

# DATA SHEET

**CURRENT SENSOR - LOW TCR  
AUTOMOTIVE GRADE**

PA\_E series

5%, 1%, 0.5%

sizes 2512

RoHS compliant & Halogen free



**SCOPE**

This specification describes PA series current sensor - low TCR with lead-free terminations made by metal substrate.

**APPLICATIONS**

- Consumer goods
- Computer
- Telecom / Datacom
- Industrial / Power supply
- Alternative Energy
- Car electronics

**FEATURES**

- AEC-Q200 qualified
- Halogen-free Epoxy
- RoHS compliant
- Reduce environmentally hazardous wastes
- High component and equipment reliability
- Non-forbidden materials used in products/production
- Low resistances applied to current sensing

**ORDERING INFORMATION - GLOBAL PART NUMBER**

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

**GLOBAL PART NUMBER**

PA XXXX X X X XX XXXX E  
(1) (2) (3) (4) (5) (6) (7)

**(1) SIZE**

2512

**(2) TOLERANCE**

D =  $\pm 0.5\%$

F =  $\pm 1\%$

J =  $\pm 5\%$

**(3) PACKAGING TYPE**

K = Embossed taping reel

**(4) TEMPERATURE COEFFICIENT OF RESISTANCE**

F =  $\pm 100 \text{ ppm}/^\circ\text{C}$

M =  $\pm 75 \text{ ppm}/^\circ\text{C}$

E =  $\pm 50 \text{ ppm}/^\circ\text{C}$

**(5) TAPING REEL**

07 = 7 inch dia. Reel & standard power (1W)

7W = 7 inch dia. Reel & 2 x standard power (2W)

7T = 7 inch dia. Reel & 3 x standard power (3W)

**(6) RESISTANCE VALUE**

0.5 m $\Omega$  to 100 m $\Omega$

**(7) DEFAULT CODE**

Letter E is the system default code for ordering only. (Note)

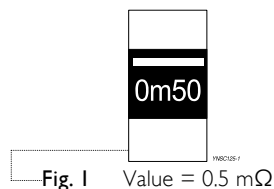
| Resistance rule of global part number |                       |
|---------------------------------------|-----------------------|
| Resistance code rule                  | Example               |
| XUXX                                  | 0U5 = 0.5m $\Omega$   |
| 0RXXX                                 | 0R001 = 1 m $\Omega$  |
| (1 to 100 m $\Omega$ )                | 0R050 = 50 m $\Omega$ |

**ORDERING EXAMPLE**

The ordering code of a PA2512 1W chip resistor, TC100, value 0.003 $\Omega$  with  $\pm 1\%$  tolerance, supplied in 7-inch tape reel is: PA2512FKF070R003E

**NOTE**

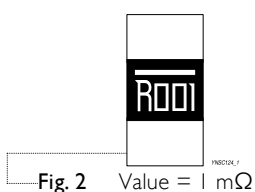
1. All our RChip products are RoHS compliant. "LFP" of the internal 2D reel label mentions "Lead-Free Process"

**MARKING****PA2512**

4 digits

The "m" is used as decimal point; the other 3 digits are significant and the unit is milliohm

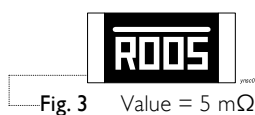
PA2512: 0.5mΩ and 0.75mΩ



4 digits

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

PA2512: 1mΩ to 4 mΩ



4 digits

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

PA2512: 5 mΩ to 100 mΩ

**CONSTRUCTION**

The resistors are constructed using outstanding TCR level material, which makes Yageo PA resistors excellent for current sensing application in battery charger circuit & DC-DC converter.

The composition of the resistive material is adjusted to give the approximate required resistance and is covered with a protective coating. Marking is printed on the top side of the resistor.

Finally, the three external terminations (Cu / Ni / matte Tin) are added, as shown in Fig. 4.

