Yageo Chip-Resistor Introduction

R-Chip PM Team

April. 2012

Introduction

Purpose

- To familiarize the customer with Yageo's chip resistors and their manufacturing process

Objectives

- Provide basic explanation of how the chip resistors are made
- Introduction to their Thin and Thick Film product offering
- Provide an overview of their resistor networks and low ohm current sense resistors
- Explore Yageo's part number breakdowns and RoHS labeling

Content

- 32 pages

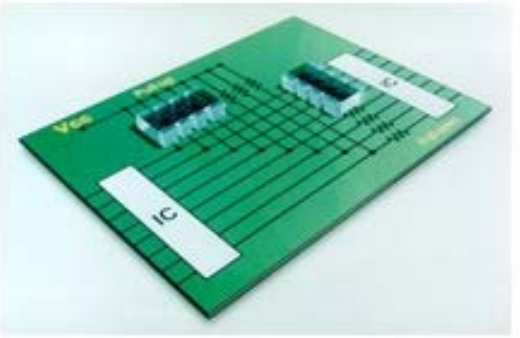
Leaning Time

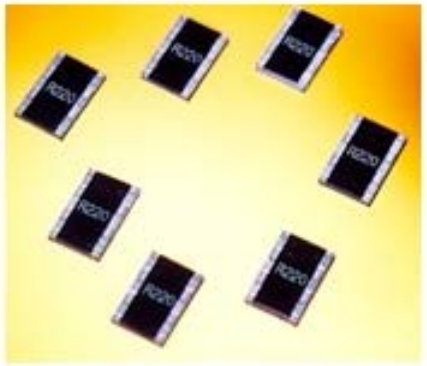
- 15 minutes

Introduction to Chip-Resistor

SMT: Surface Mounted Technology

SMD: Surface Mounted Device





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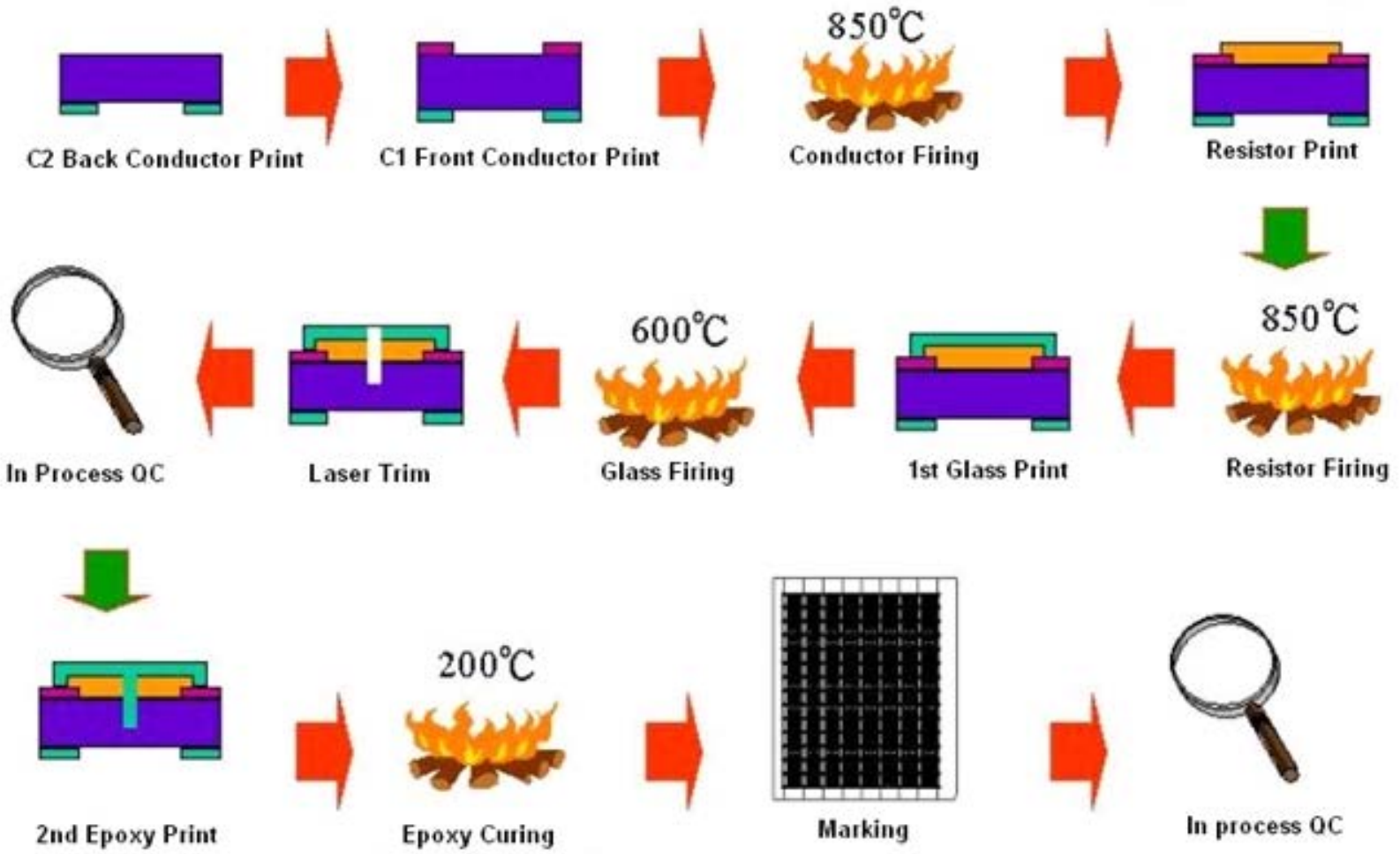
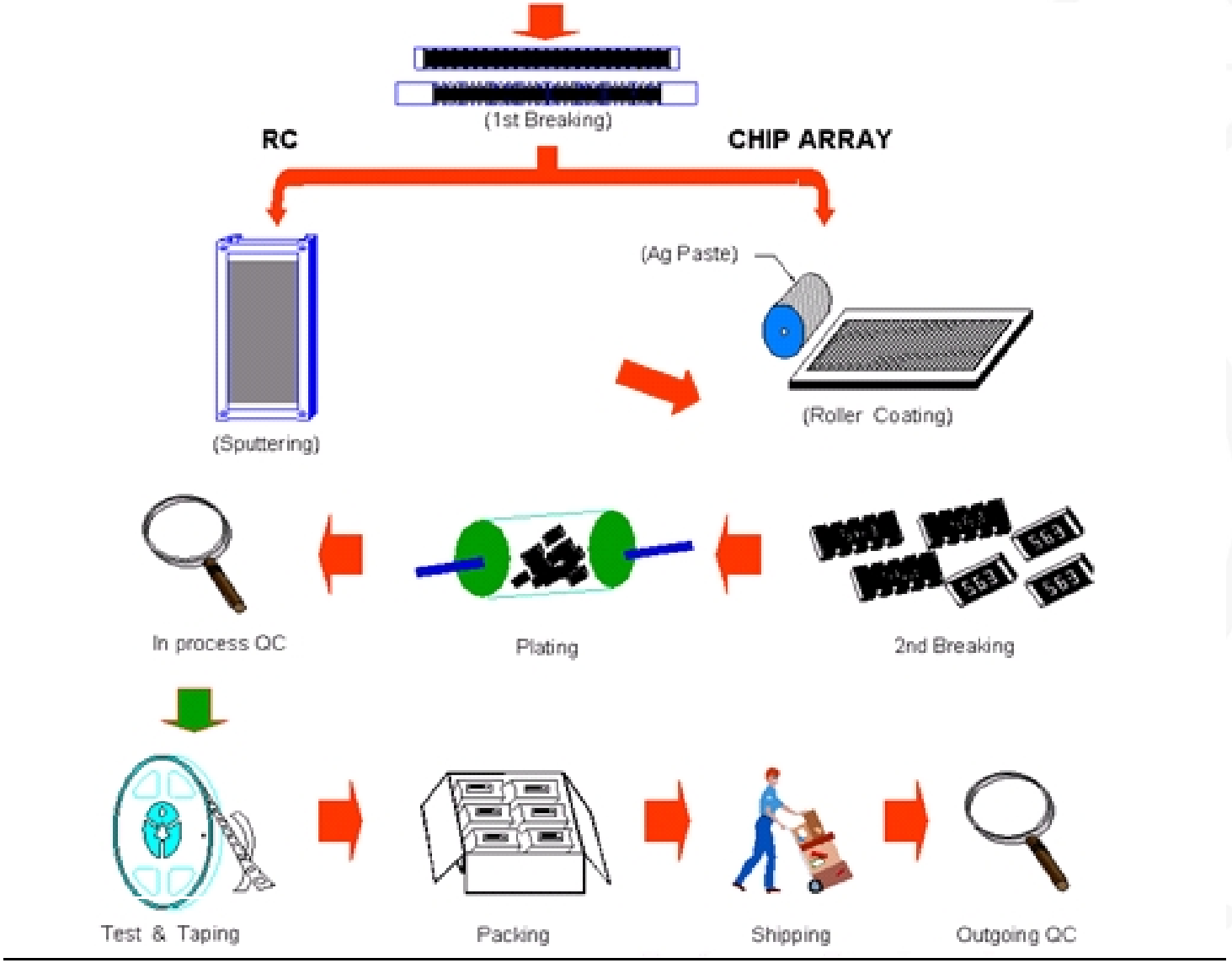
Chip Resistor Fabrication Process

