Yageo Chip Resistor Introduction

Chip Resistors Product BU
Yageo Corporation
2015 Mar.

Introduction

Purpose

- Introduce Yageo's chip resistors and coding rules

Objectives

- Provide a Decision Tree to assist customers in choosing the appropriate products
- Provide an overview of all types of chip resistors & coding rules, including
  - ✓ Current sensors: RL/PT (Thick film), PA/PE/PS (Metal)
  - ✓ Precision: RE (Thick film), RT/AT (Thin film)
  - ✓ Thick film:
    - RC/YC/TC: general
    - AC/AA: automotive
    - AF: anti-FOS
    - SR: anti-surge
    - RV: high voltage

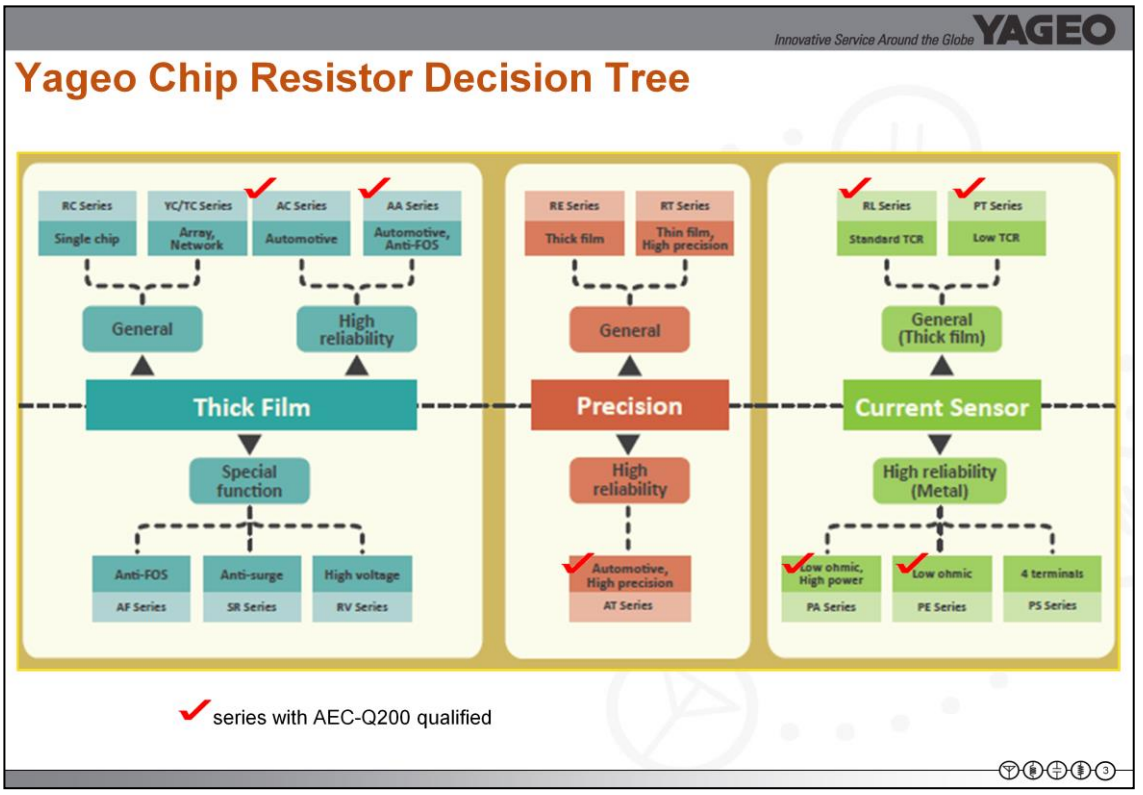
Content

- 15 slides

Learning Time

- 20 minutes

Welcome to Yageo Chip Resistor training module. This module will provide an overview of chip resistor introduction, including single chip, array, network for both general use and automotive grade. Also, R-Chip with special functions: anti-FOS, anti-surge, high voltage are included. The introduction and application of current sensors is another focus in this training module. Furthermore, Yageo part number coding rules will be introduced at the end.



Yageo offers the Chip Resistor Decision Tree to assist customers in choosing the appropriate products for your applications. R-Chip can be divided into three groups: Thick film, Precision, and Current sensor.

1. Thick film, resistance>1ohm

   General: RC series, thick film chip resistor.

   High reliability: AC & AA series, which are especially developed for automotive applications.

   Special function: Anti-surge resistor (SR series); High voltage resistors (RV series) and Anti-FOS resistors (AF series).

