Highend Data Acquisition Systems

ZAHNER

MESSSYSTEME

Made in Germany

Scientific Instrumentation

for Photons & Electrochemistry

www.zahner.de

ZAHNER ZENNIUM / IM6

electrochemical workstations

General

Our R&D team managed to create instruments with outstanding features, state-of-the-art hardware and an advanced software. The result is a milestone in scientific instrumentation. ZENNIUM and IM6 were developed using our 30 years of experience in producing high-precision electrochemical workstations of the high-end class. They provide a frequency range up to 4 MHz (ZENNIUM) / 8 MHz (IM6), an output current up to ±2.5 A (ZENNIUM) / ±3.0 A (IM6) and fast signal processing. Special measurement techniques guarantee an ultra high accuracy and a minimal interference with the test object.

ZENNIUM/IM6 come bundled with the outstanding THALES-Z (Zennium release) software package which offers all standard methods and more at a mouse click. This is why the ZENNIUM/IM6 can easily be adapted to very different measurement requirements. Furthermore, with the manifold options available, the ZENNIUM/IM6 is able to grow with its tasks. It is best suited for investigations on fuel cells, batteries and solar cells as well as on membranes and sensors or on coatings and laminates, to name only a few.

ZAHNER-elektrik is known to provide competent service all around the world. Our experienced specialists help you to plan, set up and analyze your experiments in electrochemistry, physics, material science and electronics.

Hardware

General

The hardware of the ZENNIUM/IM6 provides

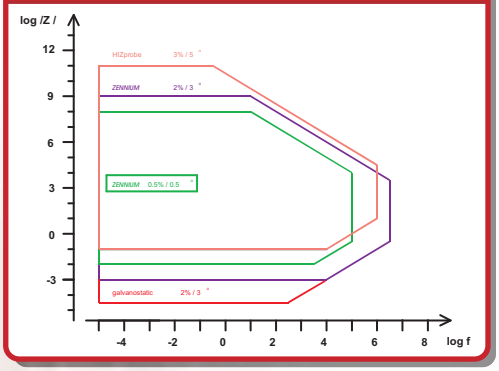
- ultra low-noise potentiostat
- wide frequency range dual DDS FRA
- high CMRR precision U/I-amplifiers
- PulSAR® state-of-the-art differential 18 bit ADCs for AC
- connectors optimized for High Z & Low Z
- 4/9 extension card slots
- 410 MIPS (Dhrystone 2.1) V4e ColdFire® signal processor
- floating USB 2.0 interface

Accuracy

The highest priorities for the developement and production of the ZENNIUM instruments are accuracy and reliability. The accuracy map of the ZENNIUM clearly shows the high quality of the hardware. These specifications are proofed by measurements for practical use, based on the high-end components we use. They are not only calculated by the theoretical specifications of some components.

PulSAR® is a registered trademark of Analog Devices, Inc.
ColdFire® is a registered trademark of Motorola, Inc.

ZENNIUM accuracy map

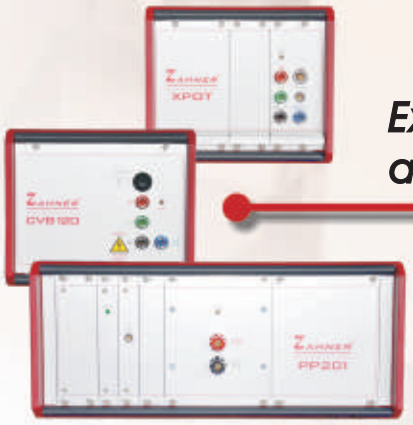


At 10mV amplitude.

Option	Function	ext	Int	EPC42 needed
PAD4	4 channel parallel AD converter		X	
TEMP/U	2 inputs for thermocouples + 2 voltage inputs		X	
DA4	4 analog outputs		X	
RMux	Relay multiplexer for the internal potentiostat		X	
PwrMux	Power multiplexer for the PP series potentiostats	X	X	
TR8M	Transient recorder up to 40 MHz		X	
HiZ probe	High impedance probe set	X		
fF probe	Low capacitance probe set	X		
LoZ	Cable set for low impedances	X		
EPC42	Control module for up to 4 external potentiostats		X	
XPot	External standard potentiostat	X		X
PP series	External power potentiostats	X		X
EL series	External high current one quadrant potentiostats	X		X
NProbe	Probe set for measuring electrochemical noise	X		X
COLT	Set-up for coating and laminate testing	X		
CIMPS	Set-up for photo electrochemical applications	X		X
ElChem Cells	KMZ and AMZ type cells for various applications			

