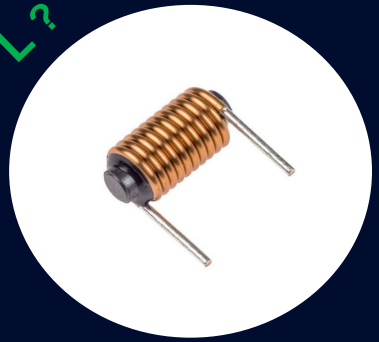
정확한 RLC 측정을 위한 솔루션!
: LCR METER와 IMPEDANCE ANALYZER 소개

Application Engineer
Jaehyun Lee

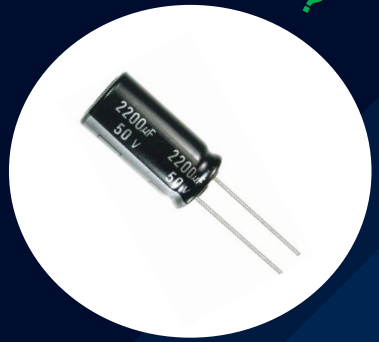
ROHDE&SCHWARZ
Make ideas real

L?



인덕터

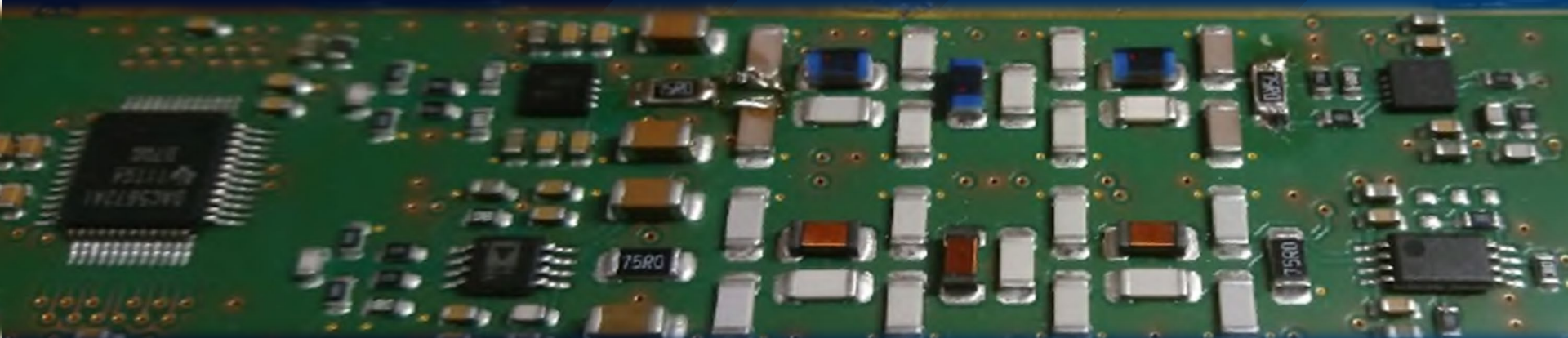
C?

