HOW TO INTERPRET THE DATASHEET

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Hardware Engineer

WÜRTH ELEKTRONIK MORE THAN YOU EXPECT

AGENDA

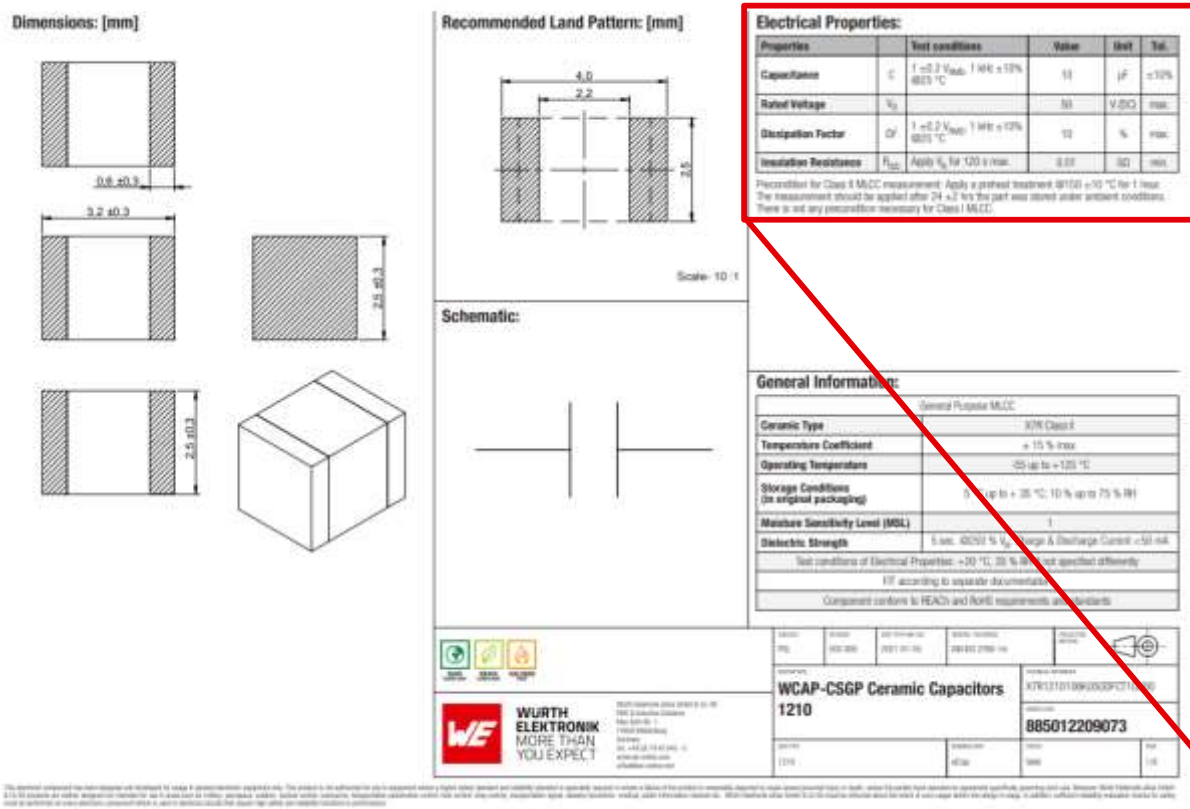
- MLCC
  - Test signals
  - Pre-condition
  - Beyond the datasheet information
    - DC-Bias
    - Capacitance vs. temperature
- Aluminum Electrolytic Capacitor
  - Capacitance vs. frequency
  - Rated voltage and leakage current
- REDEXPERT

A LOOK INTO THE DATASHEET

MLCC => WCAP-CSGP, 885012209073

A lot of information is concentrated in this table

Most users only want to see 10µF and 50V



Electrical Properties:

Properties		Test conditions	Value	Unit	Tol.
Capacitance	C	1 ±0.2 V_{RMS}, 1 kHz ±10% @25 °C	10	µF	±10%
Rated Voltage	V_R		50	V (DC)	max.
Dissipation Factor	DF	1 ±0.2 V_{RMS}, 1 kHz ±10% @25 °C	10	%	max.
Insulation Resistance	R_{ISO}	Apply V_R for 120 s max.	0.01	GΩ	min.

Precondition for Class II MLCC measurement: Apply a preheat treatment @150 ±10 °C for 1 hour. The measurement should be applied after 24 ±2 hrs the part was stored under ambient conditions. There is not any precondition necessary for Class I MLCC.

A LOOK INTO THE DATASHEET

WCAP-CSGP, 885012209073

- Capacitance is 10µF… or not?

Electrical Properties:

Properties		Test conditions	Value	Unit	Tol.
Capacitance	C	1 ±0.2 V_{RMS}, 1 kHz ±10% @25 °C	10	µF	±10%
Rated Voltage	V_R		50	V (DC)	max.
Dissipation Factor	DF	1 ±0.2 V_{RMS}, 1 kHz ±10% @25 °C	10	%	max.
Insulation Resistance	R_{ISO}	Apply V_R for 120 s max.	0.01	GΩ	min.

Precondition for Class II MLCC measurement: Apply a preheat treatment @150 ±10 °C for 1 hour. The measurement should be applied after 24 ±2 hrs the part was stored under ambient conditions. There is not any precondition necessary for Class I MLCC.

- Capacitance Formula (ideal):

$$C = \frac{Q}{V}$$

- In reality the capacitance depends on several operating conditions: Load voltage, Temperature…
- We need to load the capacitor to measure it

A LOOK INTO THE DATASHEET

WCAP-CSGP, 885012209073

- Test signal is important
- Capacitance only defined in that condition!
- Output impedance of LCR Meter is 100Ω

Electrical Properties:

Properties		Test conditions	Value	Unit	Tol.
Capacitance	C	1 ±0.2 V_{RMS}, 1 kHz ±10% @25 °C	10	µF	±10%
Rated Voltage	V_R		50	V (DC)	max.
Dissipation Factor	DF	1 ±0.2 V_{RMS}, 1 kHz ±10% @25 °C	10	%	max.
Insulation Resistance	R_{ISO}	Apply V_R for 120 s max.	0.01	GΩ	min.

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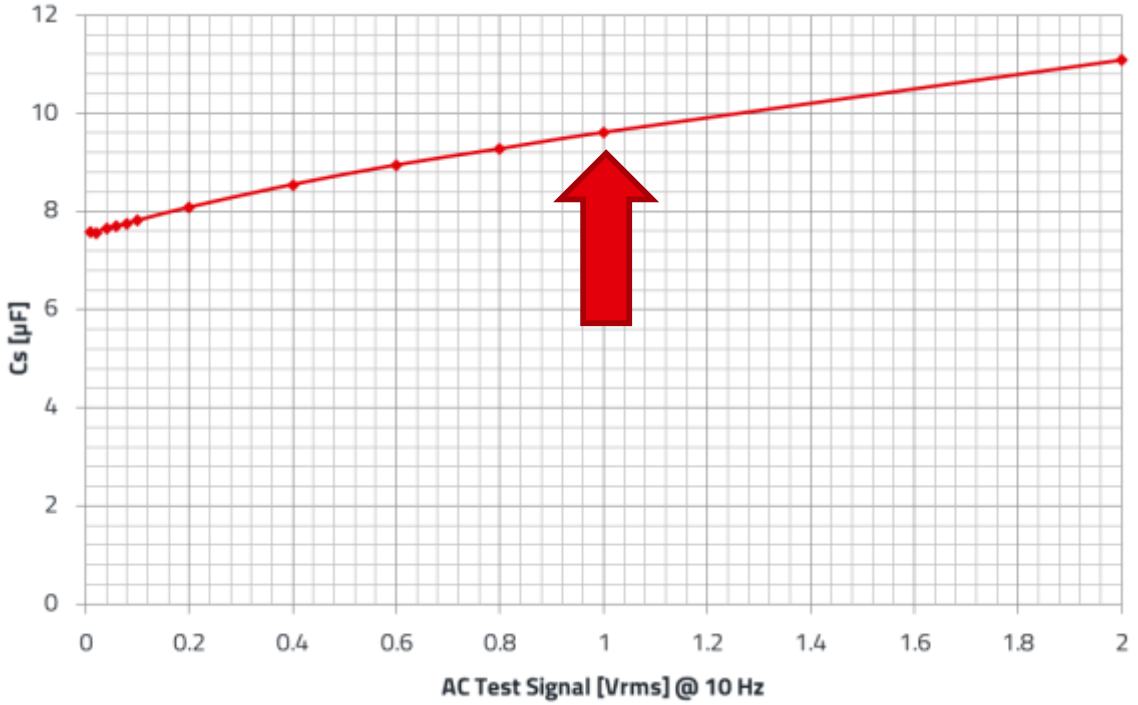
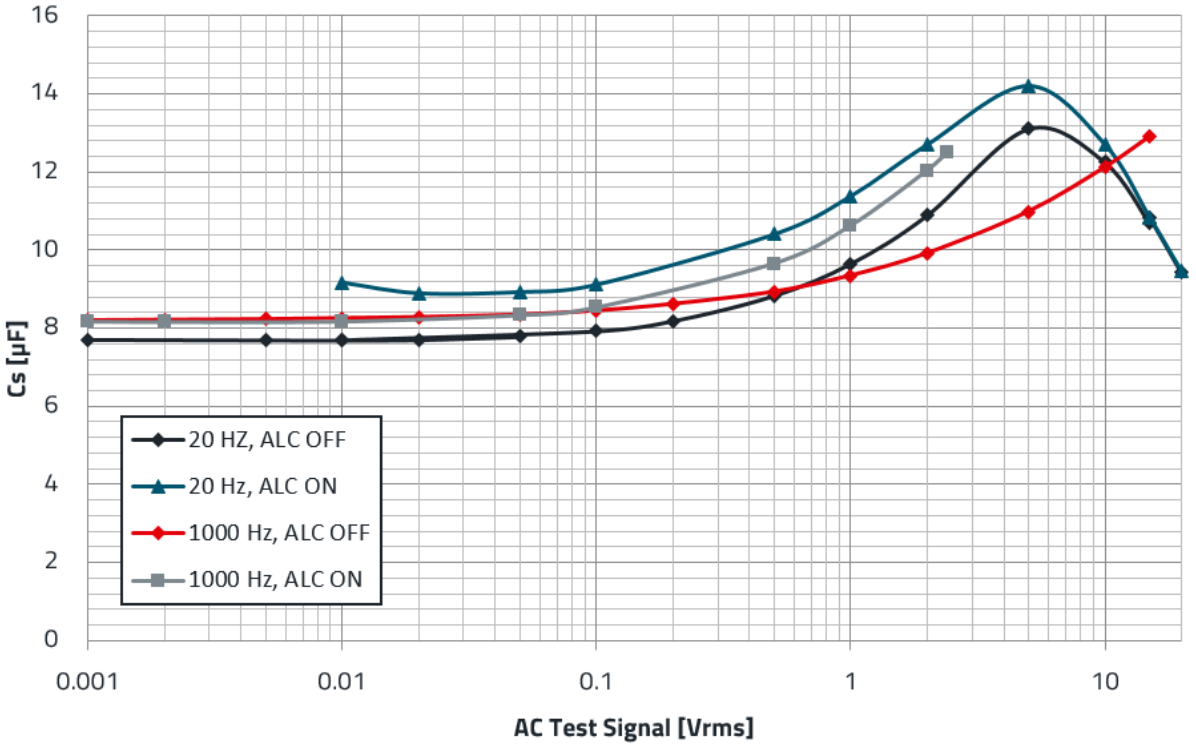


