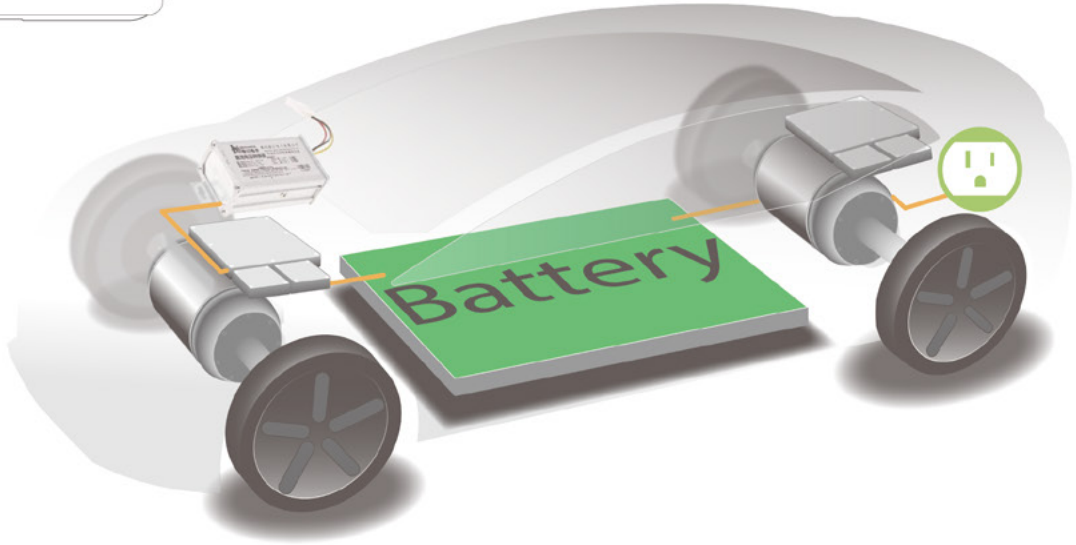
MLCC | Component Test Solution

Cs/ Cp/ D/ ESR/ DC Bias DC Bias Characteristics

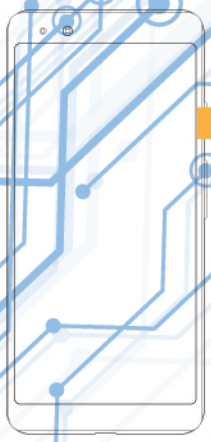


LCR Meter 6630/Impedance Analyzer 6632

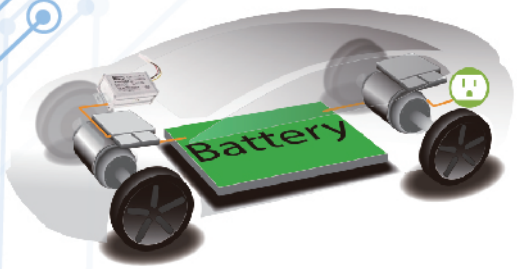
Option Automatic Level Compensation Fixture | FX-LR0001

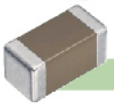
Option External Voltage Bias Fixture | F420001/F420005/F420006

MICROTEST



MLCC | Component Test Solution



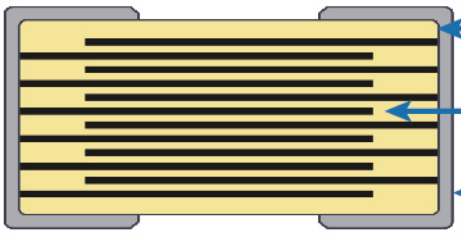


Cs / Cp / D / ESR

MLCC | Multi-layer Ceramic Capacitor is a type of capacitor where the capacitance value is proportional to the surface area of the product and the number of ceramic film layers stacked. It possesses physical characteristics such as high voltage tolerance, high heat resistance, wide operating temperature range, and low loss rate during high-frequency usage. Additionally, it can be miniaturized through chip integration.

MLCC capacitors serve various functions in circuits, including filtering, decoupling, bypassing, and coupling. They are primarily used in the consumer electronics field, such as internet tablets, PCs, electric vehicles, network communications, and industrial applications. MICROTEST will provide you with effective methods for testing the essential electrical characteristics of MLCC capacitor components.

Important Parameters of MLCC



Capacitance (C) ---------- Measured in microfarads (uF). It represents the amount of electric charge a capacitor can store.

Dissipation Factor (D) --- Also known as the loss factor or the tangent of the loss angle. It indicates the amount of energy lost in the capacitor due to internal factors such as resistance and dielectric losses.

