

Zurich  
Instruments

# MFIA 5 MHz Impedance Analyzer and Precision LCR Meter

Product Description

Release date: January 2019

## Key Features

- DC to 5 MHz, 1 m $\Omega$  to 1 T $\Omega$
- 0.05% basic accuracy at a rate of 20 ms/data point
- LabOne<sup>®</sup> Sweeper for frequency, bias voltage and test signal amplitude response measurements
- Compensation Advisor and Confidence Indicator for accurate measurements
- 25 s start-up time and high repeatability
- APIs for C, MATLAB<sup>®</sup>, LabVIEW<sup>®</sup>, Python, .NET
- Full MFLI lock-in amplifier functionality: time constants from 336 ns to 83 s



## Summary

### A fresh approach

The MFIA 5 MHz Precision LCR Meter and Impedance Analyzer provides fast and accurate measurements over a wide impedance range. Unlike other impedance analyzers the MFIA measures the voltage and the current signals directly without needing a feedback loop, e.g. a balanced-bridge configuration. As a result the MFIA is capable of measuring at frequencies as low as 1 mHz and providing reliable impedance measurements up to 1 T $\Omega$ .

### Software that makes a difference

The LabOne user interface helps the user to maximize work efficiency. Without installing software the user is provided with a complete toolset including a fully flexible parametric sweeper, data acquisition module, and a configurable numerical display with all relevant impedance parameters. Instrument and user interface settings can be saved and restored to repeat measurements at any later point in time. All measurement functions are also available at the API level where the instrument can be controlled by C, MATLAB<sup>®</sup>, Python, LabVIEW<sup>®</sup> and .NET.

The LabOne Compensation Advisor helps the user step-by-step through the elimination of any adverse effects caused by their test fixture or cabling in order to achieve reliable and accurate measurements results. In addition, each data point is validated by the LabOne Confidence Indicator and suggestions are made in case data points were compromised.

## Detailed description

### LabOne toolset

The MFLI comes with the LabOne instrument control software and runs an embedded data and web server that provide the graphical user interface to any web browser. Simply add the MFIA by ethernet into your local network or connect directly by USB, type the instrument address into your web browser, and you have access to the LabOne toolset. Data from each tool can be stored as vector graphics or a plain data file with a single mouse click. For further analysis in other software, ZView<sup>®</sup>, MATLAB<sup>®</sup> as well as customized CSV export file formats are supported. Basic cursor and statistical functions are available for an initial data analysis in time domain or frequency domain as well.

Looking at the most important LabOne tools in detail:

### Sweeper

The Sweeper enables the user to automate measurements by scanning instrument parameters over a defined range with a freely adjustable number of scan steps, either linearly or logarithmically. Most importantly, the recording of frequency dependence as well as the variation of bias voltages or test signal amplitudes can be easily automated. A variety of application modes help the user to measure with the optimal settings and get the most accurate results in a minimum of measurement time without tedious manual tweaking. A typical sweeper application is illustrated on the next page.

## Numerical

The Numerical tool displays all measurement values and model parameters in a user configurable format. You can decide which parameters matter most and display only what is relevant for your work. Each impedance unit allows simultaneous viewing of the impedance value as well as the underlying current and voltage measurements plus the model based derived parameters (L,C,R, etc.).

## Plotter and Data Acquisition

The Plotter and Data Acquisition module are tools to analyze measurement data and model parameters in the time domain. The Plotter can display multiple data streams continuously. For a window length of 10 s the time resolution goes down to 10  $\mu$ s. The Data Acquisition module captures and displays individual shots based on numerous different internal and external trigger conditions.

## Confidence indicator

All measurement data pass a confidence estimation before being presented to the user in the different tools. Whenever the measurement is compromised by either suppression, underflow, compensation error, etc. a warning flag is raised and the user is informed that the data might be inaccurate. Depending on the type of warning, suggestions are made in order to improve the result.

## Compensation advisor

In order to achieve high measurement accuracy, parasitic effects caused by the test fixture or cabling between the instrument and the device under test (DUT) need to be compensated. The LabOne Compensation Advisor provides users with step-by-step guidance and an efficient workflow to achieve maximum measurement performance. In addition to Short-Open (SO) and Short-Open-Load (SOL) compensation, a variety of other compensation schemes are offered. Each compensation step is validated and feedback provided to the user before the data is taken to correct for measurement errors.

