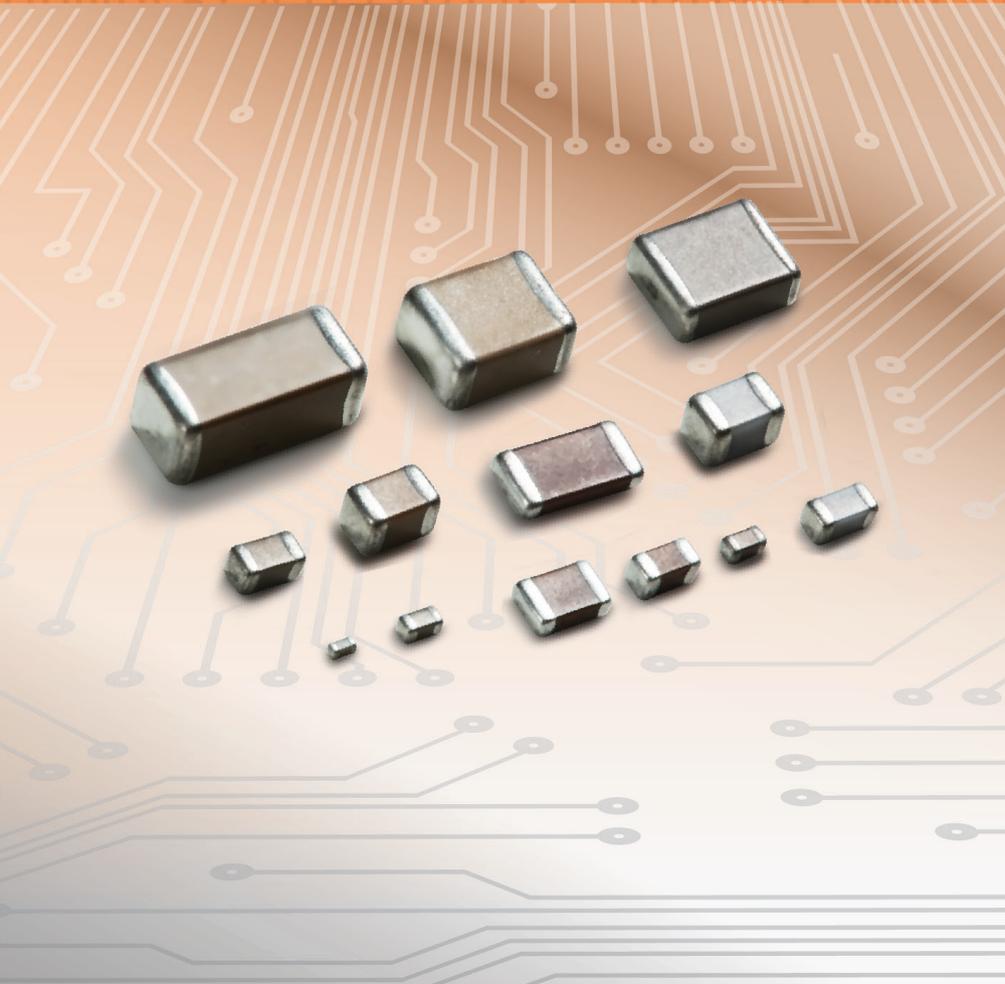


# High Capacitance MLCCs



[www.yageo.com](http://www.yageo.com)

# About Yageo



Founded in 1977, the Yageo Corporation has become a world-class provider of passive component services with capabilities on a global scale, including production and sales facilities in Asia, Europe and the Americas.

Yageo currently ranks as the world No.1 in chip-resistors, No. 3 in MLCCs and No. 4 in ferrite products, with a strong global presence: 21 sales offices in 15 countries, 9 production sites, 8 JIT logistic hubs, and 2 R&D centers worldwide. Ferroxcube and Vitrohm, who produce ferrites and leaded resistors, are also a part of the Yageo group.

We support our customers with extensive literature including datasheets, brochures and application notes, which are also available electronically on our website at: [www.yageo.com](http://www.yageo.com)

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# Introduction

## High Performance and High Reliability

The four cornerstones of technology required to manufacture high performance and high reliability high-cap MLCCs are: material technology, thin-film processing technology, production technology and base metal technology.

