Innovative Service Around the Globe YAGEO

# DATA SHEET

## THIN FILM CHIP RESISTORS

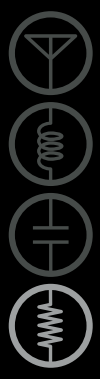
### High precision - high stability

RT series

0.05% TO 1%, TC 10 TO 50

**sizes 0402/0603/0805/1206/ 1210/2010/2512**

**RoHS compliant**



YAGEO Phicomp

Product specification – Oct 21, 2009 V.4



## SCOPE

This specification describes RT0402 to RT2512 high precision - high stability chip resistors with lead-free terminations made by thin film process.

## APPLICATIONS

- Converters
- Printer equipment
- Server board
- Telecom
- Consumer

## FEATURES

- Halogen Free Epoxy
- RoHS compliant
  - Products with lead free terminations meet RoHS requirements
  - Pb-glass contained in electrodes, resistor element and glass are exempted by RoHS
- Reducing environmentally hazardous wastes
- High component and equipment reliability
- Saving of PCB space
- None forbidden-materials used in products/production

## ORDERING INFORMATION - GLOBAL PART NUMBER & 12NC

Both part numbers are identified by the series, size, tolerance, packing type, temperature coefficient, taping reel and resistance value.

**YAGEO BRAND ordering code**

**GLOBAL PART NUMBER (PREFERRED)**

| RT | XXXX | F | X | X | XX | XXXX | L |
|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |

### (1) SIZE

0402 / 0603 / 0805 / 1206 / 1210 / 2010 / 2512

### (2) TOLERANCE

W = ±0.05%
B = ±0.1%
C = ±0.25%
D = ±0.5%
F = ±1%

### (3) PACKAGING TYPE

R = Paper/PE taping reel  K = Embossed taping reel

### (4) TEMPERATURE COEFFICIENT OF RESISTANCE

B = 10 ppm/°C  C = 15 ppm/°C  D = 25 ppm/°C  E = 50 ppm/°C

### (5) TAPING REEL

07 = 7 inch dia. Reel  10 = 10 inch dia. Reel  13 = 13 inch dia. Reel

### (6) RESISTANCE VALUE

There are 2~4 digits indicated the resistor value. Letter R/K/M is decimal point, no need to mention the last zero after R/K/M, e.g.1K2, not 1K20.

Detailed resistance rules show in table of "Resistance rule of global part number".

### (7) DEFAULT CODE

Letter L is system default code for order only (Note)

Resistance rule of global part number

| Resistance code rule | Example |
|---|---|
| XRXX (1 to 9.76 Ω) | 1R = 1 Ω<br>1R5 = 1.5 Ω<br>9R76 = 9.76 Ω |
| XXRX (10 to 97.6 Ω) | 10R = 10 Ω<br>97R6 = 97.6 Ω |
| XXXR (100 to 976 Ω) | 100R = 100 Ω |
| XKXX (1 to 9.76 KΩ) | 1K = 1,000 Ω<br>9K76 = 9760 Ω |
| XMXX (1 to 9.76 MΩ) | 1M = 1,000,000 Ω<br>9M76= 9,760,000 Ω |

### ORDERING EXAMPLE

The ordering code of a RT0603 chip resistor, TC 50 value 56 Ω with ±0.5% tolerance, supplied in 7-inch tape reel is: RT0603DRE0756RL.

### NOTE

1. All our RSMD products meet RoHS compliant and Halogen Free. "LFP" of the internal 2D reel label mentions "Lead Free Process"
2. On customized label, "LFP" or specific symbol can be printed

### PHYCOMP BRAND ordering codes

Both GLOBAL PART NUMBER (preferred) and 12NC (traditional) codes are acceptable to order Phycomp brand products. For matching traditional types with size codes, please refer to "Comparison table of traditional types and sizes".

### GLOBAL PART NUMBER (PREFERRED)

For detailed information of GLOBAL PART NUMBER and ordering example, please refer to page 2.