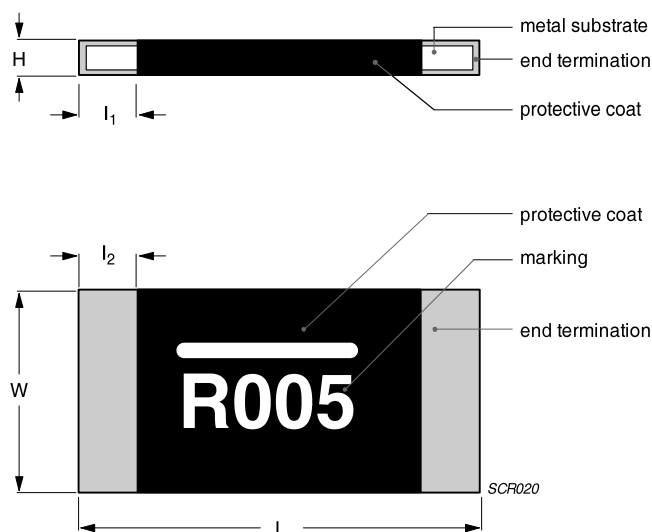
**Outlines**

Fig. 4 Chip resistor outlines

**DIMENSION**

Table 1 For outlines, please refer to Fig. 4

| TYPE   | RESISTANCE RANGE                                   | L (mm)          | W (mm)          | H (mm)          | l <sub>1</sub> (mm) | l <sub>2</sub> (mm) |
|--------|----------------------------------------------------|-----------------|-----------------|-----------------|---------------------|---------------------|
| PA2512 | $0.5\text{m}\Omega \leq R \leq 0.75\text{m}\Omega$ | $6.35 \pm 0.25$ | $3.18 \pm 0.25$ | $0.63 \pm 0.25$ | $2.72 \pm 0.25$     | $2.72 \pm 0.25$     |
|        | $1\text{m}\Omega \leq R \leq 4\text{m}\Omega$      | $6.35 \pm 0.25$ | $3.18 \pm 0.25$ | $0.63 \pm 0.25$ | $2.21 \pm 0.25$     | $2.21 \pm 0.25$     |
|        | $5\text{m}\Omega \leq R \leq 6\text{m}\Omega$      | $6.35 \pm 0.25$ | $3.18 \pm 0.25$ | $0.63 \pm 0.25$ | $1.19 \pm 0.25$     | $1.19 \pm 0.25$     |
|        | $7\text{m}\Omega \leq R \leq 100\text{m}\Omega$    | $6.35 \pm 0.25$ | $3.18 \pm 0.25$ | $0.63 \pm 0.25$ | $0.76 \pm 0.25$     | $0.76 \pm 0.25$     |

Note:

1. For relevant physical dimensions, please refer to construction outlines.
2. Please contact with sales offices, distributors and representatives in your region before ordering.

**ELECTRICAL CHARACTERISTICS**

Table 2

| TYPE | SIZE | POWER RATING | TOLERANCE   | RESISTANCE RANGE                                  | TEMPERATURE COEFFICIENT OF RESISTANCE |
|------|------|--------------|-------------|---------------------------------------------------|---------------------------------------|
| PA   | 2512 | 1W           | $\pm 0.5\%$ | $0.5\text{m}\Omega \leq R \leq 100\text{m}\Omega$ | $\pm 50\text{ppm}/^\circ\text{C}$     |
|      |      | 2W           | $\pm 1\%$   |                                                   | $\pm 75\text{ppm}/^\circ\text{C}$     |
|      |      | 3W           | $\pm 5\%$   |                                                   | $\pm 100\text{ppm}/^\circ\text{C}$    |

Note: Please contact with sales offices, distributors and representatives in your region before ordering.

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

PA2512 Range:  $-55^\circ\text{C}$  to  $+170^\circ\text{C}$

**POWER RATING**

Standard rated power at  $70^\circ\text{C}$ :

For detail power value, please refer to Table 2.

