

## SCOPE

This specification describes RL0402 to RL2512 low ohmic chip resistors with lead-free terminations made by thick film process.

## APPLICATIONS

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

## FEATURES

- AEC-Q200 qualified
- Halogen Free Epoxy
- RoHS compliant
- Hazardous wastes
- High component and equipment reliability
- Saving of PCB space
- Non-forbidden materials used in products/production
- Low resistances applied to current sensing
- MSL Class: MSL 1

## ORDERING INFORMATION - GLOBAL PART NUMBER & I2NC

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)

RL XXXX X X X XX XXXX L  
(1) (2) (3) (4) (5) (6) (7)

#### (1) SIZE

0402 / 0603 / 0805 / 1206 / 1210 / 1218 / 2010 / 2512

#### (2) TOLERANCE

F =  $\pm 1\%$

G =  $\pm 2\%$

J =  $\pm 5\%$

"-" = Jumper ordering

#### (3) PACKAGING TYPE

R = Paper taping reel

K = Embossed taping reel

#### (4) TEMPERATURE COEFFICIENT OF RESISTANCE

- = Based on spec

#### (5) TAPING REEL

07 = 7 inch dia. Reel and standard power

10 = 10 inch dia. Reel and standard power

13 = 13 inch dia. Reel and standard power

7W = 7 inch dia. Reel and 2 x standard power (0805 and 1206)

#### (6) RESISTANCE VALUE

There are 2~4 digits indicated the resistor value. Letter R/K/M is decimal point.

Detailed coding rules of resistance are shown in the 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                                         |
| 0RXXX<br>(1 to 976 mΩ)                | 0R1 = 0.1 Ω<br>0R12 = 0.12 Ω<br>0R105 = 0.105 Ω |
| XRXX<br>(1 to 9.76 Ω)                 | 1R = 1 Ω<br>1R5 = 1.5 Ω<br>9R76 = 9.76 Ω        |
| XXRX<br>(10 to 97.6 Ω)                | 10R = 10 Ω<br>97R6 = 97.6 Ω                     |
| XXXR<br>(100 to 976 Ω)                | 100R = 100 Ω                                    |
| XKXX<br>(1 to 9.76 KΩ)                | 1K = 1,000 Ω<br>9K76 = 9760 Ω                   |
| XMXX<br>(1 to 9.76 MΩ)                | 1M = 1,000,000 Ω<br>9M76 = 9,760,000 Ω          |

### ORDERING EXAMPLE

The ordering code of a RL0603 chip resistor, value 0.56Ω with  $\pm 1\%$  tolerance, supplied in 7-inch tape reel is: RL0603FR-070R56L.

### NOTE

1. All our R-Chip 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 I2NC (traditional) codes are acceptable to order Phycomp brand products.

**GLOBAL PART NUMBER (PREFERRED)**

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

**I2NC CODE****2350 / 2390 / 2322 XXX XXXXX L**

(1) (2) (3) (4)