Being vertically-integrated from material processing to production technology, Yageo is able to manufacture high-performance and high-reliability, high-cap MLCCs, controlling the production process from beginning to end. The graphics below show the trends in material development of advanced, high-cap MLCCs.

Thanks to unique material technology, Yageo offers many types of Multi-Layer Ceramic Capacitors (MLCCs), including commodity, high-capacitance, high voltage, soft termination, X2Y and MLV (multi-layer varistor).

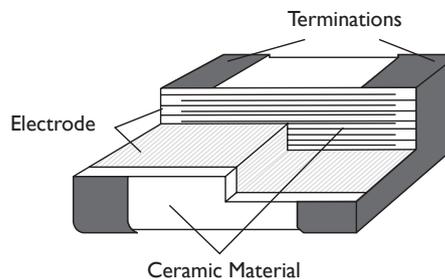
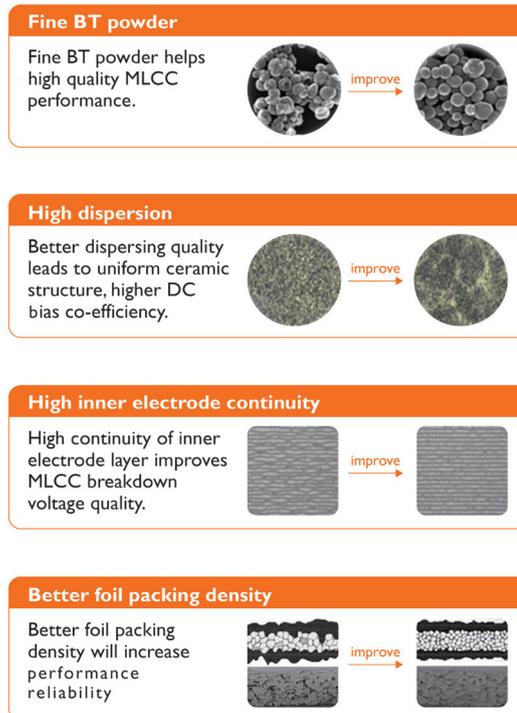
The dielectric material of Yageo's CC series ranges through NP0, X5R, X7R and Y5V, with standard EIA chip sizes available, a wide-range of capacitances for various circuit needs, rugged terminations (lead-free), and the capability to be used in both reflow and wave soldering systems.

Yageo MLCCs provide outstanding performance, reliability and cost advantages for circuit designers. The capacitors are for both paper- and plastic- embossed, tape-and-reel packaging for automatic SMD placement. High capacitance MLCCs are high-end products in terms of capacitance to accommodate trends in the electronic industry towards convergence, multi-functionality, and miniaturization.

In this subcategory, we cover  $1\mu\text{F}$  -  $100\mu\text{F}$ , depending on the case size. The available capacitance range is expanding year by year, and is particularly focused on the smaller MLCCs, with continuous R&D of the core technologies for thinner layers.

## Main Features of Yageo's High Capacitance MLCCs

- Materials: X5R, X7R and Y5V
- Wide selection of sizes: from 0201 to 2220
- Capacitance range from  $1\mu\text{F}$  to  $100\mu\text{F}$
- Working voltage rated from 6.3V - 50V
- Highly-reliable tolerance and high-speed automatic chip placement on PCBs
- Highly-resistant termination metal
- Tape & reel for surface mount assembly



Surface mount multilayer ceramic capacitor construction



## Functionality

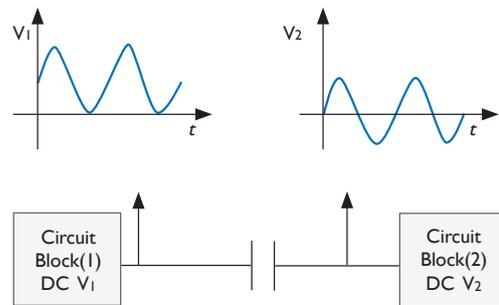
Electrical signals contain various noise components such as EMI or equipment-generated noise. This noise can cause many problems such as crosstalk, false-triggering, or incorrect logic levels. High capacitance MLCCs can be used to reduce these noise signals and provide a more stable operating system.

