VSP-300

The ultimate versatile multipotentiostat

BioLogic

APPLICATIONS

- Batteries/supercapacitors
- Fuel cells/photovoltaic cells
- Fundamental electrochemistry
- Corrosion
- Sensors
- Materials

VSP-300

marks a new step in the combination of high performance and modularity

VSP-300 is a state-of-the-art research grade potentiostat/galvanostat/FRA with remarkable specifications. It is the newest benchmark in the Bio-Logic product range.

Designed upon Bio-Logic's long history of flexible and modular potentiostats, the VSP-300 incorporates the latest technology to ensure excellent performance.

The **VSP-300** multichannel potentiostat/galvanostat is a versatile instrument
offering 6 slots used to host from 1 to 6 channel boards.
Each channel board can accomodate an ultra low current cable and can be associated with one or several booster kits.

Four types of booster kits are available 1 A/48 V, 2 A/30 V, 4 A/14 V and 10 A/5 V.

Up to four boosters can be plugged in one **VSP-300** chassis.
Boosters can be parallelized to increase the output current.
Each channel board can be optioned with an analog ramp generator.
Not only a multichannel system, this instrument can be controlled independently by several users thanks to the LAN connection.

FEATURES

- Compliance: ±12 V
- Control voltage: ±10 V
- EIS measurement: up to 7 MHz
- Current ranges: 1 A to 10 nA (standard), up to 40 A with boosters, down to 1 pA with ultra low current (ULC) option
- Current resolution: 760 fA (standard), down to 76 aA with ULC
- Floating mode
- Analog filtering
- Calibration board
- Full stability control mode (9 bandwidths)

OPTIONS

Boosters	1 A/48 V	2 A/30 V	4 A/14 V	10 A/5 V
- compliance voltage	±49 V	±30 V	-3 V ; +14 V	-1 ; +6 V
- control voltage	±48 V	±30 V	-3 V ; +10 V	-1 ; +6 V
- compliance current	±1 A	±2 A	±4 A	±10 A
- EIS measurement	2 MHz	1 MHz	1 MHz	1 MHz

- Ultra low current: 1 µA to 1 pA (resolution 76 aA)
- Analog Ramp Generator: 1 MV/s, acquisition time 1 µs

With its many unique features and excellent specifications, the VSP-300 is the perfect instrument for any application in electrochemistry. Each option can be easily installed into the chassis by the end user.

The standard potentiostat in the **VSP-300** provides ±12 V compliance, ±10 V reference control, and a maximum current of ±500 mA. A range of nine intelligent bandwidths ensures the stability of the **VSP-300** in a wide variety of experimental conditions.

The **VSP-300** is a floating instrument, allowing it to be used with grounded cells, autoclaves, and in glove boxes.

Electrochemical Impedance Spectroscopy (EIS) measurements can be added as an option to each channel of the **VSP-300**. The built-in FRA has a frequency range of 10 µHz up to 7 MHz. This remarkable high frequency measurement can be made with an accuracy of 1%/1° up to 3 MHz and 3%/3° to 7 MHz, allowing testing on dielectric materials to be performed.

A range of boosters is available to address applications requiring higher voltages and/or currents, such as Electric Vehicle (EV) batteries, solar cells and capacitors.

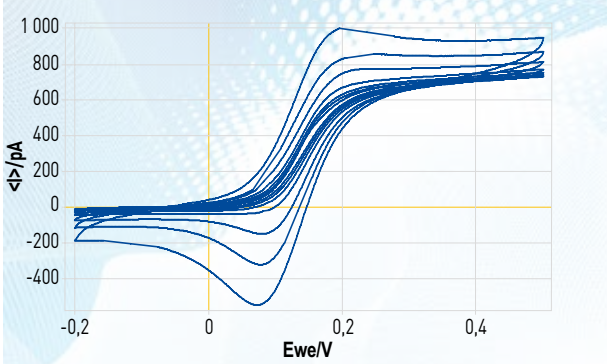
Low current sensitivity can be improved using the ultra low current option (down to 1 pA range with 76 aA resolution). Both high and low currents can be achieved in a single experiment thanks to a unique connection to the cell.

The **VSP-300** is supplied with a built-in calibration board. This allows the user to run a calibration routine as needed or when the most accurate measurement is demanded.

The **VSP-300** is interfaced by a PC using either a USB or Ethernet connection. If the Ethernet connection is used, the unit can be installed as a device on the Local Area Network, allowing multiple users access to the instrument. Remote access is also possible in this mode.