### 12NC CODE

| 2390 | X | XX | X | XXXX | L |
|---|---|---|---|---|---|
| (1) | (2) | (3) | (4) | (5) | (6) |

| START WITH (1) | TCR (2) (ppm/°C) | PACKING CODE BY SIZE (inch) (3) | TOL. (4) (%) | RESISTANCE RANGE | DEFAULT CODE (NOTE) |
|---|---|---|---|---|---|
| 2390 | 8 = ±10 | 0402: 07 = 7" reel | 7 = ±1 | The remaining 4 digits represent the resistance value with the last digit indicating the multiplier as shown in the table of "Last digit of 12NC". | Letter L is system default code for order only |
| | 7 = ±15 | 27 = 10" reel | 6 = ±0.5 | | |
| | 6 = ±25 | 47 = 13" reel | 5 = ±0.25 | | |
| | 4 = ±50 | 0603: 04 = 7" reel | 4 = ±0.1 | | |
| | | 24 = 10" reel | 3 = ±0.05 | | |
| | | 44 = 13" reel | | 0402: 10Ω ≤ R < 121KΩ | |
| | | 0805: 01 = 7" reel | | 0603: 5.1 Ω ≤ R ≤ 681 KΩ | |
| | | 21 = 10" reel | | 0805: 5.1Ω ≤ R ≤ 1.5 MΩ | |
| | | 41 = 13" reel | | 1206: 5.1Ω ≤ R ≤ 1.5 MΩ | |
| | | 1206: 11 = 7" reel | | 1210: 5.1Ω ≤ R ≤ 1.5 MΩ | |
| | | 31 = 10" reel | | 2010: 10Ω ≤ R ≤ 1 MΩ | |
| | | 51 = 13" reel | | 2512: 10Ω ≤ R ≤ 1 MΩ | |
| | | 1210: 12 = 7" reel | | | |
| | | 32 = 10" reel | | | |
| | | 52 = 13" reel | | | |
| | | 2010: 15 = 7" reel | | | |
| | | 2512: 18 = 7" reel | | | |

Exceptions to above packing code definitions:

0805 TC50 with 1%, supplied in 13" reel, the packing code is 02.

0603 TC50 with 1%, supplied in 13" reel, the packing code is 03.

2512 TC15, in 7" reel, the packing code is 35.

2010 TC15, in 7" reel, the packing code is 31.

Comparison table of traditional types and sizes

| TF (1) | X (2) | X (3) | X (4) |
|---|---|---|---|
| START WITH | SIZE CODE | TCR (ppm/°C) | TOL. (%) |
| TF | 3 = 0402 | 4 = ±10 | 0 = ±1 |
| | 2 = 0603 | 3 = ±15 | 1 = ±0.5 |
| | 1 = 0805 | 1 = ±25 | 2 = ±0.25 |
| | 0 = 1206 | 2 = ±50 | 3 = ±0.1 |
| | 5 = 1210 | | 4 = ±0.05 |
| | 7 = 2010 | | |
| | 6 = 2512 | | |

Example:

TF321 = RT0402, TC50, ±0.5% tolerance

| Resistance decade (3) | Last digit |
|---|---|
| 1 to 9.76 Ω | 8 |
| 10 to 97.6 Ω | 9 |
| 100 to 976 Ω | 1 |
| 1 to 9.76 kΩ | 2 |
| 10 to 97.6 kΩ | 3 |
| 100 to 976 kΩ | 4 |
| 1 to 9.76 MΩ | 5 |
| 10 to 97.6 MΩ | 6 |

Example: 1 Ω = 1008 or 108
33 kΩ = 3303 or 333
10 MΩ = 1006 or 106

### ORDERING EXAMPLE

The ordering code of a TF221 resistor, TC50, value 56 Ω, with ±0.5% tolerance, supplied in tape of 5,000 units per reel is: 239040465609L or RT0603DRE0756RL.

