TEST                                                                  | PROCEDURE / TEST METHOD                                                                                                                                                                                                                                                                                                                                                                                                                                            | REQUIREMENT                                                                   |       |
|-----------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------|-------|
|                                                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Resistor                                                                      | 0Ω    |
| Electrical Characteristics<br><br>JISC5201-1: 1998<br>Clause 4.8      | - DC resistance values measurement<br>- Temperature Coefficient of Resistance (T.C.R)<br>Natural resistance change per change in degree centigrade.<br>$\frac{R_2 - R_1}{R_1(t_2 - t_1)} \times 10^6 \text{ (ppm/°C)}$ $t_1 : 20^\circ\text{C}+5^\circ\text{C}-1^\circ\text{C}; t_2 : -55^\circ\text{C} \text{ or } +155^\circ\text{C}$<br>$R_1$ : Resistance at reference temperature (20°C+5°C/-1°C)<br>$R_2$ : Resistance at test temperature (-55°C or +155°C) | Within the specified tolerance<br>Refer to "QUICK REFERENCE DATA"             | <50mΩ |
| Resistance to soldering heat(R.S.H)<br>JISC5201-1:1998<br>Clause 4.18 | Un-mounted chips completely immersed for 10±1second in a SAC solder bath at 260°C±5°C                                                                                                                                                                                                                                                                                                                                                                              | ±5%:ΔR/Rmax.±(1%+0.05Ω)<br>±1%:ΔR/Rmax.±(0.5%+0.05Ω)<br>no visible damage     | <50mΩ |
| Solderability<br>JISC5201-1: 1998<br>Clause 4.17                      | Un-mounted chips completely immersed for 2±0.5 second in a SAC solder bath at 235°C±5°C                                                                                                                                                                                                                                                                                                                                                                            | 95% coverage min., good tinning and no visible damage                         |       |
| Temperature cycling<br>JISC5201-1: 1998<br>Clause 4.19                | 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                                                                                                                                                                                                                                                                                                                             | ±5%: ΔR/R max. ±(1%+0.05Ω)<br>±1%:ΔR/Rmax.±(0.5%+0.05Ω)<br>No visible damage  | <50mΩ |
| High Temperature Exposure<br>MIL-STD-202<br>method 108                | 1000+48/-0 hours; without load in a temperature chamber controlled 155±3°C                                                                                                                                                                                                                                                                                                                                                                                         | ±5%:ΔR/Rmax.±(2%+0.1Ω)<br>±1%:ΔR/Rmax.±(1%+0.1Ω)<br>No visible damage         | <50mΩ |
| Bending strength<br>JISC5201-1: 1998<br>Clause 4.33                   | Resistors mounted on a 90mm glass epoxy resin PCB(FR4), bending once 3mm for 10sec, 5mm for WR04                                                                                                                                                                                                                                                                                                                                                                   | ±5%:ΔR/Rmax.±(1%+0.05Ω)<br>±1%:ΔR/Rmax.±(1%+0.05Ω)<br>No visual damaged       | <50mΩ |
| Adhesion<br>JISC5201-1: 1998<br>Clause 4.32                           | Pressurizing force: 5N, Test time: 10±1sec.                                                                                                                                                                                                                                                                                                                                                                                                                        | No remarkable damage or removal of the terminations                           |       |
| Short Time Overload (STOL)<br>JISC5201-1: 1998<br>Clause 4.13         | 2.5 times RCWV or max. overload voltage, for 5seconds                                                                                                                                                                                                                                                                                                                                                                                                              | ±5%: ΔR/R max. ±(2%+0.05Ω)<br>±1%: ΔR/R max. ±(1%+0.05Ω)<br>No visible damage | <50mΩ |