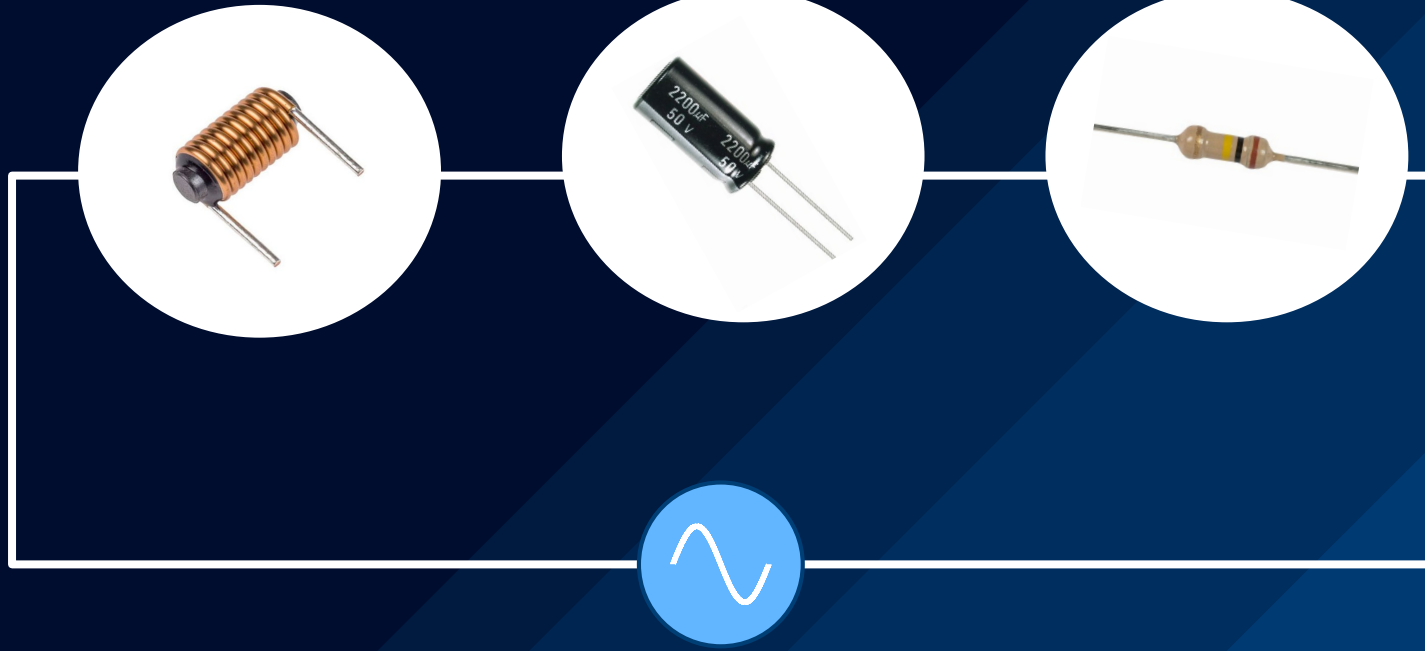


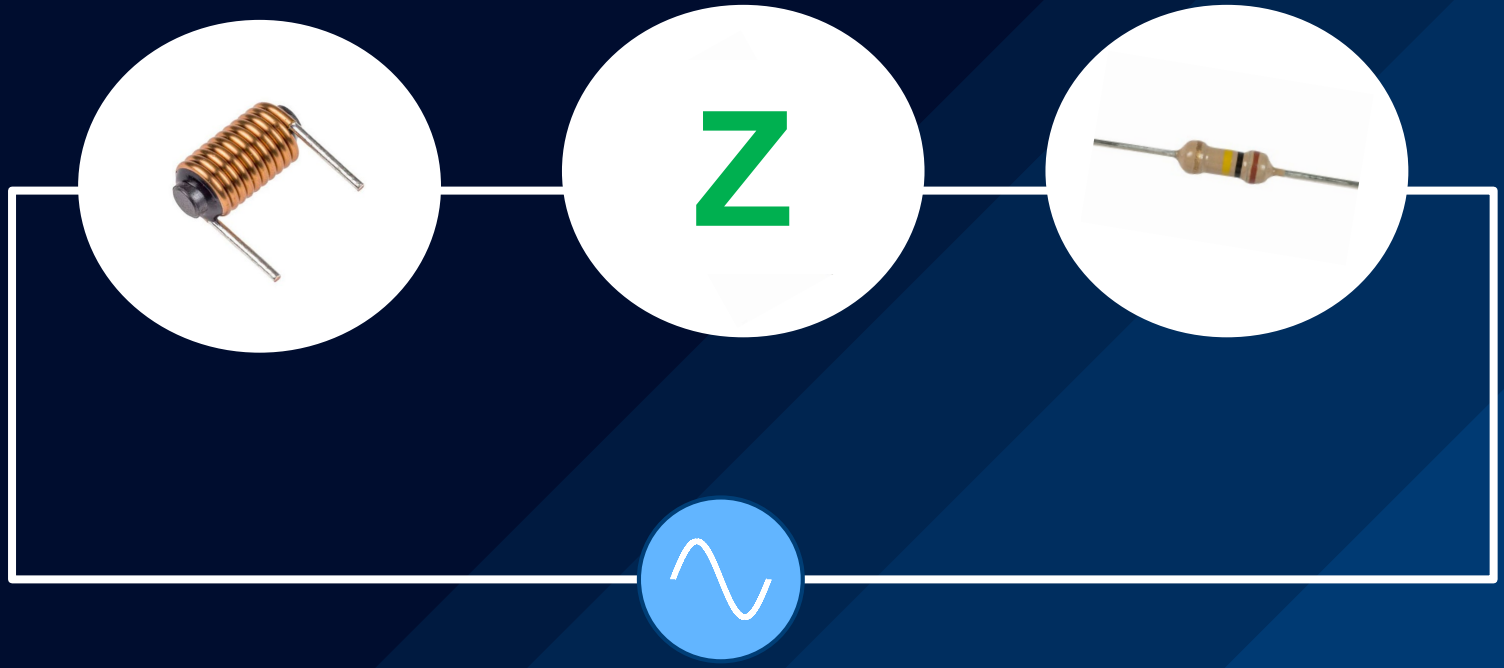
캐패시터

R?

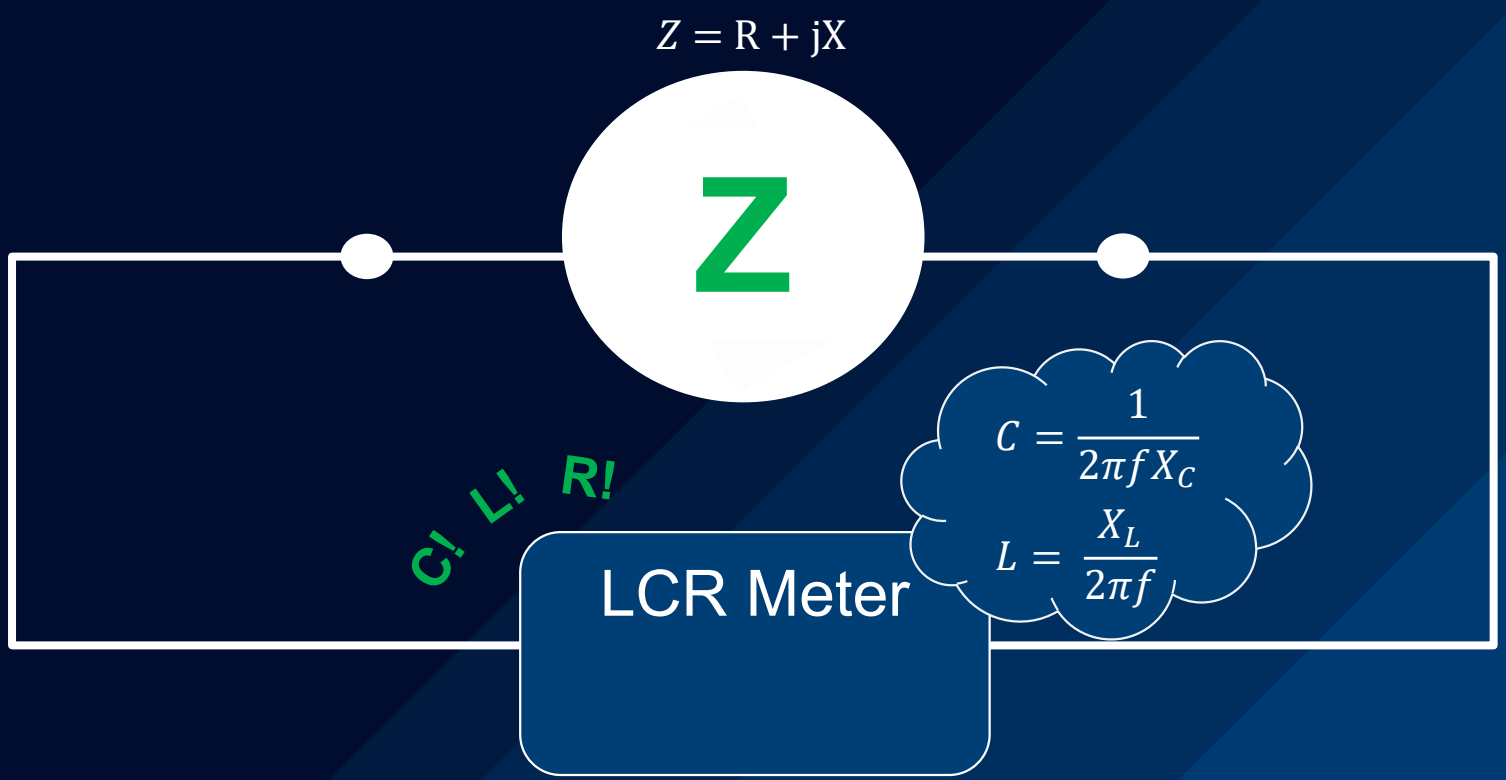
저항




2200μF
50 V

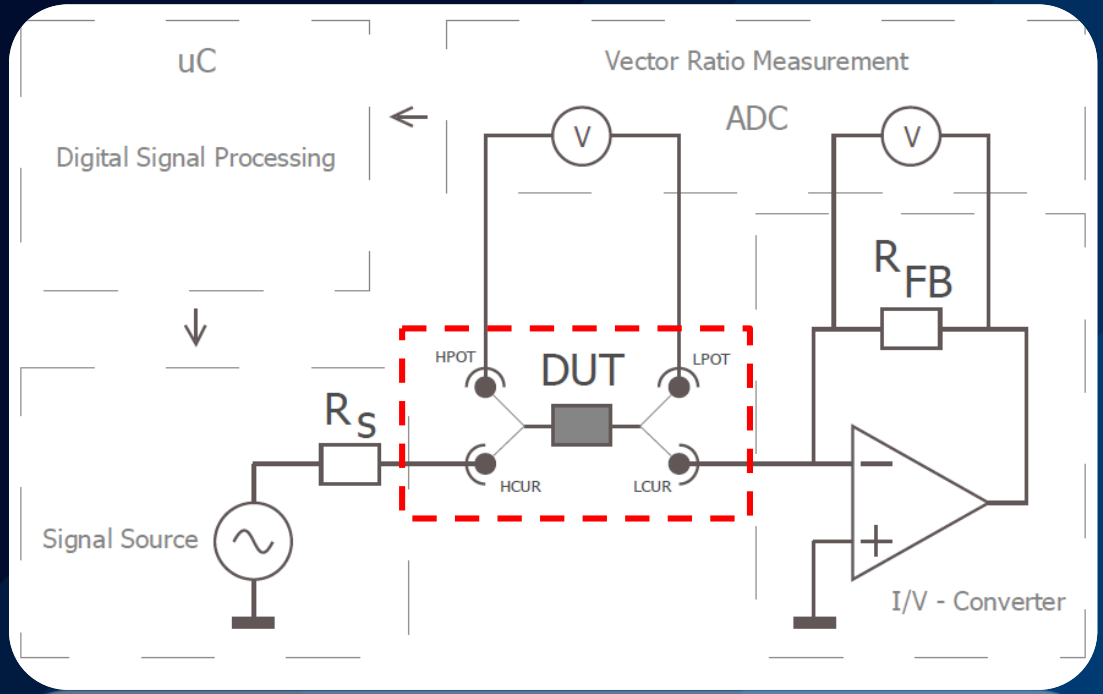

Z


Z


$Z = R + jX$
Z
C! L! R!
LCR Meter
$C = \frac{1}{2\pi f X_C}$
$L = \frac{X_L}{2\pi f}$