A LOOK INTO THE DATASHEET

AC test signal



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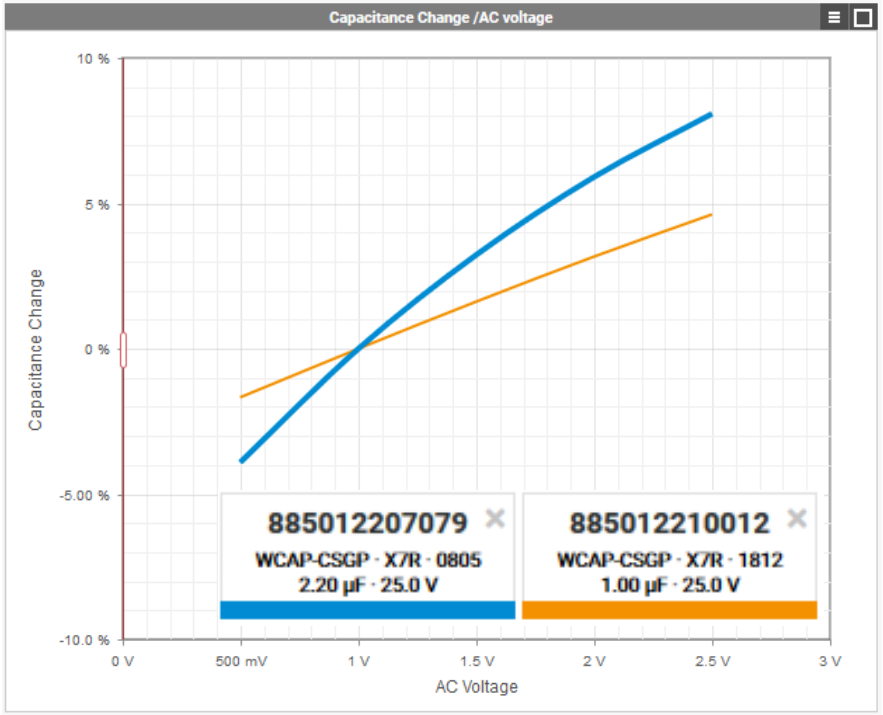
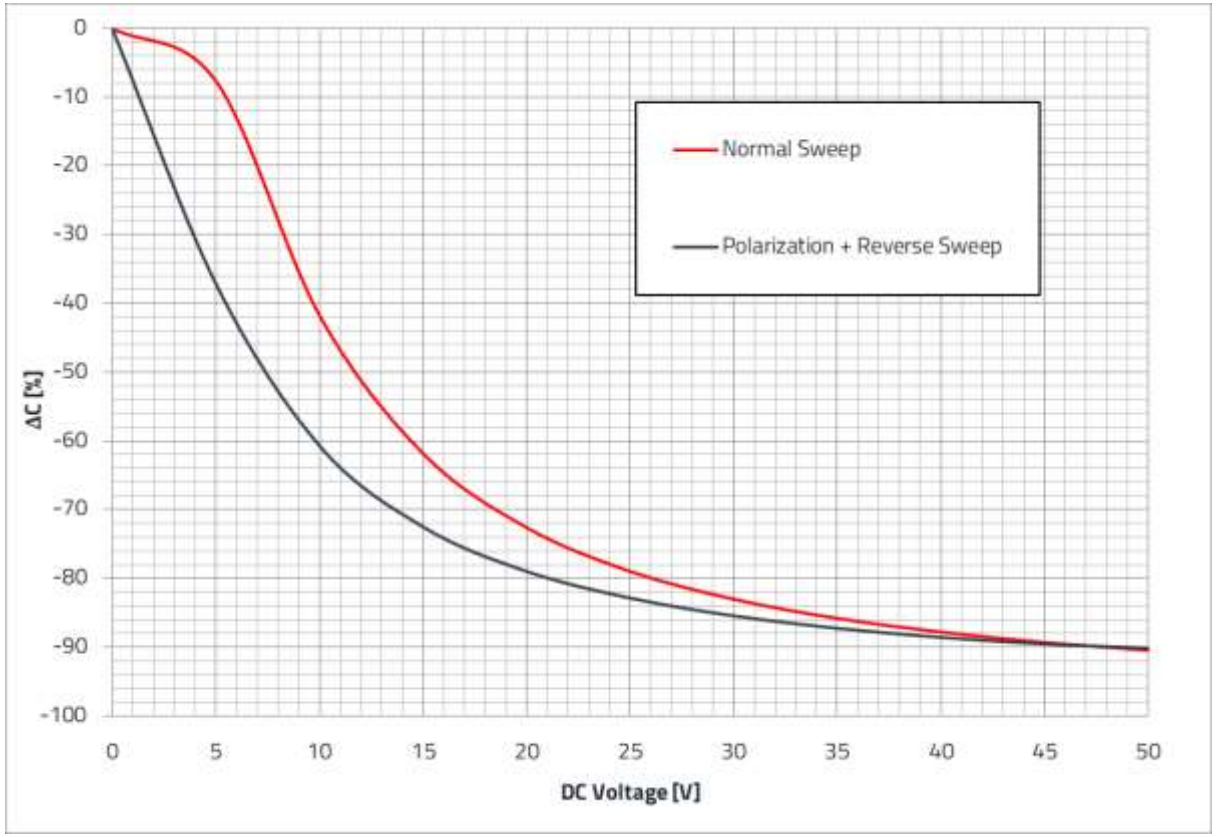


A LOOK INTO THE DATASHEET

DC Bias is… more than you expect

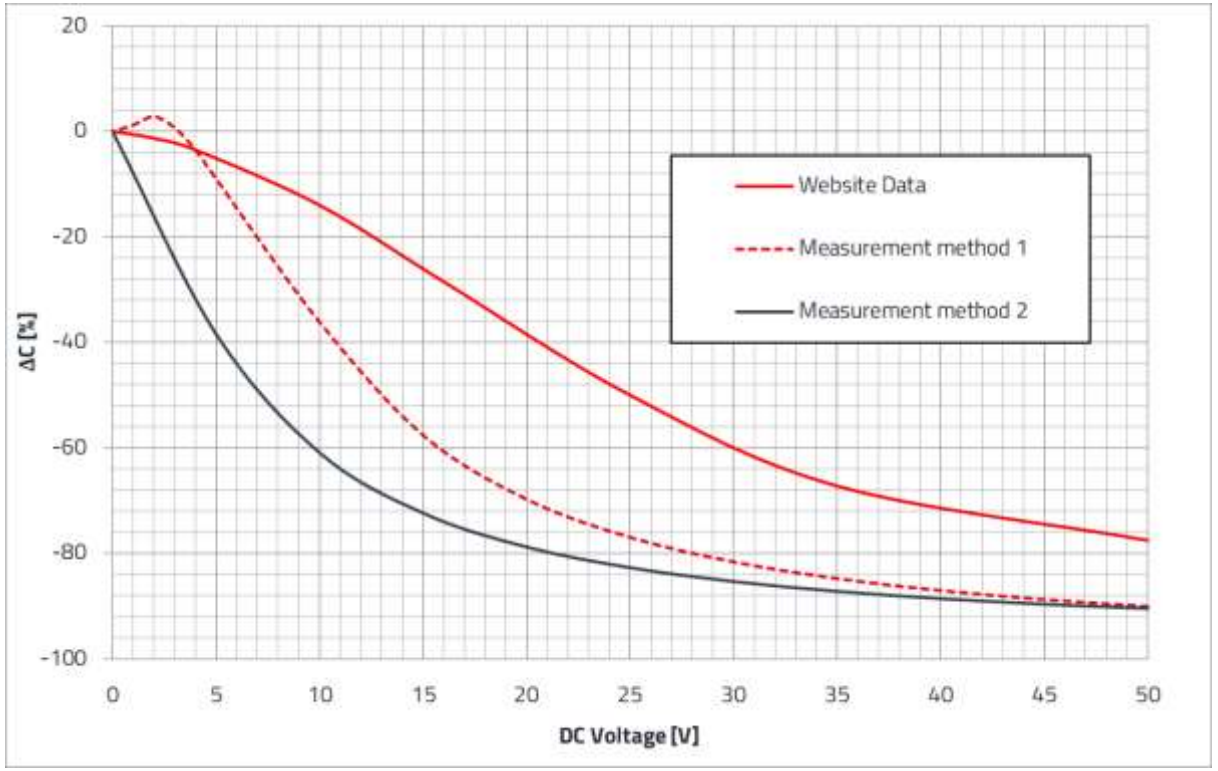


Normal Sweep →

← **Reverse Sweep**

A LOOK INTO THE DATASHEET

DC Bias is… more than you expect



A LOOK INTO THE DATASHEET

WCAP-CSGP, 885012209073 - polarized state of MLCCs

Electrical Properties:

Properties		Test conditions	Value	Unit	Tol.
Capacitance	C	1 ±0.2 V_{RMS}, 1 kHz ±10% @25 °C	10	µF	±10%
Rated Voltage	V_R		50	V (DC)	max.
Dissipation Factor	DF	1 ±0.2 V_{RMS}, 1 kHz ±10% @25 °C	10	%	max.
Insulation Resistance	R_{ISO}	Apply V_R for 120 s max.	0.01	GΩ	min.

Precondition for Class II MLCC measurement: Apply a preheat treatment @150 ±10 °C for 1 hour. The measurement should be applied after 24 ±2 hrs the part was stored under ambient conditions. There is not any precondition necessary for Class I MLCC.

- Precondition for Class II MLCC measurement:

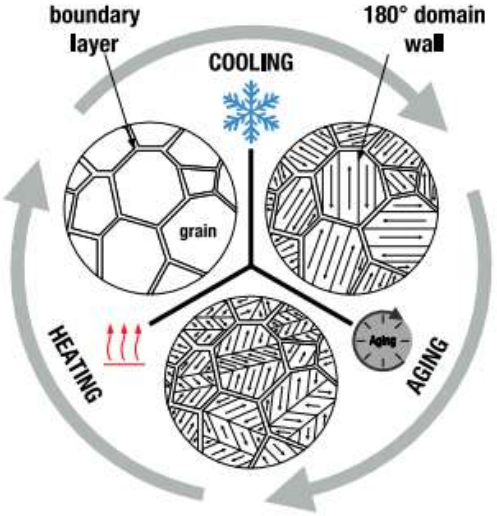
  "Apply a preheat treatment @150 ±10 °C for 1 hour"

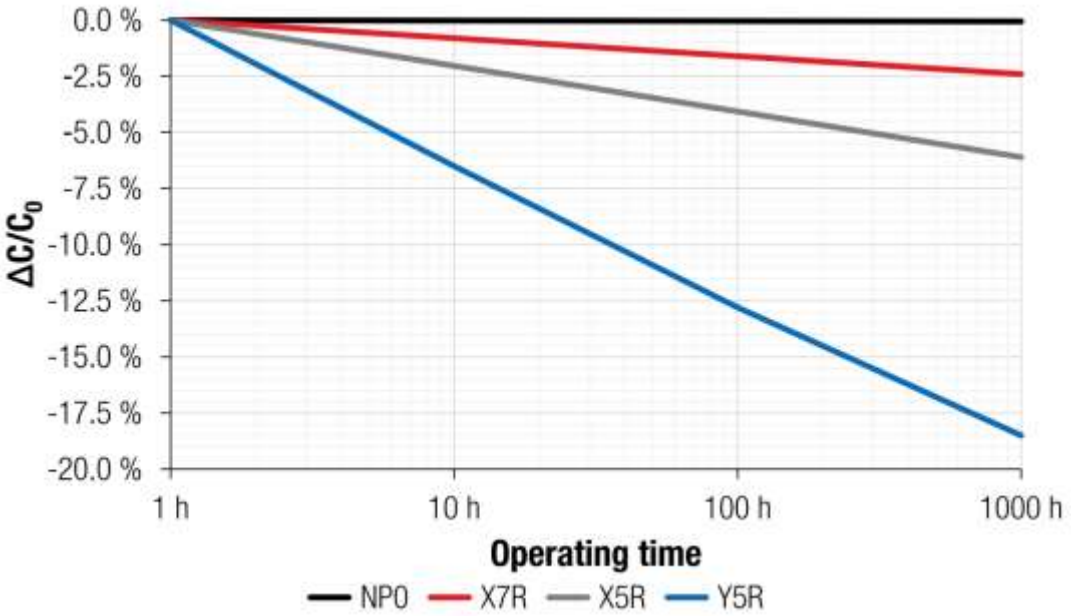
- The Curie Temperature of the ceramic material should be excedeed
- Done to reset the capacitor to a defined condition
- MLCC aging will also be reset

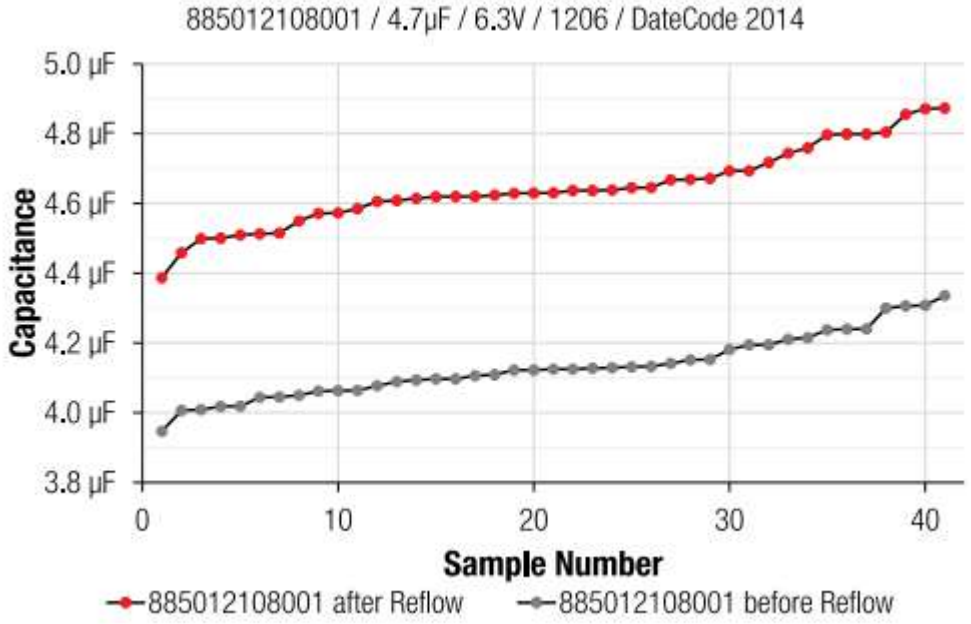
A LOOK INTO THE DATASHEET

Is preconditioning even necessary?