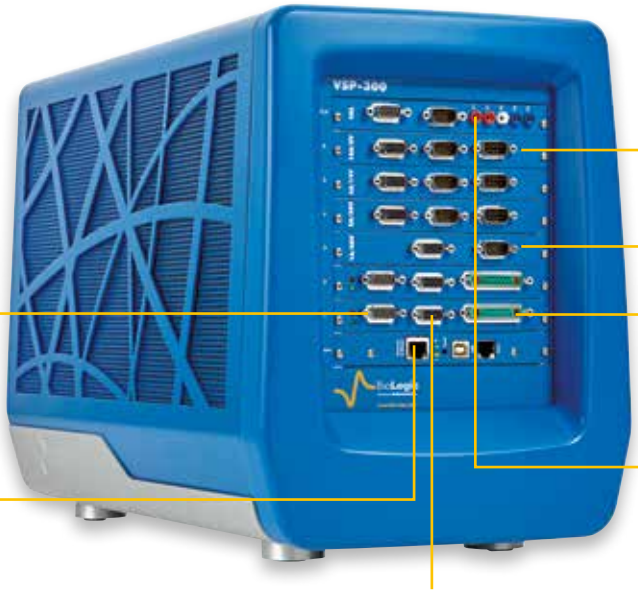
The **EC-Lab**® software package supplied with the system is an easy-to-use, feature-rich interface for new and advanced users alike. It provides a wide range of techniques and applications that can be sequenced and/or linked to design most any experiment the user can imagine.

A variety of analysis tools are available for electro-analytical and corrosion and battery data, as well as equivalent circuit modeling for impedance data interpretation.



Modules

Standard configuration



Auxiliary voltage input/outputs

The 9-pin connector on the potentiostat offers several analog and digital inputs/outputs.
They can be used to input external signals, control an external device, synchronize a **VSP-300** experiment with other devices and to add an external safety stop-on signal.
The voltage or current of the cell can be controlled by an external device through the analog input 2.
E and I monitor outputs are available to record the analog cell voltage and current.

Communication board

The communication board of the **VSP-300** is connected to a computer via USB or 100BaseT Ethernet. The unit can also be installed as a device on a Local Area Network using a static IP address. Any computer on the network can connect to the **VSP-300**, even for remote access.
Data are stored in a large on-board buffer (700,000 data points) and downloaded continuously.
In the event of a loss of communication connection, the **VSP-300** is also able to reconnect the instrument to the network automatically and restore data transmission to the controlling computer.

Potentiostat/galvanostat board

The Potentiostat/galvanostat in the **VSP-300** has 9 available performance bandwidths to prevent oscillations that may occur with high impedance cells.
As a result, the **VSP-300** exhibits excellent electronic stability while making high speed measurements.
The standard board has 3 connectors on the front panel of the potentiostat.
A 25-pin mixed connector is used for the cell cable connection. A 15-pin connector links the potentiostat board with the booster, the calibration or another optional board.
The floating mode of the **VSP-300** (with isolated power supply) allows experiments to be run on grounded cells, on pipelines or autoclaves. An exclusive feature of the **VSP-300** is the on-board operating system.
The control of the experiment is provided by the **VSP-300**'s digital board, even when communication with the computer is lost.
3 analog filters are available to remove unwanted noise during an experiment: 50 kHz, 1 kHz and 5 Hz.

Calibration board

Using the built-in calibration board, the user initiates a routine to perform a full calibration of the **VSP-300** potentiostat, and of the voltage booster channel. This calibration not only checks and adjusts offsets and gain versus precision internal reference voltages, the current ranges are also calibrated.

Hardware configurations

Configuration	Potentiostat board (P)	1 A	2 A	4 A	10 A	Slot #1	Slot #2	Slot #3	Slot #4	Slot #5	Slot #6	Options on each potentiostat board	Max. current (A)	Max. voltage (V)
Multichannel potentiostat	Up to 6	0	0	0	0	P	P	P	P	P	P	EIS/ULC/ARG	0.5	12
3 channels of 10 A (up to 30 A and 12 V)	3	0	0	0	3	P	10 A	10 A	10 A	P	P	EIS/ULC/ARG	30	12
3 channels of 4 A (up to 12 A and 14 V)	3	0	0	3	0	P	4 A	4 A	4 A	P	P	EIS/ULC/ARG	12	14
3 channels of 2 A (up to 6 A and 30 V)	3	0	3	0	0	P	2 A	2 A	2 A	P	P	EIS/ULC/ARG	6	30
High voltage multipotentiostat (±48 V) 3 channels	3	3	0	0	0	P	1 A	P	1 A	P	1A	EIS/ULC/ARG	1	48
Mixed boosters multipotentiostat	3	0	1	1	1	P	10 A	4 A	2 A	P	P	EIS/ULC/ARG	10	30
High current up to ±40 A	1	0	0	0	4	10 A	10 A	10A	10 A	P	0	EIS/ULC/ARG	40	5
High current (8 A)/high voltage (30 V)	1	0	4	0	0	2 A	2 A	2 A	2 A	P	0	EIS/ULC/ARG	8	30

Specifications are subject to change

EIS: Electrochemical Impedance Spectroscopy
ULC: Ultra Low Current
ARG: Analog Ramp Generator

Options

High current booster (1 A, 2 A, 4 A, 10 A)

The **VSP-300** has up to 5 slots available to accomodate current boosters chosen among four different boosters: ±1 A/±48 V, ±2 A/±30 V, ±4 A/[-4;14] V, ±10 A/[0;5] V. Thanks to this extended range, all the applications of electrochemistry are covered, especially battery testing. Similar boosters in the **VSP-300** chassis can be connected together in parallel to increase the maximum current.