ZAHNER ZENNIUM / IM6

electrochemical workstations



External Potentiostats and Electronic Loads

... enhance the output up to
±120 Volts
±40 Ampere
+600 Ampere (load)
50 000 Watt
64 Channels

NetVI Interface

... connect the Zennium/IM6 easily with external data acquisition & control devices over TCP/IP as virtual net instruments

Up to 9 Extension Card Slots

... expand your Zennium/IM6 optionally with plug & play cards for fast data acquisition and control output channels according to your special requests.

ethernet

The Modular System

... the only electrochemical workstation based on a universal modular data acquisition system

Probes

... prepare the Zennium for special fields of application like high impedances, electrochemical noise, very low capacitance, etc. and interface with 3rd-party devices (electronic loads, potentiostats, ...)

ZAHNER ZENNIUM / IM6

THALES Z software package

Software

The powerful Thales software package is part of the standard equipment of each IM6 and ZENNIUM system. It provides a multitude of measuring and analysis methods.

The Thales software provides unique features for the acquisition and analysis. The most prominent examples are SCRIPT and SIM. SCRIPT offers you to program user defined combinations of all types of electrochemical measurements, mathematical analysis, algorithms, documentation and data export to a reproducible, fully automatic process. With the outstanding features of SIM you are able to create equivalent circuits and fit the measurement data to these models. The ZHIT feature of SIM helps you to validate your impedance spectra.

For evaluation only it is also possible to run Thales software package on a ThalesBox. The ThalesBox provides a single user licence of Thales. So you can process your recorded data on a simple PC or Laptop while your tests still run on the IM6 or ZENNIUM ...

- System requirements: IBM compatible PC
  Microsoft® Windows® XP / Vista / 7 / 8
  (32-bit / 64-bit)
  USB 2.0

General Fields of Application

- low impedance applications
  (fuel cells, batteries, super-caps ...)
- high impedance applications
  (coatings, laminates, membranes, sensors, corrosion ...)
- photoelectrochemical applications
  (silicon, dye-sensitized and organic solar cells,
  organic LED, semiconducting films ...)

Look & Feel

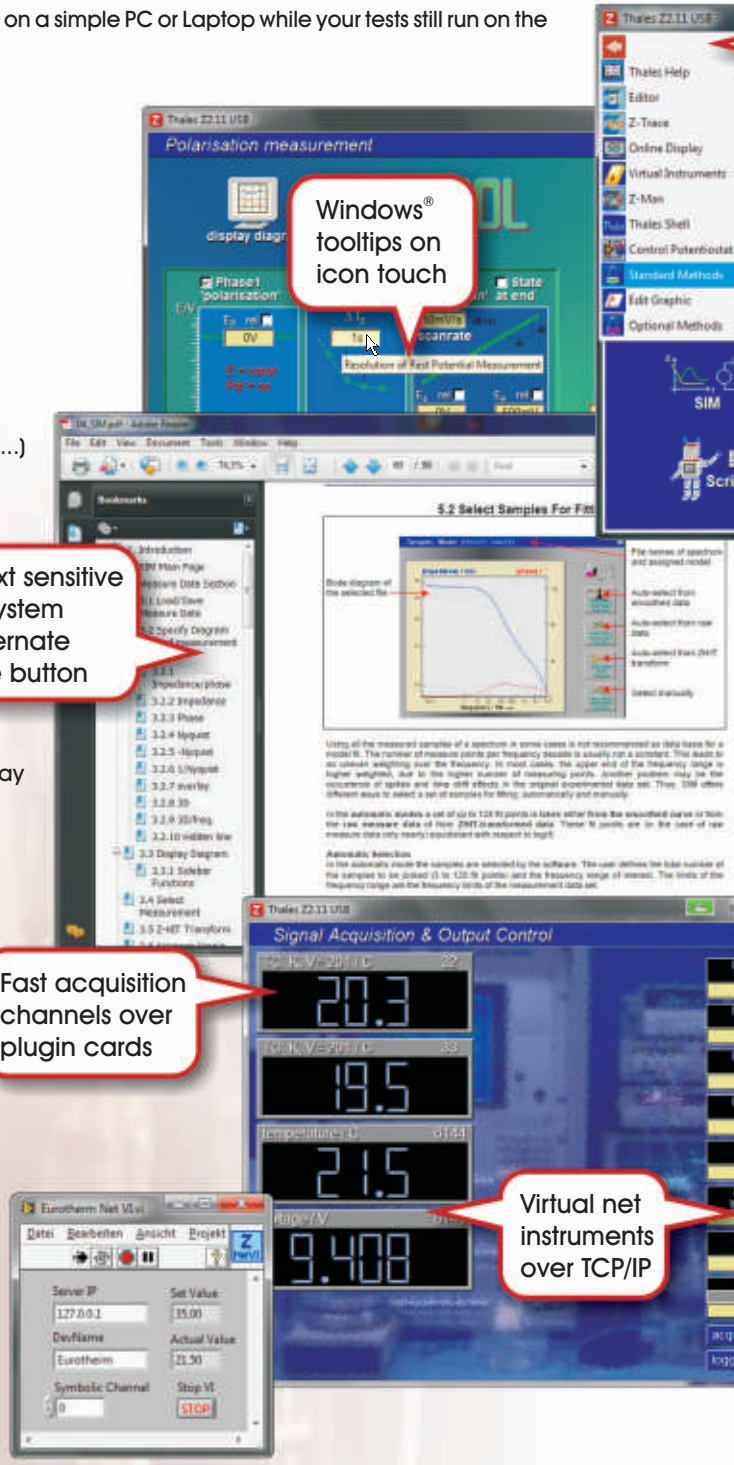
- electrochemical methods guide
- free scaleable application window
- Windows® tooltips
- ThalesViewer (Windows® Explorer extensions)
- fast online context sensitive help system
- icon navigation + direct access pull down menus
- child windows for configurable online measurement display

