

ELECTROCHEMICAL IMPEDANCE SPECTROSCOPY (EIS) – ACCURATE ANALYTICS OF BATTERY AND FUEL CELL PARAMETERS

AVL X-ion™ EIS Measurement System

THE CHALLENGE

The highly dynamic change in the market towards electrification requires a closer look at the individual system, especially at the battery and fuel cell. To improve the efficiency and lifetime, it is necessary to get an in-depth look into those components.

Furthermore, finding errors in an early stage, observing the degradation and evaluating the state of health are crucial tasks for a wide range of suitable applications from R&D to End-of-Line.

New measurement and evaluation methods like the Electrochemical Impedance Spectroscopy (EIS) provide these detailed information. EIS is a stimulus response testing technology to check the inner frequency dependent impedance of batteries and fuel cells.

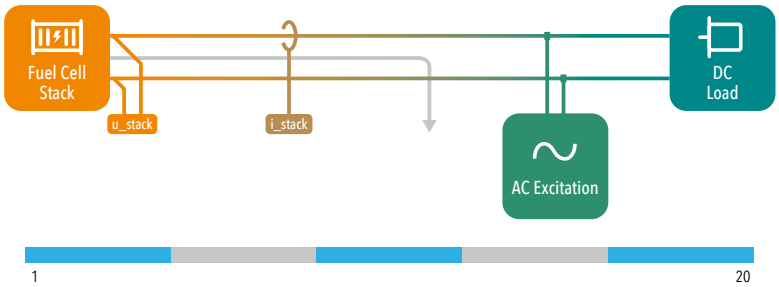
THE AVL SOLUTION

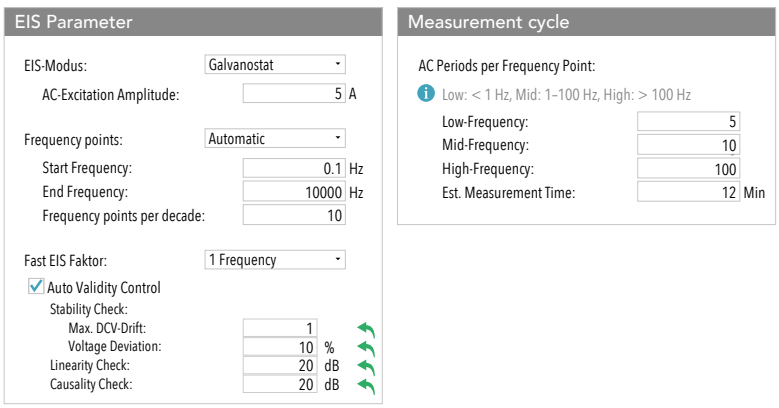
The AVL X-ion EIS solution, in combination with the AC excitation systems, offers the whole package, from the stimulus to a high-resolution measurement system to quantify the response of the inner impedance of the UUT.

The heart of the system is the AVL X-ion, a highly dynamic data acquisition unit, equipped with up to 8 EIS front-end modules (E4X1), with 4 channels each. For different use cases, the system is cascadable up to 6 X-ions, which results in 192 possible EIS measurement channels. To measure high voltages and currents, AVL provides an extension to the signal conditioning using the HVP and CTS Box.

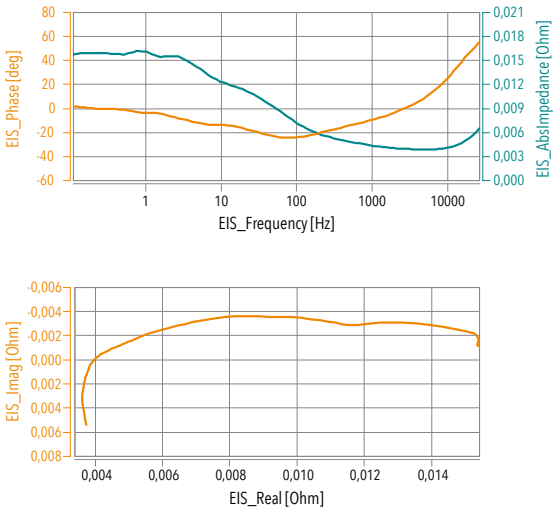
Depending on the application, AVL can offer you several mixed AC excitation solutions using AVL E-STORAGE, AVL Ripple Emulator™ and other DC load banks.

EIS Configuration





AVL IndiCom EIS Toolbox GUI for fuel cell



Bode and Nyquist plots of an EIS analysis

HIGHLY ACCURATE MEASUREMENT RESULTS

In combination with the EIS Toolbox software the AVL X-ion EIS solution enables measurements and calculations of multichannel EIS and harmonics analysis. The possible UUTs include batteries and fuel cells, and ranges from single cell up to high-voltage packs and stacks.

Additionally, the software lets you store recorded raw data in a memory-optimized "AVL IFile" format. Built-in data export functions provide raw data and results to ASAM standard format MDF4.1 and ASCII (csv or txt). You can also transfer the result data to other standard software solutions for postprocessing e.g. MATLAB or ZView. Furthermore, when combined with AVL's automation systems, you can also fully synchronize any measurement tasks.

Software Highlights

- Nyquist and Bode plot
- HFR and HFR continuous tracking loop
- Cell voltage balancing check
- Validity check via "Kramers-Kronig relations"
- Continuous display of measured raw signals

TECHNICAL DATA

X-ion X-FEM E4X1.1	
#Channels / E4X1	4
#E4X1 / X-ion	8 (32 channels, 1 current and 31 voltage)
#Channels (cascaded)	Up to 192 channels @ 6 cascaded X-ions
Acquisition rate	500 kS/s (per channel)
Resolution	24 bit (0.06 ppm)
Bandwidth	200 kHz
Input range	±(0.156 / 0.312 / 0.65 / 1.25 / 2.5 / 5 / 10) V
AC Excitation/Load Depending on the setup	Examples of possible AC excitation units • AVL E-STORAGE BTE™ / AVL E-STORAGE SiC™ • AVL Ripple Emulator™ • GLI DC load bank
Voltage	Up to 1,200 V
Current	Up to 50 App
Frequency range	0.1 Hz…200 kHz
Signal conditioning	
High current	See AVL CTS Box
High voltage	See AVL HVP Box

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