

# PRECISE MEASUREMENT OF COMPLEX ELECTRIC IMPEDANCE WITH SWEPT FREQUENCY, TEST SIGNAL LEVEL AND DC BIAS

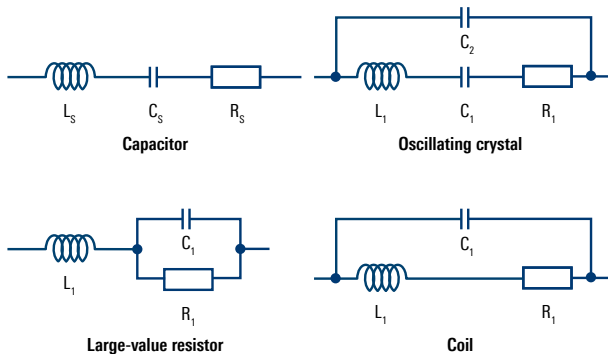
The impedance of real-world passive components depends on frequency, signal level and DC bias. This has to be taken into account during circuit design. The R&S®LCX LCR meter is ideal for measuring these dependencies. The R&S®LCX sweep tool is an application program for conveniently performing such sweeps and displaying the results on charts.



## Your task

The impedance of real-world passive components like resistors, capacitors and inductors always deviates from the ideal value depending on the technology and dimensions of the component. Parasitic elements, like inductance and resistance of leads as well as capacitance between windings of a coil, have a major impact on the properties of the component. The impedance of parasitic elements largely depends on the frequency. This has to be considered in designing electronic circuits.

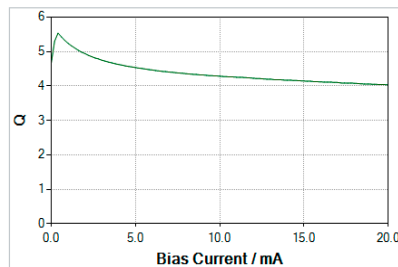
## Equivalent circuits of passive components



To some extent, the properties of passive components depend on the amplitude of the applied AC current or voltage signal and on a superimposed DC bias. Two examples are discussed in the next paragraphs.

## Coil dependency

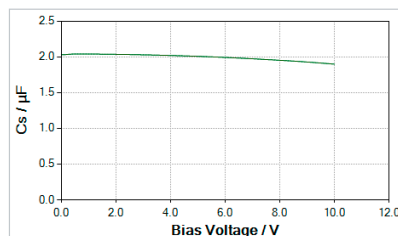
The core material used in inductors and transformers always exhibits nonlinear behavior. In small magnetic fields, coercivity causes hysteresis losses. In strong magnetic fields, the magnetic flux approaches saturation. The loss in the inductor increases with increasing signal amplitude and with increasing superimposed DC current.



Quality of a coil versus bias current

## Capacitance dependency

In ceramic capacitors, the dielectric constant of dielectric material with high permittivity can vary significantly with the applied field strength. As a consequence, the capacitance of capacitors made from such materials will change with an applied DC bias voltage.



Capacitance versus bias voltage



## Rohde & Schwarz solution

The R&S®LCX LCR meters precisely measure the complex impedance of passive components in the frequency range from 4 Hz to 300 kHz or to a maximum of 10 MHz, respectively. The dynamic impedance measurement function of the R&S®LCX-K106 advanced analysis functions option executes the measurements with swept test signal frequency, level or bias. It also collects the results in a log file. The built-in ChartView gives a quick qualitative overview that shows the dependency of the measurement results on the swept parameter.

A wealth of configuration and visualization possibilities is added with the free-of-charge R&S®LCX sweep tool, available on the Rohde & Schwarz website. The application program remote-controls the R&S®LCX with a sweep of frequency, test signal level or DC bias. Complex impedance and admittance as well as inductance, capacitance, quality

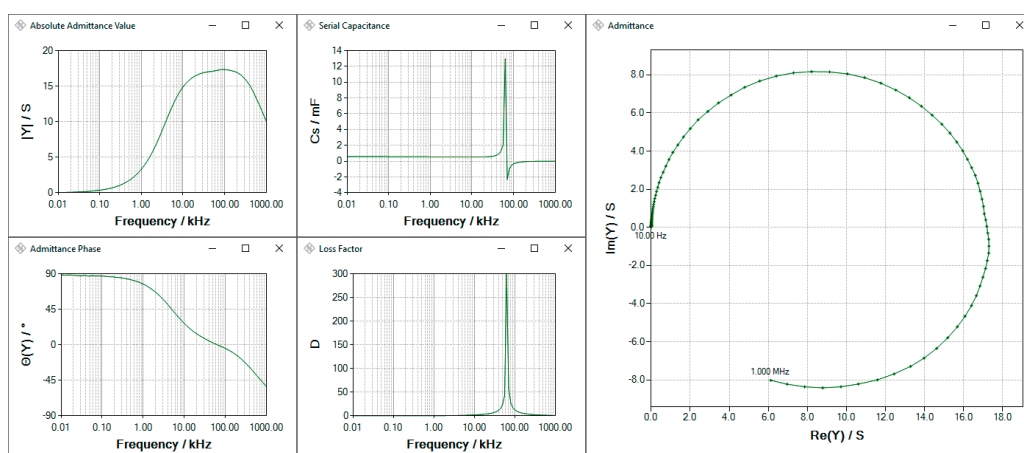
and loss factor, resistance and reactance are plotted in diagrams versus the swept parameter. In addition, impedance and admittance are plotted on the complex plane in Nyquist diagrams.

## Summary

The R&S®LCX LCR meters are the ideal solution to precisely measure complex impedance, resistance, inductance and capacitance of passive components as well as their dependence on frequency, signal level and DC bias. The R&S®LCX sweep tool (application note 1GP132) adds extra value with comfortable automation and chart-ing possibilities. For advanced applications, the Zurich Instruments MFIA impedance analyzer is a perfect complement to the R&S®LCX LCR meters.

## Sweep tool

Sweep parameters	frequency, voltage level, current level, DC bias voltage, DC bias current
Impedance and admittance charts	magnitude, phase, real part, imaginary part, Nyquist plot
Element value charts	inductance, capacitance, resistance, quality, loss factor, series resistance, parallel resistance, reactance



Admittance, capacitance and loss factor of an electrolytic capacitor versus frequency

Designation	Type	Order No.
LCR Meter, 300 kHz	R&S®LCX100	3629.8856.02
LCR Meter, 500 kHz	R&S®LCX200	3629.8856.03
Frequency upgrade to 1 MHz, for R&S®LCX200	R&S®LCX-K201	3630.1880.03
Frequency upgrade to 10 MHz, for R&S®LCX200	R&S®LCX-K210	3630.1900.03
Advanced analysis functions	R&S®LCX-K106	3630.1922.03
Test fixture, for axial/radial lead type devices	R&S®LCX-Z1	3639.2296.02
Kelvin clip lead	R&S®LCX-Z2	3638.6446.02
Test fixture, for SMD components	R&S®LCX-Z3	3639.2509.02
Test tweezers, for SMD components	R&S®LCX-Z4	3639.2515.02