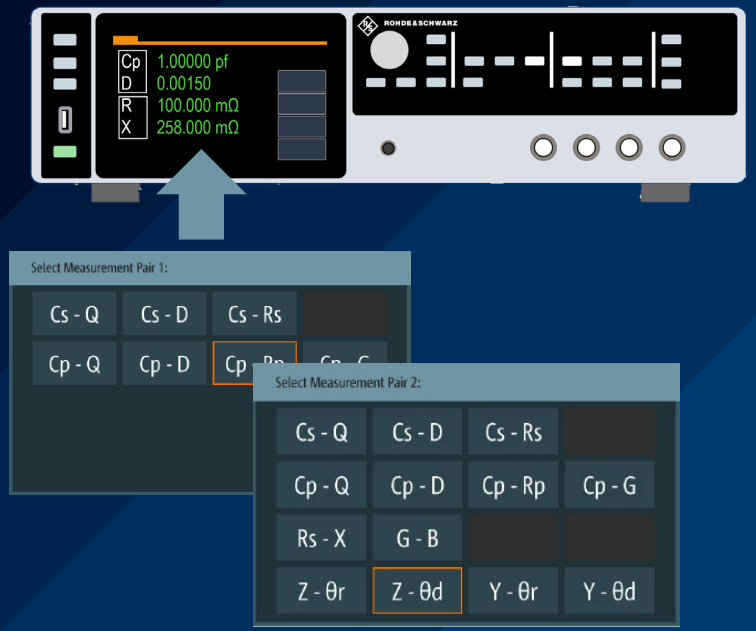
R&S®LCX


LCX200 · LCR Meter
Settings
R
Freq.
Level
Bias Level
Range
Comp.
Bias Enable
Auto
Hold
Trig.
LCUR
LPOT
HPOT
HCUR
Discharge test device before connecting

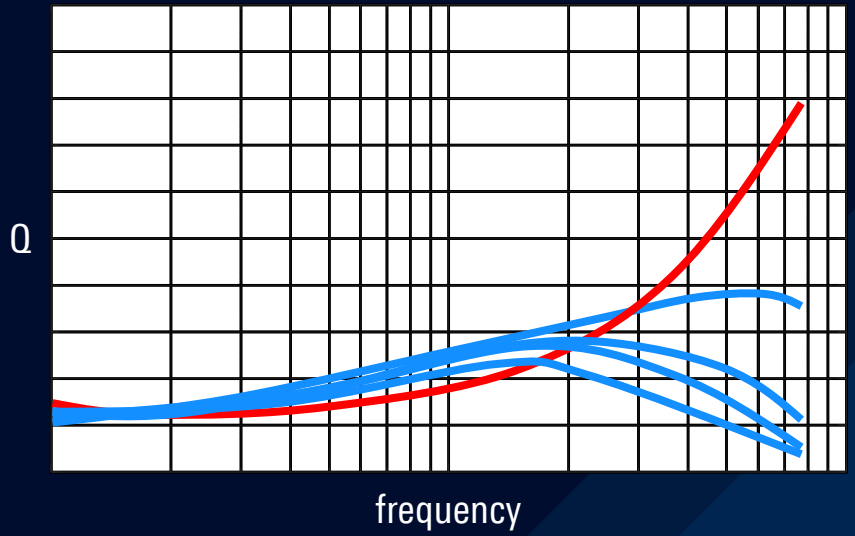

uC
Vector Ratio Measurement
Digital Signal Processing
ADC
V
V
R FB
HPOT
DUT
LPOT
R S
HCUR
LCUR
Signal Source
I/V - Converter

Cp	Capacitance value measured with parallel-equivalent circuit model
Cs	Capacitance value measured with series-equivalent circuit model
Lp	Inductance value measured with parallel-equivalent circuit model
Ls	Inductance value measured with series-equivalent circuit model
D	Dissipation factor
Q	Quality factor (inverse of D)
G	Equivalent parallel conductance measured with parallel-equivalent circuit model
Rp	Equivalent parallel resistance measured with parallel-equivalent circuit model
Rs	Equivalent series resistance measured with series-equivalent circuit model
Rdc	Direct current resistance
R	Resistance
X	Reactance
Z	Impedance
Y	Admittance
Θd	Phase angle of impedance/admittance (degree)
Θr	Phase angle of impedance/admittance (radian)
B	Susceptance
M	Mutual inductance
	Turns ratio

R&S®LCX

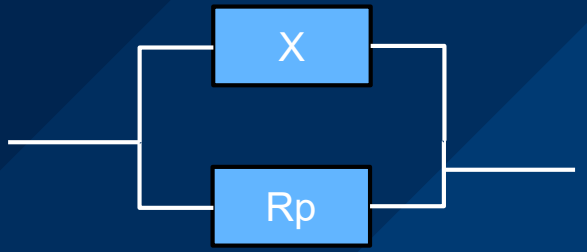


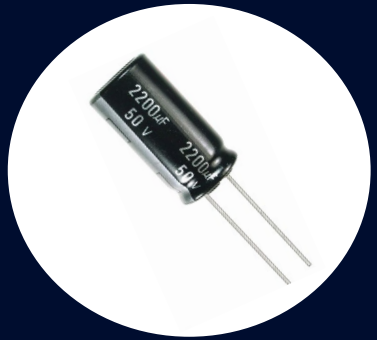
Q (quality factor)

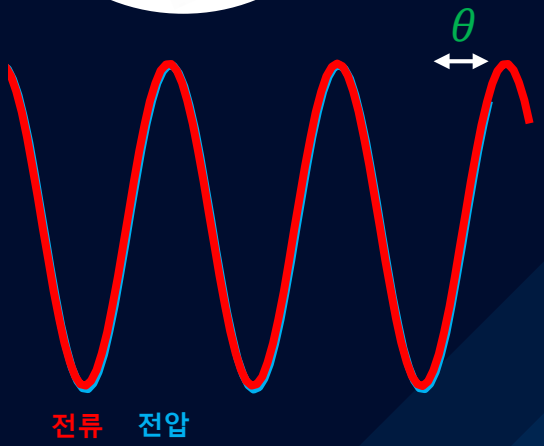


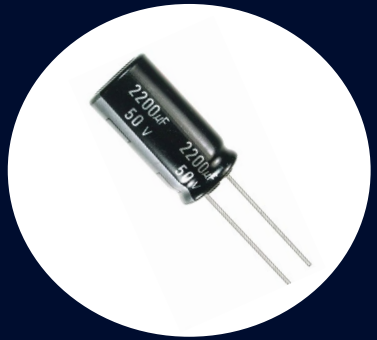
$$\boldsymbol{Q} = \frac{X}{R} \qquad \boldsymbol{D} = \frac{1}{Q} = \frac{R}{X}$$

