Innovative Service Around the Globe YAGEO

# DATA SHEET

## THICK FILM CHIP RESISTORS AUTOMOTIVE GRADE

AC series

±5%, ±1%, ±0.5%

**Sizes 0201/0402/0603/0805/1206/ 1210/1218/2010/2512**

**RoHS compliant & Halogen free**




YAGEO Phycomp

Product specification – June 20, 2017 V.6

## SCOPE

This specification describes AC0201 to AC2512 chip resistors with lead-free terminations made by thick film process.

## APPLICATIONS

- All general purpose applications
- Car electronics, industrial application

## FEATURES

- AEC-Q200 qualified
- Moisture sensitivity level: MSL 1
- AC series soldering is compliant with J-STD-020D
- 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
- Reduce environmentally hazardous waste
- High component and equipment reliability
- The resistors are 100% performed by automatic optical inspection prior to taping.

## ORDERING INFORMATION - GLOBAL PART NUMBER

Part number is identified by the series name, size, tolerance, packaging type, temperature coefficient, taping reel and resistance value.

### GLOBAL PART NUMBER

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

### (1) SIZE

0201/ 0402 / 0603 / 0805 / 1206 / 1210 / 1218 / 2010 / 2512

### (2) TOLERANCE

D = ±0.5%

F = ±1%

J = ±5% (for Jumper ordering, use code of J)

### (3) PACKAGING TYPE

R = Paper taping reel K = Embossed taping reel

### (4) TEMPERATURE COEFFICIENT OF RESISTANCE

– = Base on spec

### (5) TAPING REEL

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

13 = 13 inch dia. Reel 7W = 7 inch dia. Reel & 2 x standard power

### (6) RESISTANCE VALUE

1Ω to 22 MΩ

There are 2~4 digits indicated the resistance 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 coding rules of resistance are shown in the table of "Resistance rule of global part number".

### (7) DEFAULT CODE

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

Resistance rule of global part number

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

### ORDERING EXAMPLE

The ordering code for an AC0402 chip resistor, value 100 KΩ with ±1% tolerance, supplied in 7-inch tape reel is: AC0402FR-07100KL.

### NOTE

1. All our R-Chip products are RoHS compliant and Halogen free. "LFP" of the internal 2D reel label states "Lead-Free Process".
2. On customized label, "LFP" or specific symbol can be printed.
3. AC series with ±0.5% tolerance is also available. For further information, please contact sales.

## MARKING

### AC0201 / AC0402



Fig. 1

No marking

### AC0603 / AC0805 / AC1206 / AC1210 / AC2010 / AC2512




Fig. 2 Value=10 KΩ

E-24 series: 3 digits, ±5%
First two digits for significant figure and 3rd digit for number of zeros

### AC0603




Fig. 3 Value = 24 Ω

E-24 series: 3 digits, ±1% & ±0.5%
One short bar under marking letter




Fig. 4 Value = 12.4 KΩ

E-96 series: 3 digits, ±1% & ±0.5%
First two digits for E-96 marking rule and 3rd letter for number of zeros

### AC0805 / AC1206 / AC1210 / AC2010 / AC2512




Fig. 5 Value = 10 KΩ

Both E-24 and E-96 series: 4 digits, ±1% & ±0.5%
First three digits for significant figure and 4th digit for number of zeros

### AC1218

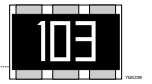



Fig. 6 Value = 10 KΩ

E-24 series: 3 digits, ±5%
First two digits for significant figure and 3rd digit for number of zeros

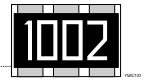



Fig. 7 Value = 10 KΩ

Both E-24 and E-96 series: 4 digits, ±1% & ±0.5%
First three digits for significant figure and 4th digit for number of zeros

**NOTE**

For further marking information, please refer to data sheet "Chip resistors marking". Marking of AC series is the same as RC series.

## CONSTRUCTION

The resistors are constructed on top of an automotive grade ceramic body. Internal metal electrodes are added at each end and connected by a resistive glaze. The resistive glaze is covered by a protective glass.
The composition of the glaze is adjusted to give the approximately required resistance value and laser trimming of this resistive glaze achieves the value within tolerance. The whole element is covered by a protective overcoat. Size 0603 and bigger is marked with the resistance value on top. Finally, the two external terminations (Ni / matte tin) are added, as shown in Fig.8.