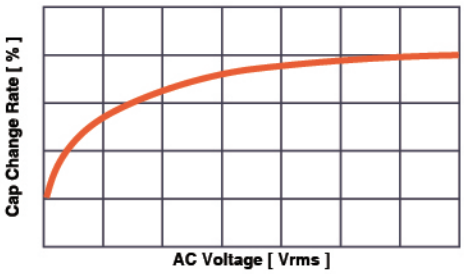
DC Bias Voltage ---------- Refers to the behavior of the MLCC when subjected to a direct current (DC) voltage bias. This parameter indicates how the capacitance and other characteristics of the capacitor change under a DC voltage load.

Correct measurement of Capacitance value and Dissipation Factor

When measuring high-capacity MLCC capacitance, discrepancies between measured values and the nominal capacitance in the product specification are common.
Here are some correct measurement methods

▸Capacitance | The actual measurement frequency and voltage differ for Class I and Class II MLCC capacitors.

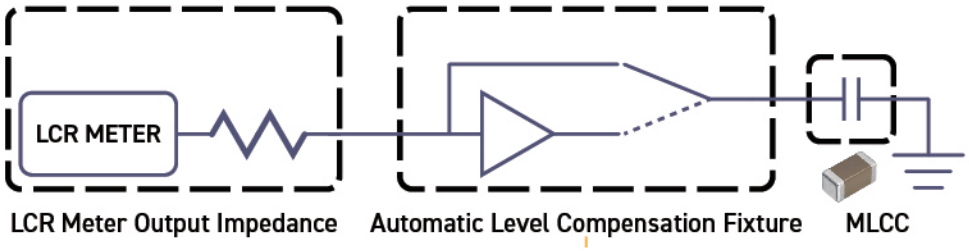
Class	Capacitance	Frequency	Voltage
Class I	1,000pF and under	1MHz ± 10%	0.5~5 Vrms
	Over 1,000pF	1kHz ± 10%	
Class II	10uF and under	1kHz ± 10%	1.0 ± 0.2 Vrms
	Over 10pF	120Hz ± 10%	0.5 ± 0.2 Vrms



Due to the use of high dielectric constant insulating materials in MLCCs, they exhibit non-linear behavior in the low voltage range. This non-linearity causes the measured capacitance to vary with different applied voltages.
The regulation (JIS C 5101-1-1998) specifies standards for the test signal.

For measuring MLCC capacitance, we typically use an LCR meter. However, LCR meters often experience voltage division due to the influence of current-limiting resistors when generating the output voltage signal. This can result in discrepancies between the measured values and the nominal capacitance stated in the product specification.

I suggest using an LCR meter that supports Automatic Level Control (ALC) functionality.
ALC incorporates a stable voltage circuit into the test circuit, automatically correcting any offset in voltage level back to the user-set voltage signal value. This feature helps to mitigate the voltage division issue and improves the accuracy of the capacitance measurement.



FX-LR0001

▸D | Dissipation Factor | cos(δ)

Refers to the ratio of losses to apparent power in AC circuits, A lower D value indicates lower losses.

$$D = \frac{i^2 R_S}{i^2 XC} = \frac{R_S}{X_C} = \omega C_S R_S$$

MICROTEST MLCC Test Solution-Option FX-LR0001

Impedance Analyzer 6632

LCR Meter 6630

1MHz	3MHz	5MHz	10MHz	20MHz	30MHz	50MHz

Test Frequency

The selection is FX-LR0001, an Automatic Level Compensation Fixture

Measuring a 10uF MLCC

The measured capacitance value is lower when the voltage signal does not meet the requirements in the absence of ALC functionality.

After performing Automatic Level Control (ALC) compensation, the measured capacitance values become more accurate/precise.

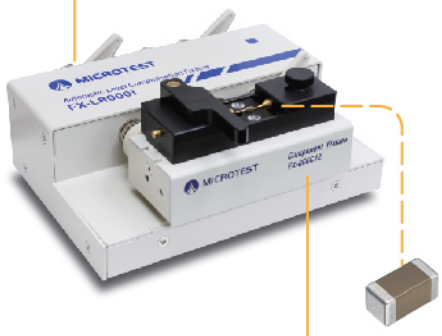
FX-LR0001

Automatic Level Compensation Fixture

Frequency: 100Hz ~ 100kHz

ALC ON
voltage: 0.1~ 1V rms
current: 0.15A

FX-LR0001

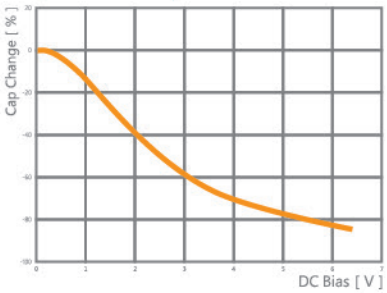


FX-000C12

SMD Test Fixture

▸DC Bias Voltage

The dissipation factor refers to the ratio of losses to apparent power in AC circuits.
DC bias is an important electrical parameter that affects MLCC capacitors. DC bias refers to the reduction in capacitance when a DC voltage is applied to an MLCC capacitor.
(Under rated voltage, the capacitance may decrease to around 20% of the nominal value.)
In particular, Class II MLCC capacitors exhibit increased losses as the DC voltage increases.



