

# **DATA SHEET**

## THICK FILM CHIP RESISTORS **AUTOMOTIVE GRADE**

AC series

 $\pm 5\%, \pm 1\%, \pm 0.5\%$  Sizes 0201/0402/0603/0805/1206/ 1210/1218/2010/2512

RoHS compliant & Halogen free



**YAGEO** 

Product specification – March 19, 2021 V.8





#### SCOPE

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

#### <u>APPLICATIONS</u>

- All general purpose applications
- Car electronics, industrial application

#### **FEATURES**

- AEC-Q200 qualified
- Moisture sensitivity level: MSL I
- 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

0201 to 2512

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 XXX L (1) (2) (3) (4) (5) (6) (7)

#### (I) SIZE

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

#### (2) TOLERANCE

D =  $\pm 0.5\%$  J =  $\pm 5\%$  (for Jumper ordering, use code of J) F =  $\pm 1\%$ 

#### (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 & $2 \times s$ tandard power
	$3W = 13$ inch dia. Reel & $2 \times$ standard power

#### (6) RESISTANCE VALUE

I  $\Omega$  to 22 M $\Omega$ 

There are  $2\sim4$  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. I K2, not I K20.

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)

number Resistance coding	Example
XRXX (1 to $9.76\Omega$ )	$IR = I\Omega$ $IR5 = I.5\Omega$ $9R76 = 9.76\Omega$
XXRX (10 to 97.6Ω)	$10R = 10\Omega$ $97R6 = 97.6\Omega$
XXXR (100 to 976Ω)	$100R = 100\Omega$ $976R = 976\Omega$
XKXX (1 to 9.76 K <b>Ω)</b>	$1K = 1,000\Omega$ $9K76 = 9760\Omega$
XMXX (1 to 9.76 MΩ)	$IM = 1,000,000\Omega$ $9M76 = 9,760,000\Omega$
XXMX (10 MΩ)	10Μ = 10,000,000Ω

Resistance rule of global part

#### **ORDERING EXAMPLE**

The ordering code for an AC0402 chip resistor, value  $100 \text{ K}\Omega$  with  $\pm 1\%$  tolerance, supplied in 7-inch tape reel is: AC0402FR-07100KL.

#### NOTE

- 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.
- AC series with ±0.5% tolerance is also available. For further information, please contact sales.





**Chip Resistor Surface Mount** AC SERIES

0201 to 2512

#### **MARKING**

#### AC0201 / AC0402



No marking

Fig. I

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



E-24 series: 3 digits, ±5%

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

#### AC0603



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

Fig. 3 Value = 24  $\Omega$ 



E-96 series: 3 digits, ±1% & ±0.5%

First two digits for E-96 marking rule and 3rd letter for number of zeros

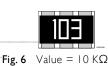
#### AC0805 / AC1206 / AC1210 / AC2010 / AC2512



Both E-24 and E-96 series: 4 digits, ±1% & ±0.5%

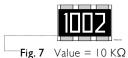
First three digits for significant figure and 4th digit for number of zeros

#### AC1218



E-24 series: 3 digits, ±5%

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



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.

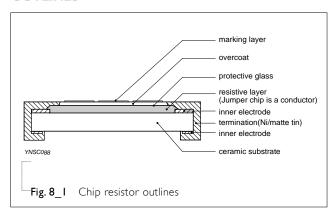
#### **CONSTRUCTION**

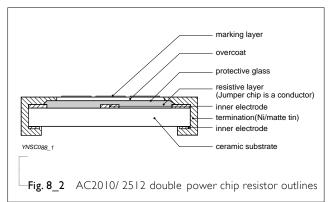
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The resistors are constructed on top of an automotive grade ceramic body. Internal metal electrodes are added at each end and connected by a resistive glaze. The resistive glaze is covered by a protective glass.