**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 ( $\Omega$ )

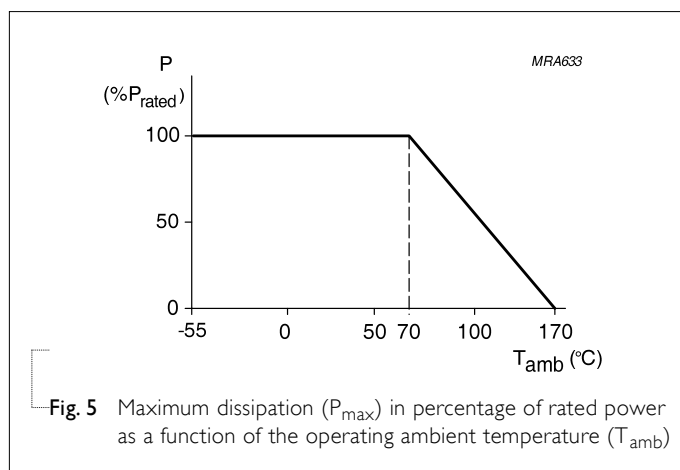
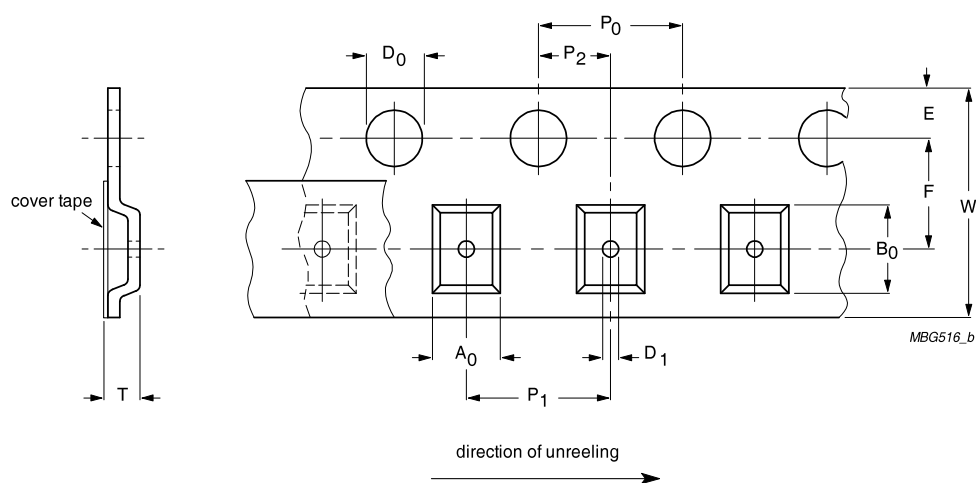


Fig. 5 Maximum dissipation ( $P_{\text{max}}$ ) in percentage of rated power as a function of the operating ambient temperature ( $T_{\text{amb}}$ )