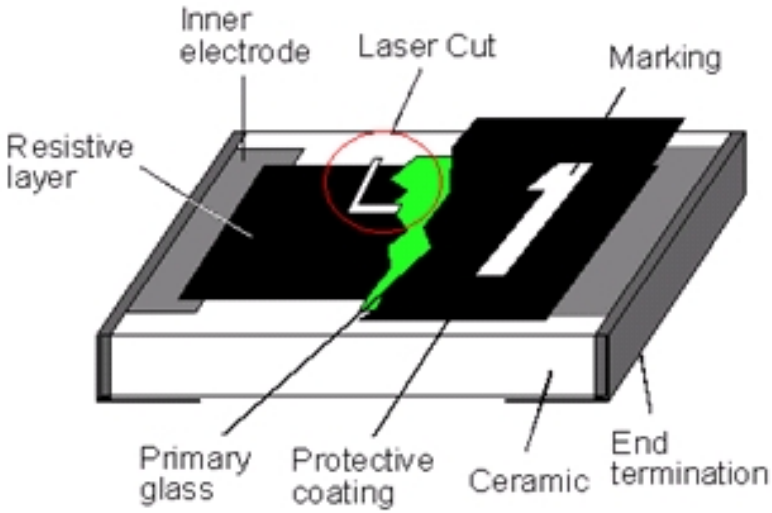


Chip Resistor Fabrication Process

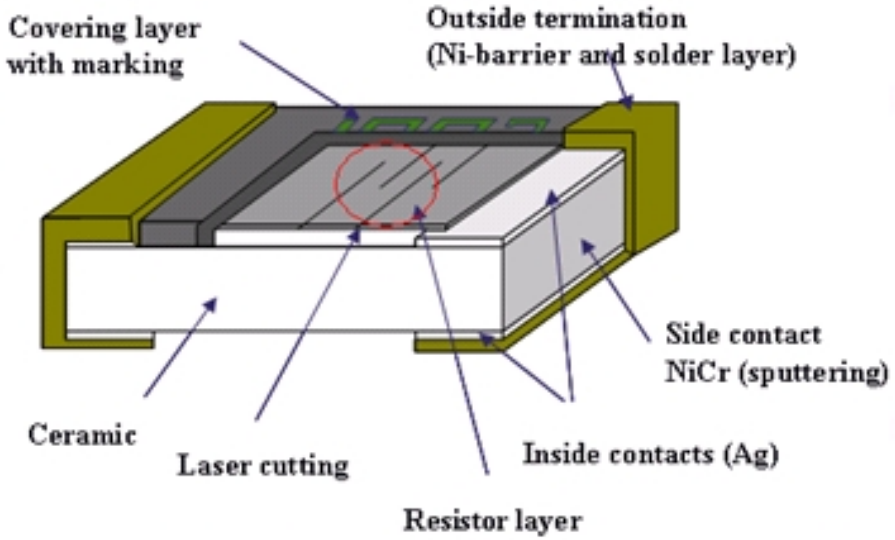


Resistance Trimming Process

Thick Film



Thin Film



Yageo Chip Resistor Overview - Thick Film

Thick Film

Discrete

RC Series
- 01005 to 2512

RE Series
- 0201 to 1206

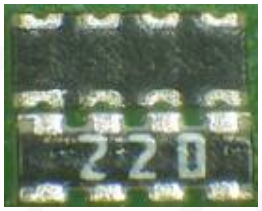
AC Series
- 0402 to 2512

AF series
- 0402 to 1206

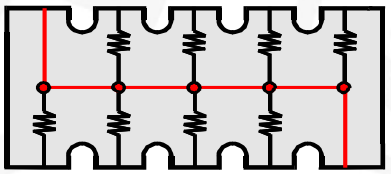
Specific Application
- AR (Gold Termination)
- RV (High Voltage)
- TR (Trimmable)
- SR (Surge)
- ATV (Attenuator)