## OUTLINES

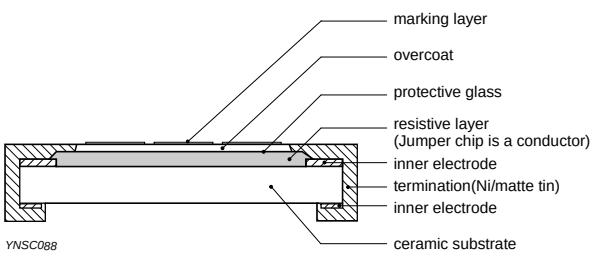



Fig. 8_1 Chip resistor outlines

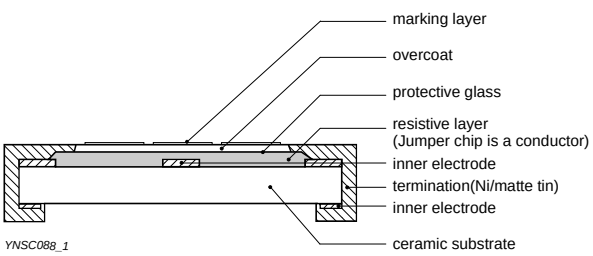



Fig. 8_2 AC2010/ 2512 double power chip resistor outlines

## DIMENSIONS

Table 1 For outlines, please refer to Fig. 9

| TYPE | L (mm) | W (mm) | H (mm) | $I_1$ (mm) | $I_2$ (mm) |
|---|---|---|---|---|---|
| AC0201 | 0.60±0.03 | 0.30±0.03 | 0.23±0.03 | 0.12±0.05 | 0.15±0.05 |
| AC0402 | 1.00 ±0.05 | 0.50 ±0.05 | 0.32 ±0.05 | 0.20 ±0.10 | 0.25 ±0.10 |
| AC0603 | 1.60 ±0.10 | 0.80 ±0.10 | 0.45 ±0.10 | 0.25 ±0.15 | 0.25 ±0.15 |
| AC0805 | 2.00 ±0.10 | 1.25 ±0.10 | 0.50 ±0.10 | 0.35 ±0.20 | 0.35 ±0.20 |
| AC1206 | 3.10 ±0.10 | 1.60 ±0.10 | 0.55 ±0.10 | 0.45 ±0.20 | 0.40 ±0.20 |
| AC1210 | 3.10 ±0.10 | 2.60 ±0.15 | 0.55 ±0.10 | 0.45 ±0.15 | 0.50 ±0.20 |
| AC1218 | 3.10 ±0.10 | 4.60 ±0.10 | 0.55 ±0.10 | 0.45 ±0.20 | 0.40 ±0.20 |
| AC2010 | 5.00 ±0.10 | 2.50 ±0.15 | 0.55 ±0.10 | 0.55 ±0.15 | 0.50 ±0.20 |
| AC2512 | 6.35 ±0.10 | 3.10 ±0.15 | 0.55 ±0.10 | 0.60 ±0.20 | 0.50 ±0.20 |