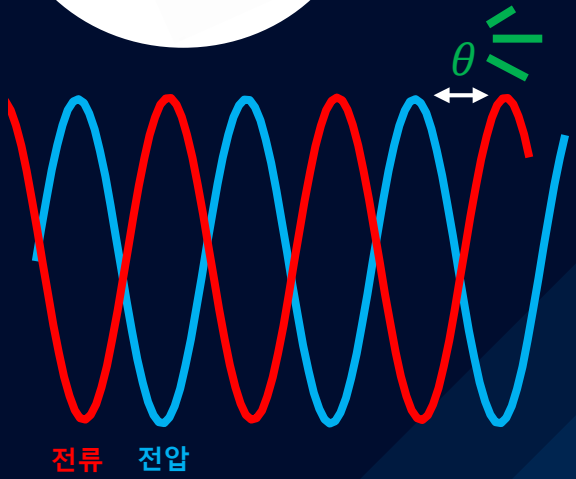
Series vs. parallel models

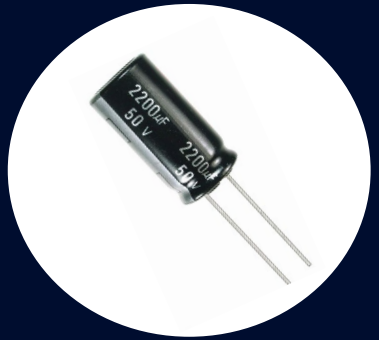


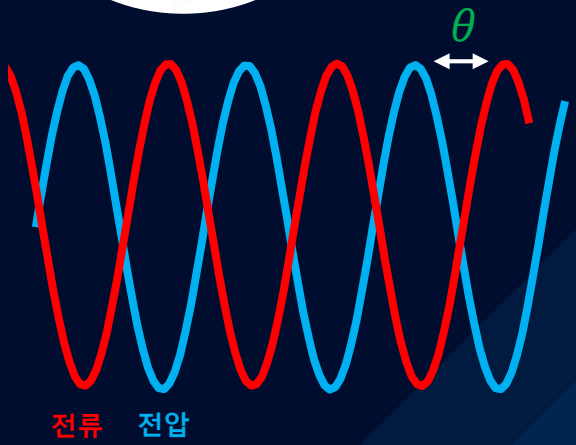

2200μF
50 V


θ
전류
전압


2200μF
50 V

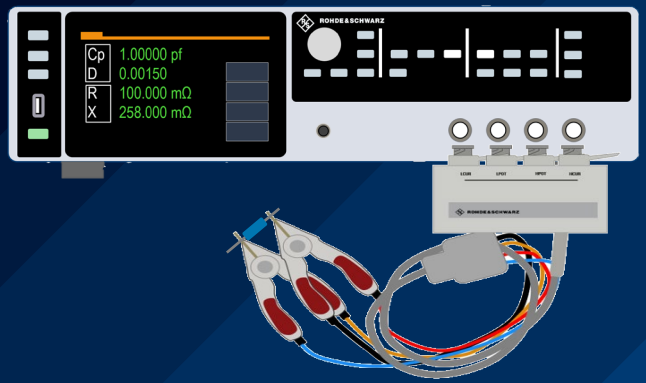

θ
전류
전압



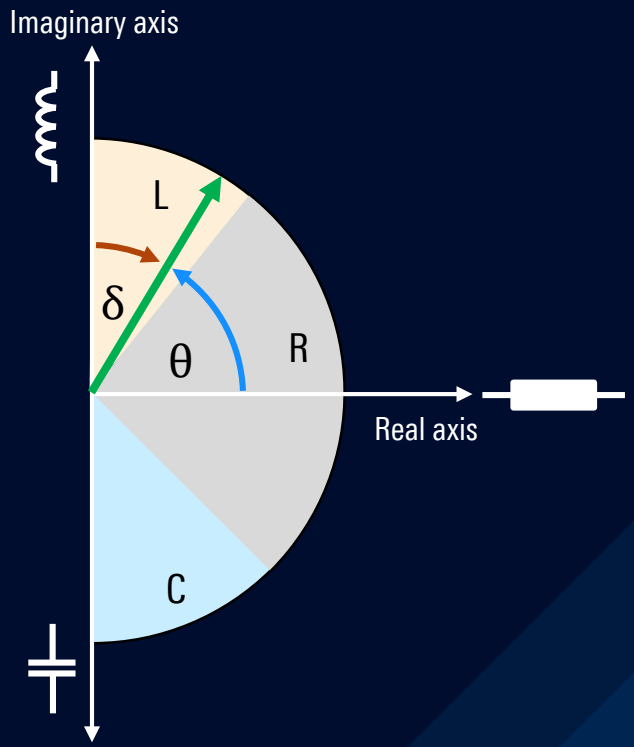


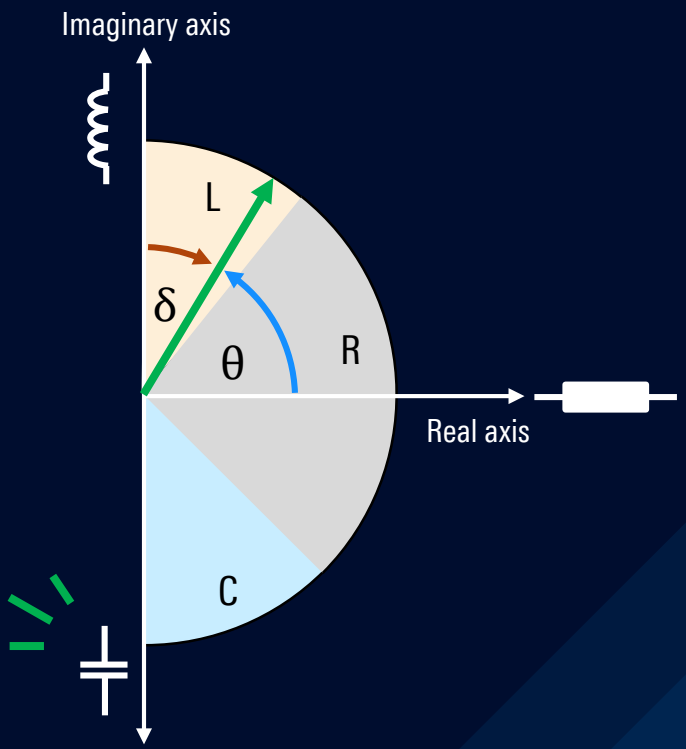
LCR Meter

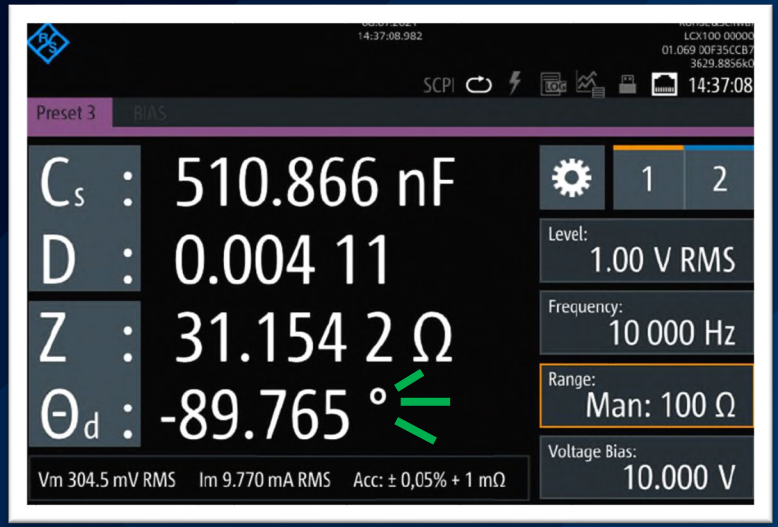
R&S®LCX



기본 임피던스 측정 정확도: **0.05%**


Imaginary axis
L
δ
θ
R
Real axis
C


Imaginary axis
L
δ
θ
R
Real axis
C

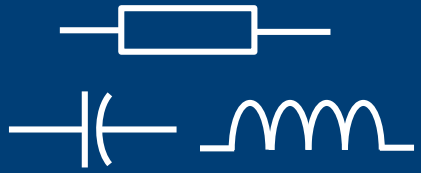

14:37:08.982
SCPI
14:37:08
Preset 3
BIAS
Cs : 510.866 nF
D : 0.004 11
Z : 31.154 2 Ω
Θd : -89.765 °
1
2
Level:
1.00 V RMS
Frequency:
10 000 Hz
Range:
Man: 100 Ω
Voltage Bias:
10.000 V
Vm 304.5 mV RMS
Im 9.770 mA RMS
Acc: ± 0,05% + 1 mΩ