## Test fixture and additional interfaces

The best measurement results can be obtained by using the MFITF Test Fixture. Both the test fixture and the DUT carriers are designed to introduce minimal parasitics and damping. However, the instrument is made to be fully compatible with other commercially available test fixtures and impedance setups.

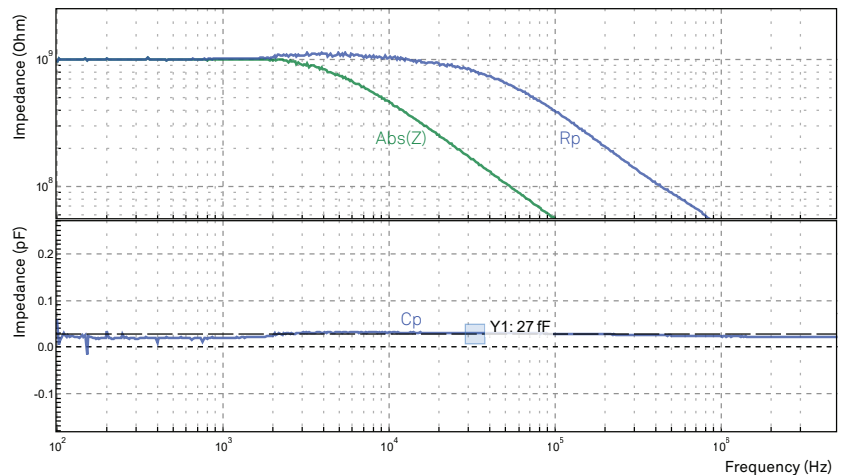
Auxiliary Outputs and Inputs provide and receive additional control signals to the DUT or analog feedback to other instrumentation. DIO connectors and Trigger ports enable measurement methods that require precise synchronization with other parts of the setup.

## LabOne user interface

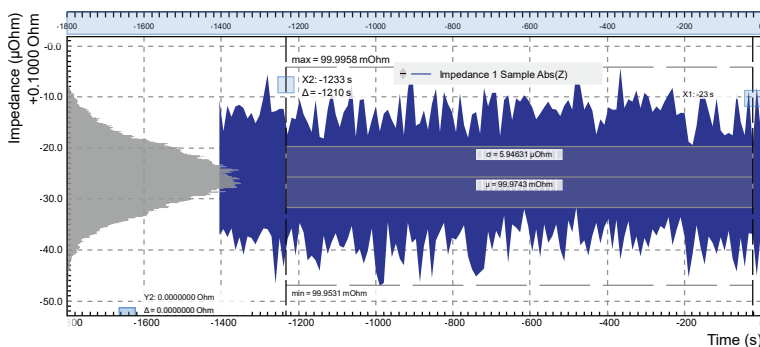


Automate your measurements with the **LabOne Sweeper** and scan the frequency, bias voltage, and test signal amplitude.

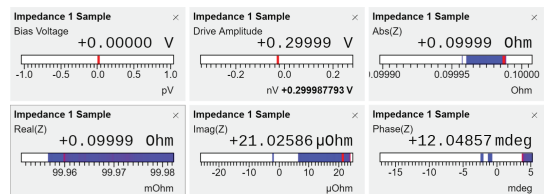
The example on the right shows a frequency sweep from 100 Hz to 5 MHz of a 1 G $\Omega$  resistor in a dual-plot representation. The top plot shows the absolute value of the impedance  $|Z|$  and the resistance  $R_p$ . The bottom plot shows the measurement of the stray capacitance  $C_p$  staying constant at about 30 fF over the entire scan range. A free choice of additional parameters can be visualized at the same time.



The **LabOne Plotter** displays your impedance data continuously. Below, data from a 100 m $\Omega$  resistor over 20 min are displayed. The histogram indicates a standard deviation of only 6  $\mu\Omega$ .