Arrays/Network

YC (convex) / TC (concave) Series
- YC102/104
- YC122 TC122
- YC124 TC124
- YC162 TC164
- YC164
- YC248
- YC324



Network
- YC 158 Series
- YC 358 Series



Yageo Chip Resistor Overview – Thin Film

Thin Film

Discrete

RT Series

Tol: ±0,05 ~ 1%,
TC: 0±10 ~ 50ppm/K

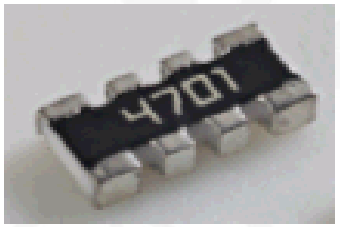
- **RT0402**
- **RT0603**
- **RT0805**
- **RT1206**
- **RT1210**
- **RT2010**
- **RT2512**

Arrays/Network

TA Series

- **TA122**
- **TA124**
- **TA162**
- **TA164**

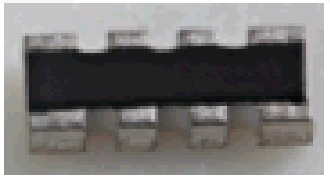
On request



TD Series (multi-value)

- **TD164**

On request



Yageo Chip Resistor Overview – Low Ohmic

Low ohmic – Current sensing

Thick Film

RL Series

Standard TCR

RL0402
RL0603
RL0805
RL1206
RL1210
RL1218
RL2010
RL2512
RL0805 double power
RL1206 double power

PT Series

	Low TCR
PT0201*	200
PT0402*	200
PT0603	200
PT0805	200
PT1206	75
PT2010	75
PT2512	75
PT0815	100

PT is double power
* Triple power available

Metal Foil

PF/PE Series

•0603 •2512
•0805 •4520
•1206 •4527
•2010

PH series

•0603 •1206

PF Series
Wide terminal

•0508 •0612 •0815
•0830 •1225

Metal Strip

PR Series

•PR1206
•PR2010
•PR2512

PS Series
4 - Terminal

•0612 •1225

Thick Film Resistor – General Purpose

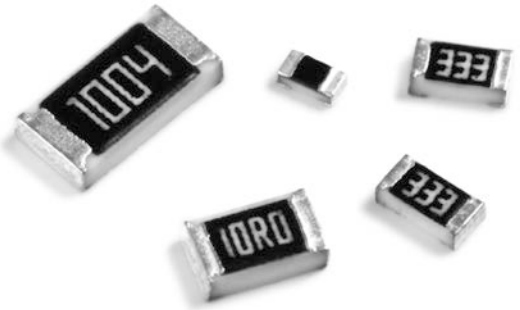
Series: RC01005, RC0201, RC0402, RC0603, RC0805, RC1206, RC1210, RC1218, RC2010, RC2512

- **Package / Case : 01005 – 2512**
- **Resistance Range : 1Ω to 22MΩ, Jumper**
- **Tolerance : 0.5%, 1%, 5%**
- **Temperature coefficient : ± 200 ppm/ °C, ± 100 ppm/ °C**

Automotive Grade Thick Film Resistors

Series: AC0402, AC0603, AC0805, AC1206, AC1218, AC2010, AC2512

- **Package/Case: 0402~2512**
- **Resistance Range: 1 Ω~10MΩ**
- **Tolerance: 1%, 5%**
- **Temperature coefficient: ± 100 ppm/˚C, ± 200 ppm/˚C**
- **AEC-Q200 compliant**
- **8,000 hours operational life test**
- **100% AOI prior to taping**
- **Stable process control including narrow specification and Cpk monitor**



Applications:

- **Infotainment– dashboard, ETC, navigation, audio/video**
- **Comfort/Security- HVAC system, power window, keyless entry system, indoor lighting, central door locking, and wiper modules**
- **Power management - BMS (Battery Management System), Battery Charger DC/DC Converter, PLC (Power Line communications)**

Anti-Sulfurated Chip Resistors

Series: AF0402, AF0603, AF0805, AF1206

- **Package/Case: 0402~1206**
- **Resistance Range: 1 Ω~22MΩ**
- **Tolerance: 1%, 5%**
- **Temperature coefficient: ± 100 ppm/˚C, ± 200 ppm/˚C**
- **Superior resistance against sulfur containing atmosphere**

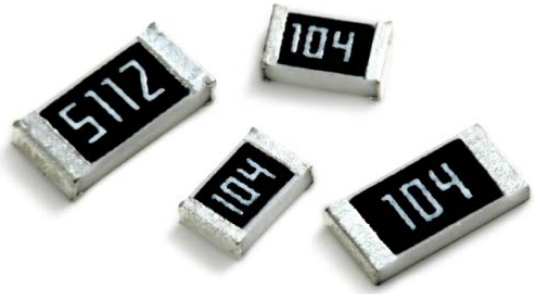
Applications:

- **All general purpose applications**
- **Car electronics**
- **Industrial and communication applications**

High Voltage Chip Resistor – for High Voltage Circuit

Series : RV series

- SMD Type : 0805 / 1206 / 2512
- Power Dissipation : 0.125W to 1W
- Resistance Range : 100KΩ to 27MΩ
- Tolerances : ± 1%, ± 5%
- Max. working voltage: 400V / 500V
- Max. overload voltage: 800V / 1kV