Special Functionalities

- fast multiple fitter for impedance and photovoltage /current spectra
- special modeling support for solar cells
- joint multiple transfer function fitting
- SCRIPT procedures for user-defined measurement, analysis- and documentation tasks
- multi-channel measuring data acquisition and control in parallel to the electrochemical experiments

Connectivity

- remote control via LabVIEW® VI
- integrate third-party signal acquisition devices over TCP/IP as NetVI
- ASCII data logging via online display



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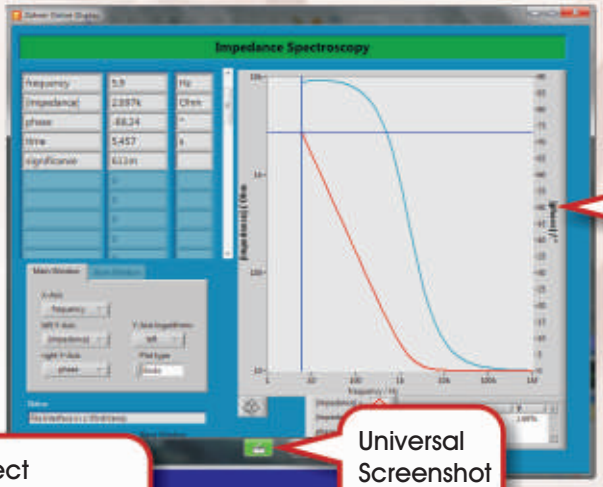
LabVIEW® is a registered trademark of National Instruments Corporation.

ZAHNER ZENNIUM / IM6

THALES Z software package

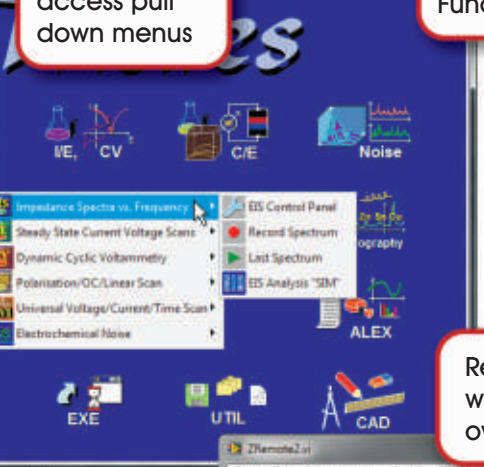


User defined realtime online display

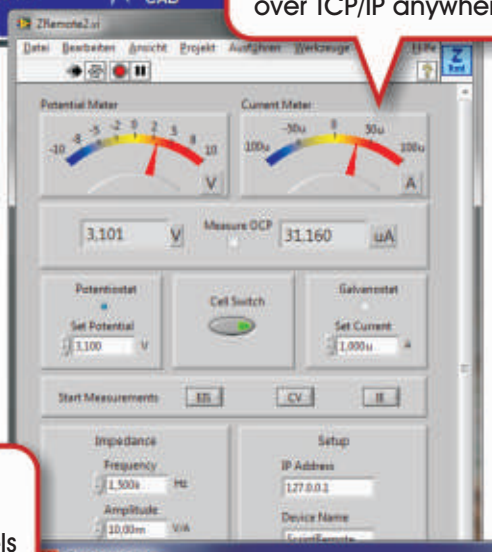
Export of ASCII text tables, vector- and bitmap graphics on all display panels