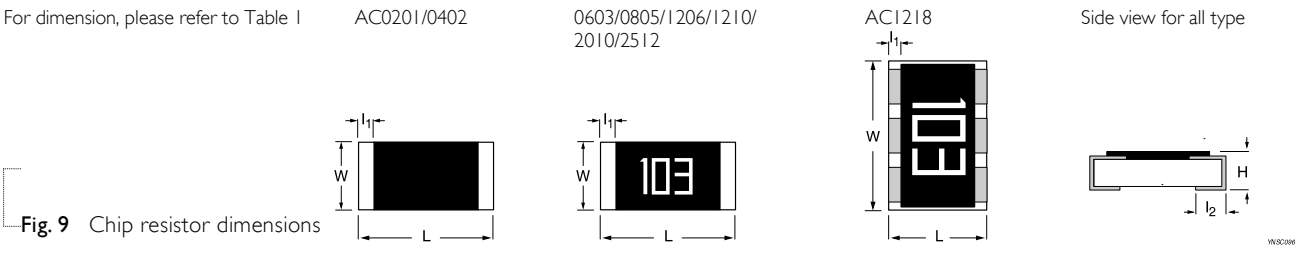



Fig. 9 Chip resistor dimensions

## ELECTRICAL CHARACTERISTICS

Table 2

| TYPE | POWER | CHARACTERISTICS | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Operating Temperature Range | Max. Working Voltage | Max. Overload Voltage | Dielectric Withstanding Voltage | Resistance Range | Temperature Coefficient | Jumper Criteria |
| AC0201 | 1/20 W | –55 °C to 155 °C | 25V | 50V | 50V | 5% (E24)<br>1Ω ≤ R ≤ 10MΩ<br>1% (E24/E96)<br>1Ω ≤ R ≤ 10MΩ<br>0.5% (E24/E96)<br>10Ω ≤ R ≤ 1MΩ<br>Jumper<50mΩ | 1Ω ≤ R ≤ 10Ω<br>-100/+350ppm°C<br>10Ω < R ≤ 10M<br>±200ppm°C | Rated Current<br>0.5A<br>Maximum<br>Current<br>1.0A |
| AC0402 | 1/16 W | –55 °C to 155 °C | 50V | 100V | 100V | 5% (E24)<br>1Ω ≤ R ≤ 22MΩ<br>0.5%, 1% (E24/E96)<br>1Ω ≤ R ≤ 10MΩ<br>Jumper<50mΩ | 1Ω ≤ R ≤ 10Ω<br>±200ppm°C<br>10Ω < R ≤ 10MΩ<br>±100ppm°C<br>10MΩ < R ≤ 22MΩ<br>±200ppm°C | Rated Current<br>1A<br>Maximum<br>Current<br>2A |
| | 1/8W | –55 °C to 155 °C | 50V | 100V | 100V | 5% (E24)<br>1Ω ≤ R ≤ 10MΩ<br>0.5%, 1% (E24/E96)<br>1Ω ≤ R ≤ 10MΩ | 1Ω ≤ R ≤ 10Ω<br>±200 ppm°C<br>10Ω < R ≤ 10MΩ<br>±100 ppm°C | |
| AC0603 | 1/10 W | –55 °C to 155 °C | 75V | 150V | 150V | 5% (E24)<br>1Ω ≤ R ≤ 22MΩ<br>0.5%, 1% (E24/E96)<br>1Ω ≤ R ≤ 10MΩ<br>Jumper<50mΩ | 1Ω ≤ R ≤ 10Ω<br>±200ppm°C<br>10Ω < R ≤ 10MΩ<br>±100ppm°C<br>10MΩ < R ≤ 22MΩ<br>±200ppm°C | Rated Current<br>1A<br>Maximum<br>Current<br>2A |
| | 1/5 W | –55 °C to 155 °C | 75V | 150V | 150V | 5% (E24)<br>1Ω ≤ R ≤ 10MΩ<br>0.5%, 1% (E24/E96)<br>1Ω ≤ R ≤ 10MΩ | 1Ω ≤ R ≤ 10Ω<br>±200 ppm°C<br>10Ω < R ≤ 10MΩ<br>±100 ppm°C | |