The **LabOne Numerical tab** displays all impedance related parameters, including model parameters, bias voltage and test signal amplitude, at a glance. The arrangement is freely configurable by the user with only a few mouse clicks. Each value is complemented by a graphical indicator for improved visual perception.



### Accuracy and measurement ranges

The reactance chart below indicates the instrument accuracy for certain frequency and impedance values. In the wide core area indicated in white, a 0.05% accuracy is specified between 1 mHz and 500 kHz, and 1 Ω and 1 MΩ (with limitations towards higher frequencies). The measurement range extends further with reduced specified accuracy of 0.1% and 1% to cover a measurement range from 20 mΩ to 50 GΩ. Even outside this range repeatable measurements are possible but accuracy might drop below 1%.

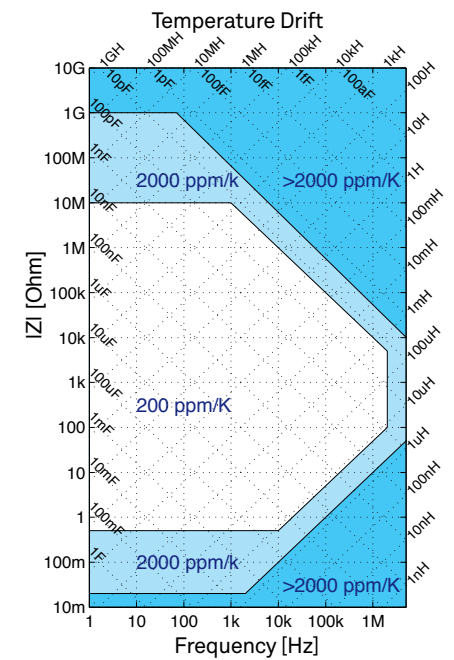
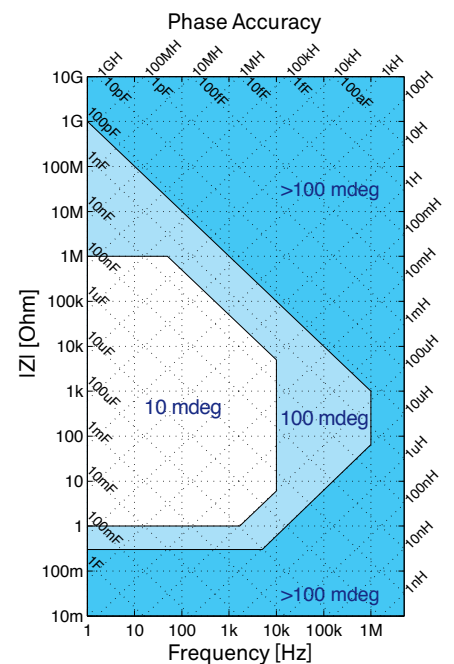
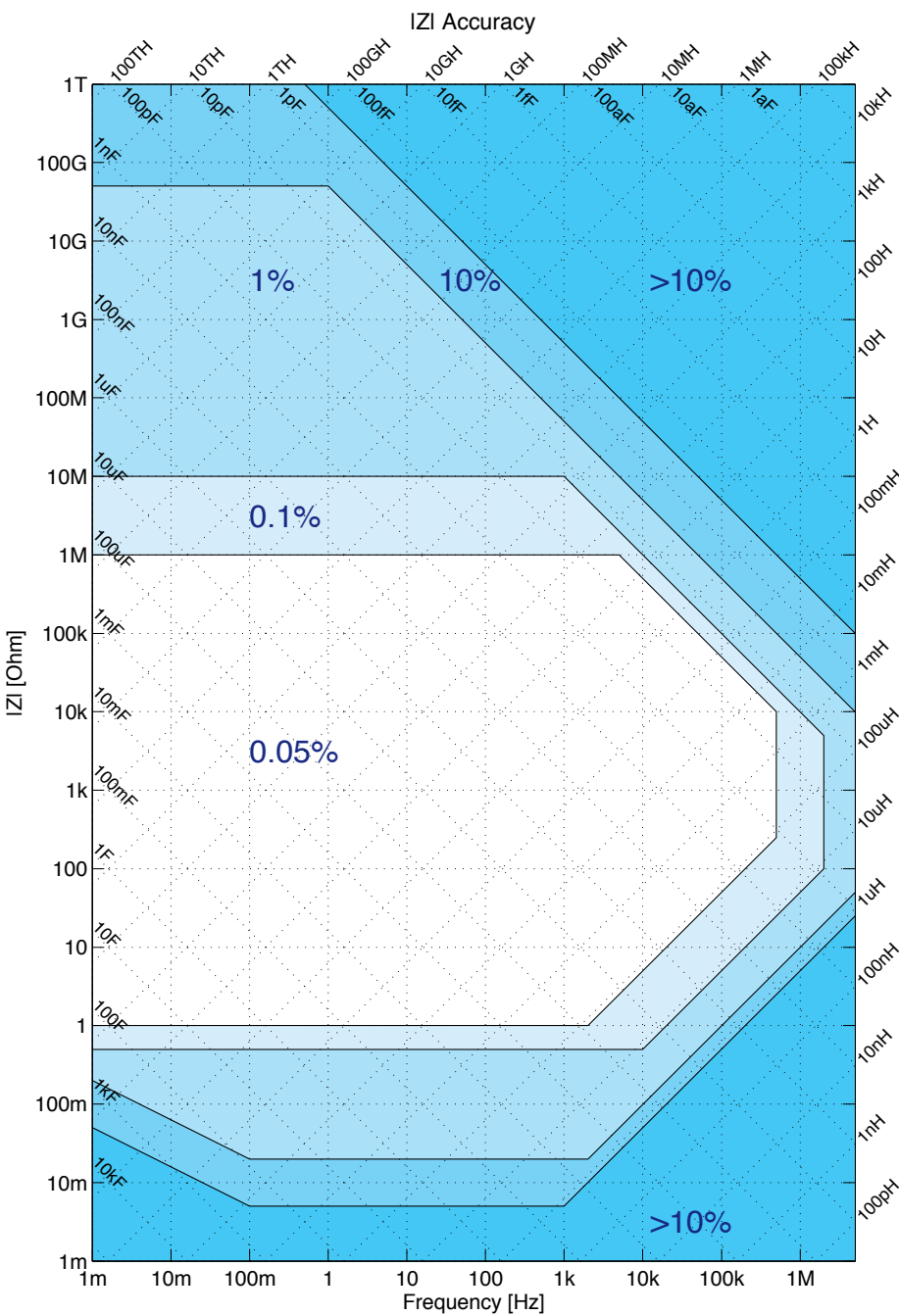
Measuring high impedances at low frequencies can be particularly challenging when values have to be obtained close to the line frequency. Adequate sample shielding along with a sinc-filter and the possibility for battery operation will give you the most accurate results.