Universal Screenshot Function

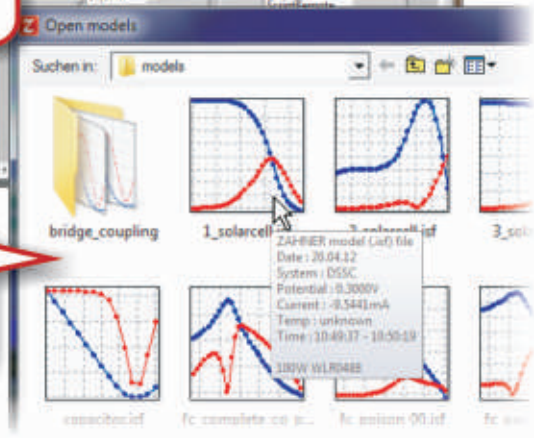
Direct access pull down menus



Remote control with LabVIEW® over TCP/IP anywhere



Output control channels



Graphic and legend preview with Windows® Explorer®

Supported Method	Option*
Testsampling Online Display and Logging	-
Parallel Testsampling Online Display and Logging	PAD4
Electrochemical Impedance Spectroscopy	-
Parallel Electrochemical Impedance Spectroscopy	PAD4
EIS Series Measurements vs. Parameters	-
Impedance Network Analysis, Simulation & Fitting	-
Impedance/Parameter, Capacity/Voltage Curves	-
Parallel Impedance/Parameter, Capacity/Voltage Curves	PAD4
AC Voltammetry	-
Cyclic Voltammetry	-
Linear Sweep Voltammetry	-
Triangular Wave Voltammetry	-
Cyclic Triangular Wave Voltammetry	-
Chronoamperometry With Multiple Triangular Potential Sweeps	-
Stationary Electrode Voltammetry	-
Chronoamperometry With Linear Potential Sweep	-
Tafelscan	-
Steady State Current/Voltage Curves	-
Multi-Cell Current/Voltage Curves	XPOT, PP series
Corrosion / Polarisation Measurement	-
Potentiometry	-
Chronopotentiometry	-
Chronoamperometry	-
Pulse Plating	-
Universal Current/Potential/Time Curves	-
Time Domain Controlled Measurements	-
Electrochemical Noise	NProbe
CorrElNoise	NProbe
Tast Polarography	-
Differential Pulse Polarography	-
Differential Pulse Voltammetry	-
Stripping Voltammetry	-
Standard Addition Measurement & Analysis	-
Universal Measurement Data Acquisition & Control	NET*
Universal Frequency Response Analysis	-
AC-DC-AC Tests	COLT
Layer Quality Test / Bi-Layer Test	COLT
Fast Pulse & Transient Recording	TR8M
High Current Interrupt Measurements	HCI
Relaxation Voltammetry	NProbe
Solar Cell Fill-Factor, Efficiency, Maximum Power, OCP, ISC	CIMPS
Controlled Intensity Modulated Photocurrent Spectroscopy	CIMPS
Controlled Intensity Modulated Photovoltage Spectroscopy	CIMPS
Charge Extraction After N. W. Duffy, L. M. Peter et. al.	CIMPS
Light Transient Measurements. Chopped Light Voltammetry	CIMPS
DC vs. Intensity Transfer Functions, Time Domain Measurements	CIMPS
Lightemission Voltage/Current Characteristic (OPV)	CIMPS +
Spectral Resolved OPV, Absolute PL Quantum Yield	CIMPS +
Spectral Absorbtion Voltage/Current Characteristic	CIMPS +
Photocurrent Spectroscopy	CIMPS +
Quantum Efficiency, Incident Photon to Charge Carrier Efficiency	CIMPS +
Photocurrent/ -voltage Response on Fast Light Transients	CIMPS +
Dynamic and Static Transmittance / Reflectance	CIMPS +
Synchronous Multi Spectral DTR with Parallel Impedance	CIMPS +
Cross Transfer Function Measurements	-
Membrane Penetration Transfer Function Measurements	-
Programmable Procedures	-