| SIZE | TYPE    | START IN <sup>(1)</sup> | TOL. (%) | RESISTANCE RANGE | EMBOSSED <sup>(2)</sup> |                    | PAPER/PE <sup>(2)</sup> |         |
|------|---------|-------------------------|----------|------------------|-------------------------|--------------------|-------------------------|---------|
|      |         |                         |          |                  | TAPE ON REEL 4,000      | TAPE ON REEL 5,000 | TAPE ON REEL 10,000     | (units) |
| 0402 | LRC31   | 2350                    | ±5%      | 0.05 to 1 Ω      | -                       | -                  | 513                     | 20xxx   |
|      | LRC32   | 2350                    | ±1%      | 0.05 to 1 Ω      | -                       | -                  | 513                     | 22xxx   |
| 0603 | LRC21   | 2350                    | ±5%      | 0.01 to 1 Ω      | -                       | 512                | 10xxx                   | -       |
|      | LRC22   | 2350                    | ±1%      | 0.01 to 1 Ω      | -                       | 512                | 12xxx                   | -       |
| 0805 | LRC11   | 2350                    | ±5%      | 0.01 to 1 Ω      | -                       | 511                | 10xxx                   | -       |
|      | LRC12   | 2350                    | ±1%      | 0.01 to 1 Ω      | -                       | 511                | 12xxx                   | -       |
|      | LRC11P  | 2350                    | ±1%      | 0.01 to 1 Ω      | -                       | 511                | 15xxx                   | -       |
|      | LRC12P  | 2350                    | ±5%      | 0.01 to 1 Ω      | -                       | 511                | 17xxx                   | -       |
| 1206 | LRC01   | 2350                    | ±5%      | 0.01 to 1 Ω      | -                       | 510                | 10xxx                   | -       |
|      | LRC02   | 2350                    | ±1%      | 0.01 to 1 Ω      | -                       | 510                | 12xxx                   | -       |
|      | LRC01P  | 2350                    | ±1%      | 0.01 to 1 Ω      | -                       | 519                | 01xxx                   | -       |
|      | LRC02P  | 2350                    | ±5%      | 0.01 to 1 Ω      | -                       | 519                | 1xxxx                   | -       |
| 1210 | LPRC101 | 2390                    | ±5%      | 0.01 to 0.0976 Ω | -                       | 735                | 90xxx                   | -       |
|      | LPRC101 | 2390                    | ±5%      | 0.1 to 1 Ω       | -                       | 735                | 60xxx                   | -       |
|      | LPRC102 | 2390                    | ±1%      | 0.01 to 1 Ω      | -                       | 735                | 3xxxx                   | -       |
| 1218 | LPRC201 | 2322                    | ±5%      | 0.01 to 1 Ω      | 735                     | 64xxx              | -                       | -       |
|      | LPRC201 | 2322                    | ±1%      | 0.01 to 1 Ω      | 735                     | 7xxxx              | -                       | -       |
| 2010 | LPRC111 | 2322                    | ±5%      | 0.01 to 0.0976 Ω | 760                     | 90xxx              | -                       | -       |
|      | LPRC111 | 2322                    | ±5%      | 0.1 to 1 Ω       | 760                     | 60xxx              | -                       | -       |
|      | LPRC111 | 2322                    | ±1%      | 0.01 to 0.0976 Ω | 761                     | 90xxx              | -                       | -       |
|      | LPRC111 | 2322                    | ±1%      | 0.1 to 1 Ω       | 761                     | 6xxxx              | -                       | -       |
| 2512 | LPRC221 | 2322                    | ±5%      | 0.01 to 0.0976 Ω | 762                     | 90xxx              | -                       | -       |
|      | LPRC221 | 2322                    | ±5%      | 0.1 to 1 Ω       | 762                     | 60xxx              | -                       | -       |
|      | LPRC221 | 2322                    | ±1%      | 0.01 to 0.0976 Ω | 763                     | 90xxx              | -                       | -       |
|      | LPRC221 | 2322                    | ±1%      | 0.1 to 1 Ω       | 763                     | 6xxxx              | -                       | -       |

Last digit of I2NC

| Resistance decade <sup>(3)</sup> | Last digit |
|----------------------------------|------------|
| 0.01 to 0.0976 Ω                 | 0          |
| 0.1 to 0.976 Ω                   | 7          |
| 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: 0.02 Ω = 0200 or 200  
 0.3 Ω = 3007 or 307  
 1 Ω = 1008 or 108  
 33 kΩ = 3303 or 333  
 10 MΩ = 1006 or 106

**ORDERING EXAMPLE**

The ordering code of a RL0603 chip resistor, value 0.56 Ω with ±1% tolerance, supplied in tape of 5,000 units per reel is: 235051212567L or RL0603FR-070R56L.