2. Precision, resistance >1ohm, TCR 5~50ppm/°C

   General: RE series is based on thick film technology, with TCR 50ppm/°C**;** RT series, by thin film technology, has better long-term stability, with TCR down to 5ppm/°C.

   High reliability: AT series, by thin film & lithography technology, robust resistor designed for automotive application.

3. Current sensor, resistance <1 ohm, with different terminations and product shapes

   General (Thick film): RL & PT series

   High reliability (Metal): PA & PE & PS series

   - PA series, made by metal plate, size 2512 with high power (up to 3W) and low ohm (1m~5mR).

   - PE series, made by metal foil, offering standard terminals and full range resistance from 5m to 910mR.

   - PS series, made by metal foil, 4- terminal, good with high heat dissipation

Features of Current Sensor

Key attributes of Current Sensor

- **Low Resistance value**
  to minimize power loss, 0.5mR to 20mR are the runner ranges
- **Tight tolerance**
  to accurately feedback the actual current (via voltage reading), normal requirement 1%
- **Low TCR**
  to avoid the distortion of measurement, metals with TCR 50 to 100ppm/ºC; thick film are 100 to 1500ppm/ºC
- **High power rating**

  2512 1W 1mR, withstand maximum 31 Amperes current,
  2512 2W 1mR max 44 Amperes,
  2512 2W 0.3mR max 81 Amperes

3 Technologies

- Thick film (RL, PT): Great surge capability, standard TCR
- Metal foil (PE, PS): Available with a wider range of R values, low TCR
- Metal plate (PA): Low resistance range, high power, robust surge capability

Current sensor, low resistance R-chip, is used as a signal to measure and to monitor current flow for circuits. It is also important to protect from excessive current and to enhance performance. Current sensor is commonly used in battery life indications, over current protection, current and voltage regulators, DC/DC converters, programmable current sources, power supplies, communication devices, automotive power electronics, and motor speed control…etc.

Current Sensor, RL/PT/PA/PE/PS

Thick film: RL, PT

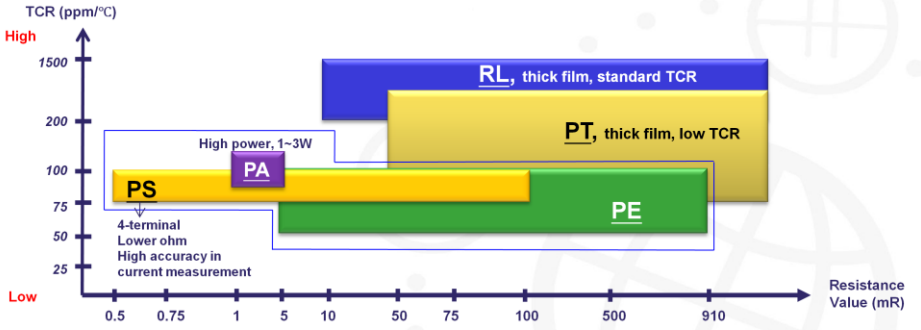
Size (inch)	Tol	Resistance	
		Min.	Max.
RL0402	1	50m	976m
RL0603	1	10m	976m
RL0805	1	10m	976m
RL1206	1	10m	976m
RL1210	1	10m	976m
RL1218	1	10m	976m
RL2010	1	10m	976m
RL2512	1	10m	976m
PT0402	1	50m	976m
PT0603	1	50m	976m
PT0805	1	50m	976m
PT1206	1	50m	976m
PT2010	1	100m	976m
PT2512	1	100m	976m

Metal: PA, PE, PS

Size (inch)	Power	TCR	Resistance		
			Min.	Max.	
PA2512	1~3	100	1m	5m	
PE0201	1/20~1/10	50 ~100	20m	200m	
PE0402	1/16~1/4		10m	910m	
PE0603	1/10~1/2		10m	910m	
PE0805	1/8~1/2		5m	910m	
PE1206	1/4~1		5m	910m	
PE2010	1/2~1		5m	100m	
PE2512	1~2		6m	100m	
PS0612	1/2~1	75	0.5m	100m	4 terminal

RL and PT series are available with tolerances ±1% and ±5%, min. resistance from 10m ohm. Yageo's metal current sensors provide typical TCR ±50ppm/°C~±100ppm/°C, high power rating of up to 3W, and low resistance down to 0.5mΩ.

