# MFIA 5 MHz Impedance Analyzer and Precision LCR Meter

Zurich Instruments

Product Description
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## Key Features

- 1 mHz to 5 MHz, 1 mΩ to 1 TΩ
- 0.05% basic accuracy
- LabOne® 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®, LabVIEW®, Python, .NET
- Full MFLI lock-in amplifier functionality: time constants from 336 ns to 83 s


## Summary


### A fresh approach

The MFIA 5 MHz Impedance Analyzer and Precision LCR Meter 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 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 TΩ. Further, it allows for a fast LCR Mode providing impedance measurements significantly faster than bridge instruments.

### Software that makes a difference

The LabOne user interface helps the user to maximize work efficiency. The complete toolset including a flexible parametric sweeper, data acquisition module, and plotter make light work of acquiring relevant impedance parameters. Instrument and user interface settings can be saved and reloaded to repeat measurements and provide traceability. All measurement functions are also available at the API level via the included APIs for C, MATLAB®, Python, LabVIEW® and .NET.

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


## Detailed description

### LabOne toolset

The MFIA 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 or use the MF-Device finder tool to select your instrument and get up and running with LabOne. 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®, MATLAB® as well as customized CSV export file formats are supported. Cursor-based math and statistical functions are available for an initial data analysis in both time and frequency domain.

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 and acquire multiple data streams continuously on time scales ranging from 12 hours down to 10 µs. 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 (S) and Short-Load (SL) 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.

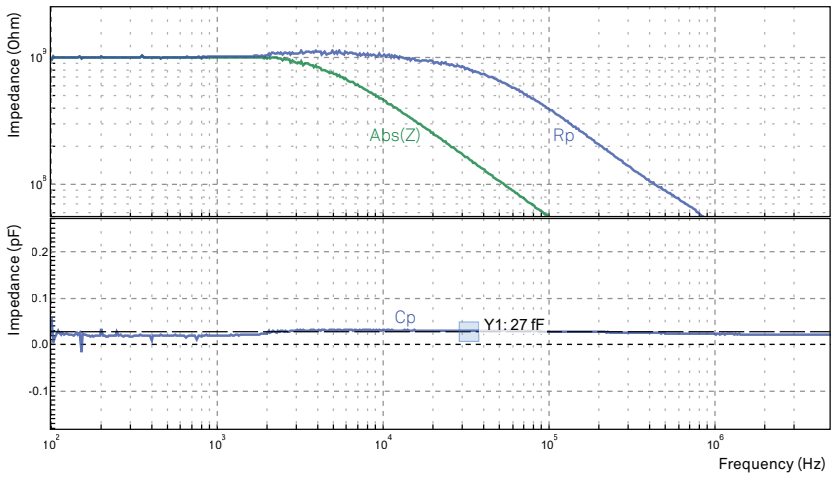
### Test fixture and additional interfaces

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

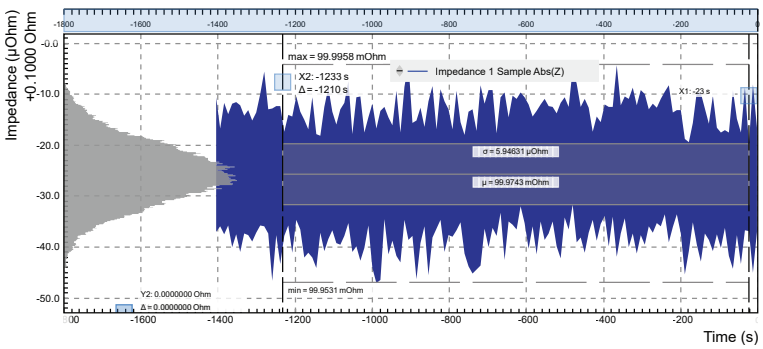
Sweeper

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 GΩ resistor in a dual-plot representation. The top plot shows the absolute value of the impedance |Z| and the resistance Rp. The bottom plot shows the measurement of the stray capacitance Cp staying constant at about 30 fF over the entire scan range. A free choice of additional parameters can be visualized at the same time.




Plotter

The LabOne Plotter displays your impedance data continuously. Below, data from a 100 mΩ resistor over 20 min are displayed. The histogram indicates a standard deviation of only 6 µΩ.




Numeric

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%. Using the Compensation Advisor improves accuracy even further.