### NOTE

1. All our RSMD products meet RoHS compliant and Halogen Free. "LFP" of the internal 2D reel label mentions "Lead Free Process"
2. On customized label, "LFP" or specific symbol can be printed

## MARKING

RT0805 / RT1206 / RT1210 / RT2010 / RT2512




Fig. 1 Value = 10 kΩ

Either resistance in E-24 or E-96: 4 digits

First three digits for significant figure and 4th digit for number of zeros

RT0603




Fig. 2 Value = 12 kΩ

E-24 series: 3 digits

First two digits for significant figure and 3rd digit for number of zeros




Fig. 3 Value = 12.4 kΩ

E-96 series: 3 digits for 0603±1% EIA-96 marking method

RT0402 / RESISTANCE VALUE IS NOT IN E-24 / E96 SERIES



Fig. 4

No marking

For further marking information, please see special data sheet "Chip resistors marking".

## CONSTRUCTION

The resistors are constructed out of a high-grade ceramic body. Internal metal electrodes are added at each end and connected by a resistive layer. The resistive layer is adjusted to give the approximate required resistance and laser cutting of this resistive layer that achieves tolerance trims the value. The resistive layer is covered with a protective coat and printed with the resistance value. Finally, the two external terminations (matte tin) are added. See fig. 5.

## DIMENSION

Table 1 For outlines see fig. 5

| TYPE | L (mm) | W (mm) | H (mm) | $I_1$ (mm) | $I_2$ (mm) |
|---|---|---|---|---|---|
| RT0402 | 1.00 ±0.10 | 0.50 ±0.05 | 0.30 ±0.05 | 0.20 ±0.10 | 0.25 ±0.10 |
| RT0603 | 1.60 ±0.10 | 0.80 ±0.10 | 0.45 ±0.10 | 0.25 ±0.15 | 0.25 ±0.15 |
| RT0805 | 2.00 ±0.10 | 1.25 ±0.10 | 0.50 ±0.10 | 0.35 ±0.20 | 0.35 ±0.20 |
| RT1206 | 3.10 ±0.10 | 1.60 ±0.10 | 0.55 ±0.10 | 0.45 ±0.20 | 0.40 ±0.20 |
| RT1210 | 3.10 ±0.10 | 2.60 ±0.15 | 0.55 ±0.10 | 0.50 ±0.20 | 0.50 ±0.20 |
| RT2010 | 5.00 ±0.10 | 2.50 ±0.15 | 0.55 ±0.10 | 0.60 ±0.20 | 0.50 ±0.20 |
| RT2512 | 6.35 ±0.10 | 3.20 ±0.15 | 0.55 ±0.10 | 0.60 ±0.20 | 0.50 ±0.20 |