Current Sensor Portfolio

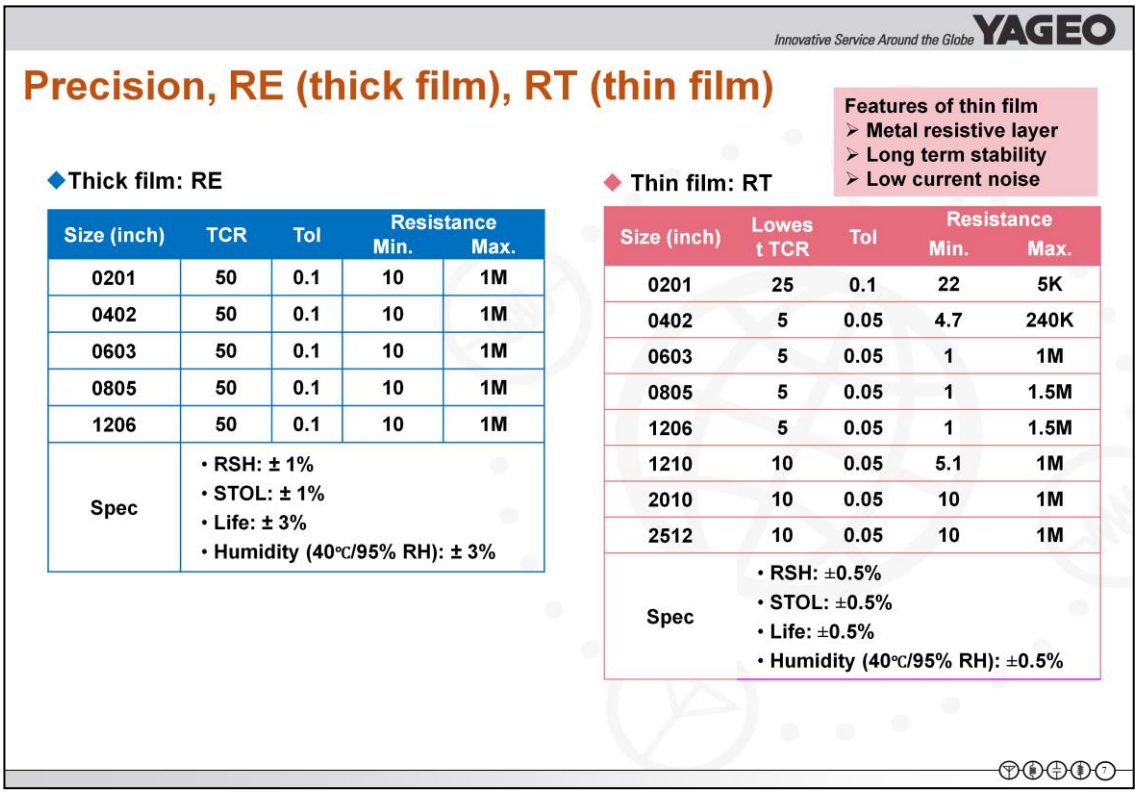


Features & Applications

- **Thick Film, RL & PT for entry level Smart Phones and Lighting ballast**
- **Metal, PE mostly used in Smart Phones, Pad, Battery, Power, LED lighting**
- **Metal, PS 4-terminal, mainly used in NB, Server**
- **Metal, PA, with high power, mostly used in Power, Networking, Automotive**
- **Metal current sensors, PA/PE/PS are with high current capability, higher power rating and higher Pulse loading capability**

• Current sensor in power supply is one of the arenas of specialized components. These products require low TCR and ultra low resistive values. Current sensor plays an ever increasing role in industrial, automotive, and mobile/NB applications. Yageo offers both thick film (RL,PT) and metal foil and metal plate PE and PA series solutions. For the highest accuracy measurements, Yageo offers the 4-terminal Kelvin series: PS.

• 4-terminal current sensor resistors which separate the terminals carrying current from those sensing voltage, are able to improve voltage and current measurement accuracy from the ideal Kelvin configuration. They also improve interference and thermoelectric effect at a higher applied power.



◆Thick film: RE

Size (inch)	TCR	Tol	Resistance Min.	Resistance Max.
0201	50	0.1	10	1M
0402	50	0.1	10	1M
0603	50	0.1	10	1M
0805	50	0.1	10	1M
1206	50	0.1	10	1M
Spec	• RSH: ± 1% • STOL: ± 1% • Life: ± 3% • Humidity (40℃/95% RH): ± 3%			

◆ Thin film: RT

Size (inch)	Lowest TCR	Tol	Resistance Min.	Resistance Max.
0201	25	0.1	22	5K
0402	5	0.05	4.7	240K
0603	5	0.05	1	1M
0805	5	0.05	1	1.5M
1206	5	0.05	1	1.5M
1210	10	0.05	5.1	1M
2010	10	0.05	10	1M
2512	10	0.05	10	1M
Spec	• RSH: ±0.5% • STOL: ±0.5% • Life: ±0.5% • Humidity (40℃/95% RH): ±0.5%			

• RE (thick film) and RT (thin film) are two precision solutions. RE with ±50 ppm/°C, offers tighten tolerance to ±0.1%, and range from 10Ω to 1MΩ.