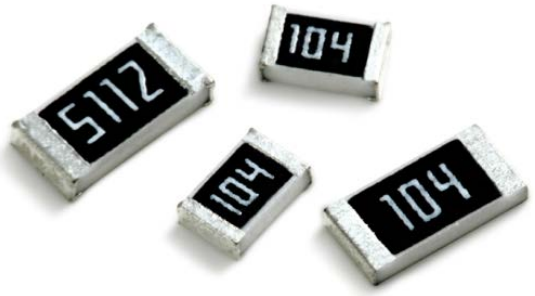


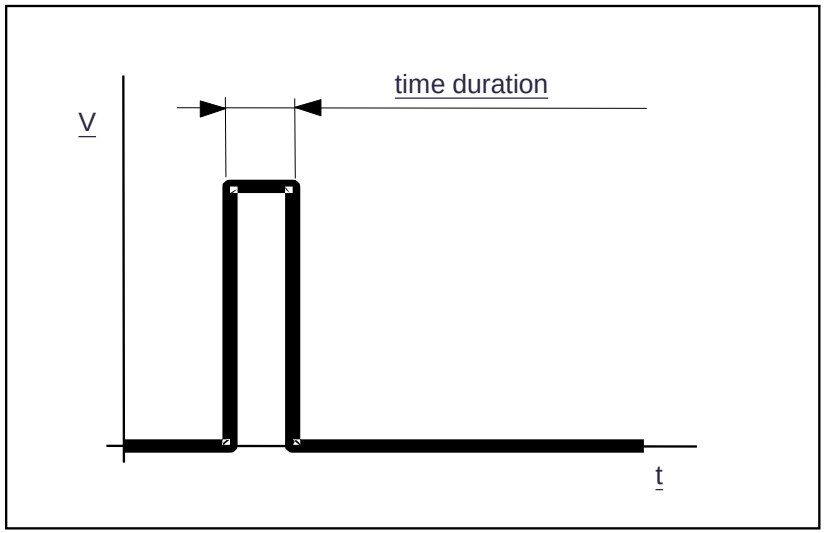
TYPE	RESISTANCE RANGE	CHARACTERISTICS					
		Rated Power	Operating Temperature Range	Max. Working Voltage	Max. Overload Voltage	Dielectric Withstanding Voltage	Temperature Coefficient of Resistance
RV0805	5% (E-24) 100K Ω to 10M Ω 1% (E-24/E-96) 100K Ω to 10M Ω	1/8 W	−55 °C to +155 °C	400 V	800 V	800 V	±200 ppm/°C
RV1206	5% (E-24) 100K Ω to 27M Ω 1% (E-24/E-96) 100K Ω to 10M Ω	1/4 W		500 V	1,000 V	1,000 V	
RV2512	5% (E-24) 4.7M Ω to 16M Ω	1 W		500 V	1,000 V	1,000 V	

Surge Chip Resistor – For Snubber Circuit

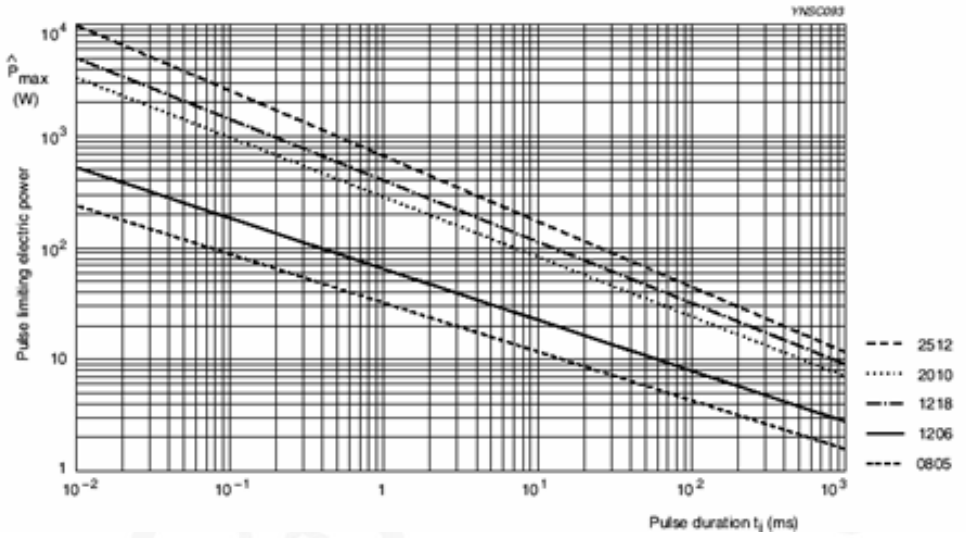
Series : SR series

- SMD Type : 0805 / 1206 / 1218 / 2010 /2512
- Power Dissipation : 0.125W to 1W
- Resistance Range : 1Ω to 100KΩ; E24 series
- Tolerances : ± 5%, ± 10% , ± 20%
- TCR : ± 200ppm/°C





(A).Single Pulse Function

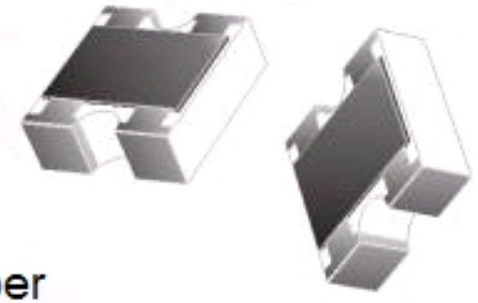


Resistor Arrays
8P4R (0402 x 4) – Convex Termination

Series : YC124

- Package / Case : 0402 x 4 Convex
- Resistance Range : 10Ω to 1MΩ, Jumper
- Tolerance : 1%, 5%
- Power dissipation (70° C) : 1/16 W
- Temperature coefficient : ± 200 ppm/°C

Resistor Arrays
4P2R (0402 x 2) – Convex Termination



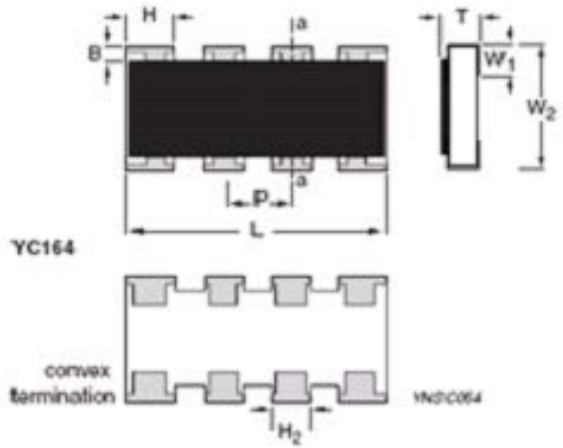
Series : YC122

- Package / Case : 0402 x 2 Convex
- Resistance Range : 10Ω to 1MΩ, Jumper
- Tolerance : 1%, 5%
- Power dissipation (70˚C) : 1/16 W
- Temperature coefficient : ± 200 ppm/ ˚C