### High-cap MLCCs have the following functions:

1. **Bypassing:** Used in filtering circuits, MLCCs having low capacitance change vs. frequency work to reduce unwanted signals (high-frequency noise) of the supply voltage to ICs, transistors, or other devices.
2. **Decoupling:** In addition to noise reduction, the MLCC works to keep voltage levels independent of each other with the proper capacitor (low-pass) filtering the supply line. The capacitance should be large enough to absorb any load shift of a device.
3. **Smoothing:** When AC signals are changed to DC signals, if the voltage waveform contains too much ripple, a capacitor is used to smooth (absorb) this voltage before it is sent to other circuits. The capacitance should be large enough to absorb the ripple current.

## Signal Coupling

Because capacitors pass AC but block DC signals (when charged up to the applied DC voltage), they are often used to separate the AC and DC components of a signal. It is widely used for separating and joining two circuit blocks.

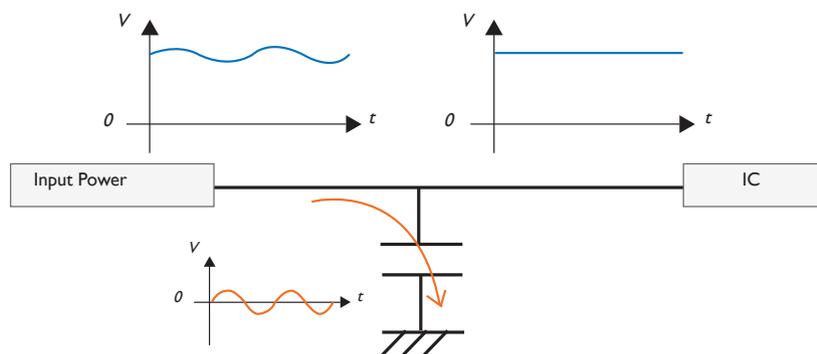


Coupling capacitor separates DC voltages of circuit blocks but couples AC signal.

## Decoupling (Bypass)

A decoupling capacitor is a capacitor used to decouple one part of a circuit from another. Noise caused by other circuit elements is shunted through the capacitor, reducing the effect they have on the rest of the circuit. It is most commonly used between the power supply and ground.

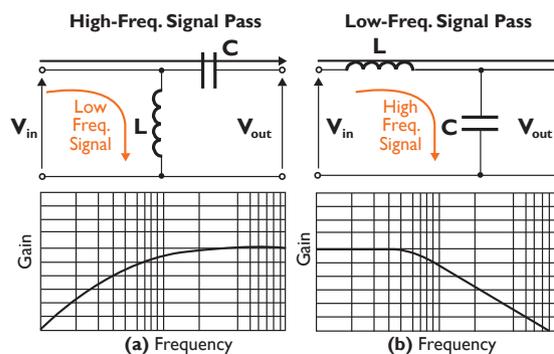
An alternative name is bypass capacitor as it is used to bypass the power supply or other high impedance component of a circuit.



## Noise Filter and Snubbers

When an inductive circuit is opened, the current through the inductance collapses quickly, creating a large voltage across the open circuit of the switch or relay. A snubber capacitor across the newly opened circuit creates a path for this impulse to bypass the contact points, thereby preserving their life; these are commonly found in contact breaker ignition systems.

Similarly, in smaller scale circuits, the spark may not be enough to damage the switch but will still radiate undesirable radio frequency interference (RFI), which a filter capacitor absorbs. Snubber capacitors are usually employed with a low-value resistor in series, to dissipate energy and minimize RFI. Such resistor-capacitor combinations are available in a single package.



Filtering functions of capacitor coupled with inductor  
(a) High Pass Filter (b) Low Pass Filter

## Applications

Consumer, industrial and communications applications, which often have very different mounting and soldering processes, and different substrates, are exposed to a wide range of application conditions. It is therefore necessary to relate their characteristics to typical applications and to consider the application limitations. Surface-mount technology is at a dynamic stage of development in its search for new components, quest for further miniaturization, improved processing, and so on.