### High repeatability, fast start-up

Temperature changes of the instrument can severely limit start-up speed and measurement repeatability. The MFIA performs exceptionally well in both aspects as can be seen from the reactance chart below and the start-up drift graph on the next page. You can start the first measurements after only 25 s from powering on the instrument.

### Dual frequency operation

The MF-MD option adds a second full 4-Terminal measurement unit to the instrument and allows the user to probe their DUT at 2 frequencies simultaneously. Whenever measurements at multiple frequencies have to be done on a regular basis, this feature can help to simplify the setup and speed up measurements by up to a factor of 2.



These reactance charts indicate the accuracy specification and temperature drift for the different measurement ranges of the MFIA.

# Specification

## General

Dimensions	28.3 × 23.2 × 10.2 cm 11.1 × 9.2 × 4 inch
Weight	3.8 kg; 8.4 lbs
Power supply	AC: 100–240 V; DC: 12 V, 2 A
Interface	USB 2.0, LAN 1GbE

## Basic specification

Frequency range	DC to 5 MHz
Frequency resolution	1 μHz
Basic accuracy	0.05% (1 mHz to 500 kHz)
Basic temp. stability	<200 ppm/K
Test signal level	0 V to 2.1 V <sub>rms</sub> , incl. monitoring
Bandwidth	276 μHz to 206 kHz
DC bias signal level	2T: ±10 V, 4T: ±3 V
Compensation	SO, SOL, LLL, SL, L, OL