| TYPE | POWER | CHARACTERISTICS | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Operating Temperature Range | Max. Working Voltage | Max. Overload Voltage | Dielectric Withstanding Voltage | Resistance Range | Temperature Coefficient | Jumper Criteria |
| AC0805 | 1/8 W | –55 °C to 155 °C | 150V | 300V | 300V | 5% (E24)<br>1Ω ≤ R ≤ 22 MΩ<br>0.5%, 1% (E24/E96)<br>1Ω ≤ R ≤ 10MΩ<br>Jumper < 50mΩ | 1Ω ≤ R ≤ 10Ω<br>±200ppm°C<br>10Ω < R ≤ 10MΩ<br>±100ppm°C<br>10MΩ < R ≤ 22MΩ<br>±200ppm°C | Rated Current<br>2A<br>Maximum<br>Current<br>5A |
| | 1/4 W | –55 °C to 155 °C | 150V | 300V | 300V | 5% (E24)<br>1Ω ≤ R ≤ 10MΩ<br>0.5%, 1% (E24/E96)<br>1Ω ≤ R ≤ 10MΩ | 1Ω ≤ R ≤ 10Ω<br>±200 ppm°C<br>10Ω < R ≤ 10MΩ<br>±100 ppm°C | |
| AC1206 | 1/4 W | –55 °C to 155 °C | 200V | 400V | 500V | 5% (E24)<br>1Ω ≤ R ≤ 22MΩ<br>0.5%, 1% (E24/E96)<br>1Ω ≤ R ≤ 10MΩ<br>Jumper<50mΩ | 1Ω ≤ R ≤ 10Ω<br>±200ppm°C<br>10Ω < R ≤ 10MΩ<br>±100ppm°C<br>10MΩ < R ≤ 22MΩ<br>±200ppm°C | Rated Current<br>2A<br>Maximum<br>Current<br>10A |
| | 1/2 W | –55 °C to 155 °C | 200V | 400V | 500V | 5% (E24)<br>1Ω ≤ R ≤ 10MΩ<br>0.5%, 1% (E24/E96)<br>1Ω ≤ R ≤ 10MΩ | 1Ω ≤ R ≤ 10Ω<br>±200 ppm°C<br>10Ω < R ≤ 10MΩ<br>±100 ppm°C | |
| AC1210 | 1/2 W | –55 °C to 155 °C | 200V | 500V | 500V | 5% (E24)<br>1Ω ≤ R ≤ 22MΩ<br>0.5%, 1% (E24/E96)<br>1Ω ≤ R ≤ 10MΩ<br>Jumper<50mΩ | 1Ω ≤ R ≤ 10Ω<br>±200ppm°C<br>10Ω < R ≤ 10MΩ<br>±100ppm°C<br>10MΩ < R ≤ 22MΩ<br>±200ppm°C | Rated Current<br>2A<br>Maximum<br>Current<br>10A |
| | 1 W | –55 °C to 155 °C | 200V | 500V | 500V | 5% (E24)<br>1Ω ≤ R ≤ 10MΩ<br>0.5%, 1% (E24/E96)<br>1Ω ≤ R ≤ 10MΩ | 1Ω ≤ R ≤ 10Ω<br>±200 ppm°C<br>10Ω < R ≤ 10MΩ<br>±100 ppm°C | |

| TYPE | POWER | CHARACTERISTICS | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | Operating Temperature Range | Max. Working Voltage | Max. Overload Voltage | Dielectric Withstanding Voltage | Resistance Range | Temperature Coefficient | Jumper Criteria |
| AC1218 | 1 W | –55 °C to 155 °C | 200V | 500V | 500V | 5% (E24)<br>1Ω ≤ R ≤ 1MΩ<br>0.5%, 1% (E24/E96)<br>1Ω ≤ R ≤ 1MΩ<br>Jumper<50mΩ | 1Ω ≤ R ≤ 10Ω<br>±200ppm°C<br>10Ω < R ≤ 1MΩ<br>±100ppm°C | Rated Current<br>6A<br>Maximum<br>Current<br>10A |
| | 1.5W | –55 °C to 155 °C | 200V | 500V | 500V | 5% (E24)<br>1Ω ≤ R ≤ 1MΩ<br>0.5%, 1% (E24/E96)<br>1Ω ≤ R ≤ 1MΩ | 1Ω ≤ R ≤ 10Ω<br>±200 ppm°C<br>10Ω < R ≤ 1MΩ<br>±100 ppm°C | |
| AC2010 | 3/4 W | –55 °C to 155 °C | 200V | 500V | 500V | 5% (E24)<br>1Ω ≤ R ≤ 22MΩ<br>0.5%, 1% (E24/E96)<br>1Ω ≤ R ≤ 10MΩ<br>Jumper<50mΩ | 1Ω ≤ R ≤ 10Ω<br>±200ppm°C<br>10Ω < R ≤ 10MΩ<br>±100ppm°C<br>10MΩ < R ≤ 22MΩ<br>±200ppm°C | Rated Current<br>2A<br>Maximum<br>Current<br>10A |
| | 1.25W | –55 °C to 155 °C | 200V | 500V | 500V | 5% (E24)<br>1Ω ≤ R ≤ 10MΩ<br>0.5%, 1% (E24/E96)<br>1Ω ≤ R ≤ 10MΩ | 1Ω ≤ R ≤ 10Ω<br>±200 ppm°C<br>10Ω < R ≤ 10MΩ<br>±100 ppm°C | |
| AC2512 | 1 W | –55 °C to 155 °C | 200V | 500V | 500V | 5% (E24)<br>1Ω ≤ R ≤ 22MΩ<br>0.5%, 1% (E24/E96)<br>1Ω ≤ R ≤ 10MΩ<br>Jumper<50mΩ | 1Ω ≤ R ≤ 10Ω<br>±200ppm°C<br>10Ω < R ≤ 10MΩ<br>±100ppm°C<br>10MΩ < R ≤ 22MΩ<br>±200ppm°C | Rated Current<br>2A<br>Maximum<br>Current<br>10A |
| | 2 W | –55 °C to 155 °C | 200V | 400V | 500V | 5% (E24)<br>1Ω ≤ R ≤ 10MΩ<br>0.5%, 1% (E24/E96)<br>1Ω ≤ R ≤ 10MΩ | 1Ω ≤ R ≤ 10Ω<br>±200 ppm°C<br>10Ω < R ≤ 10MΩ<br>±100 ppm°C | |