*) Required hardware options

ZAHNER ZENNIUM/ IM6

electronic load EL1000

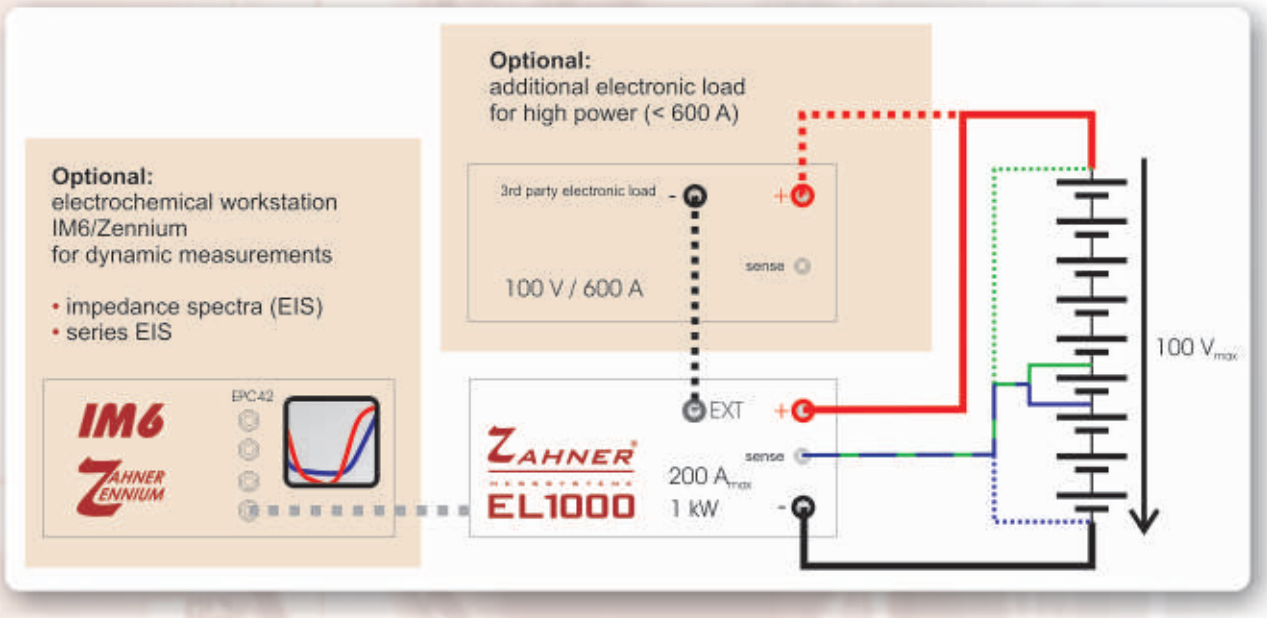
EL1000

Electronic Load EI1000

Electronic loads are indispensable tools in several fields of electrochemistry, for example in the research of batteries and fuel cells. The EL 1000 was designed to investigate single cells as well as complete stacks, either as stand-alone device under PC control or in combination with a workstation IM6 or Zennium for instance for impedance measurements.
Adding an additional external electronic load, the power can be raised up – adding the PAD4 to the controlling workstation, individual segments of the stack can be investigated synchronously in parallel.

Specifications

Frequency range	10 μHz - 100 kHz
Current range	200 A / 600 A (with 3rd party electronic load)
Voltage range	±4 V / ±100 V
Maximum power	1.000 W (stand-alone) scaleable with 3rd party electronic load
Dimensions	470 x 160 x 446 mm



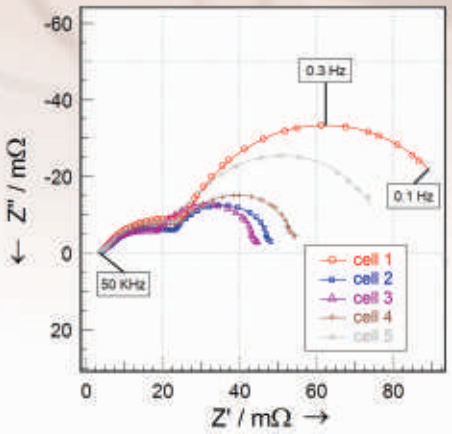
ZAHNER ZENNIUM / IM6
parallel impedance add-on

PAD4: 4 Channel Synchronous Impedance Converter

True Parallel Synchronous Impedance

Save time - measure up to 17 stack-cells in one run - no time mismatch between impedance spectra - record anodic, cathodic & total impedance simultaneously - measure additional transfer function signals...