- Class 2 has different aging
- Different materials

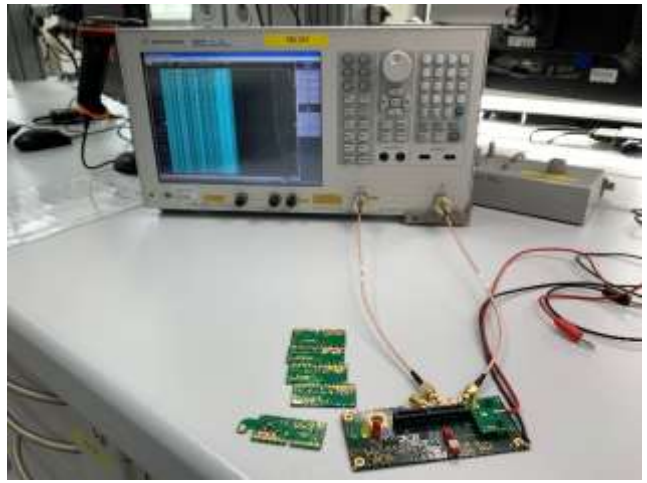


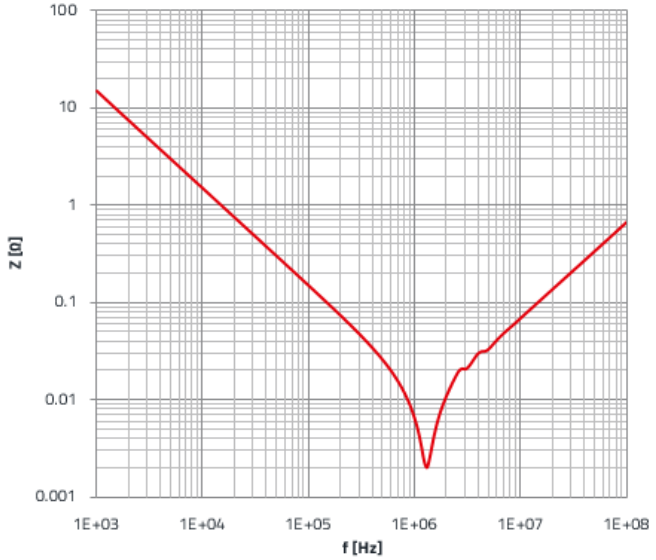


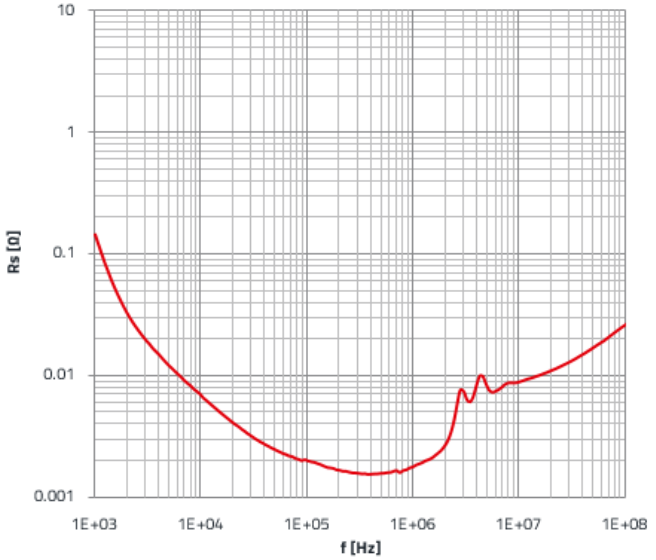


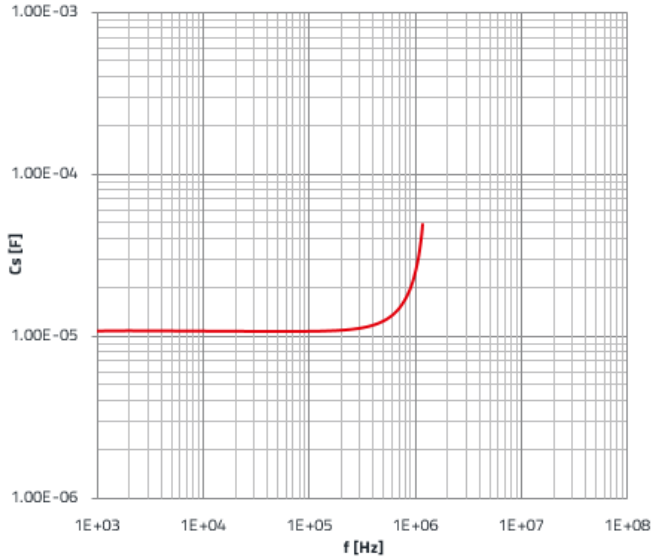
A LOOK INTO THE DATASHEET

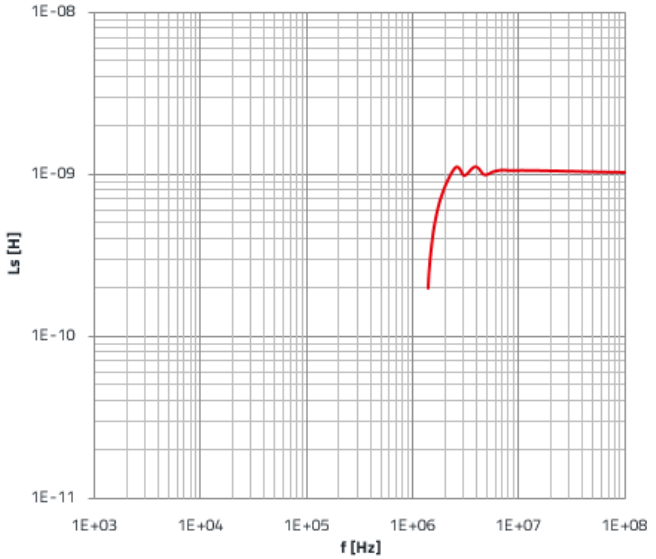
Permanent effect





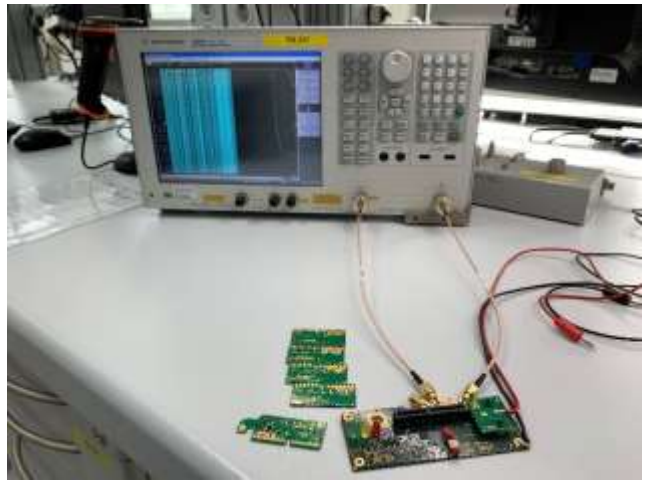


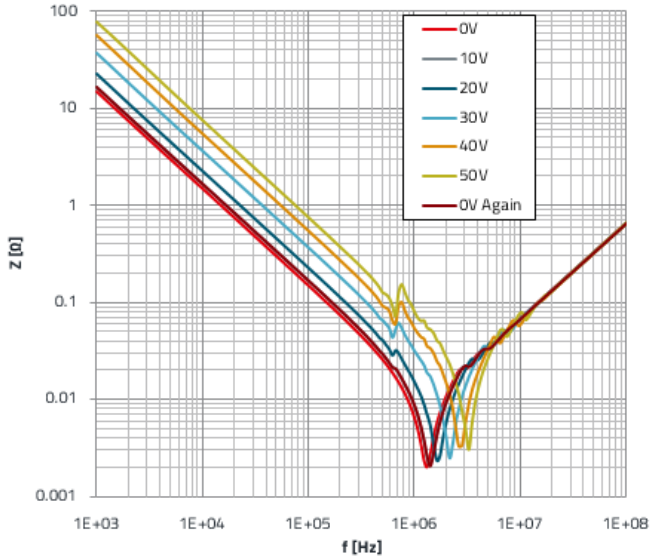


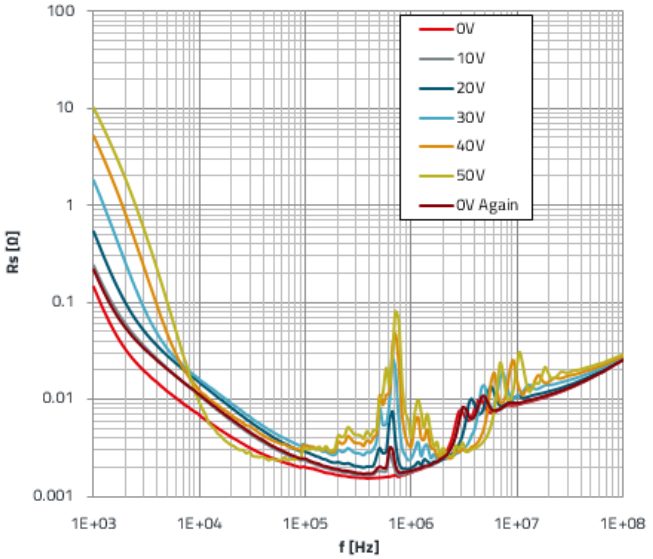


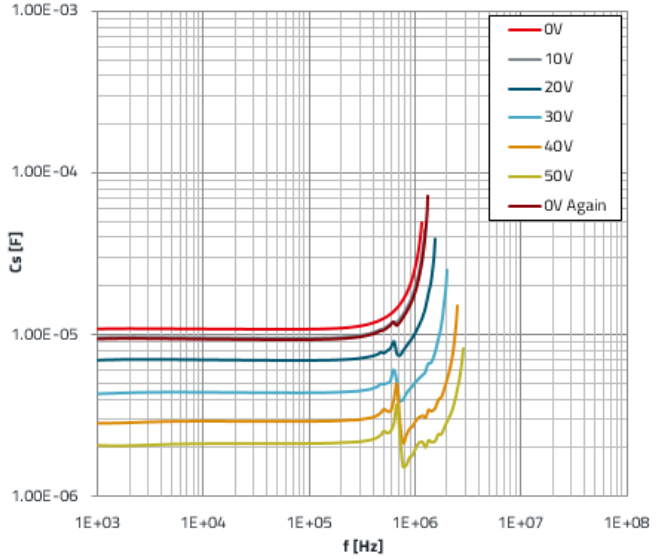
A LOOK INTO THE DATASHEET

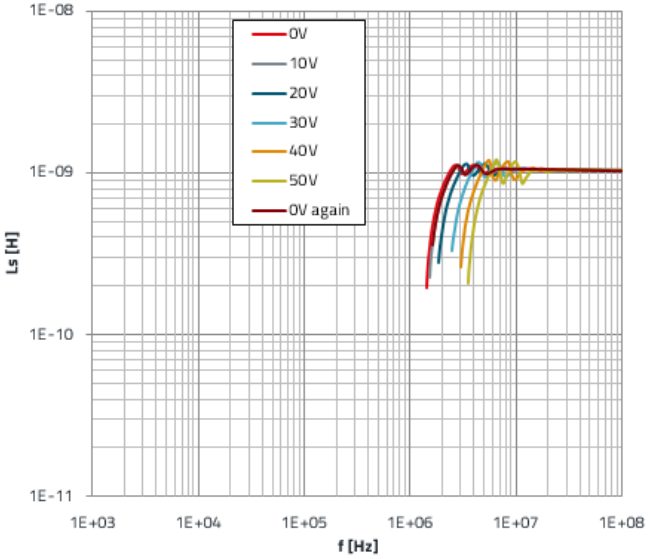
Permanent effect





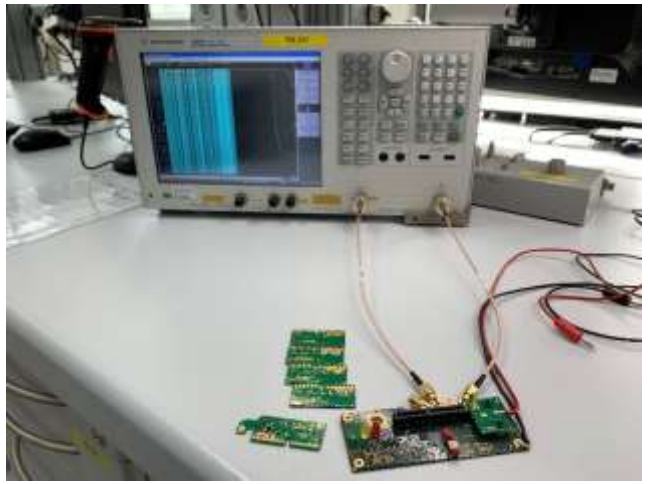


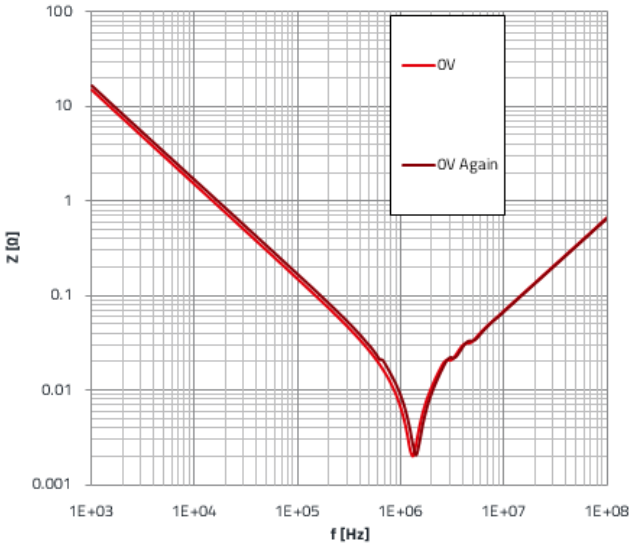


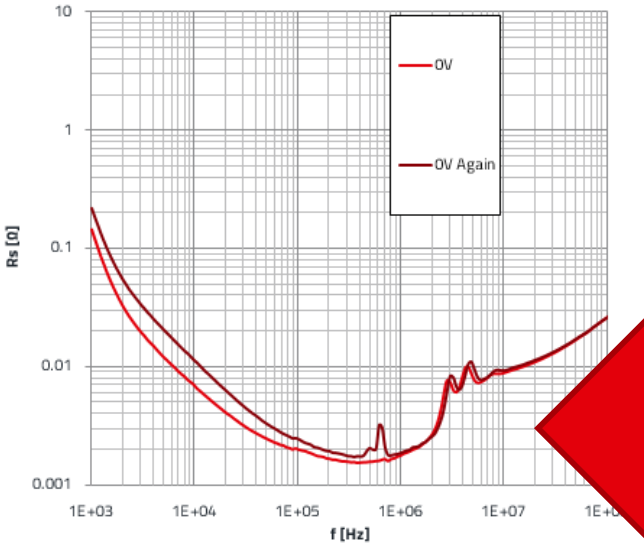


A LOOK INTO THE DATASHEET

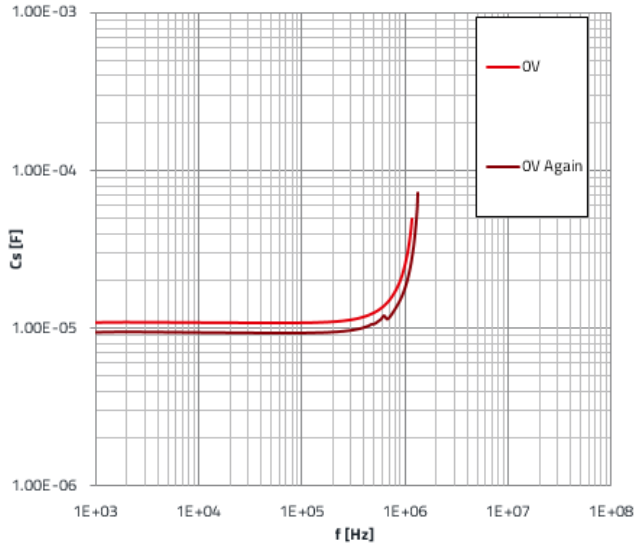