## OUTLINES

For dimension see Table 1

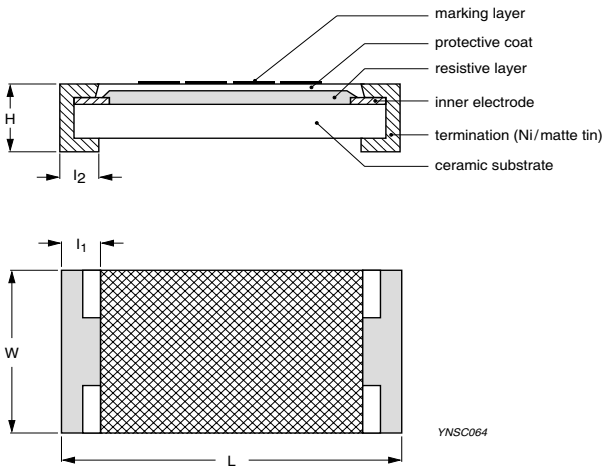



Fig. 5 Chip resistor outlines

## ELECTRICAL CHARACTERISTICS

Table 2

| TYPE | Operating Temperature Range | Power Rating | Max. Work Vol. (1) | Max. Overload Vol. | Dielectric Withstand Vol. | T.C.R. (ppm/°C) | Resistance Range (E-24/E-96 series)(2) & Tolerance | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | ±0.05% | ±0.1% | ±0.25% | ±0.5% | ±1.0% |
| **RT0402** | –55 °C to +125 °C | 1/16W | 50V | 100V | 75V | ±50 | --- | 10~121k | 10~121k | 10~121k | 10~121k |
| | | | | | | ±25 | --- | 10~121k | 10~121k | 10~121k | --- |
| | | | | | | ±15 | --- | 10~100k | 10~100k | --- | --- |
| | | | | | | ±10 | --- | 10~100k | 10~100k | --- | --- |
| **RT0603** | –55 °C to +125 °C | 1/10W | 75V | 150V | 100V | ±50 | --- | 10~681k | 5.1~681k | 5.1~681k | 5.1~681k |
| | | | | | | ±25 | 1k~47k | 10~681k | 10~681k | 10~681k | --- |
| | | | | | | ±15 | 1k~47k | 10~100k | 10~100k | --- | --- |
| | | | | | | ±10 | 1k~47k | 10~100k | 10~100k | --- | --- |
| **RT0805** | –55 °C to +125 °C | 1/8W | 150V | 300V | 200V | ±50 | --- | 10~1.5M | 5.1~1.5M | 5.1~1.5M | 5.1~1.5M |
| | | | | | | ±25 | 100~100k | 10~1.5M | 10~1.5M | 10~1.5M | --- |
| | | | | | | ±15 | 100~100k | 10~100k | 10~100k | --- | --- |
| | | | | | | ±10 | 100~100k | 10~100k | 10~100k | --- | --- |
| **RT1206** | –55 °C to +125 °C | 1/4W | 200V | 400V | 300V | ±50 | --- | 10~1.5M | 5.1~1.5M | 5.1~1.5M | 5.1~1.5M |
| | | | | | | ±25 | 100~100k | 10~1.5M | 10~1.5M | 10~1.5M | --- |
| | | | | | | ±15 | 100~100k | 10~100k | 10~100k | --- | --- |
| | | | | | | ±10 | 100~100k | 10~100k | 10~100k | --- | --- |
| **RT1210** | –55 °C to +125 °C | 1/4W | 200V | 400V | 400V | ±50 | --- | 10~1M | 5.1~1M | 5.1~1M | 5.1~1M |
| | | | | | | ±25 | 100~100k | 10~1M | 10~1M | 10~1M | --- |
| | | | | | | ±15 | 100~100k | 10~100k | 10~100k | --- | --- |
| | | | | | | ±10 | 100~100k | 10~100k | 10~100k | --- | --- |
| **RT2010** | –55 °C to +125 °C | 1/2W | 200V | 400V | 400V | ±50 | --- | 10~1M | 10~1M | 10~1M | 10~1M |
| | | | | | | ±25 | 100~100k | 10~1M | 10~1M | 10~1M | --- |
| | | | | | | ±15 | 100~100k | 10~100k | 10~100k | --- | --- |
| | | | | | | ±10 | 100~100k | 10~100k | 10~100k | --- | --- |
| **RT2512** | –55 °C to +125 °C | 3/4W | 200V | 400V | 400V | ±50 | --- | 10~1M | 10~1M | 10~1M | 10~1M |
| | | | | | | ±25 | 100~100k | 10~1M | 10~1M | 10~1M | --- |
| | | | | | | ±15 | 100~100k | 10~100k | 10~100k | --- | --- |
| | | | | | | ±10 | 100~100k | 10~100k | 10~100k | --- | --- |

**NOTE**

1. The maximum working voltage that may be continuously applied to the resistor element, see "IEC publication 60115-8"
2. Value of E-192 series is on request

## FOOTPRINT AND SOLDERING PROFILES

For recommended footprint and soldering profiles, please see the special data sheet "Chip resistors mounting".