The Zahner PAD4 is a 4-channel add-on card for Zahner Electrochemical Workstations. It introduces four additional parallel sampled signal inputs for cell voltage and impedance in fuel cell stacks and battery packs, with a common current. The Zahner Zennium supports up to two PAD4-cards for up to nine parallel channels, while the IM6 can control up to four cards for a maximum count of 17 parallel channels.
PAD4-cards are plug 'n' play – they are detected automatically on start-up. The PAD4 may be combined with the basic ECW or with the ECW controlling a slave potentiostat or an electronic load, finally providing tests on stacks of up to 100V / 600A / 50 KW.



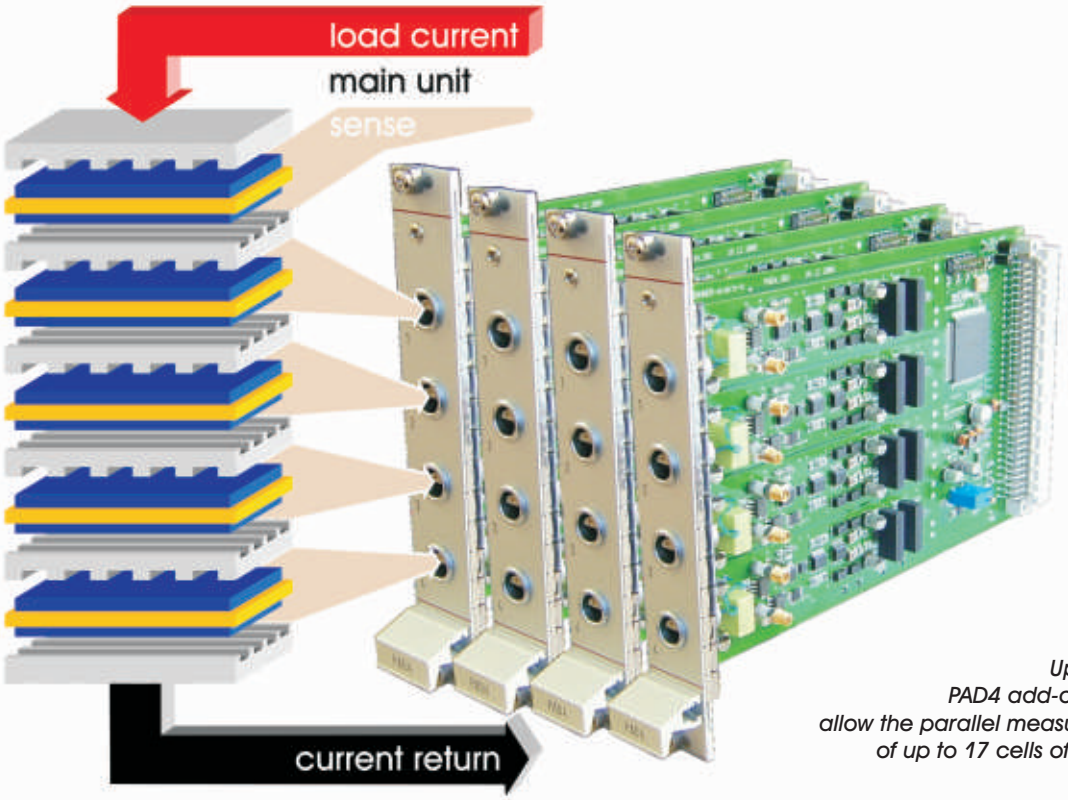
PAD4 Nyquist plot of a five cell SOFC stack

Additional Methods

- parallel electrochemical impedance spectroscopy
- parallel impedance/parameter capacitance/voltage curves
- parallel testsampling online display and logging

Specifications

Channels / card	4 individually addressable
Impedance measurement:	
Frequency range	10 µHz to 250 kHz
DC-potential measurement:	
Voltage range	±4 V
Common mode range	±100 V
A/D converter resolution	18 bit



Up to four PAD4 add-on cards allow the parallel measurement of up to 17 cells of a stack

ZAHNER ZENNIUM / IM6

low capacitance probe

fF-Probe: femto-Farad Probe

Low Capacitance Measurement Probe Set

The femto-Farad Probe works as a front-end to the IM6/Zennium potentiostat. Apart from its limited current capability, all basic functionalities of the Thales software are supported. In particular impedance spectroscopy can be applied. Due to the fact, that the primary measurement magnitude is the complex impedance, besides the sample capacity, resistive and DC contributions can be determined as well.