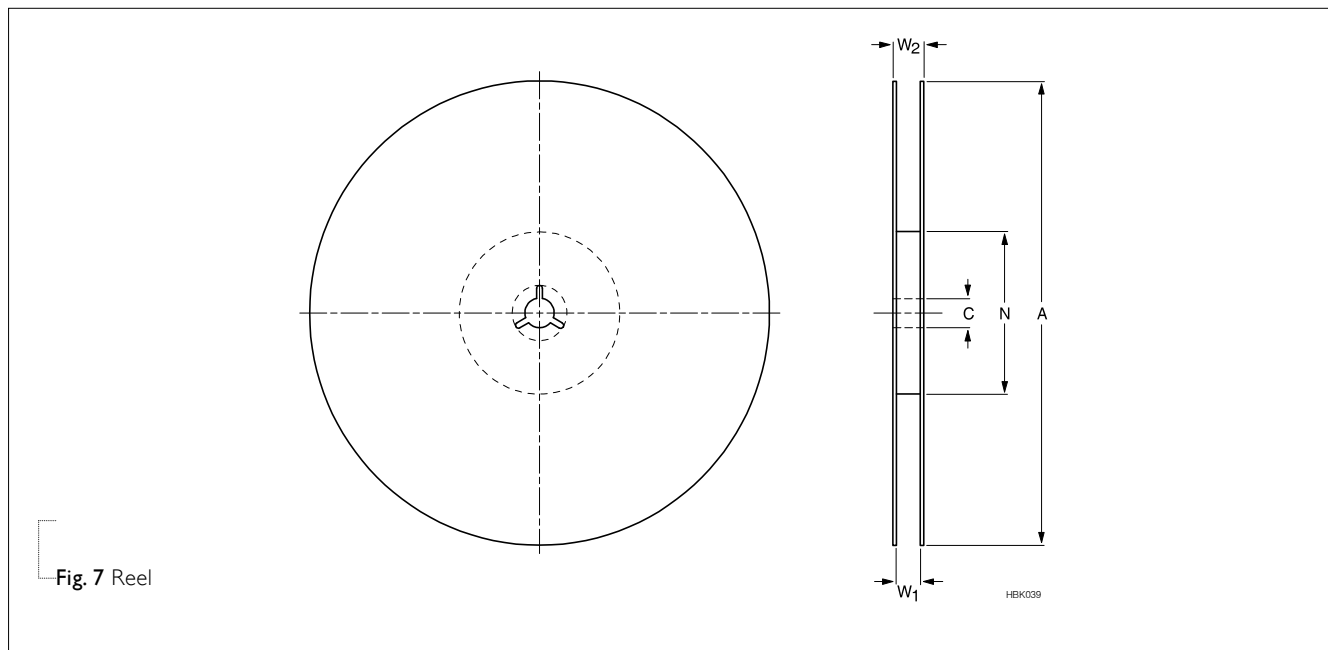
**PACKING STYLE AND PACKAGING QUANTITY****Table 3** Packing style and packaging quantity

| PACKING STYLE            | REEL DIMENSION | PA2512 |
|--------------------------|----------------|--------|
| Embossed taping reel (K) | 7" (178 mm)    | 4,000  |

**EMBOSSED TAPE****Fig. 6** Embossed Tape**Table 4** Dimensions of embossed tape for relevant chip resistors size

| SIZE   | SYMBOL          |                 |                  |                 |                 |                 |                 |                 |                   |                   | Unit: mm        |
|--------|-----------------|-----------------|------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-------------------|-------------------|-----------------|
|        | $A_0$           | $B_0$           | W                | E               | F               | $P_0$           | $P_1$           | $P_2$           | $\varnothing D_0$ | $\varnothing D_1$ | T               |
| PA2512 | $3.40 \pm 0.15$ | $6.70 \pm 0.15$ | $12.00 \pm 0.30$ | $1.75 \pm 0.10$ | $5.50 \pm 0.10$ | $4.00 \pm 0.10$ | $4.00 \pm 0.10$ | $2.00 \pm 0.10$ | $1.55 \pm 0.05$   | $1.50 \pm 0.10$   | $0.80 \pm 0.15$ |