## FOOTPRINT AND SOLDERING PROFILES

Recommended footprint and soldering profiles of AC-series is the same as RC-series. Please refer to data sheet "Chip resistors mounting".

## PACKING STYLE AND PACKAGING QUANTITY

Table 3 Packing style and packaging quantity

| PACKING STYLE | REEL DIMENSION | AC0201 | AC0402 | AC0603 | AC0805 | AC1206 | AC1210 | AC1218 | AC2010 | AC2512 |
|---|---|---|---|---|---|---|---|---|---|---|
| Paper taping reel (R) | 7" (178 mm) | 10,000 | 10,000 | 5,000 | 5,000 | 5,000 | 5,000 | --- | --- | --- |
| | 10" (254 mm) | 20,000 | 20,000 | 10,000 | 10,000 | 10,000 | 10,000 | --- | --- | --- |
| | 13" (330 mm) | 50,000 | 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 specifications/dimensions, please refer to data sheet "Chip resistors packing".

## FUNCTIONAL DESCRIPTION

### OPERATING TEMPERATURE RANGE

Range: –55 °C to +155 °C

### POWER RATING

Each type rated power at 70 °C:
AC0201=1/20W (0.05W)
AC0402=1/16W (0.0625W); 1/8W (0.125W)
AC0603=1/10W (0.1W); 1/5W (0.2W)
AC0805=1/8W (0.125W); 1/4 W(0.25 W)
AC1206=1/4W (0.25W); 1/2 W (0.5 W)
AC1210=1/2W (0.5W); 1W
AC1218=1W; 1.5W
AC2010=3/4W (0.75W); 1.25W
AC2512=1 W; 2W

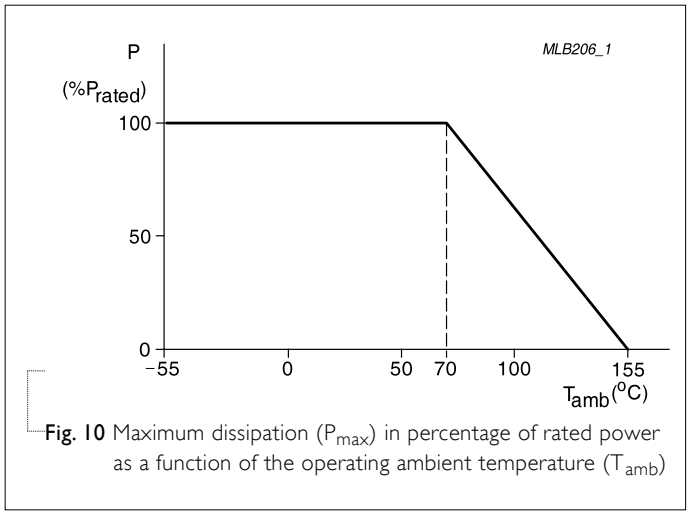



Fig. 10 Maximum dissipation ($P_{max}$) in percentage of rated power as a function of the operating ambient temperature ($T_{amb}$)

### 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 Maximum working voltage whichever is less

Where

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

P = Rated power (W)

R = Resistance value (Ω)