## PACKING STYLE AND PACKAGING QUANTITY

Table 3 Packing style and packaging quantity

| PACKING STYLE | REEL DIMENSION | RT0402 | RT0603 | RT0805 | RT1206 | RT1210 | RT2010 | RT2512 |
|---|---|---|---|---|---|---|---|---|
| Paper/PE taping reel (R) | 7" (178 mm) | 10,000 | 5,000 | 5,000 | 5,000 | 5,000 | --- | --- |
| | 10" (254 mm) | 20,000 | 10,000 | 10,000 | 10,000 | 10,000 | --- | --- |
| | 13" (330 mm) | 50,000 | 20,000 | 20,000 | 20,000 | 20,000 | --- | --- |
| Embossed taping reel (K) | 7" (178 mm) | --- | --- | --- | --- | --- | 4,000 | 4,000 |

**NOTE**

1. For Paper/Embossed tape and reel specification/dimensions, please see the special data sheet "Chip resistors packing"

## FUNCTIONAL DESCRIPTION

### POWER RATING

Each type rated power at 70°C:
RT0402=1/16 W, RT0603=1/10 W, RT0805=1/8 W, RT1206=1/4 W, RT1210=1/4 W, RT2010=1/2 W, RT2512=3/4 W.

### RATED VOLTAGE

The DC or AC (rms) continuous working voltage corresponding to the rated power is determined by the following formula:

$V=\sqrt{(P \times R)}$
or max. working voltage whichever is less

Where

V=Continuous rated DC or AC (rms) working voltage (V)

P=Rated power (W)

R=Resistance value (Ω)

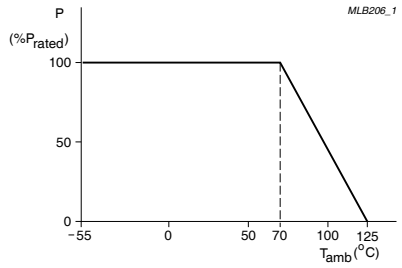



Fig. 6 Maximum dissipation (P) in percentage of rated power as a function of the operating ambient temperature ($T_{amb}$)

## TESTS AND REQUIREMENTS

Table 4 Test condition, procedure and requirements

| TEST | TEST METHOD | PROCEDURE | REQUIREMENTS |
|---|---|---|---|
| Temperature Coefficient of Resistance (T.C.R.) | IEC 60115-1 4.8 | At +25/–55 °C and +25/+125 °C<br>Formula:<br>$T.C.R= \frac{R_2-R_1}{R_1(t_2-t_1)} \times 10^6$ (ppm/°C)<br>Where<br>$t_1$=+25 °C or specified room temperature<br>$t_2$=–55 °C or +125 °C test temperature<br>$R_1$=resistance at reference temperature in ohms<br>$R_2$=resistance at test temperature in ohms | Refer to table 2 |
| Life/Endurance | IEC 60115-1 4.25.1 | At 70±5 °C for 1,000 hours, RCWV applied for 1.5 hours on, 0.5 hour off, still air required | ±(0.5%+0.05 Ω) |
| High Temperature Exposure/ Endurance at Upper Category Temperature | IEC 60068-2-2 | 1,000 hours at 155±5 °C, unpowered | ±(0.5%+0.05 Ω) |
| Moisture Resistance | MIL-STD-202G Method-106G | Each temperature / humidity cycle is defined at 8 hours, 3 cycles / 24 hours for 10d. with 25 °C / 65 °C 95% R.H, without steps 7a & 7b, unpowered<br>Parts mounted on test-boards, without condensation on parts<br>Measurement at 24±2 hours after test conclusion | ±(0.5%+0.05 Ω) |
| Thermal Shock | MIL-STD-202G Method-107G | -55/+125 °C<br>Number of cycles required is 300. Devices unmounted<br>Maximum transfer time is 20 seconds. Dwell time is 15 minutes. Air – Air | ±(0.5%+0.05 Ω) for 10 KΩ to 10 MΩ<br>±(0.5%+0.05 Ω) for others |
| Humidity (steady state) | IEC 60115-1 4.37 | Steady state for 1000 hours at 40 °C / 95% R.H.<br>RCWV applied for 1.5 hours on and<br>0.5 hour off | ±(0.5%+0.05 Ω) |