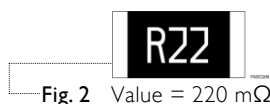
**NOTE**

1. All our R-Chip 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

- (1) The resistors have a 12-digit ordering code starting with 2350/2390/2322.
- (2) The subsequent 4 or 5 digits indicate the resistor tolerance and packaging. (In I2NC code, only 07" tape reel code is supplied. Supply of 10"/13" tape reel is requested in Global part number ordering code.)
- (3) The remaining 4 or 3 digits represent the resistance value with the last digit indicating the multiplier as shown in the table of "Last digit of I2NC".
- (4) Letter L is system default code for order only <sup>(Note)</sup>.

**MARKING**RL0402 / RL0603:  $R < 100 \text{ m}\Omega$  EXCEPT 10/20/30/40/50/60  $\text{m}\Omega$ 

No marking

RL0603:  $R \geq 100 \text{ m}\Omega$ ,  $R = 10/20/30/40/50/60 \text{ m}\Omega$ E-24 series / Non-E series ( $R = 25/40/50/60/250/400/500 \text{ m}\Omega$ ): 3 digits

The "R" is used as a decimal point; the other 2 digits are significant.

RL0805 / RL1206 / RL1210 / RL1218 / RL2010 / RL2512

E-24 series / Non-E series ( $R = 25/40/50/60/250/400/500 \text{ m}\Omega$ ): 4 digits

The "R" is used as a decimal point; the other 3 digits are significant.

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 paste. The composition of the paste 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. 4.

**DIMENSIONS**

Table I For outlines see fig. 4

| TYPE   | L (mm)          | W (mm)          | H (mm)          | $l_1$ (mm)      | $l_2$ (mm)      |
|--------|-----------------|-----------------|-----------------|-----------------|-----------------|
| RL0402 | $1.00 \pm 0.10$ | $0.50 \pm 0.05$ | $0.35 \pm 0.05$ | $0.20 \pm 0.10$ | $0.25 \pm 0.10$ |
| RL0603 | $1.60 \pm 0.10$ | $0.80 \pm 0.10$ | $0.45 \pm 0.10$ | $0.25 \pm 0.15$ | $0.25 \pm 0.15$ |
| RL0805 | $2.00 \pm 0.10$ | $1.25 \pm 0.10$ | $0.50 \pm 0.10$ | $0.35 \pm 0.20$ | $0.35 \pm 0.20$ |
| RL1206 | $3.10 \pm 0.10$ | $1.60 \pm 0.10$ | $0.55 \pm 0.10$ | $0.45 \pm 0.20$ | $0.40 \pm 0.20$ |
| RL1210 | $3.10 \pm 0.10$ | $2.60 \pm 0.15$ | $0.55 \pm 0.10$ | $0.50 \pm 0.20$ | $0.50 \pm 0.20$ |
| RL1218 | $3.05 \pm 0.15$ | $4.60 \pm 0.20$ | $0.55 \pm 0.10$ | $0.45 \pm 0.25$ | $0.50 \pm 0.25$ |
| RL2010 | $5.00 \pm 0.10$ | $2.50 \pm 0.15$ | $0.55 \pm 0.10$ | $0.60 \pm 0.20$ | $0.50 \pm 0.20$ |
| RL2512 | $6.35 \pm 0.10$ | $3.20 \pm 0.15$ | $0.55 \pm 0.10$ | $0.60 \pm 0.20$ | $0.50 \pm 0.20$ |