• RT (thin film) chip resistors are ideal for applications or designs requiring tight tolerance, low noise, accuracy and reliability. Built on Yageo's thin film technology, RT series is constructed out of a high grade ceramic body. The resistive material, nickel chromium (NiCr) is sputtered on the top side of the substrate. It features an excellent temperature coefficient and enhanced stability for audio, telecommunications, medical, industrial test & measurement. RT series comes with typical temperature coefficient of resistance (TCR) of ±25ppm/°C and ±50 ppm/°C (superior TCR down to ±5ppm/°C available in size 0402 to 1206), precision tolerances of ±0.05%; ±0.1%; ±0.25%; ±0.5%; ±1%, and resistance range from 1Ω to 1.5MΩ.

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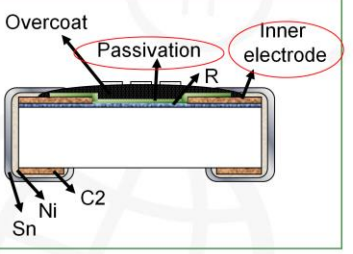
Precision, High Reliability, AT (thin film)

◆ **Automotive thin film: AT**

Size (inch)	Lowest TCR	Tol	Resistance	
			Min.	Max.
0402	25	0.1	10	100K
0603	25	0.1	10	330K
0805	25	0.1	10	1M
1206	25	0.1	10	1M