- Industrial drives and controls
- Factory automation
- Facility management

**Industrial**



- SMPS
- Smart grid meters
- DC/DC converters

**Power Management**



- Street lighting
- LED lighting
- Industrial lighting

**Lighting**



- Notebooks/Tablets
- Servers

**Computing**



- Smartphones
- Handheld devices

**Mobile**



- Solar inverters
- Wind turbines

**Alternative Energy**



- Base stations
- Set-top Boxes
- Modems

**Telecom**



- Point-of-Care
- Imaging equipment
- Patient monitoring

**Medical**

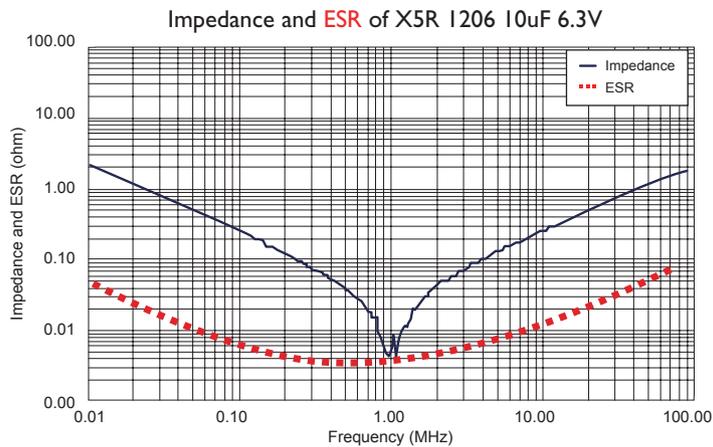
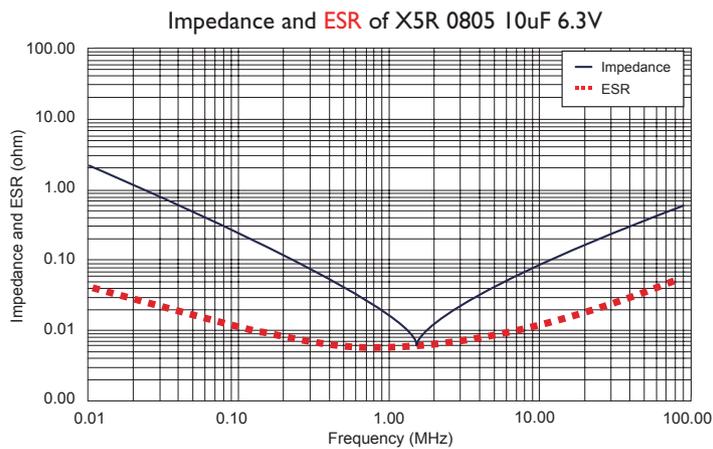
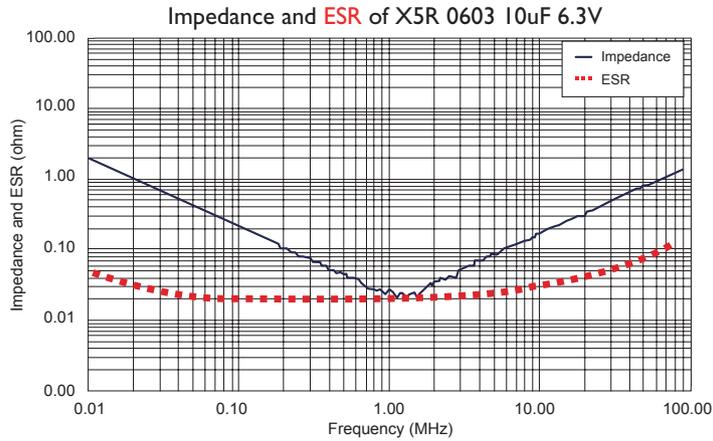


# Performance Characteristics

## ESR vs Frequency Characteristics

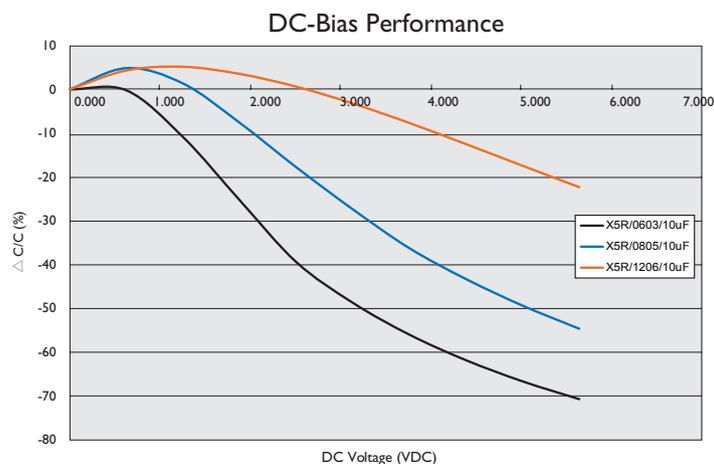
Power losses are in part caused by the inherent resistive elements of capacitors. In the case of an MLCC, the ESR is a electrode resistance and dielectric loss, which decreases as the frequency increases.