R&S®LCX

Steps in using the LCX

Select / attach fixture

Select DUT type



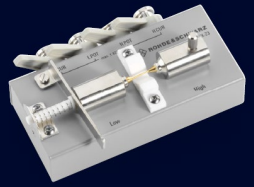
Configure test signal

Rerform corrections

Choose measurements

Review results

Select fixture and DUT type



LCX-Z3 SMD Test Fixture

LCX-Z4: tweezers

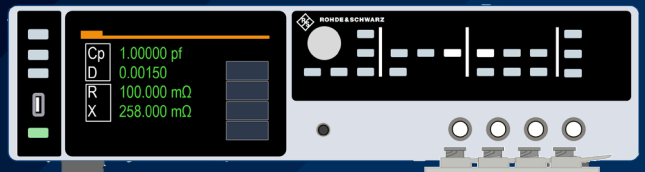
LCX-Z1: through hole

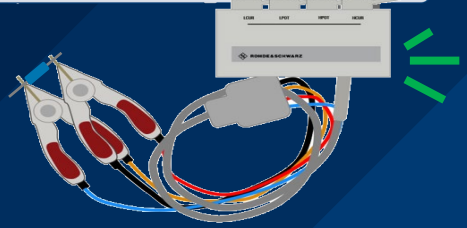
LCX-Z11 BNC Extension

LCX-Z5 Transformer
Test Cable

LCR Meter

R&S®LCX





LCX-Z2: Kelvin clips

Configure test signal

R&S®LCX

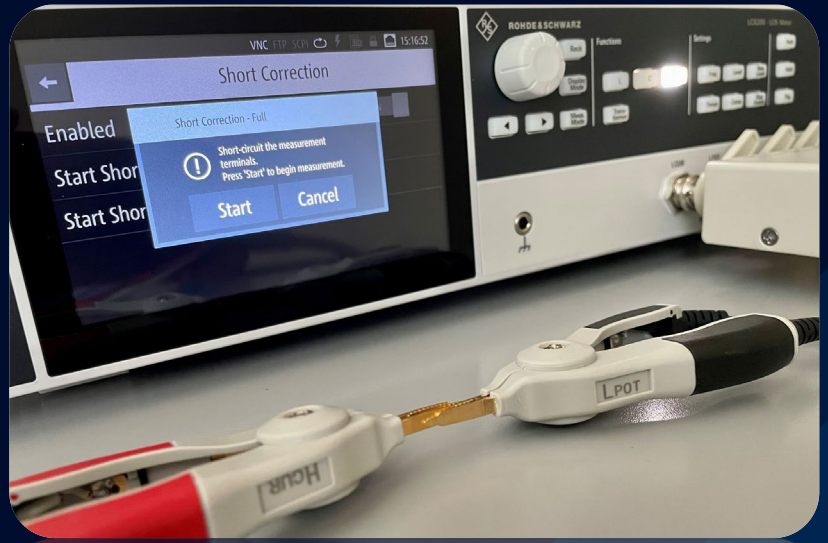
측정 파라미터

테스트 신호 레벨

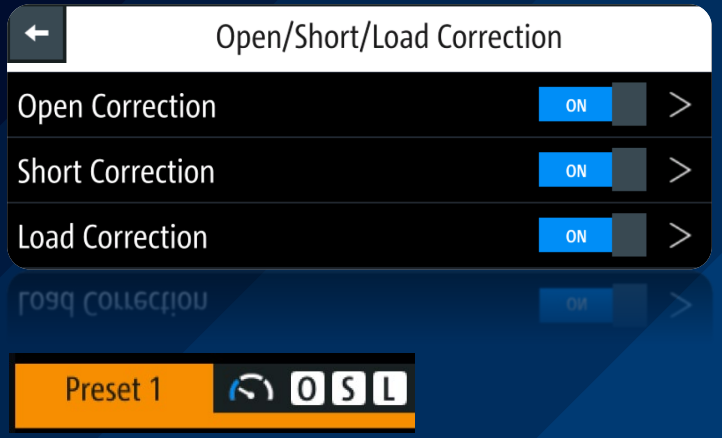
측정 주파수

측정 임피던스 범위

Perform corrections



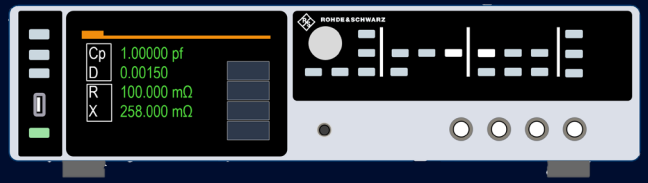
Correction menu



https://www.youtube.com/watch?v=SRnBh_s5Ozg

참고영상 - LCR 미터를 가장 잘 사용하는 방법! R&S®LCX

LCR Meter



R&S®LCX

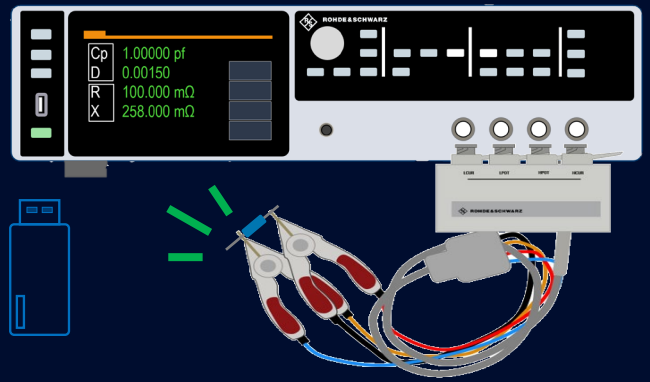
측정 주파수 범위: **DC, 4 Hz to 10 MHz**

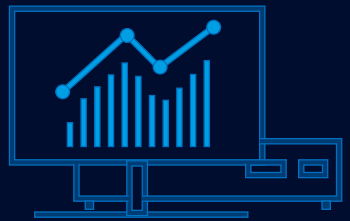
테스트 전압 및 전류 : **100 mV to 10 V / max. 200mA**