Permanent effects



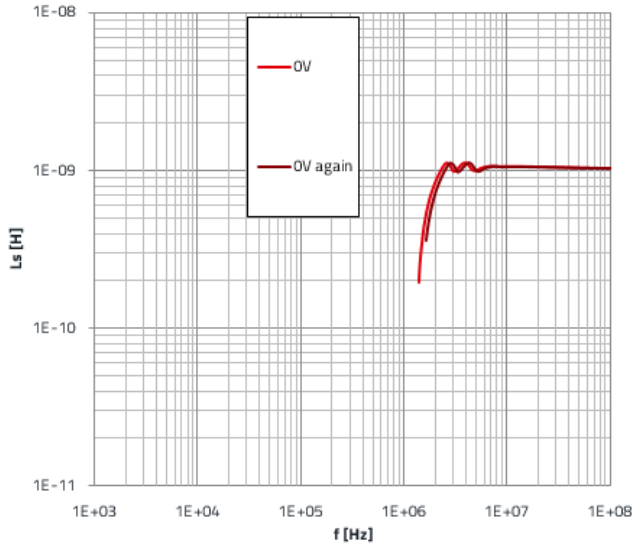




Permanent ESR rise at 0V

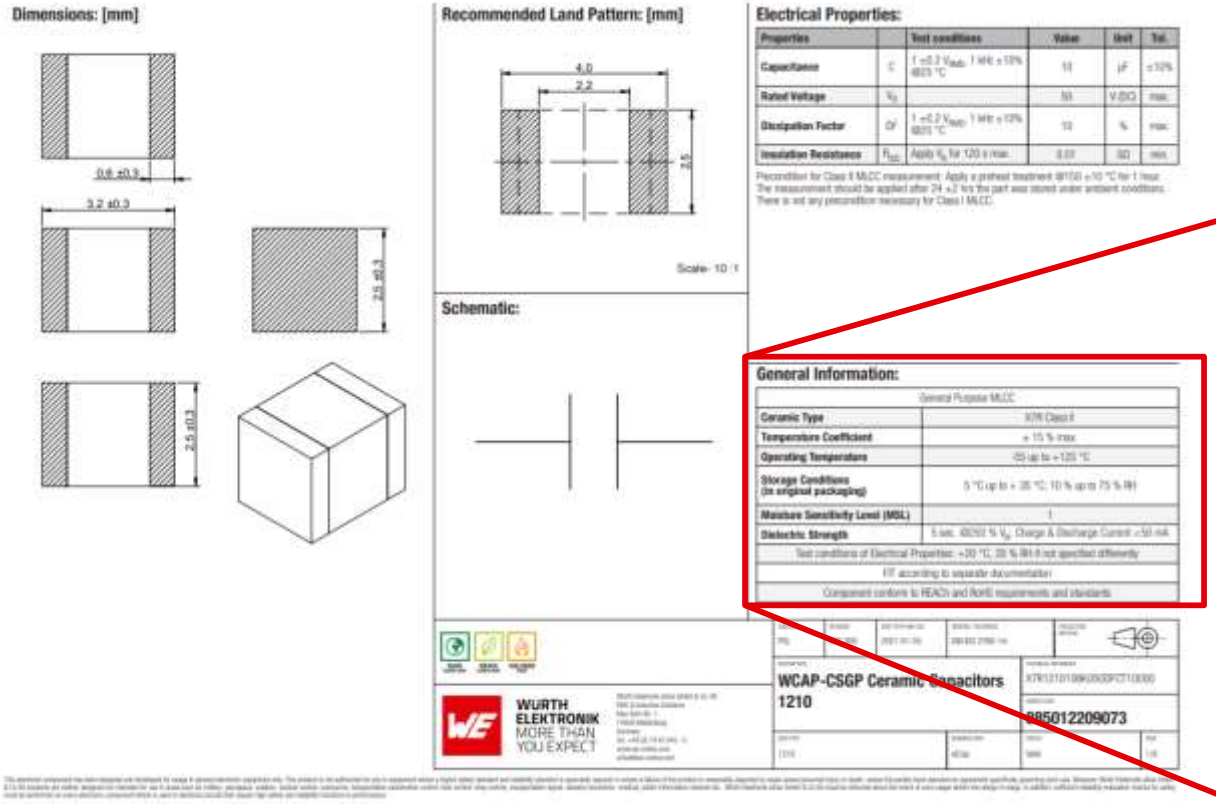


Permanent Capacitance drop at 0V



A LOOK INTO THE DATASHEET

MLCC => WCAP-CSGP, 885012209073



General Information:

General Purpose MLCC	
Ceramic Type	X7R Class II
Temperature Coefficient	± 15 % max.
Operating Temperature	-55 up to +125 °C
Storage Conditions (in original packaging)	5 °C up to + 35 °C; 10 % up to 75 % RH
Moisture Sensitivity Level (MSL)	1
Dielectric Strength	5 sec. @250 % V_R; Charge & Discharge Current <50 mA
Test conditions of Electrical Properties: +20 °C, 35 % RH if not specified differently	
FIT according to separate documentation	
Component conform to REACh and RoHS requirements and standards	