Structure

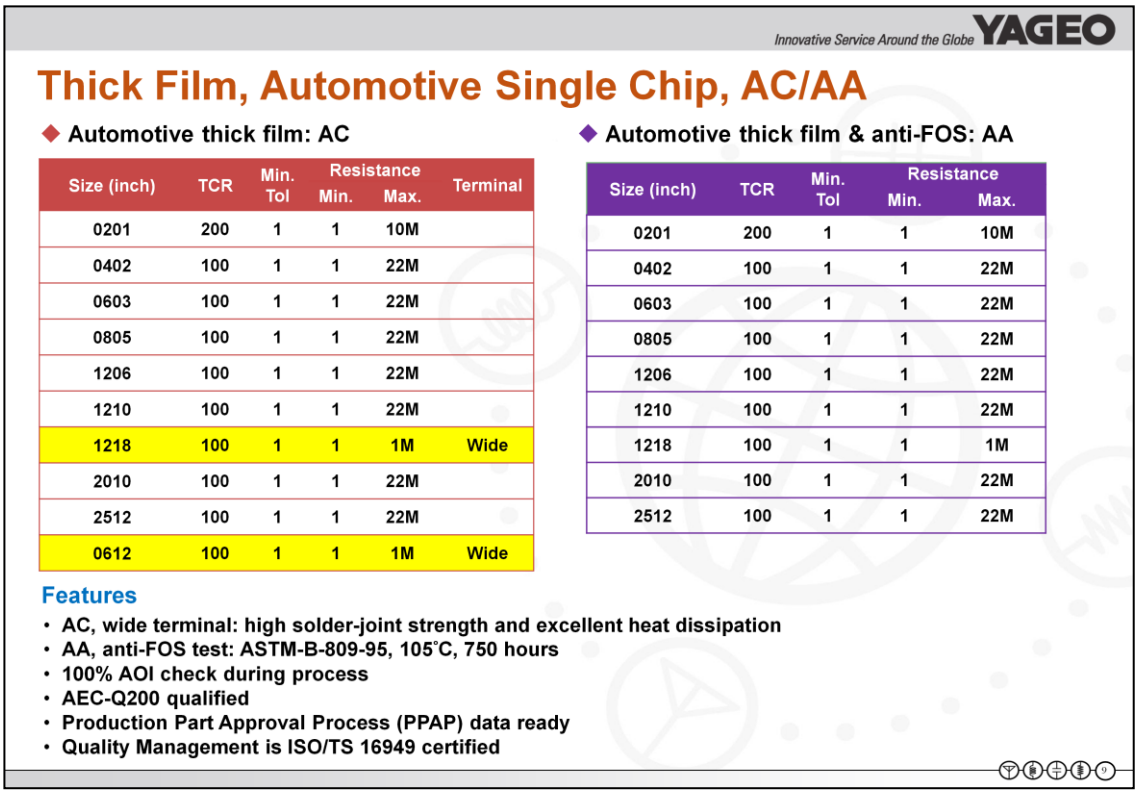


Features

- **Passivation**
  - ✓ the key of robust design for high temperature and moisture resistance (85℃/85%R.H. **Δ R/R: ±0.1%**)
  - ✓ no oxidation reacted in resistive layer, performs stably with the minimal resistance drift **(Δ R/R: ±0.1%)**
- **Lithography process for inner electrode**
  - ✓ Anti-Oxidation material from harsh environment, Life test 1000hrs/70 ℃ **(Δ R/R: ±0.1%)**
- **Anti-FOS test: ASTM-B-809-95, 105℃, 750 hours**
- **Higher pulse load performance, especially for high ohmic values (> 33 kohm)**
- **AEC-Q200 qualified**

• AT series is designed to survive in severe environments of automotive applications. The advanced lithography technology and robust product design all contribute to the tighter tolerance and better reliability. During process control, 100% AOI is applied for eliminating early failures before final testing at taping/sealing. Production Part Approval Process (PPAP) data and quality reports are all available.

• High precision resistors working under humid conditions must meet unsurpassed reliability standards. AT products from Yageo are the perfect choice for circuitry in power steering, instrument clusters, ECU, and ABS.



For the majority of automotive applications, the workhorse solution has been the standard AC series of R-Chip Thick Film technology, available in 0201 to 2512 case sizes.

Only a specially designed solution manufactured using selected materials can meet the needs of harsh environmental conditions in safety systems where sulfur may be a challenge. Yageo has the ultimate solution, the AA R-Chip series.

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Thick Film, Anti-FOS Single Chip & Array, AF

◆ Anti-FOS, single chip: AF

Size (inch)	TCR	Min. Tol	Resistance	
			Min.	Max.
0201	200	1	1	10M
0402	100	1	1	22M
0603	100	1	1	22M
0805	100	1	1	22M
1206	100	1	1	22M
1210	200	1	1	22M
1218	200	1	1	1M
2010	200	1	1	22M
2512	200	1	1	22M

◆ Anti-FOS, array: AF

Size (inch)	TCR	Min. Tol	Resistance	
			Min.	Max.
122	200	1	1	1M
124	200	1	1	1M
162	200	1	10	1M
164	200	1	10	1M

Features

- Superior resistance against sulfur containing environment
- Anti-FOS test: ASTM-B-809-95, 105 degC, 750 hours
- High reliability

Applications

- Industrial, Power Application, Networking Application, High-end Computer & Multimedia Electronics, Memory modules…any environments where sulfuration may occur

Sulfur-resistant thick film Rchips offer a rugged solution to prevent device failure in challenging environmental conditions where the air is polluted by sulfur dioxide. Yageo's AF series offers a wide range of case sizes, single chip 0201 to 2512 and arrays. AF series passed ASTM-B-809-95 anti-FOS test, one with standard condition: sulfur (saturated vapor) 1,000 hours, 90± 2 ˚C, 91~93% R.H., unpowered (Δ R/R 1%), and another severe condition: 105˚C, 750 hours, unpowered (Δ R/R 4%).

Thick Film, Anti-Surge Single Chip, SR

◆ **Anti-surge: SR**

Size (inch)	Power	Min. Tol	Resistance	
			Min.	Max.
0402	1/16,1/8	0.5	1	100k
0603	1/10,1/5	0.5	1	100k
0805	1/8,1/4	0.5	1	100k
1206	1/4, 1/2	0.5	1	100k
1210	1/2	0.5	1	100k
1218	1	0.5	1	100k
2010	3/4	0.5	1	100k
2512	1	0.5	1	100k

Features

- High power rating, compared to standard RC series
- Thick film construction, strong against surge
- High peak voltage, effective for short duration waveform

Applications

- Circuit requiring high power, against surge voltage
- Power Supply, Telecom/ Server, Home Appliance
- LCD TV, LED lighting, Smart meter

Yageo anti-surge chip resistors, SR series covers sizes from 0402 to 2512, with ±1%, ±5%, ±10%, and ±20% tolerances. The resistance range is from 1Ω to 100KΩ at an operating temperature range of -55°C to +155°C. SR series with excellent anti-surge characteristics, could protect electronic devices against short time overload.