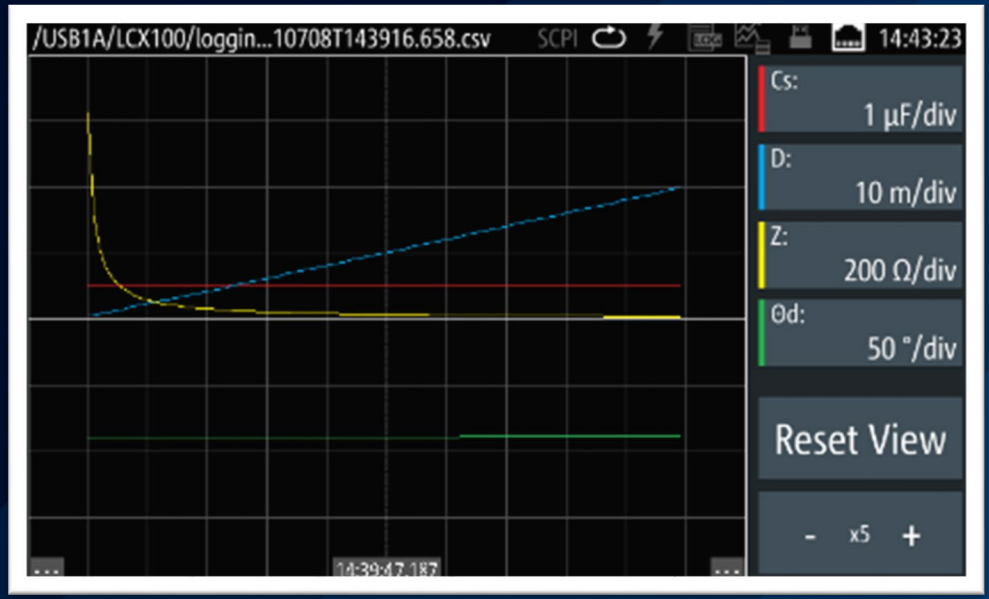
- 외부 DC 바이어스 입력 기능
- 데이터 Logging 기능
- Sweep 측정 기능
- Transformer 측정 기능
- Remote 컨트롤 기능
- Source 모니터링 기능
- 외부 트리거 입력 기능
- 디지털 I/O 포트

LCR Meter

R&S®LCX

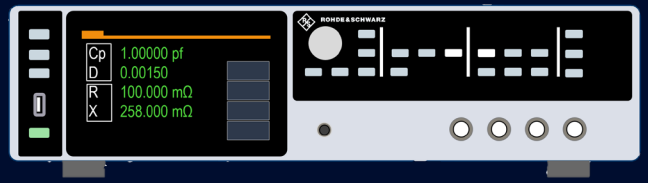






주파수, 테스트 전압 및 전류, DC 바이어스

LCR Meter



R&S®LCX

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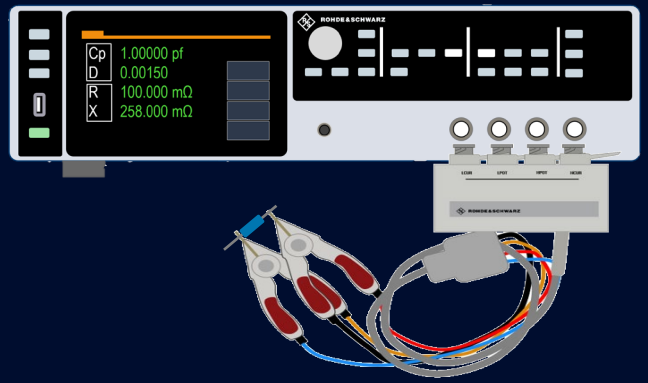
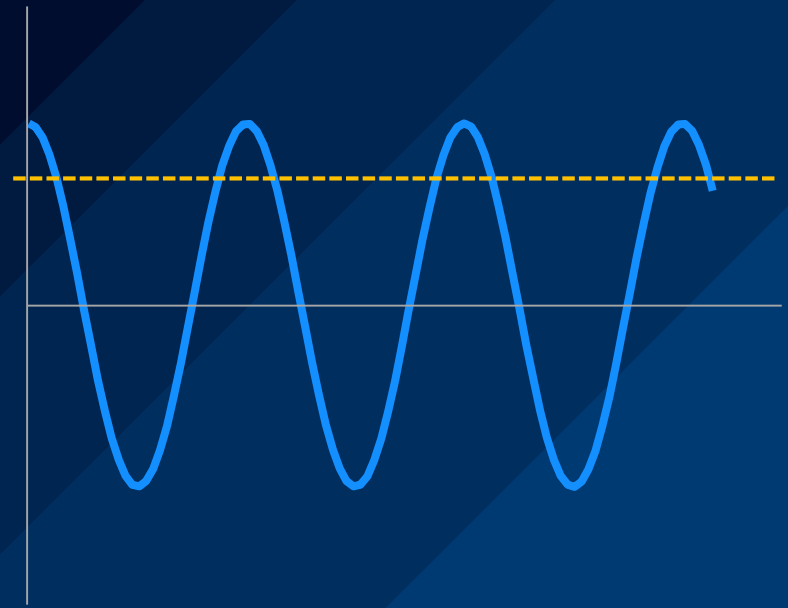
Remote 컨트롤 기능
Source 모니터링 기능
외부 트리거 입력 기능
디지털 I/O 포트

LCR Meter

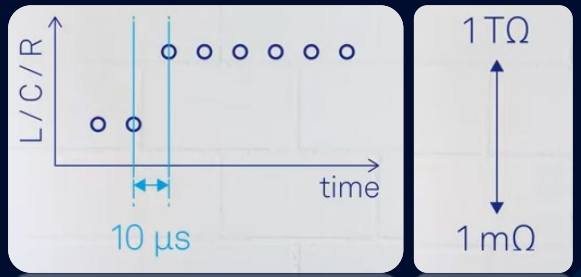
R&S®LCX



외부 DC 바이어스 : **0 V to +40 V (DC)**

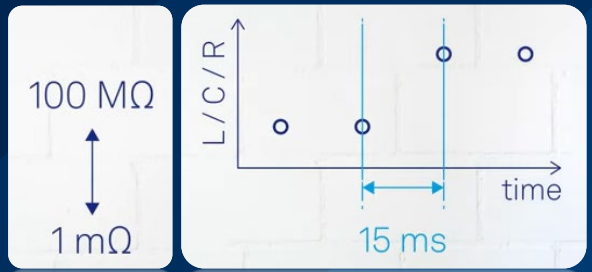


Impedance Analyzer



Wide impedance range
Fast and high resolution
Advanced test (Material science)

LCR Meter



General purpose
Suitable for production

https://www.youtube.com/watch?v=fA3PNKB7AqE

참고영상 - MFIA IMPEDANCE ANALYZER (자동번역 국문 자막 제공)

► MFIA Technical Specs

- 1 mHz to 5 MHz
- 1 mΩ to 1 TΩ
- 10 V bias, no current bias
- No current drive
- Test signal 1 µV to 10 V
- 0.05% basic accuracy
- Lock-in based, no ext. feedback, DC coupled