**OUTLINES**

For dimension see Table I

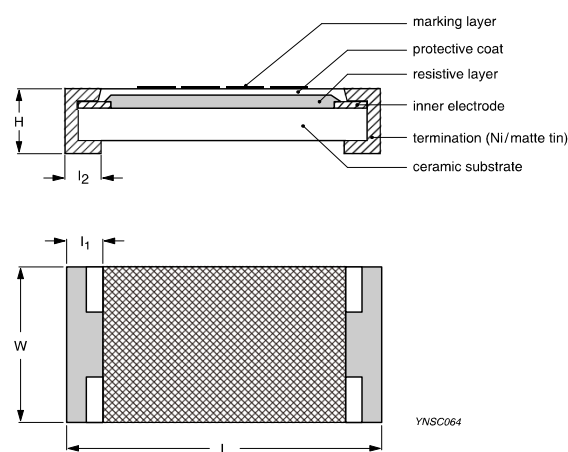


Fig. 4 Chip resistor outlines

## ELECTRICAL CHARACTERISTICS

Table 2

| Type   | Power<br>P <sub>70</sub> | Operating Temp.<br>range | Resistance range & tolerance        | T. C. R.<br>( ppm/°C)                      | Jumper criteria                            |
|--------|--------------------------|--------------------------|-------------------------------------|--------------------------------------------|--------------------------------------------|
| RL0402 | 1/16W                    | -55°C to +155°C          | $50\text{m}\Omega \leq R < 1\Omega$ | See following table<br>"T.C.R.- RL series" | Max. resistance 20mΩ<br>Rated current 1.5A |
| RL0603 | 1/10W                    |                          | $10\text{m}\Omega \leq R < 1\Omega$ |                                            | Max. resistance 20mΩ<br>Rated current 2A   |
| RL0805 | 1/8W                     |                          | $10\text{m}\Omega \leq R < 1\Omega$ |                                            | Max. resistance 20mΩ<br>Rated current 2.5A |
|        | 1/4W                     | -55°C to +125°C          | $10\text{m}\Omega \leq R < 1\Omega$ |                                            | -- --                                      |
| RL1206 | 1/4W                     | -55°C to +155°C          | $10\text{m}\Omega \leq R < 1\Omega$ |                                            | Max. resistance 20mΩ<br>Rated current 3.5A |
|        | 1/2W                     | -55°C to +125°C          | $10\text{m}\Omega \leq R < 1\Omega$ |                                            | -- --                                      |
| RL1210 | 1/2W                     | -55°C to +155°C          | $10\text{m}\Omega \leq R < 1\Omega$ |                                            | -- --                                      |
| RL1218 | 1W                       |                          | $10\text{m}\Omega \leq R < 1\Omega$ |                                            | -- --                                      |
| RL2010 | 3/4W                     |                          | $10\text{m}\Omega \leq R < 1\Omega$ |                                            | -- --                                      |
| RL2512 | 1W                       |                          | $10\text{m}\Omega \leq R < 1\Omega$ |                                            | -- --                                      |