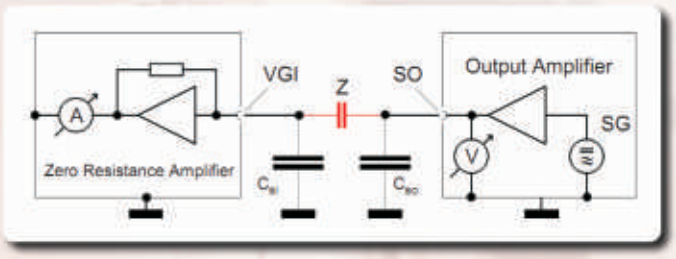
Additional Methods

low capacitance electrochemical impedance spectroscopy •
low capacitance impedance/parameter •

Specifications

Frequency range	10 μHz to 1 MHz
Current auto ranging, defeatable current ranges	0nA - ±40 nA ±40nA - ±400 nA ±400nA - ±4 μA ±4 μA - ±40 μA
Voltage range	±4 V
Resolution of any range	18 bit
Capacity offset	±1 fF *)
Capacity resolution	±0,1 fF *)
Capacity accuracy	±0,25% of reading ±2 fF *)

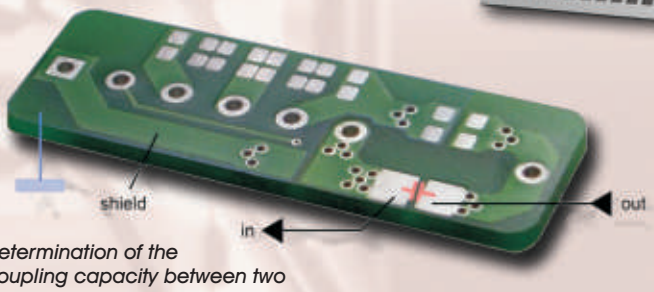
*) current range ±40 nA, AC amplitude ≥ 100 mV, zero DC current



The trans-impedance principle for the determination of small capacities

SO "hot" test signal output
VGI "virtual ground" signal input
Z device under test
V, A voltage and current measurement
C_{si} and C_{so} parasitic stray capacitance at the input and output terminal

Microelectromechanical systems (MEMS) and Sensors



Determination of the coupling capacity between two adjacent pads of a printed circuit board

Nanoelectrodes

ZAHNER ZENNIUM / IM6

PP-Series power potentiostats

PP2x1 Power Potentiostats

The PP-Series potentiostats are designed to apply and sink high currents up to ±40A at a total power dissipation of up to 200W.
The PP-Series potentiostats are controlled by an EPC42, a plug-in module for the Electrochemical Workstations IM6 and Zennium.

Up to four EPC42 cards can be installed in an IM6 or an Zennium. In total, up to 16 PPs can be controlled by one IM6/Zennium. Each potentiostat will hold the control parameters from one access to the next one, so that no potential or current disturbances can occur while scanning the potentiostats. If series measurements are performed with more than one PP-Series potentiostat, spectra are taken from all modules in a definable order.

The PP-Series is embedded completely in the IM6/Zennium environment. Thus, all acquisition and analysis techniques that run on the IM6/Zennium can be applied with the power potentiostats as well. The installation of one or more PP-Series potentiostat will upgrade your IM6/Zennium to an even more versatile, high-current electrochemical workstation.
The PP-Series potentiostats can also be controlled by a Windows®-PC. In this case they provide methods, summarized in the table below. They also work as a LabVIEW™ Virtual Instrument under the LabVIEW™ software. To implement the PP-Series potentiostats into existing test environment, a supporting DLL is available on demand.

You can control the PP-Series potentiostats in a mixed mode with an IM6/Zennium and a PC in parallel. Both devices can be connected and disconnected during operation.

Supported Methods with IM6/Zennium

- impedance spectroscopy
- simulation & model fitting
- cyclic voltammetry
- polarisation curves
- multicell multitasking voltammetry
- arbitrary current/potential/time measurements
- capacity/potential measurements
- automatic series measurements

Supported Methods with PC

- test sampling
- U vs. time, I vs. time
- current potential curves (U/I)
- cyclic voltammetry
- charging/discharging, battery cycling
- LabView® virtual instrument
- DLL support available

Specifications

Model name	**PP201**	**PP211**	**PP241**
Operating modes	pot/gal/oc	pot/gal/oc	pot/gal/oc
Potential range	±10 V	±20 V	±5 V
Potential accuracy	±0.1% / ±1 mV	±0.1% / ±2 mV	±0.1% / ±1 mV
Current range	0 A ... ±20 A	0 A ... ±10 A	0 A ... ±40 A
Current accuracy	±0.25% / ±1 mA	±0.25% / ±1 mA	±0.25% / ±1 mA
Output power	200 W	200 W	200 W
Frequency range	10 µHz - 200 KHz	10 µHz - 200 KHz	10 µHz - 200 KHz
Impedance range	1 µΩ - 1 KΩ	1 µΩ - 1 KΩ	1 µΩ - 1 KΩ
Ambient temperature	0 °C ... 30 °C	0 °C ... 30 °C	0 °C ... 30 °C
System requirements	IM6/Zennium+EPC42 or PC	IM6/Zennium+EPC42 or PC	IM6/Zennium+EPC42 or PC