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Thick Film, High Voltage, RV

◆ High voltage: RV

Size (inch)	Resistance Range & Tolerance	Rated Power	Operating Temp	Max. Working Voltage	Max. Overload Voltage	T.C.R
RV0603	10KΩ to 10M Ω (1%,5%)	1/10W	-55℃ to +155 ℃	350V	500V	±200ppm/ ℃
RV0805	100KΩ to 10MΩ (1%,5%)	1/8W		400V	800V	
RV1206	100KΩ to 27MΩ (5%) 100KΩ to 10MΩ (1%)	1/4W		500V	1000V	
RV2010	100K to 10M (1%, 5%)	3/4W		500V	1000V	
RV2512	4.7MΩ to 16MΩ (5%)	1W		500V	1000V	

Features

- Higher max. working voltage compared to RC series
- Highly stable in auto-placement surface mounting

Applications

- Battery charger, Converter, Power supply, Printer equipment

Yageo high voltage chip resistors, RV series covers sizes from 0603 to 2512, with ±1%, ±5% tolerances. The resistance range is from 10KΩ to 27MΩ at an operating temperature range of -55°C to +155°C. RV series could withstand higher working voltage (350V~500V) and is suitable for high voltage circuit designed in battery charger, converter, and power supply.

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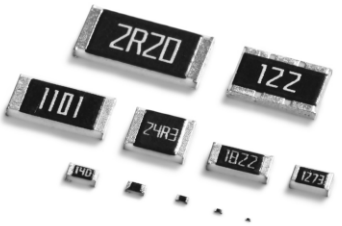
Thick Film, General Single Chip, RC

◆Thick film: RC

Size (inch)	Tol	Resistance Min.	Resistance Max.	Power (W)	TCR (ppm/C)
RC0075	±1% ±5%	10	1M	1/50	±100 ±200 ±250 ±300
RC0100		1	22M	1/32	
RC0201		1	10M	1/20	
RC0402		1	22M	1/16, 1/8	
RC0603		1	22M	1/10, 1/5	
RC0805		1	100M	1/8, 1/4	
RC1206		1	100M	1/4, 1/2	
RC1210		1	22M	1/2	
RC1218		1	1M	1	
RC2010		1	22M	3/4	
RC2512		1	22M	1, 2	



Applications

- for all general purpose application, eg. wearable device, mobile, PC, tablet, NB…

Features

- RoHS compliance: Lead-free terminations
- Halogen Free Epoxy
- Highly stable in auto-placement surface mounting applications
- Jumper is available

The growing complexity and decreasing size and weight of devices requires ever more and smaller components. The tiny 0075, 01005 R-Chips for wearable devices are ideal to help reduce board space on the PCB. Yageo is privileged with its RC capacity volumes and experienced production techniques.

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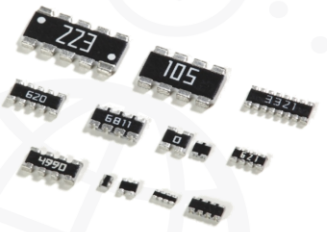
Thick Film, General Array & Network, YC/TC

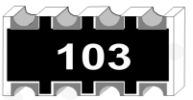
◆Thick film: YC/TC

Series	Size	Pin no./R no.
YC102	2 x 0201	4P2R
YC104	4 x 0201	8P4R
YC/TC122	2 x 0402	4P2R
YC/TC124	4 x 0402	8P4R
YC162	2 x 0603	4P2R
YC/TC164	4 x 0603	8P4R
YC248	8 x 0602	16P8R
YC324	4 x 1206	8P4R
YC158/358	network	10P8R