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**

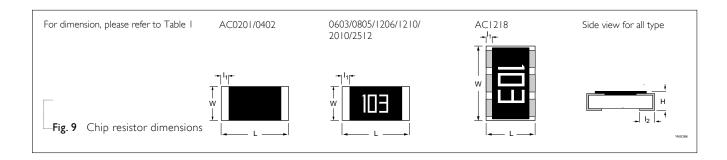




#### **DIMENSIONS**

**Table I** For outlines, please refer to Fig. 9

TYPE	L (mm)	W (mm)	H (mm)	I₁ (mm)	l <sub>2</sub> (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





### **ELECTRICAL CHARACTERISTICS**

Table 2

**YAGEO** 

					CHARAC	TERISTICS		
TYPE	POWER	Operating Temperature Range	Max. Working Voltage	Max. Overload Voltage	Dielectric Withstanding Voltage	Resistance Range	Temperature Coefficient	Jumper Criteria
						5% (E24)	IΩ≤R≤ I0Ω	Rated Current
						$1\Omega \le R \le 10M\Omega$	-100/+350ppm°C	0.5A
		-55 °C to				1% (E24/E96)	$10\Omega < R \le 10M$	Maximum
AC0201	1/20 W	-55 °C	25V	50V	50V	$ \Omega \le R \le 10M\Omega$	±200ppm°C	Current
		133 C				0.5% (E24/E96)		I.0A
						$10\Omega \le R \le 1M\Omega$		
						Jumper $<$ 50m $\Omega$		
						5% (E24)	$1\Omega \le R \le 10\Omega$	Rated Current
						$1\Omega \le R \le 22M\Omega$	±200ppm°C	IA
	-55 °C to	50V	100V	′ 100V	0.5%, 1% (E24/E96)	$10\Omega < R \le 10M\Omega$	Maximum	
	1/16 VV	155 °C	30 v	7 1000	VV 100V	$1\Omega \le R \le 10M\Omega$	±100ppm°C	Current
						Jumper<50mΩ	$10M\Omega < R \le 22M\Omega$	2A
AC0402							±200ppm°C	
_		-55 °C to		ZEV 100V	100V 100V	5% (E24)	$1\Omega \le R \le 10\Omega$	
	L /O\ A /		75\/			$1\Omega \le R \le 10M\Omega$	±200 ppm°C	
	1/8W	155 °C	75V	1000		0.5%, 1% (E24/E96)	$10\Omega < R \le 10M\Omega$	
						$1\Omega \le R \le 10M\Omega$	±100 ppm°C	
						5% (E24)	$1\Omega \le R \le 10\Omega$	Rated Current
						$1\Omega \le R \le 22M\Omega$	±200ppm°C	IA
		-55 °C to				0.5%, 1% (E24/E96)	$10\Omega < R \le 10M\Omega$	Maximum
	1/10 W	155 °C	75V	150V	150V	$1\Omega \le R \le 10M\Omega$	±100ppm°C	Current
						Jumper<50mΩ	$10M\Omega < R \le 22M\Omega$	2A
AC0603							±200ppm°C	
-						5% (E24)	IΩ≤R≤ I0Ω	
		-55 °C to				$1\Omega \le R \le 10M\Omega$	±200 ppm°C	
	1/5 W	155 °C	75V	150V	150V	0.5%, 1% (E24/E96)	$10\Omega < R \le 10M\Omega$	
						$1\Omega \le R \le 10M\Omega$	±100 ppm°C	