Lower dielectric losses result in a higher self-resonance frequency, a higher quality factor, reduced self-heating, and better reliability and performance characteristics.



## Capacitance vs DC Bias Voltage

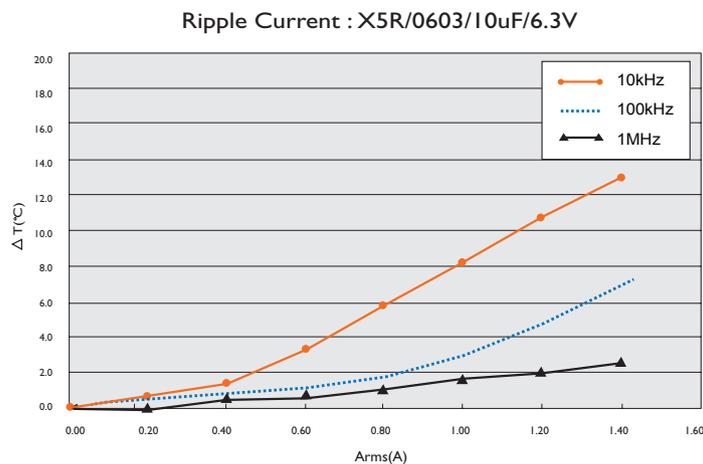
Another consideration when selecting an MLCC is the inherent characteristics of capacitance change versus DC bias voltage. For Class II capacitors (X5R, X7R, Y5V, etc.), larger case size components with equal capacitance, have less capacitance change versus DC bias voltage than smaller-size components.



## Ripple Current

One requirement of any high-frequency capacitor is its ability to withstand high ripple currents. In almost all cases, the current rating is constrained by the allowable temperature rise of the capacitor. The heat generated in a capacitor is dependent solely on its ESR value.

Because the ESR of the MLCC is lower compared to other capacitor technologies, the component operating temperature of self-heating is reduced, effectively increasing the life and reliability of the user's module or product.

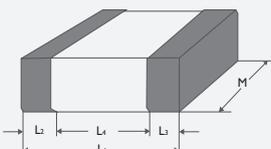


# Product Portfolio

## Electrical Characteristics

Type	TC	Operating Temp range	Capacitance range	Voltage range	Tolerance
CC0201	X5R	-55°C to 85°C	1uF	6.3V	±20%
CC0402	X5R	-55°C to 85°C	1uF ~ 10uF	6.3V ~ 25V	±10%, ±20%
	X7R	-55°C to 125°C	1uF	6.3V	±10%
	Y5V	-30°C to 85°C	1uF ~ 2.2uF	6.3V ~ 10V	+80% ~ -20%
CC0603	X5R	-55°C to 85°C	1uF ~ 22uF	6.3V ~ 50V	±10%, ±20%
	X7R	-55°C to 125°C	1uF ~ 4.7uF	6.3V ~ 50V	±10%
	Y5V	-30°C to 85°C	1uF ~ 10uF	10V ~ 16V	+80% ~ -20%
CC0805	X5R	-55°C to 85°C	1uF ~ 47uF	6.3V ~ 50V	±10%, ±20%
	Y5V	-30°C to 85°C	1uF ~ 47uF	6.3V ~ 50V	+80% ~ -20%
	X7R	-55°C to 125°C	1uF ~ 10uF	6.3V ~ 50V	±10%
CC1206	X5R	-55°C to 85°C	1uF ~ 100uF	6.3V ~ 50V	±10%, ±20%
	X7R	-55°C to 125°C	1uF ~ 22uF	6.3V ~ 50V	±10%
	Y5V	-30°C to 85°C	1uF ~ 47uF	10V ~ 50V	+80% ~ -20%
CC1210	X5R	-55°C to 85°C	1uF ~ 100uF	6.3V ~ 50V	±10%, ±20%
	X7R	-55°C to 125°C	1uF ~ 100uF	6.3V ~ 50V	±10%
	Y5V	-30°C to 85°C	10uF ~ 100uF	6.3V ~ 25V	+80% ~ -20%
CC1812	X7R	-55°C to 125°C	1uF	50V	±10%
CC2220	X7R	-55°C to 125°C	1uF	50V	±10%