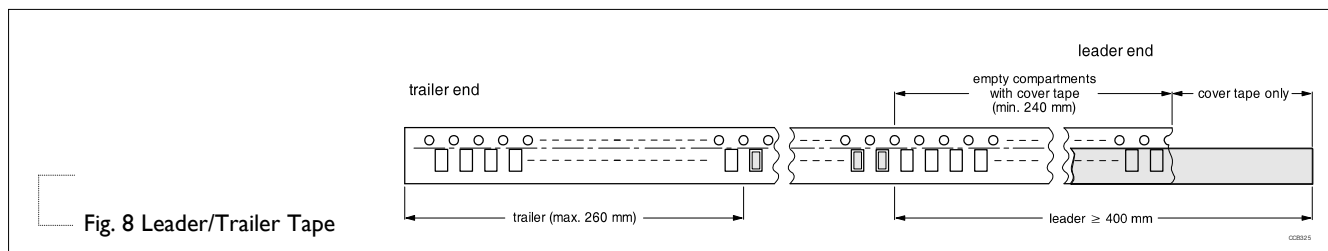
## REEL SPECIFICATION



**Table 5** Dimensions of reel specification for relevant chip resistors size

| SIZE   | QUANTITY<br>PER REEL | REEL SIZE         |                    | SYMBOL    |           |           |          | Unit: mm       |                     |
|--------|----------------------|-------------------|--------------------|-----------|-----------|-----------|----------|----------------|---------------------|
|        |                      | 8 mm<br>TAPE WIDE | 12 mm<br>TAPE WIDE | A         | N         | C         | D        | W <sub>1</sub> | W <sub>2</sub> MAX. |
| PA2512 | 4000                 | --                | 7" (Ø178 mm)       | 178.0±1.0 | 60.0+1/-0 | 13.50±0.5 | 21.0±0.8 | 13.6±0.5       | 16.5±0.5            |

## LEADER/TRAILER TAPE SPECIFICATION



## FOOTPRINT AND SOLDERING PROFILES

For recommended soldering profiles, please refer to data sheet “Chip resistors mounting”.

### FOOTPRINT

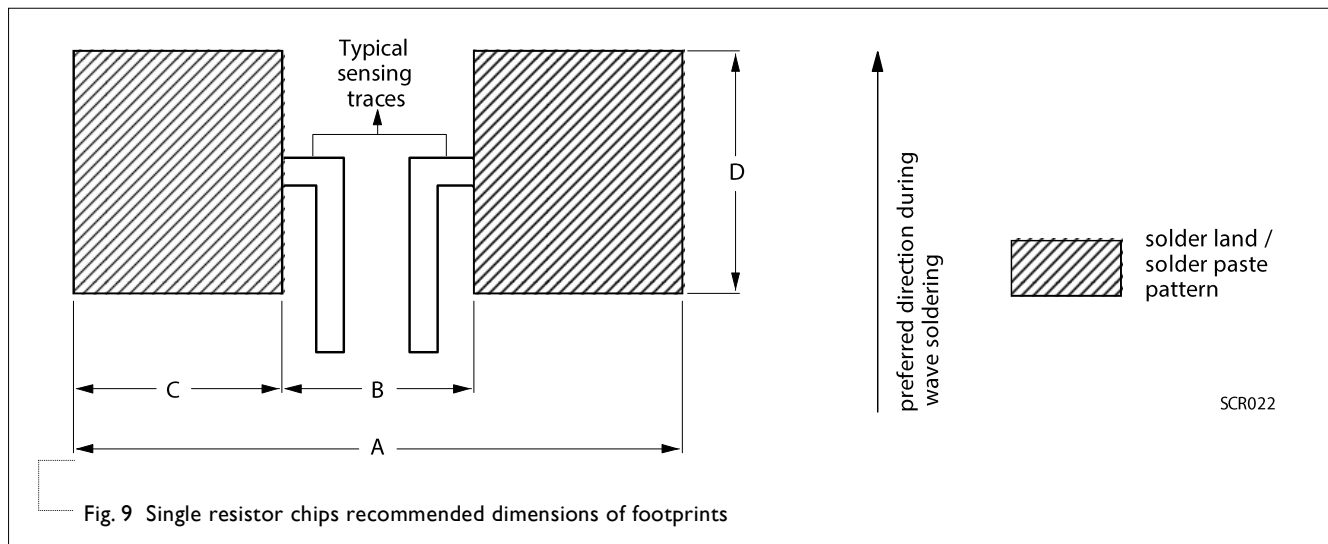


Table 6 Footprint dimensions

|        |                                                 | Unit: mm |      |      |      |
|--------|-------------------------------------------------|----------|------|------|------|
| SIZE   | RESISTANCE RANGE                                | A        | B    | C    | D    |
| PA2512 | $0.5\text{m}\Omega \leq R < 1\text{m}\Omega$    | 7.36     | 0.50 | 3.43 | 3.68 |
|        | $1\text{m}\Omega \leq R \leq 4\text{m}\Omega$   | 7.37     | 1.27 | 3.05 | 3.68 |
|        | $5\text{m}\Omega \leq R \leq 6\text{m}\Omega$   | 7.40     | 3.18 | 2.11 | 3.68 |
|        | $7\text{m}\Omega \leq R \leq 100\text{m}\Omega$ | 7.36     | 4.06 | 1.65 | 3.68 |