					CHARAC	TERISTICS															
TYPE	POWER	Operating Temperature Range	Max. Working Voltage	Max. Overload Voltage	Dielectric Withstanding Voltage	Resistance Range	Temperature Coefficient	Jumper Criteria													
						5% (E24)	$1\Omega \le R \le 10\Omega$	Rated Current													
						$1\Omega \le R \le 22 M\Omega$	±200ppm°C	2A													
		-55 °C to				0.5%, 1% (E24/E96)	$10\Omega < R \le 10M\Omega$	Maximum													
	1/8 W	155 °C	150V	300V	300V	$1\Omega \le R \le 10M\Omega$	±100ppm°C	Current													
						Jumper $<$ 50m $\Omega$	$10M\Omega < R \le 22M\Omega$	5A													
AC0805							±200ppm°C														
=						5% (E24)	$ \Omega \le R \le  \Omega $														
	1/4 W	<b>−</b> 55 °C to	150V	300V	300V	$1\Omega \le R \le 10M\Omega$	±200 ppm°C														
	1/4 VV	155 °C	1304	3007	2004	0.5%, 1% (E24/E96)	$10\Omega < R \le 10M\Omega$														
						$1\Omega \le R \le 10M\Omega$	±100 ppm°C														
						5% (E24)	$1\Omega \le R \le 10\Omega$	Rated Current													
		-55 °C to W 155 °C	200V	400V	500V	$I\Omega \le R \le 22M\Omega$	±200ppm°C	2A													
	1/4 W					0.5%, 1% (E24/E96)	$10\Omega < R \le 10M\Omega$	Maximum													
					300 V	$1\Omega \le R \le 10M\Omega$	±100ppm°C	Current													
						Jumper $<$ 50m $\Omega$	$10M\Omega < R \le 22M\Omega$	10A													
AC1206							±200ppm°C														
						5% (E24)	$1\Omega \le R \le 10\Omega$														
		<b>−</b> 55 °C to	0.001	400V	. = =		400	400: -	400:	400: -	,							= 0.01 /	$1\Omega \le R \le 10M\Omega$	±200 ppm°C	
	1/2 W	200V	200V		500V	0.5%, 1% (E24/E96)	$10\Omega < R \le 10M\Omega$														
							$1\Omega \le R \le 10M\Omega$	±100 ppm°C													
						5% (E24)	$ \Omega \le R \le  \Omega $	Rated Current													
						$I\Omega \le R \le 22M\Omega$	±200ppm°C	2A													
		-55 °C to	0.001	500	= 0.01 /	0.5%, 1% (E24/E96)	$10\Omega < R \le 10M\Omega$	Maximum													
	1/2 W	155 °C	200V	500V	500V	$1\Omega \le R \le 10M\Omega$	±100ppm°C	Current													
						Jumper<50mΩ	$10M\Omega < R \le 22M\Omega$	10A													
AC1210							±200ppm°C														
-						5% (E24)	$1\Omega \le R \le 10\Omega$														
	1 \ A /	-55 °C to	2001/	F00) (	,	$1\Omega \le R \le 10M\Omega$	±200 ppm°C														
	IW	155 °C	200V	500V	500V	0.5%, 1% (E24/E96)	$10\Omega < R \le 10M\Omega$														
						$1\Omega \le R \le 10M\Omega$	±100 ppm°C														

TYPE POW	VER	Operating Temperature Range	Max. Working Voltage	Max. Overload Voltage	Dielectric Withstanding Voltage	Resistance Range	Temperature Coefficient	Jumper Criteria						
	ΙW	-55 °C to						21100110						
	IW	-55 °C to				5% (E24)	$1\Omega \le R \le 10\Omega$	Rated Current						
	l W	33 C to				$I\Omega \le R \le IM\Omega$	±200ppm°C	6A						
		155 °C	200V	500V	500V	0.5%, 1% (E24/E96)	$10\Omega < R \le IM\Omega$	Maximum						
		133 C				$1\Omega \le R \le 1M\Omega$	±100ppm°C	Current						
AC1218						Jumper<50mΩ		10A						
						5% (E24)	$1\Omega \le R \le 10\Omega$							
	1.5W	-55 °C to	200V	500V	500V	$ \Omega \le R \le  M\Omega $	±200 ppm°C							
1,		155 °C	200 v	300 v	J00 V	0.5%, 1% (E24/E96)	$10\Omega < R \le IM\Omega$							
							$1\Omega \le R \le 1M\Omega$	±100 ppm°C						
							5% (E24)	IΩ≤R≤ I0Ω	Rated Current					
		/ -55 °C to / 155 °C	200V 50	500V		$I\Omega \le R \le 22M\Omega$	±200ppm°C	2A						
2/	3/4 W				F00\/	0.5%, 1% (E24/E96)	$10\Omega < R \le 10M\Omega$	Maximum						
3/4					500V	$1\Omega \le R \le 10M\Omega$	±100ppm°C	Current						
						Jumper<50m $\Omega$	$10M\Omega < R \le 22M\Omega$	10A						
AC2010							±200ppm°C							
				200V 500V	)V 500V	5% (E24)	$ \Omega \le R \le  \Omega $							
		-55 °C to W 155 °C				$1\Omega \le R \le 10M\Omega$	±200 ppm°C							
1.2	25W		200V			0.5%, 1% (E24/E96)	$10\Omega < R \le 10M\Omega$							
	155 (												$1\Omega \le R \le 10M\Omega$	±100 ppm°C
						5% (E24)	IΩ≤R≤ I0Ω	Rated Current						
						$1\Omega \le R \le 22M\Omega$	±200ppm°C	2A						
		-55 °C to				0.5%, 1% (E24/E96)	$10\Omega < R \le 10M\Omega$	Maximum						
	IW	155 °C	200V	500V	500V	$1\Omega \le R \le 10M\Omega$	±100ppm°C	Current						
						Jumper<50mΩ	$10M\Omega < R \le 22M\Omega$	10A						
AC2512							±200ppm°C							
						5% (E24)	IΩ≤R≤ I0Ω							
		-55 °C to				$1\Omega \le R \le 10M\Omega$	±200 ppm°C							
	2 W	155 °C	200V	500V	500V	0.5%, 1% (E24/E96)	$10\Omega < R \le 10M\Omega$							
						$1\Omega \le R \le 10M\Omega$	±100 ppm°C							