## Dimensions

	Inch-based	Metric	L1 (mm)	W (mm)	L2 / L3 (mm)		L4 (mm)
					min.	max.	min.
	0201	0603M	0.6 ±0.03	0.3 ±0.03	0.1	0.2	0.2
	0402	1005M	1.0 ±0.05	0.5 ±0.05	0.15	0.3	0.4
	0603	1608M	1.6 ±0.10	0.8 ±0.10	0.2	0.6	0.4
	0805	2012M	2.0 ±0.10	1.25 ±0.10	0.25	0.75	0.55
	1206	3216M	3.2 ±0.15	1.6 ±0.15	0.25	0.75	1.4
	1210	3225M	3.2 ±0.20	2.5 ±0.20	0.25	0.75	1.4
	1812	4532M	4.5 ±0.20	3.2 ±0.20	0.25	0.75	2.2
	2220	5750M	5.7 ±0.40	5.0 ±0.30	0.25	0.75	3.4

Note : Actual product specifications, please refer to datasheet

## Packing Quantities

Size code	Thickness classification (mm)	Tape width	180mm / Ø7" reel		330mm / Ø13" reel		Quantity per bulk case
			Paper	Blister	Paper	Blister	
0201	0.3 ±0.03 / ±0.05	8 mm	15 000	---	50 000	---	---
0402	0.5 ±0.05 / ±0.15 / ±0.20		10 000	---	50 000	---	50 000
0603	0.8 ±0.1 / ±0.2		4 000	---	15 000	---	15 000
0805	0.6 ±0.1		4 000	---	20 000	---	10 000
	0.85		4 000	---	15 000	---	8 000
	1.25 ±0.2		---	3 000	---	10 000	5 000
1206	0.6 ±0.1		4 000	---	20 000	---	---
	0.85 ±0.1		4 000	---	15 000	---	---
	1.15 ±0.1		---	3 000	---	10 000	---
	1.25 ±0.2		---	3 000	---	10 000	---
	1.6 ±0.2	---	2 000	---	10 000	---	
1210	0.6	---	4 000	---	15 000	---	
	0.85 ±0.1	---	4 000	---	10 000	---	
	1.25 ±0.2	---	3 000	---	---	---	
	1.6	---	2 000	---	---	---	
1812	1.6 ±0.2	12 mm	---	1 000	---	---	---
2220	1.15 ±0.1		---	1500	---	---	---

# Product Selection Tables

## X7R Product Range

Size(mm)Cap	0402	0603	0805	1206	1210	1812	2220
1uF	6.3V	50V	50V	50V	50V	50V	50V
2.2uF	---	10V	25V	50V	50V	---	---
4.7uF	---	6.3V	25V	50V	50V	---	---
10uF	---	---	16V	25V	50V	---	---
22uF	---	---	---	10V	25V	---	---
47uF	---	---	---	---	10V	---	---
100uF	---	---	---	---	6.3V	---	---