A LOOK INTO THE DATASHEET

WCAP-CSGP, 885012209073

1st character		2nd character		3rd character	
Letter	Lower temperature limit	Number	Upper temperature limit	Letter	Capacitance change over permitted temperature range
X	-55 °C	2	+45 °C	A	± 1.0 %
Y	-30 °C	4	+65 °C	B	± 1.5 %
Z	+10 °C	5	+85 °C	C	± 2.2 %
		6	+105 °C	D	± 3.3 %
		7	+125 °C	E	± 4.7 %
		8	+150 °C	F	± 7.5 %
		9	+200 °C	P	± 10 %
				R	± 15 %
				S	± 22 %
				T	+22 % / -33 %
				U	+22 % / -56 %
				V	+22 % /-82 %

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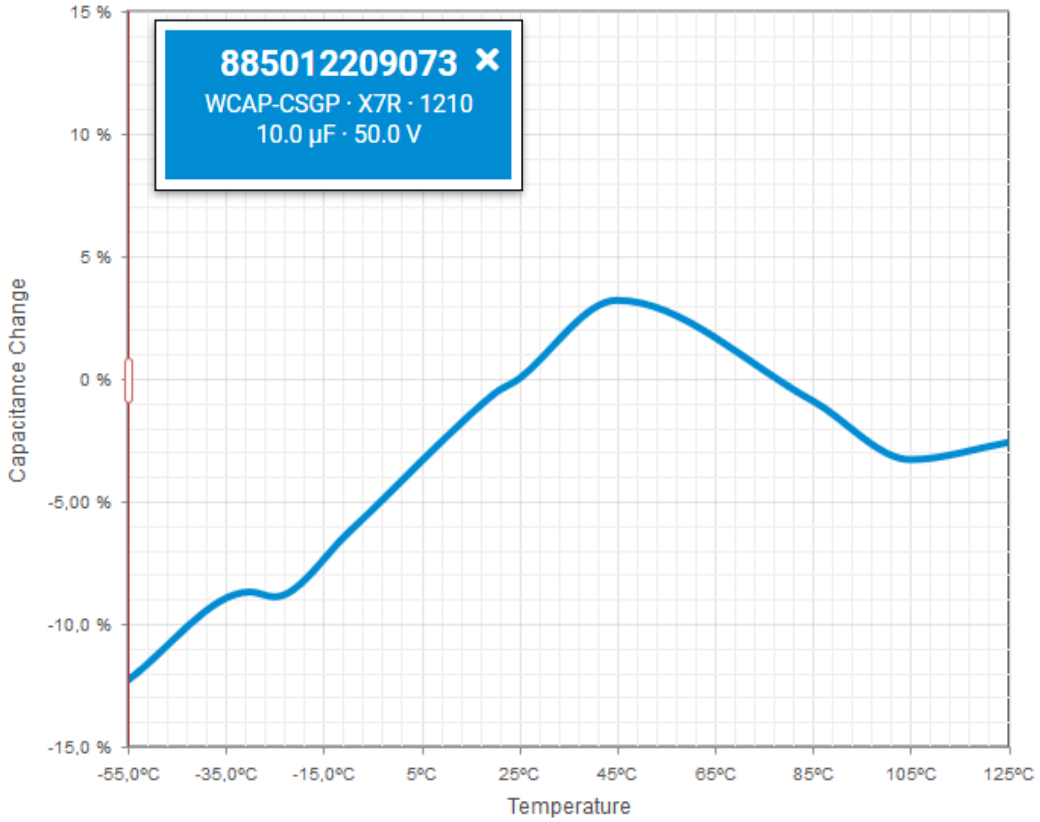
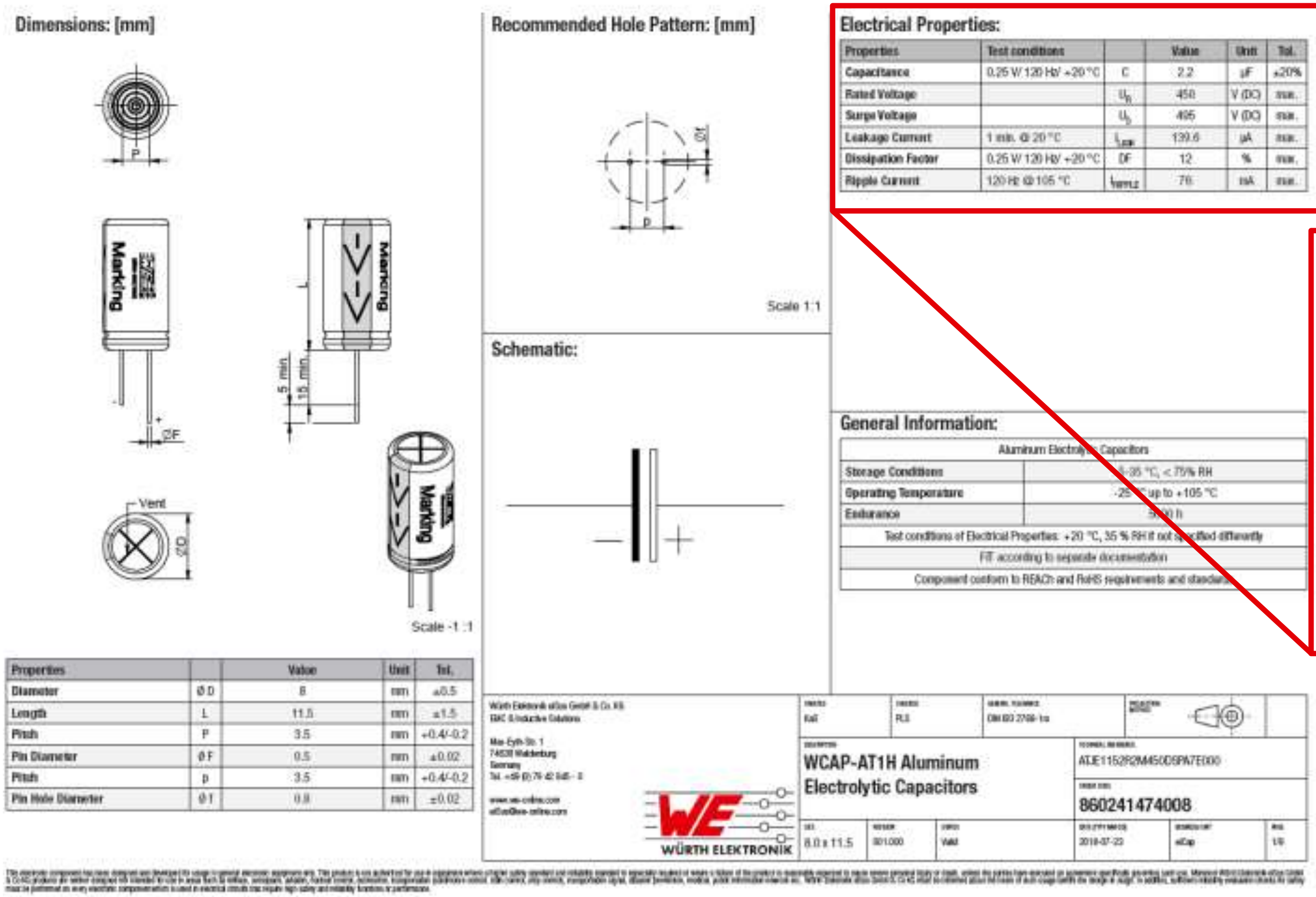


A LOOK INTO THE DATASHEET

Capacitance vs frequency
WCAP-AT1H - THT Radial; 2.2 µF ± 20%; 450 V(DC);



Dimensions: [mm]

Properties		Value	Unit	Tol.
Diameter	Ø D	8	mm	±0.5
Length	L	11.5	mm	±1.5
Pitch	P	3.5	mm	+0.4/-0.2
Pin Diameter	Ø F	0.5	mm	±0.02
Pitch	p	3.5	mm	+0.4/-0.2
Pin Hole Diameter	Ø 1	0.8	mm	±0.02

Recommended Hole Pattern: [mm]

Schematic:

Electrical Properties:

General Information:

Aluminum Electrolytic Capacitors

Operating Temperature: -25 °C up to +105 °C

FIT according to separate documentation

WCAP-AT1H Aluminum Electrolytic Capacitors

860241474008

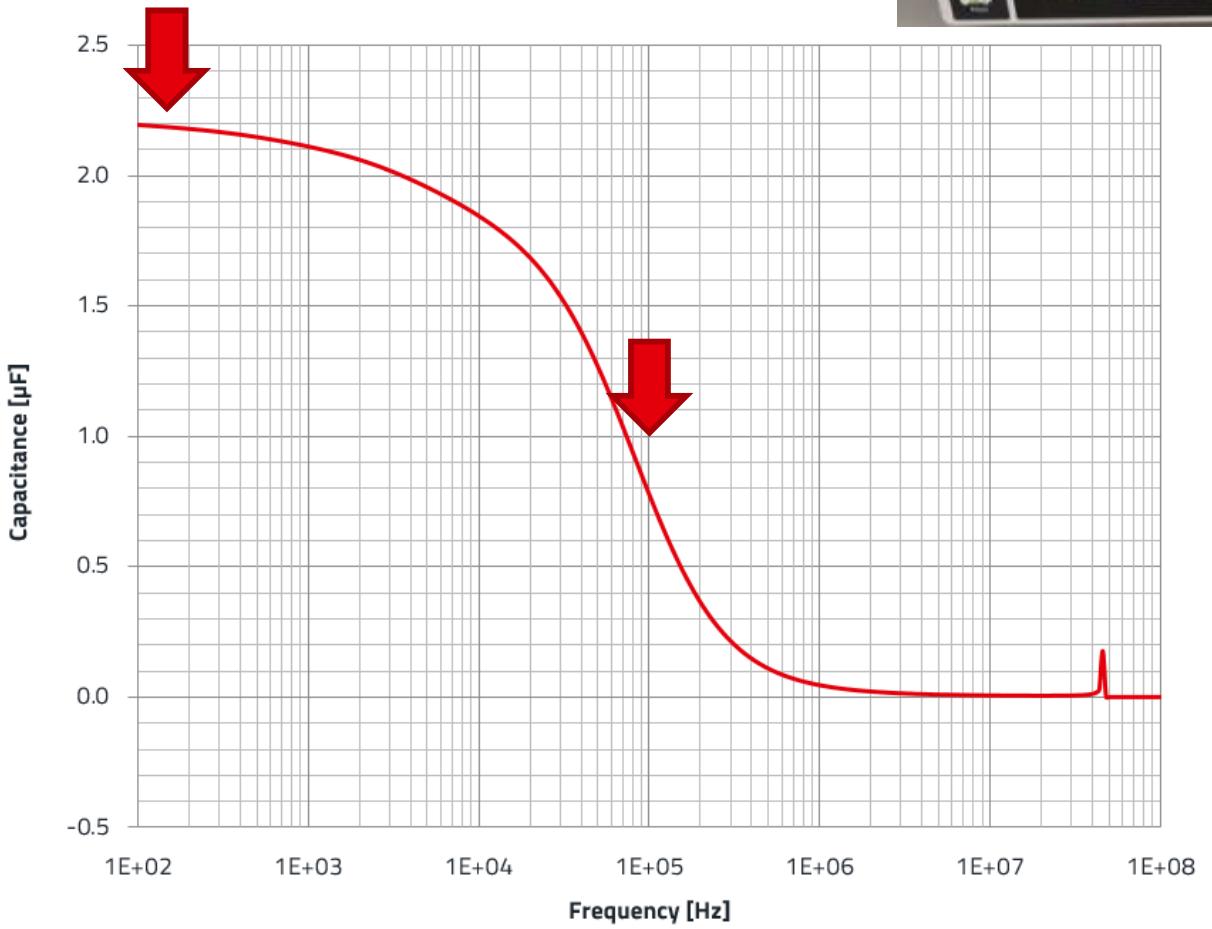
WÜRTH ELEKTRONIK

Electrical Properties:

Properties	Test conditions		Value	Unit	Tol.
Capacitance	0.25 V/ 120 Hz/ +20 °C	C	2.2	µF	±20%
Rated Voltage		U_R	450	V (DC)	max.
Surge Voltage		U_S	495	V (DC)	max.
Leakage Current	1 min. @ 20 °C	I_{Leak}	139.6	µA	max.
Dissipation Factor	0.25 V/ 120 Hz/ +20 °C	DF	12	%	max.
Ripple Current	120 Hz @ 105 °C	I_{RIPPLE}	76	mA	max.

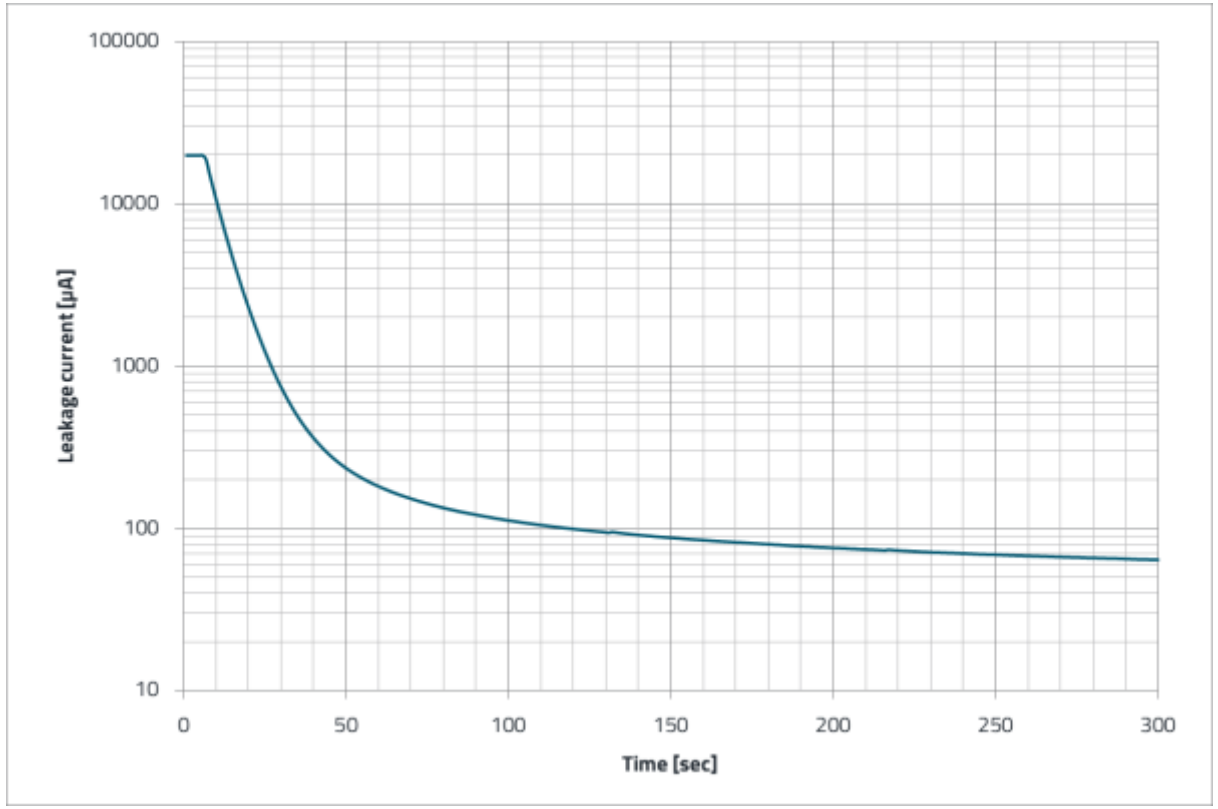
A LOOK INTO THE DATASHEET

Capacitance vs frequency
WCAP-AT1H - THT Radial; 2.2 µF ± 20%; 450 V(DC);



A LOOK INTO THE DATASHEET

Leakage current and storage time



A LOOK INTO THE DATASHEET

Leakage current and storage time

Cautions and Warnings:

The following conditions apply to all goods within the product series of Aluminum Electrolytic Snap-In Capacitors of Würth Elektronik eiSos GmbH & Co. KG:

General:

- This electronic component is designed and manufactured for use in general electronic equipment.

- If a capacitor is stored for a long time without applying voltage or storage conditions of 35 °C or above and more than 75 % relative humidity, the leakage current may increase.
- The leakage current will return to normal level when applying the rated voltage to the capacitor before use. If the capacitor was stored for more than 6 months, it is recommended to apply DC working voltage to the capacitor for 30 minutes through a 1 kΩ protective series resistor.
- The storage conditons stated in the original packaging apply to the storage time and not to the transportation time of the components.

Packaging:

- If a capacitor is stored for a long time without applying voltage or storage conditions of 35 °C or above and more than 75 % relative humidity, the leakage current may increase.
- The leakage current will return to normal level when applying the rated voltage to the capacitor before use. If the capacitor was stored for more than 6 months, it is recommended to apply DC working voltage to the capacitor for 30 minutes through a 1 kΩ protective series resistor.

Product specific:

Storage conditions:

- A storage of Würth Elektronik products for longer than 12 months is not recommended. Within other effects, the terminals may suffer degradation, resulting in bad solderability. Therefore, all products shall be used within the period of 12 months based on the day of shipment.
- Do not expose the components into direct sunlight.
- The storage condition in the original packaging is defined according to DIN EN 61760-2.
- The environment in which the capacitors are operated and stored has to have atmospheric characteristics and must be free of dew condensation and toxic gases (e.g. chlorine, ammonia, sulfur, hydrogen sulphide and hydrogen sulfate).
- Do not expose the capacitor to environments with hazardous gas, ozone, ultraviolet rays or any kind of radiation. Avoid any contact of the capacitor with direct sunshine, saltwater, spray of water or types of oil during storage.