| TEST | TEST METHOD | PROCEDURE | REQUIREMENTS |
|---|---|---|---|
| Short Time Overload | IEC60115-1 4.13 | 2.5 times of rated voltage or maximum overload voltage whichever is less for 5 sec at room temperature | ±(0.5%+0.05 Ω)<br>No visible damage |
| Board Flex/ Bending | IEC 60068-2-21 | Chips mounted on a 90mm glass epoxy resin PCB (FR4)<br>Bending: see table 6 for each size<br>Bending time: 60±5 seconds | ±(0.25%+0.05 Ω)<br>No visible damage |
| Low Temperature Operation | IEC 60068-2-1 | The resistor shall be subjected to a DC rated voltage for 1.5 h-on, 0.5 h-off, at -55±3 °C<br>This constitutes shall be repeated for 96 hours<br>However the applied voltage shall not exceed the maximum operating voltage | ±(0.5%+0.05 Ω)<br>No visible damage |
| Insulation Resistance | IEC 60115-1 4.6 | Rated continuous overload voltage (RCOV) for 1 minute<br>Details see below table 5 | ≥10 GΩ |
| Dielectric Withstand Voltage | IEC 60115-1 4.7 | Maximum voltage ($V_{rms}$) applied for 1 minute<br>Details see below table 5 | No breakdown or flashover |
| Solderability<br>- Wetting | IPC/JEDEC J-STD-002B test B | Electrical Test not required<br>Magnification 50X<br>SMD conditions:<br>1st step: method B, aging 4 hours at 155°C dry heat<br>2nd step: leadfree solder bath at 245±3°C<br>Dipping time: 3±0.5 seconds | Well tinned (≥95% covered)<br>No visible damage |
| - Leaching | IPC/JEDEC J-STD-002B test D | Leadfree solder, 260 °C, 30 seconds immersion time | No visible damage |
| - Resistance to Soldering Heat | IEC 60068-2-58 | Condition B, no pre-heat of samples.<br>Leadfree solder, 260 °C, 10 seconds immersion time<br>Procedure 2 for SMD: devices fluxed and cleaned with isopropanol | ±(0.5%+0.05 Ω)<br>No visible damage |

Table 5 Criteria of rated continued working voltage and overload voltage

| TYPE | RT0402 | RT0603 | RT0805 | RT1206 | RT1210 | RT2010 | RT2512 |
|---|---|---|---|---|---|---|---|
| Voltage (DC/unit: V); (AC/ unit: $V_{rms}$) | 100 | 100 | 300 | 500 | 500 | 500 | 500 |

Table 6 Bending for sizes 0402 to 2512

| TYPE | RT0402 | RT0603 | RT0805 | RT1206 | RT1210 | RT2010 | RT2512 |
|---|---|---|---|---|---|---|---|
| Specification (mm) | 5 | 3 | 3 | 2 | 2 | 2 | 2 |

## REVISION HISTORY

| REVISION | DATE | CHANGE NOTIFICATION | DESCRIPTION |
|---|---|---|---|
| Version 4 | Oct 21, 2009 | - | - Test Items and methods updated<br>- Test requirements upgraded |
| Version 3 | Jul 11, 2008 | - | - Change to dual brand datasheet that describe RT0402 to RT2512 with RoHS compliant<br>- Description of "Halogen Free Epoxy" added<br>- Define global part number<br>- Modify electrical characteristic |
| Version 2 | Dec 26, 2005 | - | - New datasheet for thin film high precision - high stability chip resistors sizes of 0201/0402/0603/0805/1206/1210/2010/2512, 1%, 0.5%, 0.25%, 0.1%, 0.05%, TC25/50 with lead-free terminations<br>- Replace the 0402 to 1210 parts of pdf files: TFx10_1_1, TFx11_.5_2, TFx12_.25_2, TFx13_.1_3, TFx14_.05_1, TFx20_1_2, TFx21_.5_2, TFx22_.25_2, TFx23_.1_2, TFx24_.05_1, and combine into a document.<br>- Test method and procedure updated<br>- PE tape added (paper tape will be replaced by PE tape) |

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