## X5R Product Range

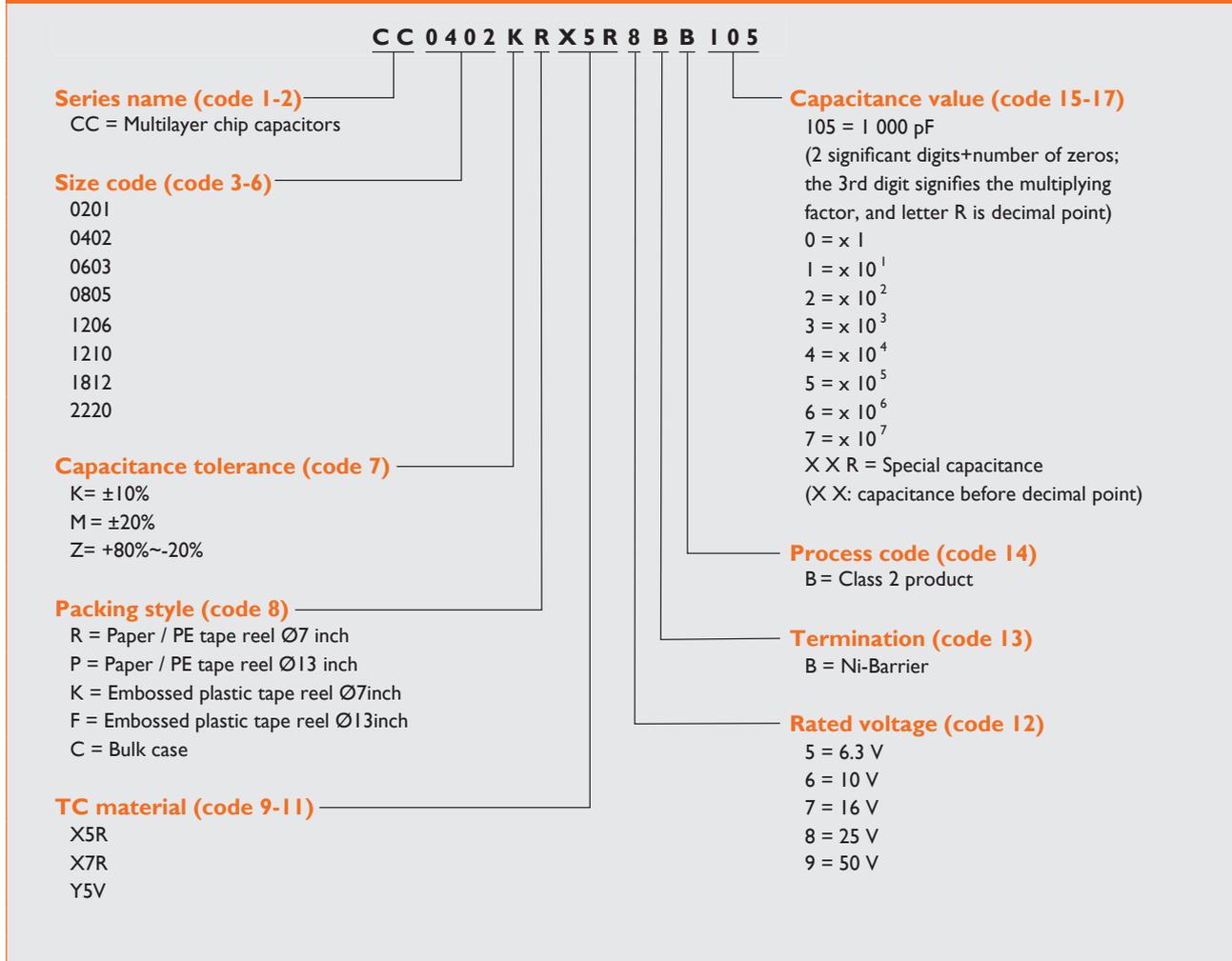
Size(mm)Cap	0201	0402	0603	0805	1206	1210
1uF	6.3V	25V	50V	50V	50V	50V
2.2uF	---	16V	25V	25V	50V	50V
4.7uF	---	10V	25V	25V	50V	50V
10uF	---	6.3V	25V	25V	25V	50V
22uF	---	---	10V	10V	16V	25V
47uF	---	---	---	6.3V	10V	16V
100uF	---	---	---	---	6.3V	16V

## Y5V Product Range

Size(mm)Cap	0402	0603	0805	1206	1210
1uF	---	---	---	---	---
2.2uF	10V	16V	50V	50V	---
4.7uF	---	16V	25V	50V	---
10uF	---	10V	16V	16V	---
22uF	---	---	16V	16V	25V
47uF	---	---	10V	16V	16V
100uF	---	---	---	---	6.3V

# Ordering Code Definition

Ordering example : **CC0402KRX5R8BB105**



## Cross Reference

Size	Yageo	Murata	SEMCO	TDK	TaiyoYuden
0201	CC02021	GRM03	SL03	C0603	MK063
0402	CC0402	GRM15	SL05	C1005	MK105
0603	CC0603	GRM18	SL10	C1608	MK107
0805	CC0805	GRM21	SL21	C2012	MK212
1206	CC1206	GRM31	SL31	C3216	MK316
1210	CC1210	GRM32	SL32	C3225	MK325
1812	CC1812	GRM43	SL43	C4532	---



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