## **YAGEO**

#### 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)

ACI206=I/4W (0.25W); 1/2 W (0.5 W)

AC1210=1/2W (0.5W); IW

AC1218=1W; 1.5W

AC2010=3/4W (0.75W); 1.25W

AC2512=1 W; 2W

#### **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

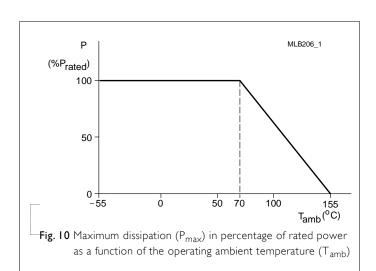
#### Where

V = Continuous rated DC or AC (rms) working

voltage (V)

P = Rated power (W)

 $R = Resistance value (\Omega)$ 





#### TESTS AND REQUIREMENTS

 Table 4
 Test condition, procedure and requirements

TEST	TEST METHOD	PROCEDURE	REQUIREMENTS
High Temperature Exposure	AEC-Q200 Test 3 MIL-STD-202 Method 108	1,000 hours at $T_A$ = 155 °C, unpowered	$\pm (1.0\% + 0.05 \Omega)$ for D/F tol $\pm (2.0\% + 0.05 \Omega)$ for J tol <50 m $\Omega$ for Jumper
Moisture Resistance	AEC-Q200 Test 6 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	$\pm (0.5\% + 0.05\Omega)$ for D/F tol $\pm (2.0\% + 0.05\Omega)$ for J tol <100 m $\Omega$ for Jumper
Biased Humidity	AEC-Q200 Test 7 MIL-STD-202 Method 103	I,000 hours; 85 °C / 85% RH I 0% of operating power Measurement at 24±4 hours after test conclusion.	$\pm (1.0\% + 0.05\Omega)$ for D/F tol $\pm (3.0\% + 0.05\Omega)$ for J tol <100 m $\Omega$ for Jumper
Operational Life	AEC-Q200 Test 8 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	$\pm (1.0\% + 0.05\Omega)$ for D/F tol $\pm (3.0\% + 0.05\Omega)$ for J tol <100 m $\Omega$ for Jumper
Resistance to Soldering Heat	AEC-Q200 Test 15 MIL-STD-202 Method 210	Condition B, no pre-heat of samples Lead-free solder, 260±5 °C, 10±1 seconds immersion time Procedure 2 for SMD: devices fluxed and cleaned with isopropanol	$\pm (0.5\% + 0.05\Omega)$ for D/F tol $\pm (1.0\% + 0.05\Omega)$ for J tol <50 m $\Omega$ for Jumper No visible damage
Thermal Shock	AEC-Q200 Test 16 MIL-STD-202 Method 107	-55/+125 °C  Number of cycles is 300. Devices mounted  Maximum transfer time is 20 seconds.  Dwell time is 15 minutes. Air – Air	$\pm (0.5\% \pm 0.05\Omega)$ for D/F tol $\pm (1.0\% \pm 0.05\Omega)$ for J tol <50 m $\Omega$ for Jumper
ESD	AEC-Q200 Test 17 AEC-Q200-002	Human Body Model,  I pos. + I neg. discharges  0201: 500V  0402/0603: IKV  0805 and above: 2KV	$\pm (3.0\% + 0.05 \Omega)$ <50 m $\Omega$ for Jumper