For example, MLCC capacitors with high dielectric constant using barium titanate ferroelectric materials.
Therefore, when selecting MLCC capacitors, it is necessary to consider the application of DC voltage components on the power (signal) lines and measure the static capacitance to determine the actual static capacitance value.

MICROTEST MLCC DC Bias Test Solution-Option F420005

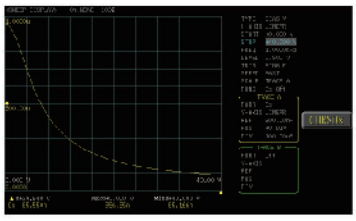
Impedance Analyzer 6632

LCR Meter 6630

1MHz	3MHz	5MHz	10MHz	20MHz	30MHz	50MHz

Test Frequency

The selection is F420005, an External Voltage/Current Bias Fixture

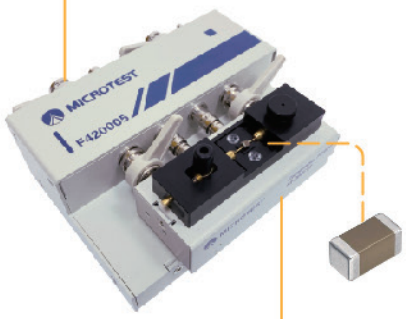


F420005

External Voltage/Current Bias Fixture

Frequency: ≤ 30 MHz
Max. output voltage:DC ±40V
Max. output current:DC ±100mA
DUT Connection: 4-Terminal

F420005



FX-000C12

SMD Test Fixture

High power capacitor DC Bias Voltage Test Solution

F420001

External Voltage Bias Fixture

Frequency: 100Hz ~ 1MHz
Max. voltage: ±200V
DUT Connection: 4-Terminal

F420006

External Voltage Bias Fixture

Frequency: 100Hz ~ 1MHz
Max. voltage: ±2000V
DUT Connection: 2-Terminal

FX-LR0001

Option SMD Test Fixture (FX-000C12)

SMD 

Automatic Level Compensation Fixture	
Frequency	100Hz ~ 100kHz
Output impedance (ALC + BOX ON)	10 Ω
Output impedance (ALC + BOX OFF)	25 Ω/ 100 Ω
Output Voltage swimming range (ALC ON)	AC 0.1 ~ 1V rms
Output Voltage accuracy	120 Hz 3%, 1k Hz 3%
Maximum output current (approx.)	0.15A
Terminal Connector	4-Terminal Pair, BNC
Dimensions (approx.)	150x55x120mm (W/H/D)
Weight (approx.)	350 g
Operating Temperature	18~28° C
Applicable Models	6632、6630

Applicable Models

6630

6632

F420005

SMD

DIP

External Voltage/Current Bias	
Frequency	≤ 30 MHz
Max. output voltage	DC ±40V
Max. output current	DC ±100mA
Terminal Connector	4-Terminal Pair, BNC
DUT Connection	4-Terminal
Dimensions (approx.)	145x102x46mm(W/H/D)
Weight (approx.)	396g
Operating Temperature	18° C to 28° C
Applicable Models	6632、6630

Freq.	1MHz	5MHz	10MHz	20MHz	30MHz	50MHz

Applicable Models

6630

6632

F420001

200Vdc External Voltage Bias Fixture	
Frequency	DC to 1 MHz
Max. Voltage	±200V peak max.(AC+DC)
Terminal Connector	4-Terminal Pair, BNC
DUT Connection	4-Terminal
Dimensions (approx.)	150x97x145mm (W/H/D)
Weight (approx.)	829g
Operating Temperature	0° C to 55° C
Applicable Models	6632、6630

SMD

DIP

Freq.	1MHz	5MHz	10MHz	20MHz	30MHz	50MHz

Applicable Models

6630

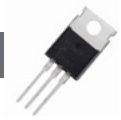
6632

F420006

2000Vdc External Voltage Bias Fixture	
Frequency	DC to 1 MHz
Max. Voltage	±2000V peak max.(AC+DC)
Terminal Connector	4-Terminal Pair, BNC
DUT Connection	2-Terminal
Dimensions (approx.)	180x150x115mm (W/H/D)
Operating Temperature	0° C to 55° C
Applicable Models	6632、6630

SMD

DIP



Freq.	1MHz	5MHz	10MHz	20MHz	30MHz	50MHz

Applicable Models

6630

6632