| TYPE / RESISTANCE RANGE |           | TEMPERATURE COEFFICIENT OF RESISTANCE |               |                |               |                |
|-------------------------|-----------|---------------------------------------|---------------|----------------|---------------|----------------|
| RL0402                  | 50mΩ≤R<1Ω | 50mΩ ≤R<100mΩ                         |               | 100mΩ ≤R<500mΩ |               | 500mΩ ≤R<1Ω    |
|                         |           | ±1000 ppm/°C                          |               | ±800 ppm/°C    |               | ±300 ppm/°C    |
| RL0603                  | 10mΩ≤R<1Ω | 10mΩ ≤R≤36mΩ                          |               | 36mΩ <R≤91mΩ   | 91mΩ <R≤500mΩ | 500mΩ <R<1Ω    |
|                         |           | ±1,500 ppm/°C                         |               | ±1,200 ppm/°C  | ±800 ppm/°C   | ±300 ppm/°C    |
| RL0805                  |           | 10mΩ ≤R≤18mΩ                          | 18mΩ <R≤47mΩ  | 47mΩ <R≤91mΩ   | 91mΩ <R≤360mΩ | 360mΩ <R<500mΩ |
|                         |           | ±1,500 ppm/°C                         | ±1,200 ppm/°C | ±1,000 ppm/°C  | ±600 ppm/°C   | ±300 ppm/°C    |
|                         |           | 10mΩ ≤R≤18mΩ                          | 18mΩ <R≤47mΩ  | 47mΩ <R≤91mΩ   | 91mΩ <R≤360mΩ | 360mΩ <R≤500mΩ |
| RL1206                  | 10mΩ≤R<1Ω | ±1,500 ppm/°C                         | ±1,200 ppm/°C | ±1,000 ppm/°C  | ±600 ppm/°C   | ±300 ppm/°C    |
| RL1210                  |           | ±1,500 ppm/°C                         | ±1,000 ppm/°C | ±800 ppm/°C    | ±600 ppm/°C   | ±300 ppm/°C    |
| RL2010                  |           | ±1,500 ppm/°C                         | ±1,200 ppm/°C | ±1,000 ppm/°C  | ±600 ppm/°C   | ±300 ppm/°C    |
| RL2512                  |           | ±1,500 ppm/°C                         | ±1,200 ppm/°C | ±800 ppm/°C    | ±600 ppm/°C   | ±300 ppm/°C    |
| RL1218                  | 10mΩ≤R<1Ω | 10mΩ ≤R≤30mΩ                          |               | 30mΩ <R≤56mΩ   | 56mΩ <R≤180mΩ | 180mΩ <R<1Ω    |
|                         |           | ±2,000 ppm/°C                         |               | ±1,000 ppm/°C  | ±700 ppm/°C   | ±250 ppm/°C    |

## 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 | RL0402 | RL0603 | RL0805 | RL1206 | RL1210 | RL1218 | RL2010 | RL2512 |
|--------------------------|----------------|--------|--------|--------|--------|--------|--------|--------|--------|
| Paper 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  | 4,000  |

**NOTE**

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

**FUNCTIONAL DESCRIPTION****OPERATING TEMPERATURE RANGE**

Normal Power: Range: -55 °C to +155 °C (Fig. 5)

Double Power: Range: -55 °C to +125 °C (Fig. 6)

**POWER RATING**

Each type rated power at 70 °C:

RL0402=1/16 W;

RL0603=1/10 W;

RL0805=1/8 W, 1/4W;

RL1206=1/4 W, 1/2W;

RL1210=1/2 W;

RL1218=1 W;

RL2010=3/4 W;

RL2512=1 W.

**RATED VOLTAGE**

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

$$V = \sqrt{P \times R}$$

Where

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

P = Rated power (W)

R = Resistance value (Ω)

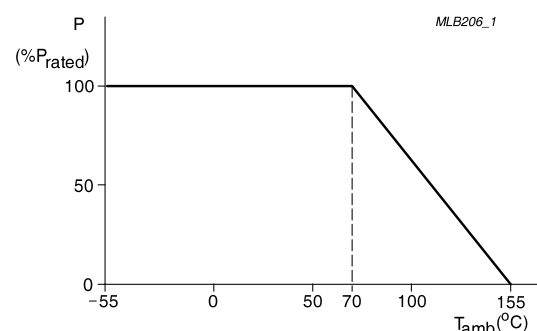


Fig. 5 Maximum dissipation ( $P_{max}$ ) in percentage of rated power as a function of the operating ambient temperature ( $T_{amb}$ )

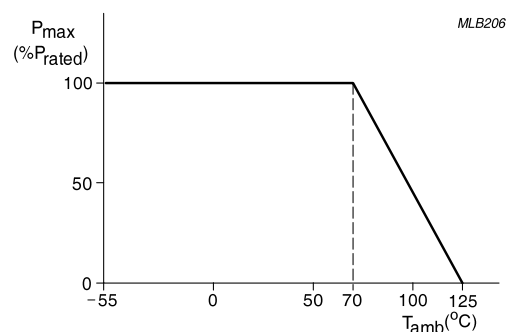


Fig. 6 Maximum dissipation ( $P_{max}$ ) in percentage of rated power as a function of the operating ambient temperature ( $T_{amb}$ )