YC - Convex Termination

TC - Concave Termination



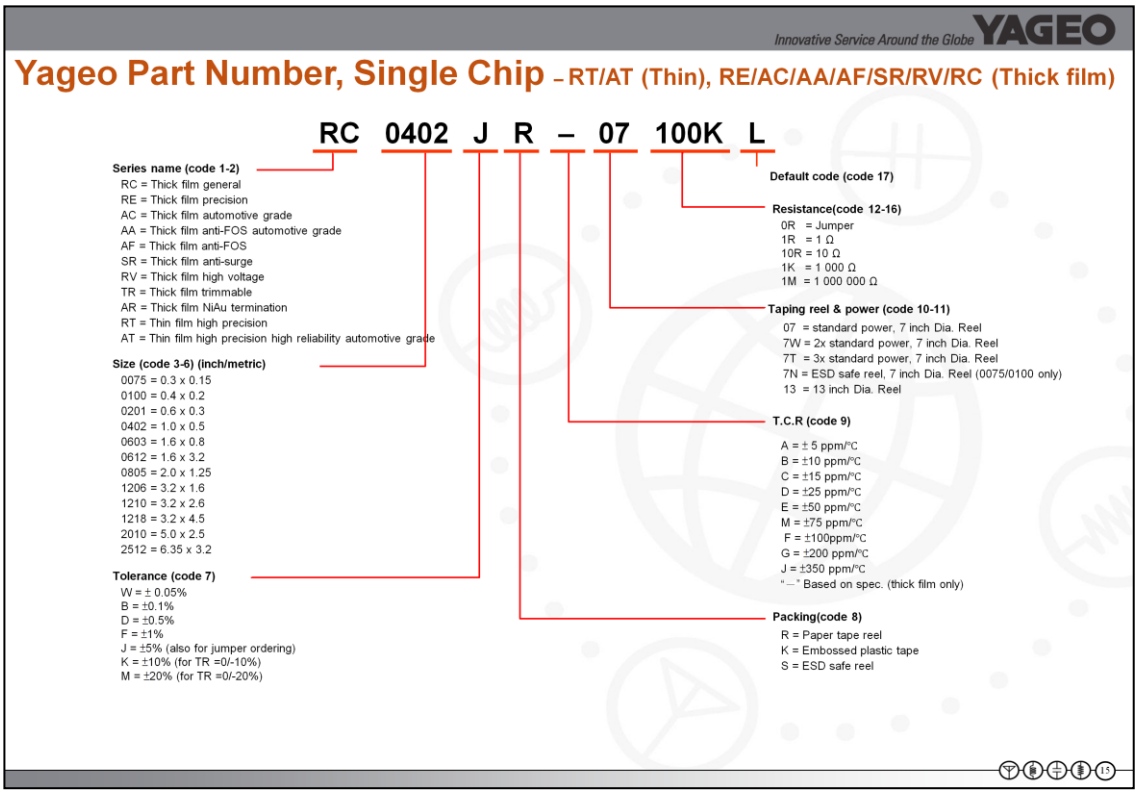
Applications

- for all general purpose application, eg. memory module, mobile, NB...

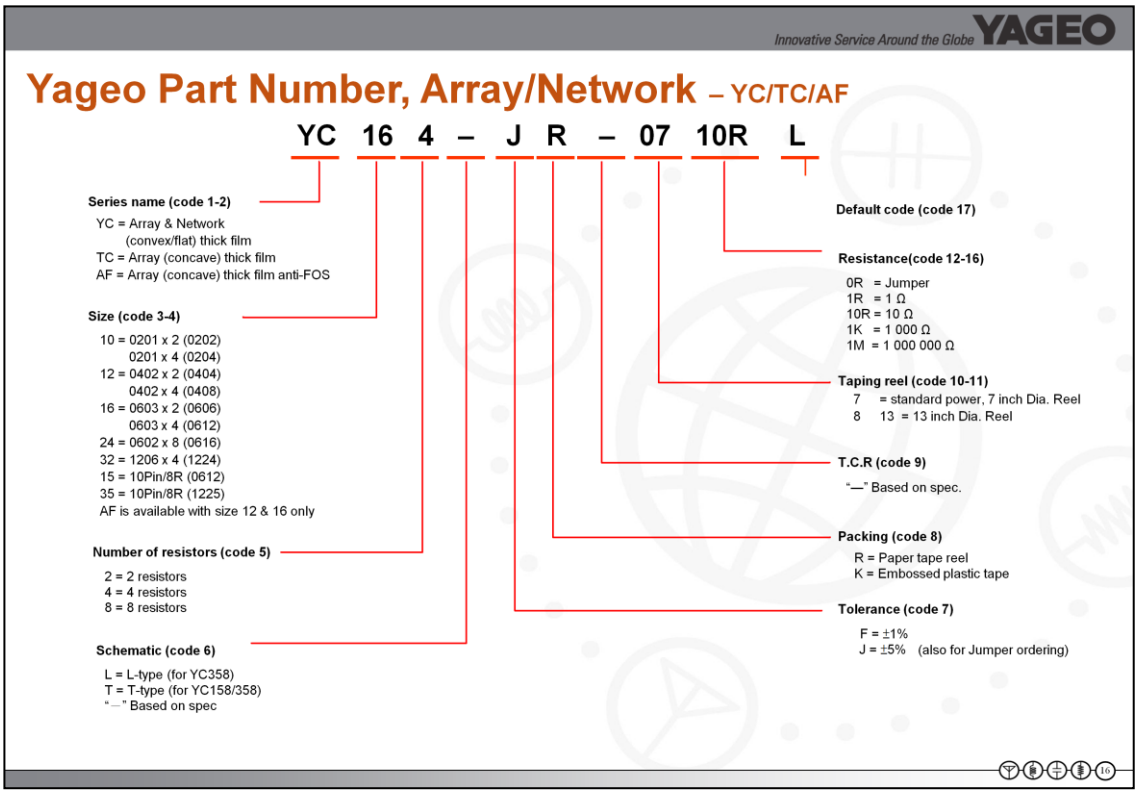
Features

- More efficient in pick & place application
- Low assembly costs
- Saving of PCB space
- Jumper is available

