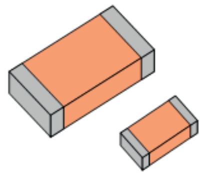
MULTI-LAYER CERAMIC CAPACITORS (MLCC)

What are Multi-Layer Ceramic Capacitors (MLCC)?

There are two types of MLCC : a high-dielectric-constant type whose capacitance varies with the measurement voltage and a temperature-compensated type whose capacitance does not vary.



The measurement conditions used when defining capacitance are set forth by separate JIS standards for temperature-compensated and high-dielectric-constant MLCCs.

Setting example of measurement conditions

Parameters	large capacitance : Cs-D, small capacitance : CP-D
Frequency	See the table below
DC bias	OFF
Signal level	Rated voltage or less
Measurement range	AUTO
Speed	SLOW2
LowZ mode	Off

*Otherwise, default settings are used.
*The above settings apply to an example measurement. Since optimal conditions vary with the measurement target, specific settings should be determined by the instrument operator.

IEC 60384-21 Fixed surface mount multilayer capacitors of ceramic dielectric(JIS C5101-21)
Class 1 : Temperature compensating type (EIA type C0G, JIS type CH etc.)(IEC30384-21)

Parameters	Rated capacitance	Rated voltage	Measurement Frequency	Voltage *1	DC bias *2
C,D (tanδ)	C ≤ 1000pF	ALL	1 MHz or 100 kHz (Reference 1 MHz)	5Vrms or less	-
	C > 1000pF		1 kHz or 100 kHz (Reference 1 kHz)		

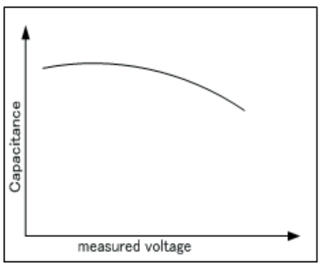
IEC 60384-22 Fixed surface mount multilayer capacitors of ceramic dielectric(JIS C5101-22)
Class 2 : High dielectric constant type (EIA type X5R, X7R, JIS type B, F etc.)(IEC30384-22)

Parameters	Rated capacitance	Rated voltage	Measurement Frequency	Voltage *1	DC bias *2
C,D (tanδ)	C ≤ 1000pF	ALL	1 MHz	1.0 ± 0.2 Vrms	-
	100pF < C ≤ 10μF	6.3 V or More	1 kHz	1.0 ± 0.2 Vrms	
		6.3 V or More	1 kHz	0.5 ± 0.2 Vrms	
	C > 10μF	ALL	100 Hz or 120 Hz	0.5 ± 0.2 Vrms	

*1 The measurement voltage (i.e., the voltage applied to the sample) is the voltage obtained by dividing the open-terminal voltage by the output resistance and the sample.
*1 The measurement voltage (i.e., the voltage applied to the sample) can be calculated based on the open-terminal voltage, the output resistance, and the sample's impedance.
*2 CV mode is convenient when measuring a sample whose impedance is unknown and when measuring multiple samples that exhibit a large degree of variability.

High-dielectric-constant capacitors

Capacitors bearing temperature characteristics such as B, X5R, and X7R use high-dielectric-constant materials.
While high-dielectric-constant capacitors can deliver high capacitance in a small package, their capacitance tends to vary greatly with the measurement voltage and temperature.



Products used

Mass Production Applications

Model	Measurement frequency	Features
3504-40	120 Hz, 1 kHz	Ideal for large capacitance inspection High speed CV measurement
3504-50		
3504-60		
3506-10	1 kHz, 1 MHz	Ideal for small capacitance inspection, high repeatability

Research and Development Applications

Model	Measurement frequency	Features
IM3570	DC, 4 Hz to 5 MHz	Frequency sweep with analyzer mode

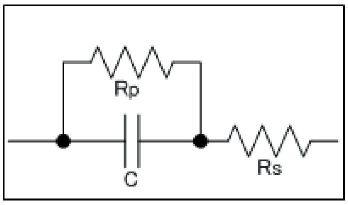
*For more information, plese see the product catalog.

Selecting Parameter, Cs or Cp

Impedance according to frequency (when D is sufficiently small)

	100 Hz	120 Hz	1 kHz	100 kHz	1 MHz
1 pF				1. 6 Meg Ω	160 kΩ
10 pF				160 kΩ	16 kΩ
100 pF				16 kΩ	1.6 kΩ
1 nF			160 kΩ	1.6 kΩ	160 Ω
10 nF			16 kΩ	160 Ω	16 Ω
100 nF			1.6 kΩ	160 Ω	1.6 Ω
1 uF			160 Ω	1.6 Ω	160 mΩ
10 uF			16 Ω	160 mΩ	16 mΩ
100 uF	16 Ω	13 Ω	1.6 Ω	16 mΩ	1.6 mΩ

Choose CP
Depends on the case
Choose Cs



Equivalent cuircuit of capacitors

Large capacitance capacitors : Rp can be ignored since impedance of C is low. Select series equivalent circuit modes.

Small capacitance capacitors : Rs can be ignored since impedance of C is high. Select series equivalent circuit modes.

Generally speaking, series equivalent circuit mode is used when measuring low-impedance elements (approximately 100Ω or less) such as high-capacity capacitors, and parallel equivalent circuit mode is used when measuring high-impedance elements (approximately 10 kΩ or greater) such as low-capacity capacitors.

An actual capacitor will behave as though Rs and Rp have been connected in series and in parallel, respectively, with the ideal capacitor C, as in the figure. Rp is usually extremely large (megaohm-order or greater), and Rs is extremely small (several ohms or less). An ideal capacitor's reactance can be calculated using the following equation based on its capacitance and frequency : $Xc=1/j2\varpi f C[\Omega]$. When Xc is small, the impedance when Rp is placed in parallel can be considered to be approximately equal to Xc. On the other hand, because Rs cannot be ignored when Xc is small, the overall setup can be treated as a series equivalent circuit with Xc and Rs. By contrast, when Xc is large, Rp cannot be ignored but Rs can, so the setup can be treated as a parallel equivalent circuit.

Related Products List

IMPEDANCE ANALYZER
IM3570

C METER
3506-10

C HiTESTER
3504

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