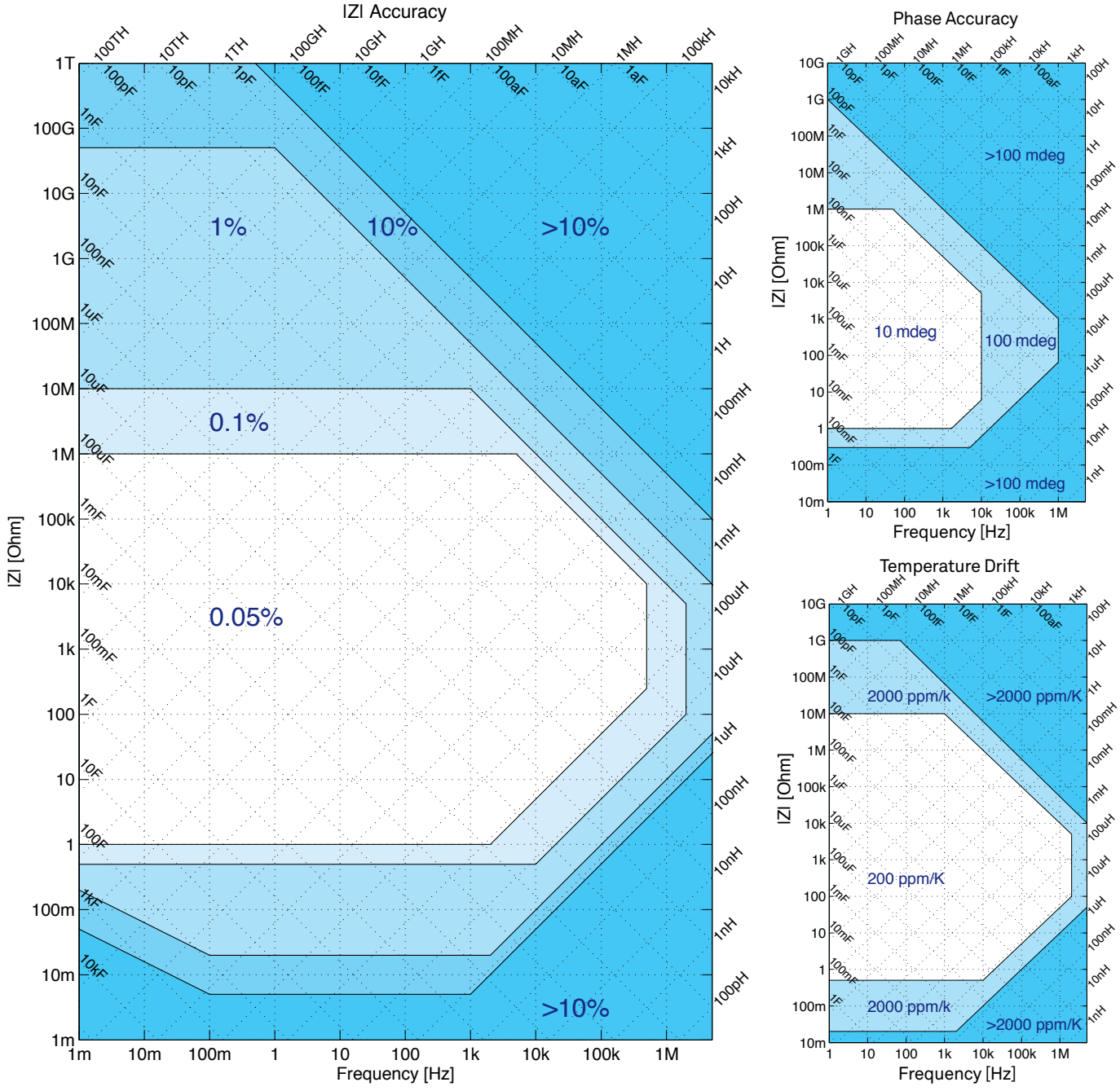
Measuring high impedances at low frequencies can be particularly challenging when values have to be obtained close to the line frequency. Adequate sample shielding along with a sinc-filter and the possibility for battery operation will give you the most accurate results.

## 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<br>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 | 1 mHz 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 | 2T: 0 V to 10 V, 4T: 0 V to 3 V |
| Bandwidth | 276 µHz to 206 kHz |
| DC bias signal level | 2T: ±10 V, 4T: ±3 V |
| Compensation | SO, SOL, LLL, SL, L, OL, S |

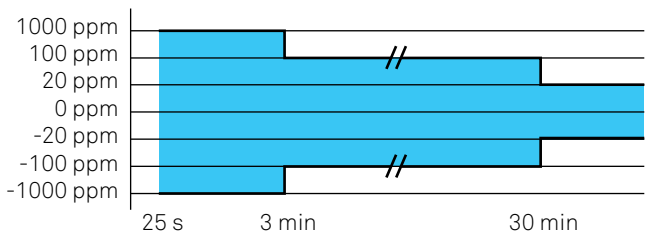
| Measurement parameters, range and basic accuracy | |
|---|---|
| Impedance Z | 1 mΩ to 1 TΩ, 0.05% |
| Admittance Y | 100 pS to 1 kS, 0.05% |
| Voltage V | 0 V to 3 V, 1% |
| Current I | 0 mA to 10 mA, 2% |
| Phases $\Theta_Z$,$\Theta_Y$, $\Theta_V$, $\Theta_I$ | ±180 deg, 10 µdeg resolution |
| Resistance $R_s$, $R_p$ | 1 mΩ to 1 TΩ, 0.05%[1] |
| Capacitance $C_s$, $C_p$ | 1 fF to 1 kF, 0.05%[1] |
| Inductance $L_s$, $L_p$ | 10 pH to 1 H, 0.05%[1] |
| DC Resistance $R_{DC}$ | 1 mΩ to 1 TΩ, 2% |
| Reactance X | 1 mΩ to 1 TΩ, 0.05% |
| Conductance G, Susceptance B | 1 nS to 1 kS, 0.05%[1] |
| Loss coefficient D | $10^{-5}$ to 100'000 |
| Q factor | $10^{-5}$ to 100'000 |

[1]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 | $Z_X$, $Z_Y$, $Z_R$, $Z_\Theta$, $V_X$, $V_Y$, $V_R$, $V_\Theta$, $I_X$, $I_Y$, $I_R$, $I_\Theta$, model parameter 1/2, frequency, Aux. Input |
| Display options | single plot, dual plot (Bode plots), Nyquist, 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 | $R_p \| \| C_p$, $R_p \| \| L_p$, $R_s$+$C_s$, $R_s$+$L_s$, G-B, D-$C_s$, Q-$C_s$, D-$L_s$, Q-$L_s$ |
| 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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