## Measurement parameters, range and typ. accuracy

Impedance Z	1 mΩ to 1 TΩ, 0.05%
Admittance Y	100 pS to 1 kS, 0.05%
Voltage V	0 V to 3 V, 1%
Current I	0 mA to 10 mA, 2%
Phases $\theta_Z, \theta_Y, \theta_V, \theta_I$	±180 deg, 10 μdeg resolution
Resistance R <sub>s</sub> , R <sub>p</sub>	1 mΩ to 1 TΩ, max(10 μΩ, 0.05%) <sup>1</sup>
Capacitance C <sub>s</sub> , C <sub>p</sub>	10 fF to 1 F, max(10 fF, 0.05%) <sup>1</sup>
Inductance L <sub>s</sub> , L <sub>p</sub>	100 nH to 1 H, max(10 nH, 0.05%) <sup>1</sup>
DC Resistance R <sub>DC</sub>	1 mΩ to 1 TΩ, 2%
Reactance X	1 mΩ to 1 TΩ, 0.05%
Conductance G, Susceptance B	1 nS to 1 kS, max(100 nS, 0.05%)
Loss coefficient D	10 <sup>-5</sup> to 100'000
Q factor	10 <sup>-5</sup> to 100'000

<sup>1</sup>Accuracy valid if parameter is the dominant value of the circuit representation.

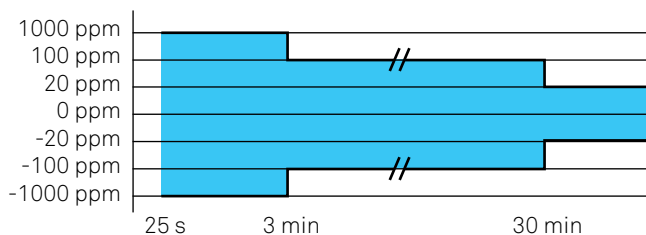
## LabOne Sweeper

Sweep parameters	frequency, test signal amplitude, bias voltage, etc.
Sweep points	2 to 100'000
Sweep resolution	arbitrary, defined by start value, stop value and number of sweep points
Display parameters	Z <sub>X</sub> , Z <sub>Y</sub> , Z <sub>R</sub> , Z <sub>θ</sub> , V <sub>X</sub> , V <sub>Y</sub> , V <sub>R</sub> , V <sub>θ</sub> , I <sub>X</sub> , I <sub>Y</sub> , I <sub>R</sub> , I <sub>θ</sub> , model parameter 1/2, frequency, Aux. Input
Display options	single plot, dual plot (e.g. for Bode plots), multitrace
Application modes	impedance, FRA, 3-omega, etc.
Sweep modes	sequential, binary, bidirectional, reverse
Sweep step modes	linear, logarithmic
Sweep speed	20 ms/pt for f > 10 kHz

## Additional tools and features

LabOne toolset	Numerical view, Spectrum Analyzer, Plotter, Data Acquisition, Oscilloscope
APIs	C, MATLAB®, LabVIEW®, Python, .NET
Modes	2-Terminal, 4-Terminal
Confidence Indicator	suppression, compensation, open, underflow, overflow
Input range control	auto, impedance, manual
Test signal amplitude	auto, manual
Bandwidth control	auto, manual
Replacement circuit models	R <sub>p</sub>    C <sub>p</sub> , R <sub>p</sub>    L <sub>p</sub> , R <sub>s</sub> +C <sub>s</sub> , R <sub>s</sub> +L <sub>s</sub> , G-B, D-C <sub>s</sub> , Q-C <sub>s</sub> , D-L <sub>s</sub> , Q-L <sub>s</sub>
DCR measurements	yes
Test fixture compatibility	yes

## Start-up drift behavior



## Upgrade options and accessories

Option	Description
MFITF	The Impedance Test Fixture is optimized for low parasitics and includes 12 DUT carrier modules.
MF-MD	The Multi-Demodulator option adds a second 4-Terminal measurement unit to analyze a DUT at a second frequency.
MF-DIG	The Digitizer option extends the functionality of the oscilloscope by a second channel, continuous streaming and cross-domain triggering.



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