Resistor Arrays
8P4R (0603 x 4) – Convex/Concave Termination

Series : YC164, TC164

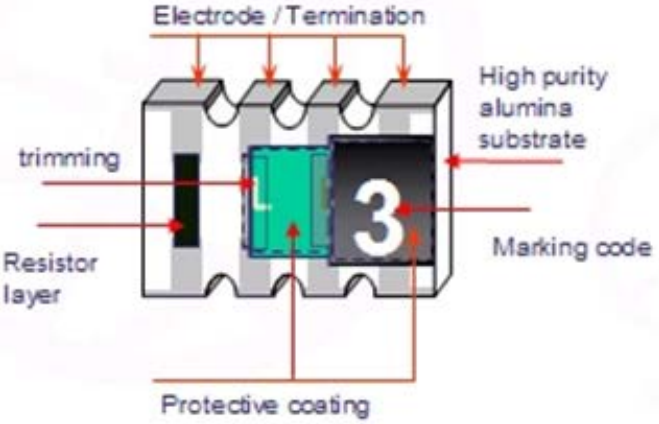
- Package / Case : 0603 x 4 Convex / Concave
- Resistance Range : 10Ω to 1MΩ, Jumper
- Tolerance : 1%, 5%
- Power (70° C) : 1/16 W
- Temperature coefficient : ± 200 ppm/ °C



Resistor Arrays
8P4R (1220~1206 x 4) – Convex Termination

Series : YC324

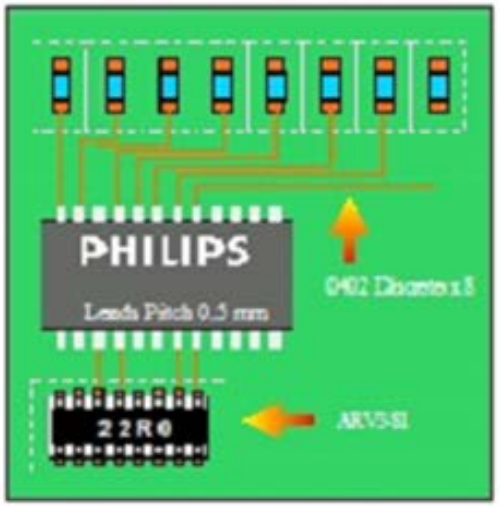
- Package / Case : 8P4R (1220 ~1206 x 4) Convex
- Resistance Range : 10Ω to 1MΩ, Jumper
- Tolerance : 1%, 5%
- Power (70˚C) : 1/8 W
- Temperature coefficient : ± 200 ppm/ °C



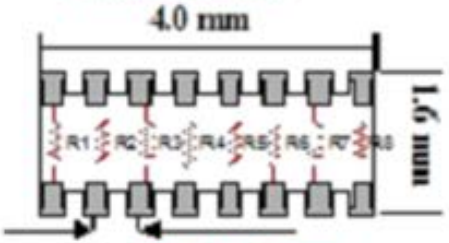
Resistor Arrays
16P8R (0616) – Convex Termination

Series : YC248

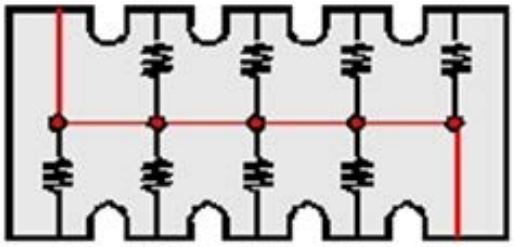
- Package / Case : 16P8R (0616 ~ 0602 x 8) Convex
- Resistance Range : 1Ω to 100KΩ
- Tolerances : ± 1 and ± 5%
- Power (70°C) : 1/16 W
- TCR : ±200ppm/ °C



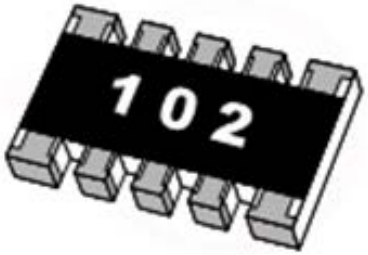
Construction



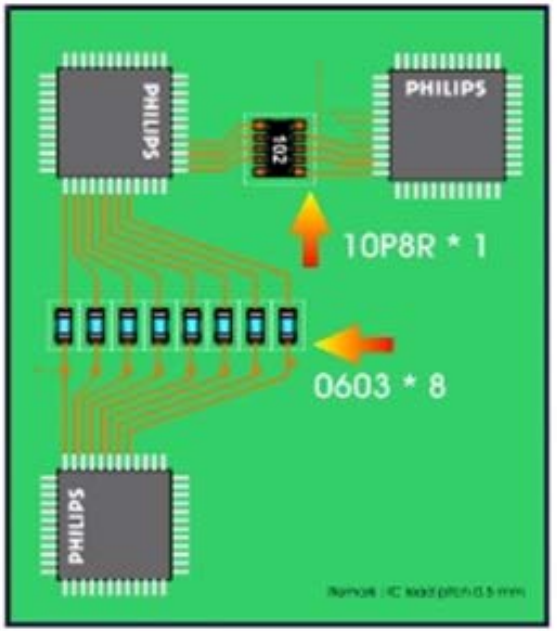
10P8R Resistor Network



Series : YC358



- Package / Case : 10P8R (0612 / 1225)
- Resistance range : 10 Ω to 330K Ω
- Tolerances : ± 1 and ± 5%
- Power dissipation (70°C) : 1/32 W,1/16W
- Temperature coefficient : ±200 ppm/ °C



Low Ohmic Resistors -- RL / PT / PF / PR Series

- **Application Fields**
  - **<10mR for high current sensing**
    - Server main board (high end MB), NB, Networking, high current battery pack (100A)
  - **10mR ~ 50mR for DC/DC Converter circuit or battery current sensing**
    - NB, Battery of NB, Networking, PC power peripheral
  - **50mR~270mR for estimating the rotation speed of a motor**
    - HDD, Micro-Motor, stepper motor
  - **>270mR , general power management**
    - Mobile, Power supply, Projector, LED lighting driver