ZAHNER ZENNIUM / IM6

specifications

General		Zennium	IM6
Overall Bandwidth		DC - 5 MHz	DC - 10 MHz
ADC Resolution		18 bit	
Harmonic Reject		> 60 dB @ ½ full scale	
Potentiostat Modes		Potentiostatic, galvanostatic, pseudo-galvanostatic, rest potential, off	
Cell Connection		2-, 3-, 4-terminal Kelvin	
Chassis		ground	
Extension Slots		4	9 (incl. 1x EPC42)
PC interface		USB 2.0	
Dimensions		364 x 160 x 376 mm	470 x 160 x 376 mm
Weight		12 kg	15 kg
Accessories		U-buffer, 2 cell cable set, USB-cable, power cord, manual	+Thalesbox, +EPC42
Power supply		230/115 V, 50/60 Hz	
Ambient temperature		+10° C to +30° C	
Ambient Humidity		< 60% without derating	

Frequency Generator & Analyzer			
Frequency Range		10 µHz to 4 MHz	10 µHz to 8 MHz
Accuracy		< 0.0025%	
Resolution		0.0025%, 10.000 steps/decade	

Output Potentiostatic			
Controlled Voltage	Pot	±4 V	
	U-buffer	±10 V	
Resolution	Pot	125 µV	
	U-buffer	320 µV	
Accuracy	Pot	±250 µV	
	U-buffer	±1 mV	
Temperature Stability		better 20 µV/°C	
Compliance Voltage	Pot	±14 V	
	CVB120	±120 V	
AC-Amplitude		1 mV to 1 V	
Bandwidth		4 MHz @ 33 Ω load	8 MHz @ 33 Ω load
IR Compensation	Method	Auto AC Impedance Technique	
	Range	0 to 10 MΩ	
	Resolution	0.012%	
Small Signal Rise Time		250 ns to 200 µs in 5 steps, automatic selection	
Slew Rate		15 MV/s	
Phase Shift		10° @ 250 kHz	

Output Galvanostatic			
Controlled current		±2.5 A	±3.0 A
Current Range	Pot	±100 nA to ±2.5 A in 10 steps	±100 nA to ±3.0 A in 10 steps
	HiZ	±1 nA to ±0.5 A in 12 steps	
Min. Resolution		0.025%	
Accuracy		0.1% @ > 2 µA to 100 mA	
		1% @ < 2 µA or > 100 mA	

Input			
Potential Ranges	Pot	±1, ±2, ±4 V	
	U-buffer	±4, ±10 V	
Potential Resolution		256.000 steps per range	
Offset Voltage		< 100 µV	
Offset Temperature Stability		< 20 µV/°C	
Current Range	Pot	±100 nA to ± 2.5 A in 30 steps, automatic range selection	±100 nA to ± 3.0 A
	HiZ	±1 nA to ±0.5 A in 32 steps, automatic range selection	
Accuracy		0.05% @ > 2 µA to 100 mA	
		0.5% @ < 2 µA or > 100 mA	
Input Bias Current	Pot	10 pA	
	HiZ	12 fA	
Current Resolution	Pot	2.5 pA	
	HiZ	25 fA	
Input Impedance	Pot	1 TΩ // ±5 pF (typical), 50 GΩ // ±5 pF (min.)	
	HiZ	10 TΩ // ±1 pF (typical), 1 TΩ // ±1 pF (min.)	
Impedance Range	Pot	1 mΩ to 1 GΩ / 2%	
		100 mΩ to 10 MΩ / 0.2%	
	HiZ	100 mΩ to 100 GΩ / 3%	
	Gal	30 µΩ to 1 GΩ / 2%	
Common Mode Rejection		> 86 dB @ 10 µHz to 100 kHz	
		> 66 dB @ 100 kHz to 4 MHz	> 66 dB @ 100 kHz to 8 MHz
Input Channel Phase-Tracking accuracy		±0.1° @ 10 µHz to 100 kHz	
		±0.25° @ 100 kHz to 4 MHz	±0.25° @ 100 kHz to 8 MHz
Equiv. Effective Input Noise		20 µV rms / 2 pA rms @ 1 mHz to 10 Hz	

specifications