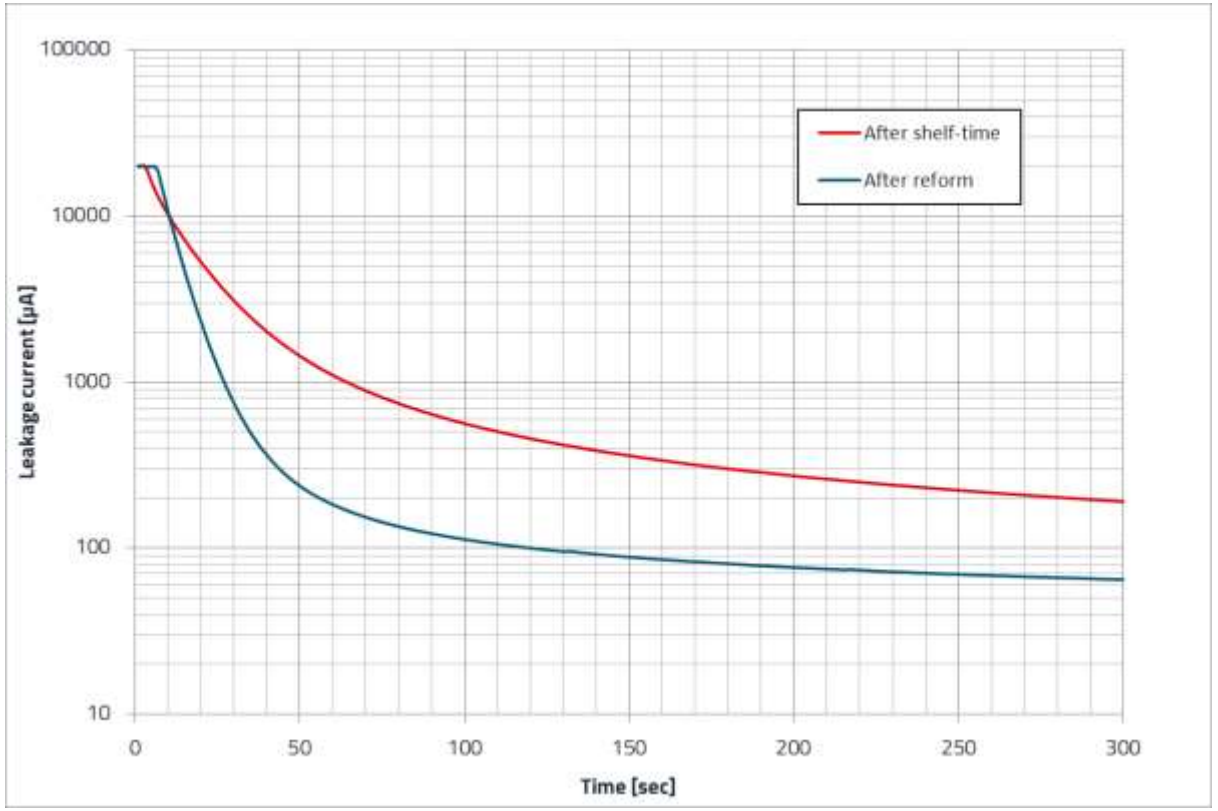
The capacitor shall not be operated above the operating temperature, which is stated in the datasheet of the specific capacitor. The achievable lifetime of the capacitor is correlating to the applied temperature. In order to achieve the maximum lifetime, the capacitor should be operated at the lowest possible temperature conditions within the application.

Ripple current:

The applied ripple current shall not exceed the specified maximum ripple current of the capacitor. If a higher ripple current as permitted is applied , it can cause excessive heat generation and higher temperature inside the capacitor. This happens due to pole change effects. This can result in damage or lifetime shortage of the capacitor and may cause deterioration. Electrolytic capacitors are regularly not designed for usage in AC applications and ripple current is applied / based due to parasitic effects on DC signal. Please see electrical specification within this datasheet for maximum allowed ripple current.

A LOOK INTO THE DATASHEET

Forming / Repairing of the Oxide Layer



- When charging for the first time after a long time discharged, the forming process while happen again
- A significant voltage is required
- With higher voltage the forming is faster
- Leakage current may fall outside of specification

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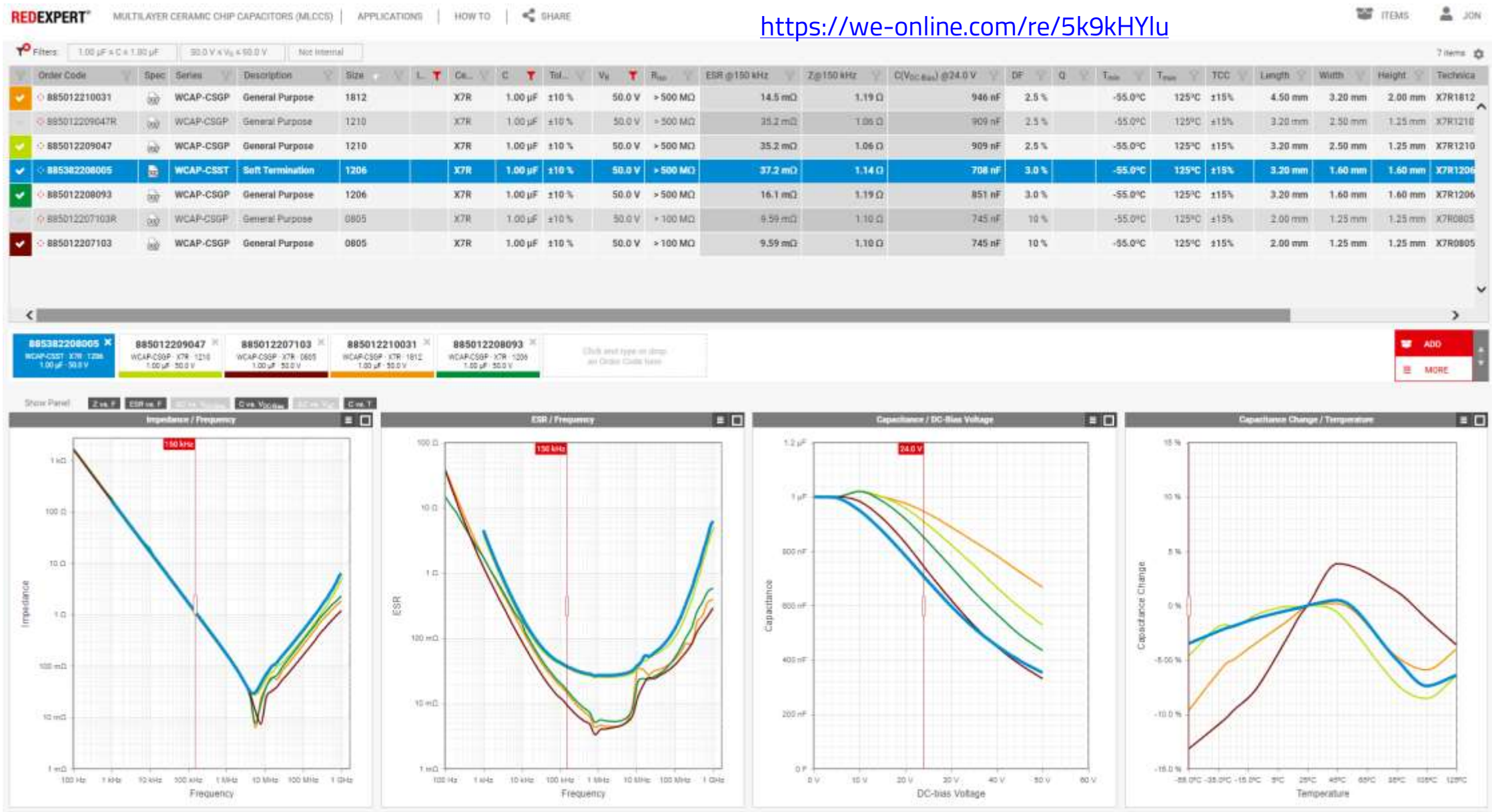
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MULTILAYER CERAMIC CHIP CAPACITORS (MLCCS)
APPLICATIONS
HOW TO
SHARE
ITEMS
JON
https://we-online.com/re/5k9kHYlu
Filters
7 items
Order Code
Spec
Series
Description
Size
C
Tol.
ESR @150 kHz
Z @150 kHz
DF
Q
TCC
Length
Width
Height
Technica
885012210031
WCAP-CSGP
General Purpose
1812
X7R
1.00 µF
±10 %
50.0 V
> 500 MΩ
14.5 mΩ
1.19 Ω
946 nF
2.5 %
-55.0°C
125°C
±15%
4.50 mm
3.20 mm
2.00 mm
X7R1812
885012209047R
WCAP-CSGP
General Purpose
1210
X7R
1.00 µF
±10 %
50.0 V
> 500 MΩ
35.2 mΩ
1.06 Ω
909 nF
2.5 %
-55.0°C
125°C
±15%
3.20 mm
2.50 mm
1.25 mm
X7R1210
885012209047
WCAP-CSGP
General Purpose
1210
X7R
1.00 µF
±10 %
50.0 V
> 500 MΩ
35.2 mΩ
1.06 Ω
909 nF
2.5 %
-55.0°C
125°C
±15%
3.20 mm
2.50 mm
1.25 mm
X7R1210
885382208005
WCAP-CSST
Soft Termination
1206
X7R
1.00 µF
±10 %
50.0 V
> 500 MΩ
37.2 mΩ
1.14 Ω
708 nF
3.0 %
-55.0°C
125°C
±15%
3.20 mm
1.60 mm
1.60 mm
X7R1206
885012208093
WCAP-CSGP
General Purpose
1206
X7R
1.00 µF
±10 %
50.0 V
> 500 MΩ
16.1 mΩ
1.19 Ω
851 nF
3.0 %
-55.0°C
125°C
±15%
3.20 mm
1.60 mm
1.60 mm
X7R1206
885012207103R
WCAP-CSGP
General Purpose
0805
X7R
1.00 µF
±10 %
50.0 V
> 100 MΩ
9.59 mΩ
1.10 Ω
745 nF
10 %
-55.0°C
125°C
±15%
2.00 mm
1.25 mm
1.25 mm
X7R0805
885012207103
WCAP-CSGP
General Purpose
0805
X7R
1.00 µF
±10 %
50.0 V
> 100 MΩ
9.59 mΩ
1.10 Ω
745 nF
10 %
-55.0°C
125°C
±15%
2.00 mm
1.25 mm
1.25 mm
X7R0805
885382208005
885012209047
885012207103
885012210031
885012208093
ADD
MORE
Show Panel
Impedance / Frequency
150 kHz
Impedance
Frequency
ESR / Frequency
150 kHz
ESR
Frequency
Capacitance / DC-Bias Voltage
24.0 V
Capacitance
DC-bias Voltage
Capacitance Change / Temperature
Capacitance Change
Temperature