## TESTS AND REQUIREMENTS

Table 8 Test condition, procedure and requirements

| TEST                         | TEST METHOD            | PROCEDURE                                                                                                                                                                                                                       | REQUIREMENT                                    |
|------------------------------|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------|
| Short time overload          | IEC60115-1 4.13        | 5 times of rated power for 5 seconds at room temperature                                                                                                                                                                        | $\pm(0.5\%+0.0005\Omega)$<br>No visible damage |
| High Temperature Exposure    | MIL-STD-202-Method 108 | 1,000 hours at maximum operating temperature depending on specification, unpowered<br><br>No direct impingement of forced air to the parts Tolerances: $170\pm3^{\circ}\text{C}$                                                | $\pm(1.0\%+0.0005\Omega)$                      |
| Temperature Cycling          | JESD22-A104C           | 1,000 cycles, $-55/+125^{\circ}\text{C}$ for 1 cycle per hour                                                                                                                                                                   | $\pm(0.5\%+0.0005\Omega)$                      |
| Moisture Resistance          | MIL-STD-202-Method 106 | Each temperature / humidity cycle is defined at 8 hours (method 106F), 3 cycles / 24 hours for 10d with $25^{\circ}\text{C}$ / $65^{\circ}\text{C}$ 95% R.H, without steps 7a & 7b, unpowered                                   | $\pm(0.5\%+0.0005\Omega)$                      |
| Biased Humidity              | MIL-STD-202 Method 103 | 1,000 hours; $85^{\circ}\text{C}$ / 85% RH<br><br>10% of operating power                                                                                                                                                        | $\pm(0.5\%+0.0005\Omega)$                      |
| Operational Life/ Endurance  | MIL-STD-202-Method 108 | 1,000 hours at $125\pm3^{\circ}\text{C}$ , de-rated voltage applied for 1.5 hours on, 0.5 hour off, still-air required                                                                                                          | $\pm(1.0\%+0.0005\Omega)$                      |
|                              |                        | 1,000 hours at $70\pm2^{\circ}\text{C}$ applied RCWV<br>1.5 hours on, 0.5 hour off, still air required                                                                                                                          | $\pm(1.0\%+0.0005\Omega)$                      |
| Resistance to Solvents       | MIL-STD-202 Method 215 | Immerse in isopropyl alcohol for 5 min with ultrasonic at room temperature                                                                                                                                                      | No Visible damage                              |
| Mechanical Shock             | MIL-STD-202 Method 213 | Three shocks in each direction shall be applied along the three mutually perpendicular axes of the test specimen.<br><br>Peak value: 100 g's<br><br>Duration: 6 ms<br><br>Velocity change: 12.3 ft/s<br><br>Waveform: Half sine | $\pm(0.5\%+0.0005\Omega)$                      |
| Vibration                    | MIL-STD-202 Method 204 | 5 g's for 20 min., 12 cycles each of 3 orientations<br><br>Test from 10-2000 Hz.                                                                                                                                                | $\pm(0.5\%+0.0005\Omega)$                      |
| Resistance to Soldering Heat | MIL-STD-202-method 210 | Condition B, no pre-heat of samples<br>Leadfree solder, $260^{\circ}\text{C}$ , 10 seconds immersion time<br><br>Procedure 2 for SMD: devices fluxed and cleaned with isopropanol                                               | $\pm(0.5\%+0.0005\Omega)$<br>No visible damage |
| Thermal Shock                | MIL-STD-202 Method 107 | $-55/+125^{\circ}\text{C}$ , Number of cycles is 300.<br><br>Devices mounted.<br><br>Maximum transfer time is 20 seconds.<br><br>Dwell time is 15 minutes. Air -Air                                                             | $\pm(0.5\%+0.0005\Omega)$<br>No visible damage |