## Chip Resistor Surface Mount AC SERIES 0201 to 2512

TEST	TEST METHOD	PROCEDURE	REQUIREMENTS
Solderability - Wetting	AEC-Q200 Test 18 J-STD-002	Electrical Test not required Magnification 50X SMD conditions:	Well tinned (≥95% covered) No visible damage
		(a) Method B, aging 4 hours at 155 °C dry heat, dipping at 235±3 °C for 5±0.5 seconds.	INO VISIDIE GAITIAGE
		(b) Method B, steam aging 8 hours, dipping at $215\pm3$ °C for $5\pm0.5$ seconds.	
		(c) Method D, steam aging 8 hours, dipping at 260±3 °C for 30±0.5 seconds.	
Board Flex	AEC-Q200 Test 21	Chips mounted on a 90mm glass epoxy resin PCB (FR4)	±(1.0%+0.05Ω)
	AEC-Q200-005	Bending for 0201/0402: 5 mm 0603/0805: 3 mm 1206 and above: 2 mm	$<$ 50 m $\Omega$ for Jumper
		Holding time: minimum 60 seconds	
Temperature Coefficient of Resistance (T.C.R.)	MIL-STD-202 Method 304	At +25/-55 °C and +25/+125 °C	Refer to table 2
,		Formula:	
		T.C.R= $\frac{R_2-R_1}{R_1(t_2-t_1)} \times 10^6 \text{ (ppm/°C)}$	
		Where t <sub>1</sub> =+25 °C or specified room temperature	
		$t_2$ =-55 °C or +125 °C test temperature	
		R <sub>1</sub> =resistance at reference temperature in ohms	
		R <sub>2</sub> =resistance at test temperature in ohms	
Short Time	IEC60115-1 4.13	2.5 times of rated voltage or maximum	$\pm (1.0\% \pm 0.05\Omega)$ for D/F tol
Overload		overload voltage whichever is less for 5 sec at room temperature	$\pm (2.0\% + 0.05\Omega)$ for J tol <50 m $\Omega$ for Jumper
FOS	ASTM-B-809-95	Sulfur (saturated vapor) 500 hours, 60±2°C, unpowered	±(1.0%+0.05Ω)



Chip Resistor Surface Mount | AC | SERIES | 0201 to 2512

#### REVISION HISTORY

REVISION	DATE	CHANGE NOTIFICATION	DESCRIPTION
Version 8	Mar. 19, 2021	-	- Upgrade the working voltage of 0402 double power to 75V
Version 7	July 10, 2017	-	- Add "3W" part number coding for 13" Reel & double power
Version 6	May 31, 2017	-	- Add 10" packing
Version 5	Dec. 07, 2015	-	- Add in AC double power
			- Remove 7D packing
Version 4	May 25, 2015	_	- Extend resistance range
, 6, 5, 6, 1	, 20, 20.0		- Add in AC0201
			- Update FOS test and requirements
			- Feature description updated
Version 3	Feb 13, 2014	-	- add ±0.5%
			- delete 10" taping reel
	F   10 0010		- Jumper criteria added
Version 2	Feb. 10, 2012	-	- ACI218 marking and outline figure updated
-			
			- Case size 1210, 1218, 2010, 2512 extended
Version I	Feb. 01, 2011	-	- Test method and procedure updated
			- Packing style of 7D added
Version 0	Nov. 10, 2010	-	- First issue of this specification

#### Chip Resistor Surface Mount AC 0201 to 2512

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