**TESTS AND REQUIREMENTS****Table 4** Test condition, procedure and requirements

| TEST                         | TEST METHOD                                   | PROCEDURE                                                                                                                                                                                                                           | REQUIREMENTS                       |
|------------------------------|-----------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------|
| Life/<br>Endurance           | IEC 60115-1 4.25.1<br>MIL-STD-202 Method 108A | 1,000 hours at 70±2°C applied RCWV<br>1.5 hours on, 0.5 hour off, still air required                                                                                                                                                | ±(2% +0.5mΩ )                      |
| High Temperature<br>Exposure | IEC 60068-2-2                                 | 1,000 hours at maximum operating<br>temperature depending on specification,<br>unpowered<br><br>No direct impingement of forced air to the<br>parts<br><br>Normal power : Tolerances: 155±5°C<br>Double power : Tolerances: 125±5°C | ±(1% +0.5mΩ )                      |
| Moisture Resistance          | MIL-STD-202 Method 106G                       | Each temperature / humidity cycle is defined at<br>8 hours, 3 cycles / 24 hours for 10d with 25 °C<br>/ 65 °C 95% R.H, without steps 7a & 7b,<br>unpowered<br><br>Parts mounted on test-boards, without<br>condensation on parts    | ±(2% +0.5mΩ )                      |
| Thermal Shock                | MIL-STD-202 Method 107G                       | -55/+125 °C<br><br>Number of cycles required is 300.<br><br>Devices mounted<br><br>Maximum transfer time is 20 seconds. Dwell<br>time is 15 minutes.                                                                                | ±(1% +0.5mΩ )                      |
| Short time overload          | IEC60115-1 4.13                               | RL standard power: 2.5 times rated voltage for<br>5 sec at room temperature<br><br>RL high power: 5 times rated power for 5 sec<br>at room temperature                                                                              | ±(2% +0.5mΩ )<br>No visible damage |
| Board Flex/<br>Bending       | IEC 60115-1 4.33                              | Device mounted on PCB test board as<br>described, only 1 board bending required<br><br>3 mm bending<br><br>Bending time: 60±5 seconds<br><br>Ohmic value checked during bending                                                     | ±(1% +0.5mΩ )<br>No visible damage |

| TEST                              | TEST METHOD      | PROCEDURE                                                                                                                                                                                                                            | REQUIREMENTS                                    |
|-----------------------------------|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------|
| Solderability<br>- Wetting        | J-STD-002 test B | Electrical Test not required<br>Magnification 50X<br>SMD conditions:<br>1 <sup>st</sup> step: method B, aging 4 hours at 155 °C<br>dry heat<br>2 <sup>nd</sup> step: leadfree solder bath at 245±3 °C<br>Dipping time: 3±0.5 seconds | Well tinned (≥95% covered)<br>No visible damage |
| - Leaching                        | J-STD-002 test D | Leadfree solder, 260 °C, 30 seconds<br>immersion time                                                                                                                                                                                | No visible damage                               |
| - Resistance to<br>Soldering Heat | IEC 60115-1 4.18 | Condition B, no pre-heat of samples.<br>Leadfree solder, 260 °C, 10 seconds<br>immersion time<br>Procedure 2 for SMD: devices fluxed and<br>cleaned with isopropanol                                                                 | ±(1% +0.5mΩ)<br>No visible damage               |

REVISION HISTORY

| REVISION  | DATE          | CHANGE NOTIFICATION | DESCRIPTION                         |
|-----------|---------------|---------------------|-------------------------------------|
| Version 2 | May 31, 2017  | -                   | - Add 10" packing                   |
| Version 1 | Dec. 16, 2015 | -                   | - Extend 0805 T.C.R. range          |
| Version 0 | Nov. 11, 2014 | -                   | - First issue of this specification |

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