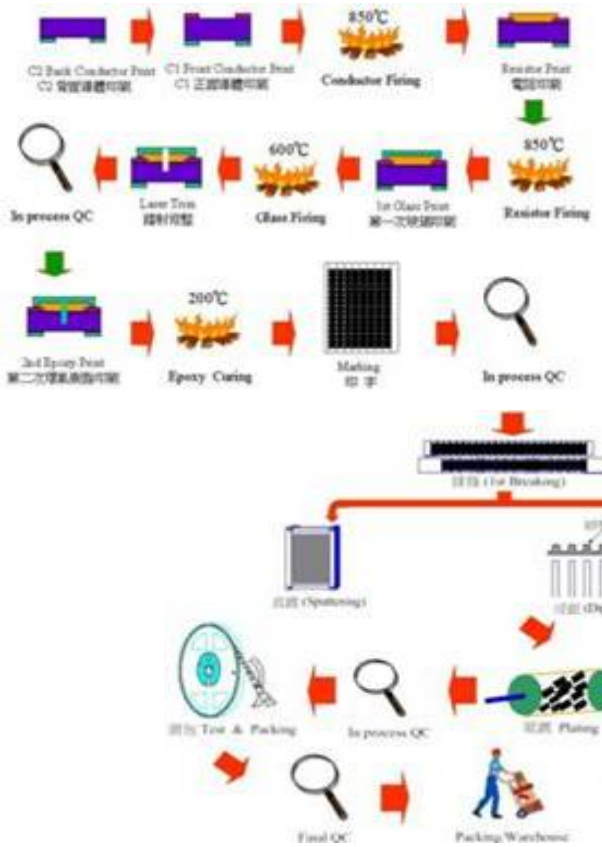
- **Why users looking for Low ohmic - Low TCR**
  - **Current sensing with low power dissipation = low ohmic value!**
  - **low TCR to get low temperature depending sensor**
  - **excellent stability with high current consumption**

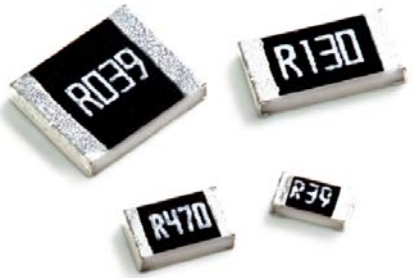
Yageo Low Ohmic Series – RL, PT

Thick Film Technology

- **RL** **Price Competitive**
- **PT** **TCR enhanced**

Yageo	Vishay
RL	RCWE
PT	RCWL





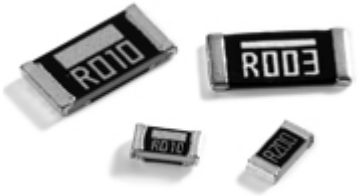
Application: middle/low voltage power supply (<700W)
Runner Item: 0805~2512, 0R1~0R91, x1~3