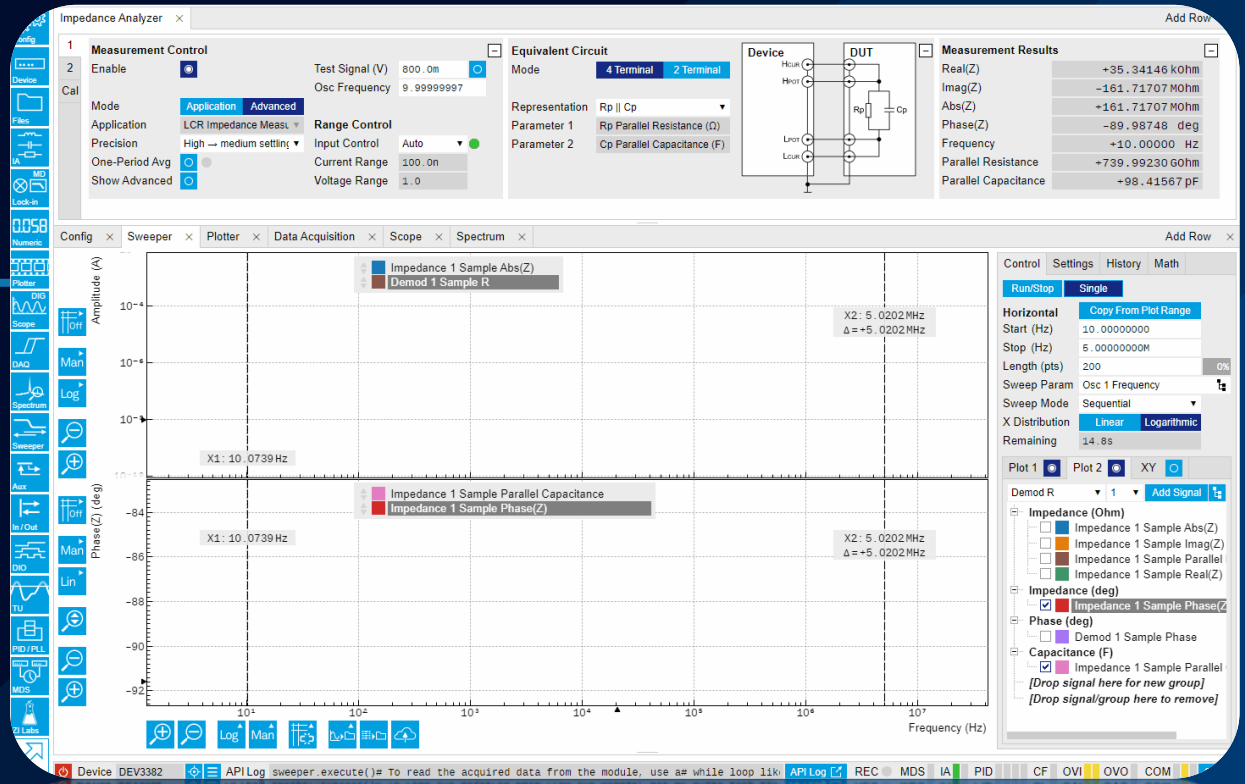
► LCX Technical Specs

- 4 Hz to 10 MHz
- 100 mΩ to 100 MΩ
- 40 V bias, 200 mA bias
- Current drive (200 mA)
- Test signal 10 mV to 10 V
- 0.05% basic accuracy
- ABB architecture