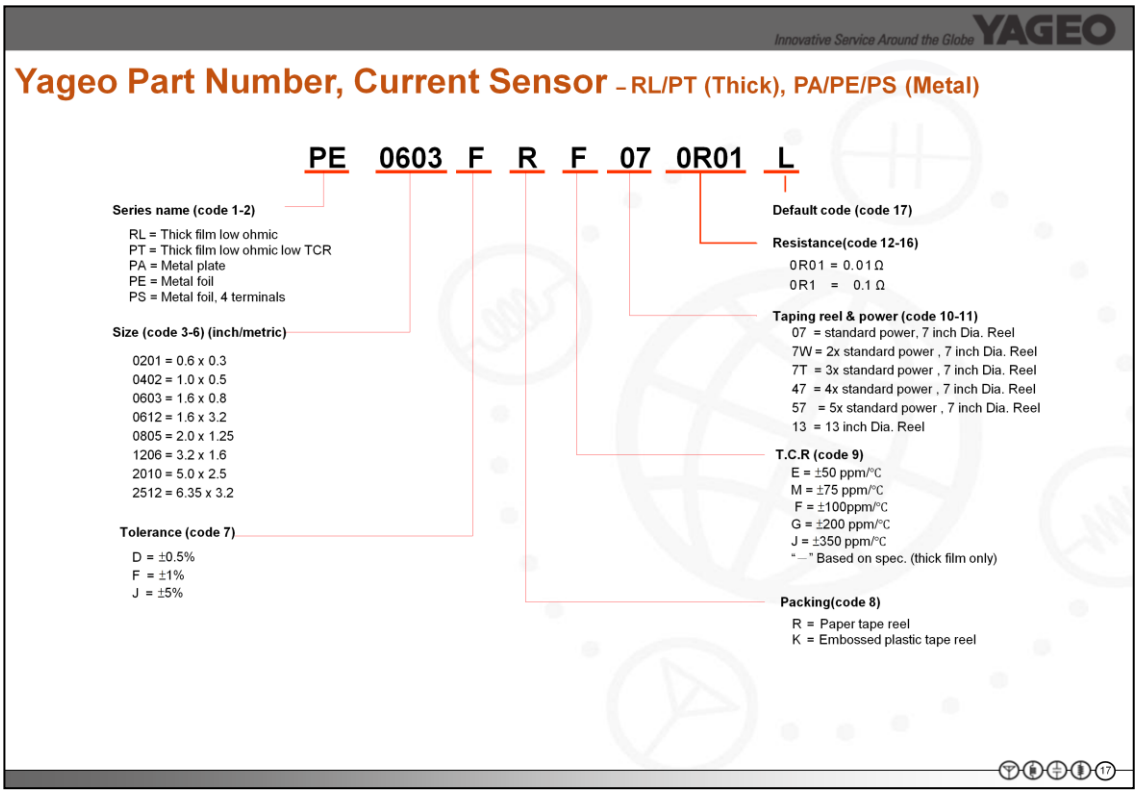
By building on its unique strengths, Yageo is set to deliver the solutions to meet the unrelenting drive for miniaturization. Further optimization of space on the PCB is achieved by integration of discrete components in 2 and 4 element resistors, such as YC102 (0.8mm X 0.6mm)/YC104 (1.4mm X 0.6mm) are chosen in memory module. Array/network are also available in various case sizes.



A total of 14~17 codes is set for Yageo global part number. Rchip series are defined in the first two codes, followed by 4 codes of size indicated in inch. Double or triple power is offered and defined in code 10~11 with taping reel.



The termination shapes of Yageo's array and network are indicated in first two codes: YC= convex/flat, TC= concave. Code 3~5 are for size and number of resistors. Code 6 is network schematic of two different circuit configurations (check datasheet for more details).



Current sensor coding rule is similar to single chip coding on page 16, except resistance explanation in code 12~16. For example, 0R01 represents 10m ohm and 0R1 for 100m ohm.

Thanks for your attention!

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