| TEST                                           | TEST METHOD            | PROCEDURE                                                                                                                                                                                                                                                                                       | REQUIREMENT                                        |
|------------------------------------------------|------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------|
| Electrostatic Discharge                        | AEC-Q200-002           | Human Body Model, 1 pos + 1 neg.<br>Discharges 2512=2KV                                                                                                                                                                                                                                         | $\pm(1.0\%+0.0005\Omega)$<br>No visible damage     |
| Solderability<br>- Wetting                     | J-STD-002B test B      | (a) Method B, aging 4 hours at 155°C dry heat, dipping at 235±3°C for 5±0.5 seconds.<br>(b) Method B, steam aging 8 hours, dipping at 215±3°C for 5±0.5 seconds.<br>(c) Method D, steam aging 8 hours, dipping at 260±3 °C for 7±0.5 seconds.                                                   | Well tinned<br>(>95% covered)<br>No visible damage |
| Flammability                                   | UL94                   | Try to inflame a specimen by a needle flame                                                                                                                                                                                                                                                     | No ignition of specimen;<br>V-0                    |
| Board Flex / Bending                           | AEC-Q200-005           | Chips mounted on a 90mm glass epoxy resin PCB (FR4), Bending for 2512=2 mm<br>Holding time: Min.60 seconds                                                                                                                                                                                      | $\pm(1.0\%+0.0005\Omega)$                          |
| Terminal Strength (SMD)                        | AEC-Q200-006           | Applied a 17.7N (1.8Kg) for 60±1 seconds.                                                                                                                                                                                                                                                       | $\pm(1.0\%+0.0005\Omega)$<br>No visible damage     |
| Flame Retardance                               | AEC-Q200-001           | Apply voltage from 9V to 32V to increase the surface temp to 350°C                                                                                                                                                                                                                              | No flame,<br>no explosion                          |
| Temperature Coefficient of Resistance (T.C.R.) | MIL-STD-202 Method 304 | At +25/+150°C<br>Formula:<br>$T.C.R = \frac{R_2 - R_1}{R_1(t_2 - t_1)} \times 10^6 (\text{ppm}/^\circ\text{C})$<br>Where<br>t1=+25°C or specified room temperature<br>t2=+150°C test temperature<br>R1=resistance at reference temperature in ohms<br>R2=resistance at test temperature in ohms | Refer to table 2                                   |
| Flower-of-Sulfur (FOS)                         | Modified ASTM B809-95  | Sulfur 105°C, 750 hours, unpowered.                                                                                                                                                                                                                                                             | $\pm(1.0\%+0.0005\Omega)$                          |

**REVISION HISTORY**

| REVISION   | DATE          | CHANGE NOTIFICATION | DESCRIPTION                                                                               |
|------------|---------------|---------------------|-------------------------------------------------------------------------------------------|
| Version 10 | Jan.31, 2018  | -                   | - Extend 0.5% Tolerance                                                                   |
| Version 9  | Nov. 21, 2017 | -                   | - Extend resistor value for 3W                                                            |
| Version 8  | Oct. 23, 2017 | -                   | - Update footprint dimensions                                                             |
| Version 7  | Jul. 24, 2017 | -                   | - Add part number coding details for the relationship between taping reel and rated power |
| Version 6  | Apr. 19, 2017 | -                   | - Extend resistor value                                                                   |
| Version 5  | Nov. 30, 2016 | -                   | - Extend resistor value                                                                   |
| Version 4  | Oct. 27, 2016 | -                   | - Modify the error of test procedure                                                      |
| Version 3  | Mar. 31, 2016 | -                   | - Update TCR                                                                              |
| Version 2  | Dec. 31, 2015 | -                   | - Extend resistor value                                                                   |
| Version 1  | Dec. 18, 2015 | -                   | - Update tests and requirements                                                           |

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