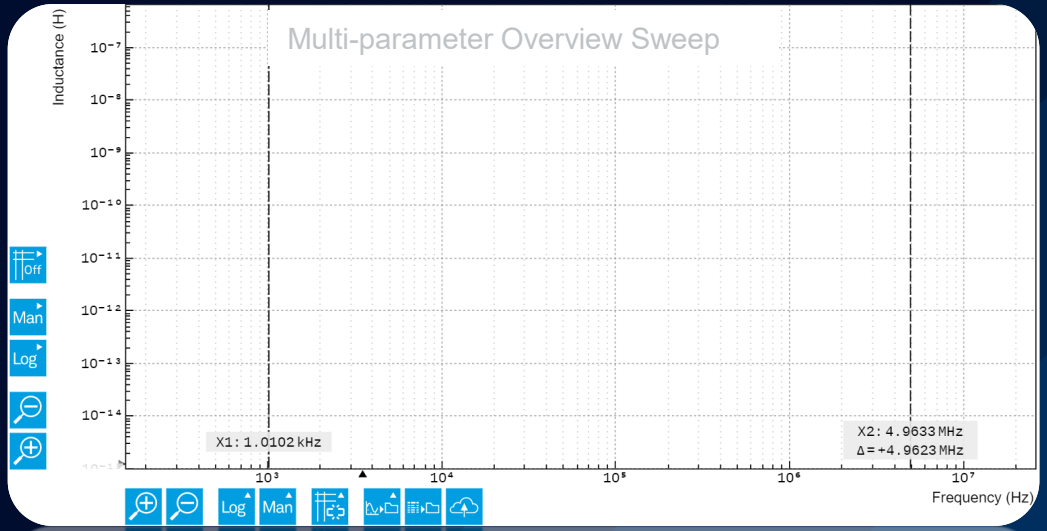
MFIA Impedance Analyzer

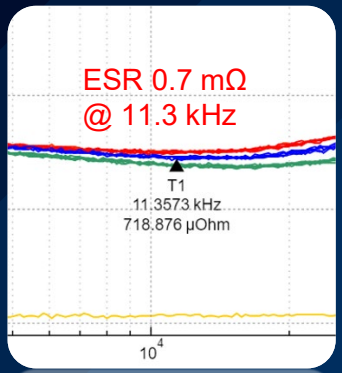
USB
LAN

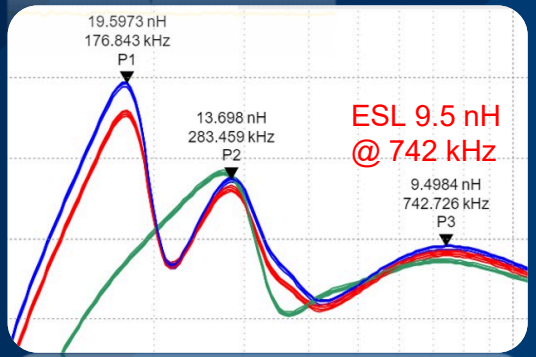
LabOne® S/W on PC



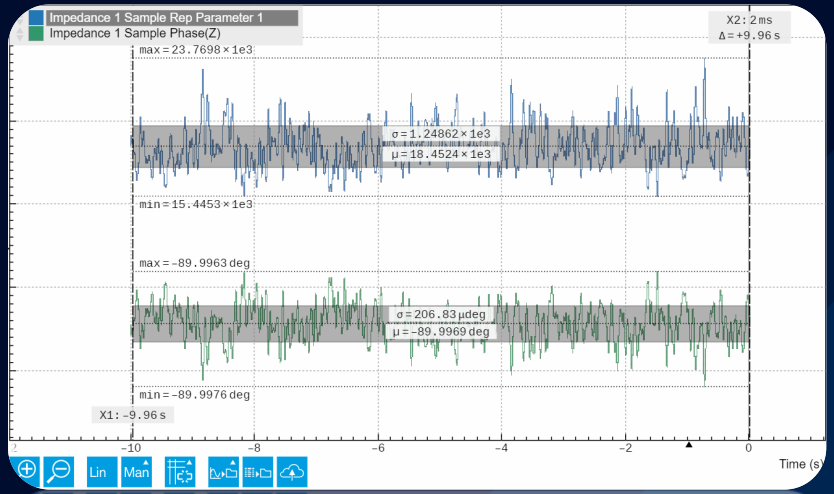
DC-Link Capacitor

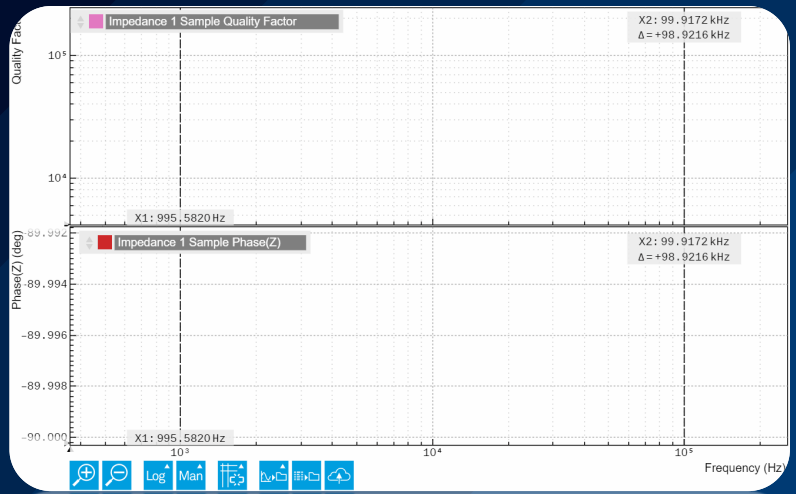




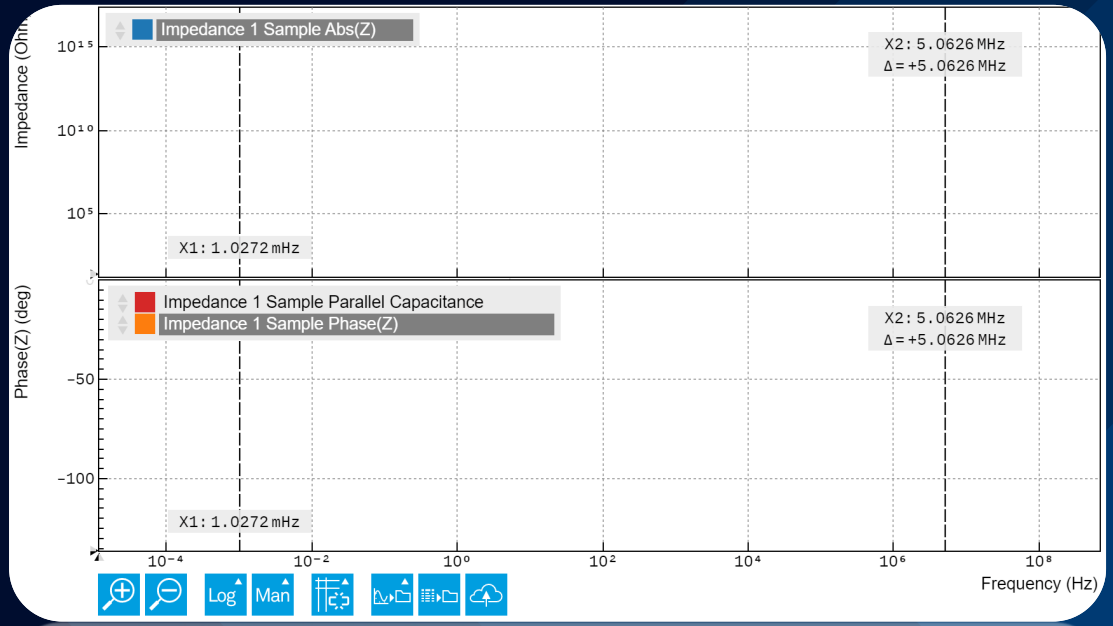


High-Q Capacitors & Supercapacitors test

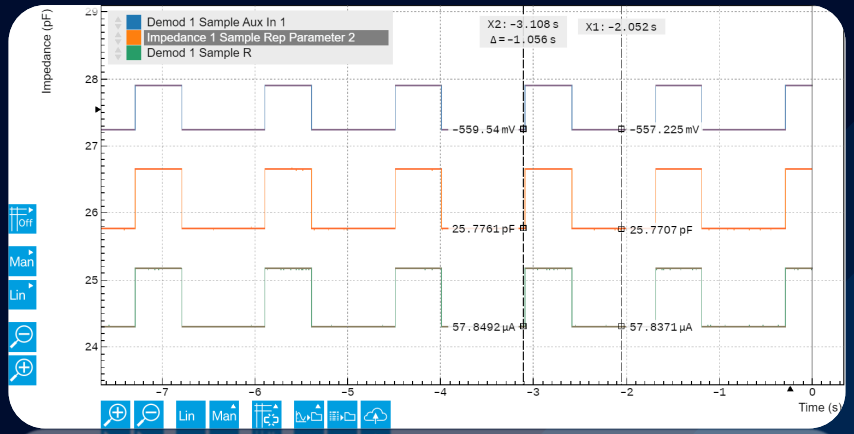


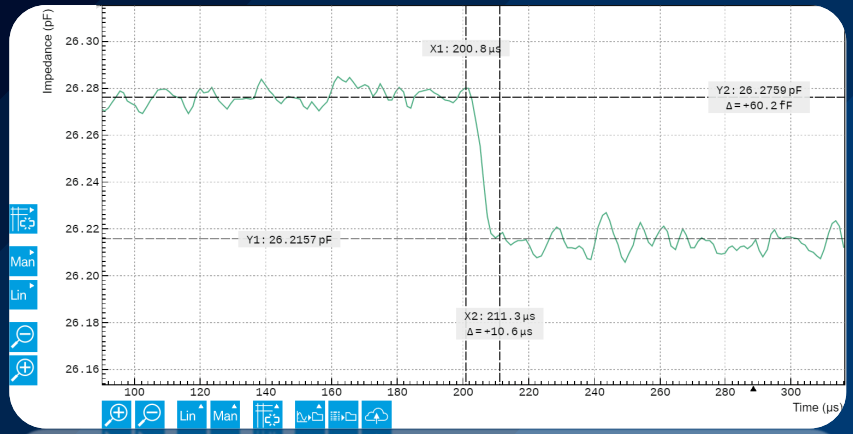


Materials Research
: Dielectric Materials



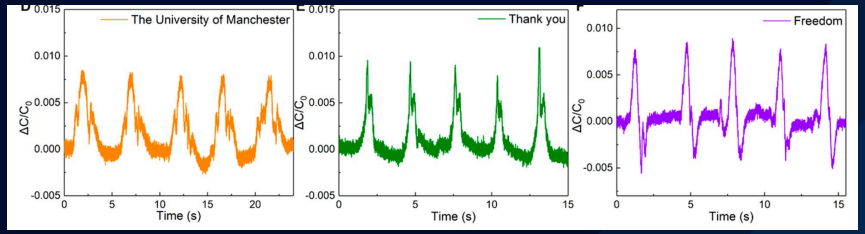
Semiconductor Characterization
: Deep Level Transient Spectroscopy DLTS
: Fast C-V Profiling





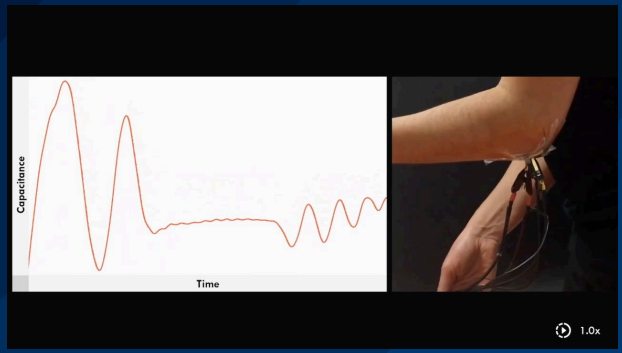
Bioimpedance
: Sensors

Spoken word recognition via capacitive sensors



Chen, L. et al. Textile-Based Capacitive Sensor for Physical Rehabilitation via Surface Topological Modification. ACS Nano 14, 8191–8201 (2020).

Arm movement via capacitive sensors



Sencadas, V. et al. Low-Hysteresis and Ultrasensitive Microcellular Structures for Wearable Electronic Applications. ACS Appl. Mater. Interfaces 13, 1632-1643 (2021).


Zurich
Instruments
MFIA
Signal Input
Signal Output
Aux Input
Aux Output
Rs : 3.439 5 Ω
X : 1.695 9 mΩ
Z : 3.439 5 Ω
θd : 0.028 °
1.000 kHz
2.00 V rms
Auto: 10 Ω
Power

Q&A