Yageo Low Ohmic Series – PR, PF

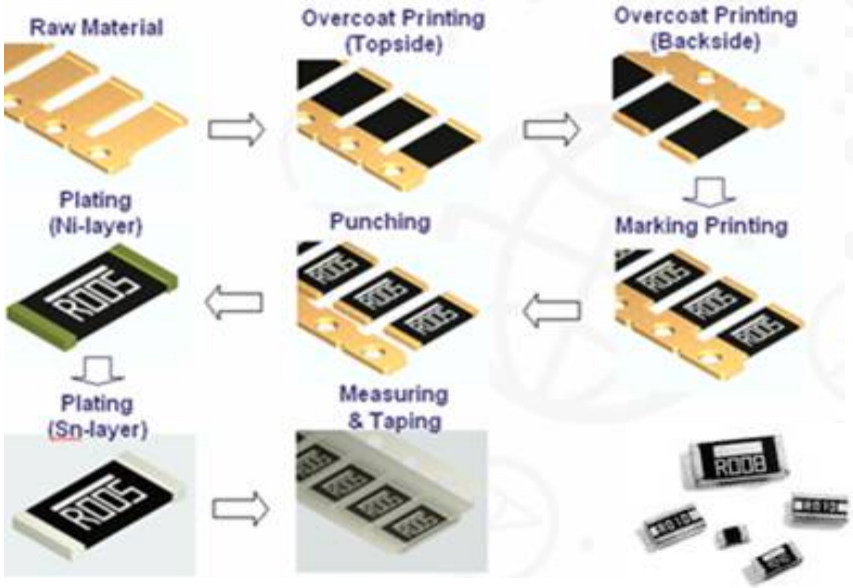
Metal Technologies

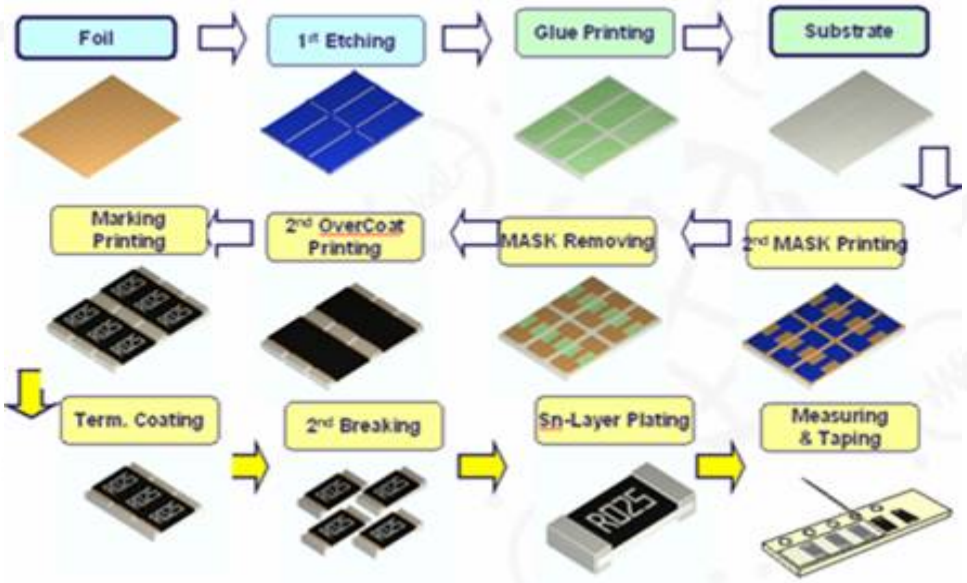
- ✓ Metal Strip
- ✓ Metal Foil

- **PR** Low TCR
- **PF** Low TCR



Yageo	Vishay
PR	WSL
PF	WSLP

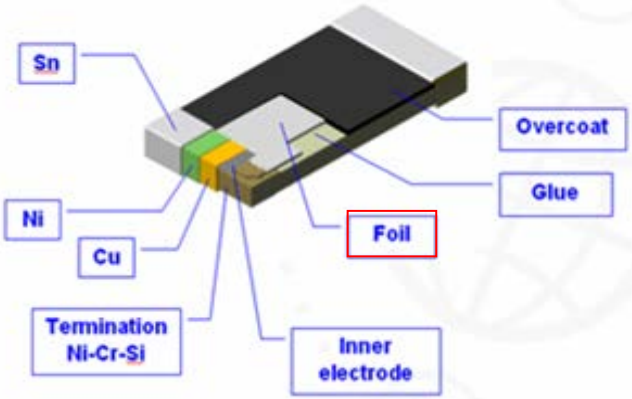


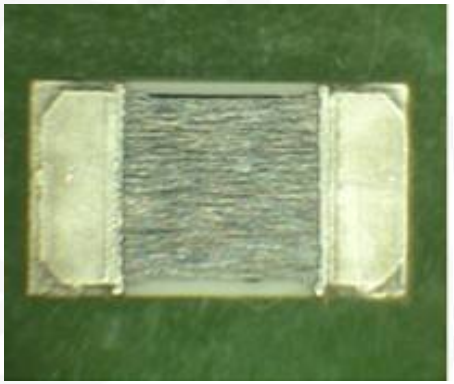


Application: middle/high voltage power supply (>700W)
Runner Item: 1206~2512, 0R001~0R1, x1~3

PE Series Current Sensing, Low Ohmic, Low Thermo EMF

- **Case Size:**
  - New - **0603, 0805, 1206, 2010, 2512**
- **Features:**
  - **Low thermo-EMF < 0.03μV/℃ , Mn-Cu Alloy**
  - **Range**
    New **0603: 10 mΩ ~ 100 m Ω, 0805: 2 mΩ ~ 100 m Ω**
  - **Low TCR: ± 50 ~ ± 100 ppm/ °C**
  - **Power enhancement**
    0603: 0.5 W
    0805: 0.125, 0.25, 0.33, 0.5, 0.7 W
    2010: 2W
  - **Part number: PEXXXXXXXFXXXXXZ**



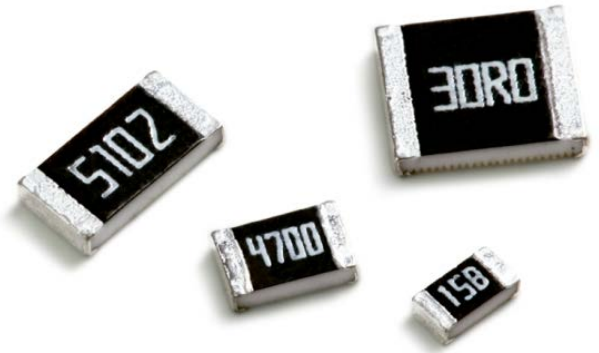


T. C. R. (code 9)
E = ±50 ppm/°C
M = ±75 ppm/°C
F = ±100 ppm/°C

PE1206xRx07xxxxxx	PE	1206	1/2W	(PxR)^1/2	-55°C to 155°C	3mΩ ≤ R ≤ 100mΩ	±1% ±2% ±5%	3mΩ ≤ R ≤ 9mΩ ±100 ppm/°C 10mΩ ≤ R ≤ 100mΩ ±75 ppm/°C
PE1206xRx7Wxxxxxx			1W					
PE2512xKx07xxxxxx		2512	1W	(PxR)^1/2	-55°C to 155°C	1mΩ ≤ R ≤ 100mΩ	±1% ±2% ±5%	1mΩ ≤ R ≤ 9mΩ ±100 ppm/°C 10mΩ ≤ R ≤ 100mΩ ±75 ppm/°C
PE2512xKx7Wxxxxxx			2W					

Thin Film Resistor Introduction

Series: RT/RJ



- **Package / Case : 0402 – 2512**
- **Resistance Range : 1Ω to 1.5MΩ**
- **Tolerance : ±0.05%, ±0.1%, ±0.25%, ±0.5%, ±1%**
- **Temperature coefficient : ± 10, ± 15, ± 25, ± 50 ppm/ °C**

Technical Information
Basic Theorems - TCR

Calculate the Temperature Coefficient of Resistance (TCR) as follows:

$$T.C.R. = \frac{R_2 - R_1}{R_1 (t_2 - t_1)} X10^6 \ (ppm/℃)$$

R_1 = resistance at reference temperature in ohms

R_2 = resistance at test temperature in ohms

t_1 = +25 ℃ or specified room temperature

t_2 = -55 ℃ or +155 ℃ test temperature

Chip Resistor Product Segment Mapping

	Alternative Energy	Power	Computing	Lighting
	Industrial	Mobile	Display	Medical
General Purpose	**RC Series** 0603~2512	**RC Series** 0402~2512	**RC Series** 0402~2512	**RC Series** 01005~1206	**RC Series** 0201~0603	**RC Series** 0402~1206	**RC Series** 0603~1206	**RC Series** 0402~0805
Low Ohmic ★	**PT, RL Series** 1206/2010/2512	**PF, PR Series** 2512	**RL, PT, PR, PF, PE Series** 0402~1206	**RL, PT, PF Series** 0201~0603	**RL, PT, PR, PF Series** 0805~2512	**RL, PT, PR, PF Series** 0805~2512	**RL, PT, PR, PF Series** 0805~1206	**RL, PF, PT, PR Series** Full size
Precision ★	**RT Series** 0603 ~1206	**RT Series** 0603 ~1206	**RT Series** 0603 ~1206		**RT/RE Series** 0603 ~1206		**RT/RE Series** 0603 ~1206	**RT/RE Series** 0603 ~1206
Special anti-Surge, High Voltage	**SR/RV Series** 0805~2512	**SR/RV Series** 0805~2512	**SR/RV Series** 0805~2512					
Special Anti-Sulfurated		**AF Series** 0402~1206	**AF Series** 0402~1206		**AF Series** 0402~1206			
Integration				**YC Series** YC102/104 to YC 124	**Array YC Series** YC124, 164	**Array YC Series** YC124, 164		

Yageo Part Number Information
Single Chip Resistor

RC	0201	J	R	-	07	100R	L
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)