## TESTS AND REQUIREMENTS

Table 4 Test condition, procedure and requirements

| TEST | TEST METHOD | PROCEDURE | REQUIREMENTS |
|---|---|---|---|
| High Temperature Exposure | AEC-Q200 Test 3<br>MIL-STD-202 Method 108 | 1,000 hours at $T_A$ = 155 °C, unpowered | ±(1.0%+0.05Ω) for D/F tol<br>±(2.0%+0.05Ω) for J tol<br><50 mΩ for Jumper |
| Moisture Resistance | AEC-Q200 Test 6<br>MIL-STD-202 Method 106 | Each temperature / humidity cycle is defined at 8 hours (method 106F), 3 cycles / 24 hours for 10d. with 25 °C / 65 °C 95% R.H, without steps 7a & 7b, unpowered | ±(0.5%+0.05Ω) for D/F tol<br>±(2.0%+0.05Ω) for J tol<br><100 mΩ for Jumper |
| Biased Humidity | AEC-Q200 Test 7<br>MIL-STD-202 Method 103 | 1,000 hours; 85 °C / 85% RH<br>10% of operating power<br>Measurement at 24±4 hours after test conclusion. | ±(1.0%+0.05Ω) for D/F tol<br>±(3.0%+0.05Ω) for J tol<br><100 mΩ for Jumper |
| Operational Life | AEC-Q200 Test 8<br>MIL-STD-202 Method 108 | 1,000 hours at 125 °C, derated voltage applied for 1.5 hours on, 0.5 hour off, still-air required | ±(1.0%+0.05Ω) for D/F tol<br>±(3.0%+0.05Ω) for J tol<br><100 mΩ for Jumper |
| Resistance to Soldering Heat | AEC-Q200 Test 15<br>MIL-STD-202 Method 210 | Condition B, no pre-heat of samples<br>Lead-free solder, 260±5 °C, 10±1 seconds immersion time<br>Procedure 2 for SMD: devices fluxed and cleaned with isopropanol | ±(0.5%+0.05Ω) for D/F tol<br>±(1.0%+0.05Ω) for J tol<br><50 mΩ for Jumper<br>No visible damage |
| Thermal Shock | AEC-Q200 Test 16<br>MIL-STD-202 Method 107 | -55/+125 °C<br>Number of cycles is 300. Devices mounted<br>Maximum transfer time is 20 seconds. Dwell time is 15 minutes. Air – Air | ±(0.5%+0.05Ω) for D/F tol<br>±(1.0%+0.05Ω) for J tol<br><50 mΩ for Jumper |
| ESD | AEC-Q200 Test 17<br>AEC-Q200-002 | Human Body Model,<br>$1_{pos.}$ + $1_{neg.}$ discharges<br>0201: 500V<br>0402/0603: 1KV<br>0805 and above: 2KV | ±(3.0%+0.05 Ω)<br><50 mΩ for Jumper |

| TEST | TEST METHOD | PROCEDURE | REQUIREMENTS |
|---|---|---|---|
| Solderability<br>- Wetting | AEC-Q200 Test 18<br>J-STD-002 | Electrical Test not required Magnification 50X<br>SMD conditions:<br>(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 (≥95% covered)<br>No visible damage |
| Board Flex | AEC-Q200 Test 21<br>AEC-Q200-005 | Chips mounted on a 90mm glass epoxy resin PCB (FR4)<br>Bending for 0201/0402: 5 mm<br>0603/0805: 3 mm<br>1206 and above: 2 mm<br>Holding time: minimum 60 seconds | ±(1.0%+0.05Ω)<br><50 mΩ for Jumper |
| Temperature Coefficient of Resistance (T.C.R.) | MIL-STD-202 Method 304 | 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 |
| 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 | ±(1.0%+0.05Ω) for D/F tol<br>±(2.0%+0.05Ω) for J tol<br><50 mΩ for Jumper |
| FOS | ASTM-B-809-95 | Sulfur (saturated vapor) 500 hours, 60±2℃, unpowered | ±( 1.0%+0.05Ω) |

## REVISION HISTORY

| REVISION | DATE | CHANGE NOTIFICATION | DESCRIPTION |
|---|---|---|---|
| Version 6 | May 31, 2017 | - | - Add 10" packing |
| Version 5 | Dec. 07, 2015 | - | - Add in AC double power |
| Version 4 | May 25, 2015 | - | - Remove 7D packing<br>- Extend resistance range<br>- Add in AC0201<br>- Update FOS test and requirements |
| Version 3 | Feb 13, 2014 | - | - Feature description updated<br>- add ±0.5%<br>- delete 10" taping reel |
| Version 2 | Feb. 10, 2012 | - | - Jumper criteria added<br>- AC1218 marking and outline figure updated |
| Version 1 | Feb. 01, 2011 | - | - Case size 1210, 1218, 2010, 2512 extended<br>- Test method and procedure updated<br>- Packing style of 7D added |
| Version 0 | Nov. 10, 2010 | - | - First issue of this specification |

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