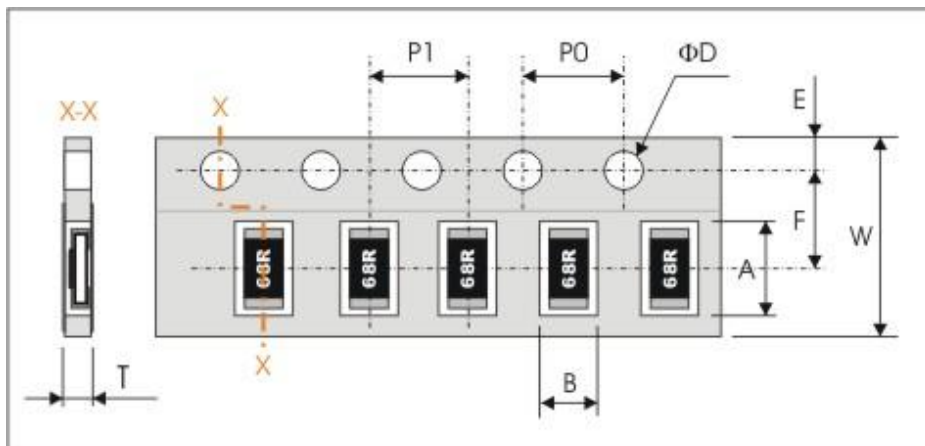
| TEST                                                           | PROCEDURE / TEST METHOD                                                                                                                            | REQUIREMENT                                                                                                     |       |
|----------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------|-------|
|                                                                |                                                                                                                                                    | Resistor                                                                                                        | 0Ω    |
| Load life in Humidity<br>JISC5201-1: 1998<br>Clause 4.24       | 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 | ±5%: $\Delta R/R$ max. $\pm(2\%+0.1\Omega)$<br>±1%: $\Delta R/R$ max. $\pm(1\%+0.1\Omega)$<br>No visible damage | <50mΩ |
| Load life (endurance)<br>JISC5201-1: 1998<br>Clause 4.25       | 1000 +48/-0 hours, loaded with RCWV or Vmax in chamber controller 70±2°C, 1.5 hours on and 0.5 hours off                                           | ±5%: $\Delta R/R$ max. $\pm(3\%+0.1\Omega)$<br>±1%: $\Delta R/R$ max. $\pm(1\%+0.1\Omega)$<br>No visible damage | <50mΩ |
| Insulation Resistance<br>JISC5201-1: 1998<br>Clause 4.6        | Apply the maximum overload voltage (DC) for 1minute                                                                                                | $R \geq 10G\Omega$                                                                                              |       |
| Dielectric Withstand Voltage<br>JISC5201-1: 1998<br>Clause 4.7 | Apply the maximum overload voltage (AC) for 1 minute                                                                                               | No breakdown or flashover                                                                                       |       |

**TEST CONDITION FOR JUMPER (0 Ω)**

| Item                  | WR12         | WR08 | WR06  | WR04  |
|-----------------------|--------------|------|-------|-------|
| Power Rating At 70°C  | 1/4W         | 1/8W | 1/10W | 1/16W |
| Resistance            | MAX.50mΩ     |      |       |       |
| Rated Current         | 2A           | 1.5A | 1A    | 1A    |
| Peak Current          | 5A           | 3.5A | 3A    | 2A    |
| Operating Temperature | -55 ~ +155°C |      |       |       |

## PACKAGING

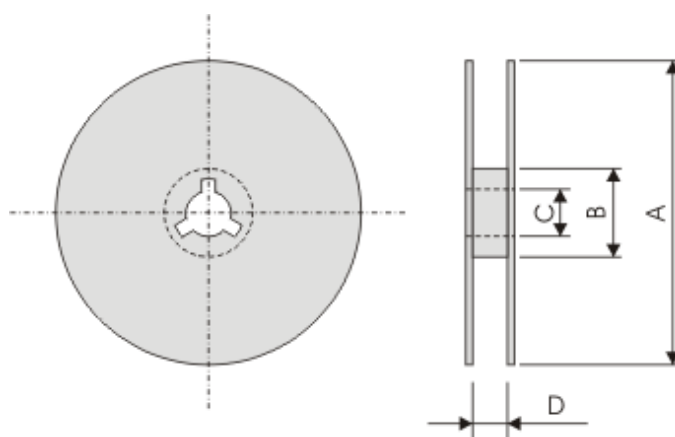
Paper Tape specifications (unit :mm)



| Series No. | A         | B         | W         | F         | E         |
|------------|-----------|-----------|-----------|-----------|-----------|
| WR12       | 3.60±0.20 | 2.00±0.20 | 8.00±0.30 | 3.50±0.20 | 1.75±0.10 |
| WR08       | 2.40±0.20 | 1.65±0.20 |           |           |           |
| WR06       | 1.90±0.20 | 1.10±0.20 |           |           |           |
| WR04       | 1.20±0.10 | 0.70±0.10 |           |           |           |

| Series No.  | P1        | P0        | ΦD                        | T         |
|-------------|-----------|-----------|---------------------------|-----------|
| WR12 / WR08 | 4.00±0.10 | 4.00±0.10 | $\Phi 1.50^{+0.1}_{-0.0}$ | Max. 1.0  |
| WR06        |           |           |                           | 0.65±0.05 |
| WR04        | 2.00±0.10 |           |                           | 0.40±0.05 |

### 7" Reel dimensions



| Symbol   | A                    | B                    | C        | D       |
|----------|----------------------|----------------------|----------|---------|
| 7" reel  | $\Phi 178.0 \pm 2.0$ | $\Phi 60.0 \pm 1.0$  | 13.0±0.2 | 9.0±0.5 |
| 10" reel | $\Phi 254.0 \pm 2.0$ | $\Phi 100.0 \pm 1.0$ | 13.0±0.2 | 9.0±0.5 |
| 13" reel | $\Phi 330.0 \pm 2.0$ | $\Phi 100.0 \pm 1.0$ | 13.0±0.2 | 9.0±0.5 |