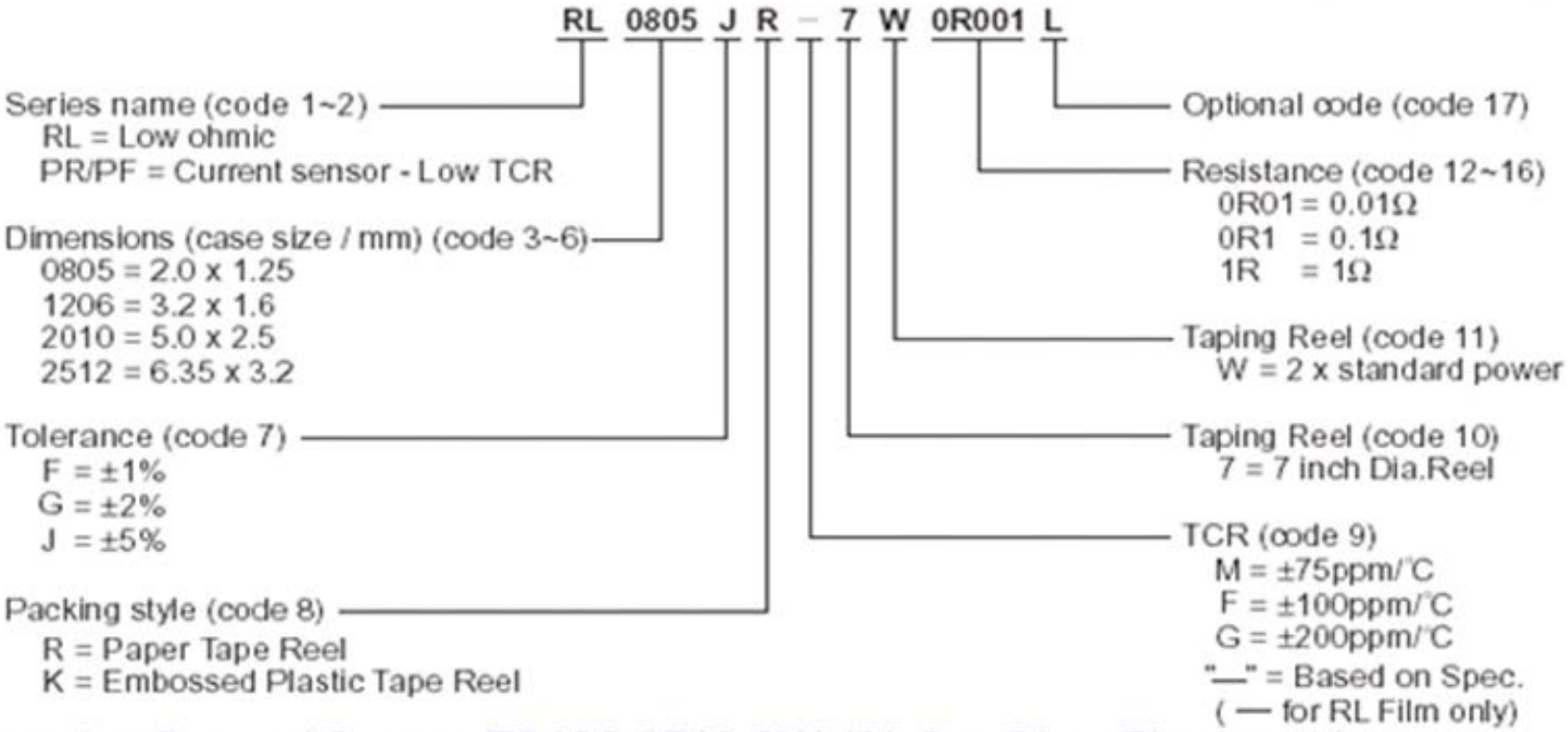
(1) Series Name	(2) Size code	(3) Resistance Tolerance	(4) Packing style	(5) TCR	(6) Reel Type	(7) Resistance	(8) Termination
RC = Thick film resistor RT = Thin film high precision – high stability RJ = Thin film general purpose RL = Low ohmic resistor PR = current sensor – low TCR PF = current sensor – low TCR TR = Trimmable SR = Surge FR = Fusible AR= NiAu termination RV = High voltage	0201 0402 0603 0805 1206 1210 1218 2010 2512	B = ±0.1% C = ±0.25% D = ±0.5% F = ±1% J = ±5% P = ±0.02% W= ±0.05%	R = Paper Tape K = Embossed Plastic Tape B = Bulk Bag	C = ±15ppm/ °C D = ±25ppm/ °C E = ±50ppm/ °C M= ±75ppm/ °C F = ±100ppm/ °C G = ±200ppm/ °C I = ±300ppm/ °C – = Base on Spec.	07= 7 inch 10=10 inch 13=13 inch	Example 0R1 10K 1R 100K 10R 1M 100R 10M 1K	L=Lead Free

Yageo Part Number Information
Array and Network Resistors

YC	15	8	L	J	R	-	07	100R	L
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Series Name	Size code	Number of resistor	Schematic	Tol.	Packing style	TCR	Reel Type	Resistance	Termination
YC = convex TC = concave	12 = 0402x2, x4 15 = 0612 for 10P8R 16 = 0603 x4 24 = 0616 for 16P8R 32 = 1220 for 8P4R 35 = 1225 for 10P8R	2 = 2 resistor 4 = 4 resistor 8 = 8 resistor	L = L- Type T = T- Type – = Base on spec.	F=±1% J=±5%	R = Paper Tape K = Embossed Plastic Tape B = Bulk Bag	– =Base on Spec.	07= 7 inch 13=13 inch	Example 1R 100K 10R 1M 100R 10M 1K	L= Lead Free

Yageo Part Number Information
Power Rating Upgrade



Example: Current Sensor TC100 2512 2W 1% 5m Ohm 7inch reel

Yageo PN is PR2512FKF7W0R005L

Available Series : RL0805, RL1206, PRPF

Lead Free Products

- Products with Lead-free termination are available & ready to meet CUSTOMERS request

GREEN SUPPLIER for all your PASSIVE COMPONENTS

Lead Free, Label for Identification

Since 01/01/2004 All Yageo R-Chips become fully lead free, with RoHS 6/6 compliance.

Old label format for Pb containing termination

Label format for Pb-free termination

Summary

- Provide a basic explanation of how the chip resistors are made
- Introduced their Thin and Thick Film product offering
- Provide an overview of their resistor networks and low ohm current sense resistors
- Explored Yageo's part number breakdowns and RoHS labeling

Innovative Service Around the Globe YAGEO

Thank you