High voltage booster board (30 V/48 V)

The **VSP-300**'s high voltage booster option is perfect for applications in renewable energy sources. This option increases the unit's compliance and cell polarization voltages to ±48 volts. With this increased voltage capability, battery stacks, fuel cells and photovoltaic panels can be evaluated.
The current increases from 500 mA with the standard board to 1 A or 2 A according to the booster.

Electrochemical Impedance Spectroscopy (EIS)

By choosing the EIS capable potentiostat (Z option) the user can perform Electrochemical Impedance Spectroscopy up to 7 MHz. This built-in option does not require an external analyzer. In addition to the Single Sine method of EIS measurements, the **VSP-300** can utilize a fast Fourier-based Multi-Sine technique to reduce experimental acquisition time.

Additional potentiostat

The **VSP-300** can accommodate up to 6 potentiostat boards with or without EIS capability. Each of them can be equipped with a low current option.

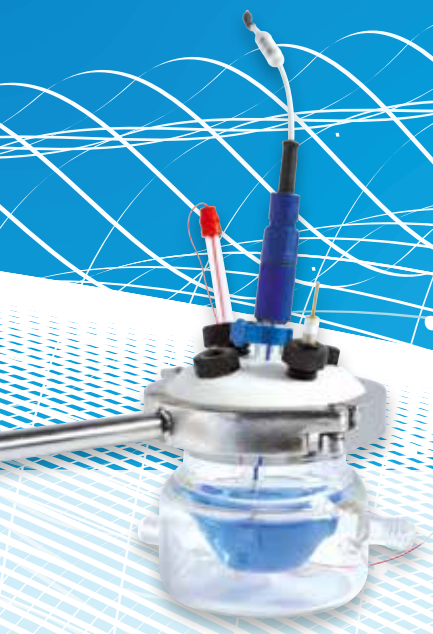
Ultra Low Current (ULC)

An ultra low current option is available for the **VSP-300**. This option will lower the base current range from 1 µA to 1 pA, thus the resolution of the low current option is 76 aA on the 1 pA full scale range.
This option will be able to work in concert with the high voltage booster, resulting in dynamic full scale current ranges from 1 pA to 1 A.
The low current option can be included at time of purchase, or added at any time after. It consists of a cell cable with a high sensitivity electrometer in-line that will be located close to the cell.
Positioning the electrometer close to the cell increases the accuracy
of the measurement and avoids any electromagnetic disruption of the signal.

Analog Ramp Generator (ARG)

The analog ramp generator is an optional module that can be purchased as an upgrade. It is automatically detected and provides an analog voltage scan up to 1 MV/s and an acquisition time down to 1µs.

Applications



Fundamental electrochemistry

Fundamental and analytical electrochemistry research is probably the most demanding application with respect to instrumentation.
This type of research is aimed at exploring material limits, and therefore requires the most advanced instrument capabilities.
Fast potential scans can be used to highlight intermediate reaction species.
For low current measurements, the excellent sensitivity of the **VSP-300**'s ultra low current option is a big advantage in detecting very low concentrations.

Corrosion

The **VSP-300**'s ultra low current option is ideal for corrosion experiments.
With an input impedance of 10^{14} ohms (with 1 pF in parallel) and a 1 pA range, the **VSP-300** can measure extremely low corrosion rates. With the floating mode, measurements can be carried out
on grounded cells, such as pipelines, tribo-corrosion experiments or with autoclaves.
The **VSP-300** exhibits extremely high resolution and accuracy in current and potential measurements.
Combined with a high acquisition speed, the **VSP-300** is well-suited for making Electrochemical Noise Measurements using dedicated techniques (ZRA - ZVC).

Fuel cells/batteries

Research interest in new energy sources for Electric Vehicles (EVs) and Hybrid Electric Vehicles (HEVs) is rapidly growing especially in fuel cell
and battery R&D activity.
Researchers in these fields require an instrument that can measure and apply high voltages and currents.
The **VSP-300**, with its high voltage/current boosters options, is the perfect solution.
Bio-Logic has a long experience and history in providing instruments to investigate intercalation compounds and batteries.
A major feature of the **VSP-300** is the ability to switch from potential control to galvanic control in a very short time.
EIS capability is an important technique to study aging of batteries in real operating conditions.
EC-Lab® software, supplied with the **VSP-300** includes a Multi-Sine EIS technique which allows measurements to be made quickly to avoid changes during the experiment.
And a patented algorithm will correct for "drift" that may still occur during the experiment.

Photovoltaic/ solar cell

A major area in renewable energy research is in capturing the energy of sunlight.
Solar cells have been studied for several years now.
With the need to develop commercial solar cells and modules, it is becoming increasingly important to improve efficiencies and performance of these devices, as well as their price.
The **VSP-300** and its high voltage/current capabilities is an important tool in developing photovoltaic cells and components.

Coating/ plating

The study of protective coatings requires measurements of very high impedance.
The **VSP-300**'s low current option allows impedance up to 10 GΩ to be measured.
Dielectric materials in general impose challenging measurement conditions for potentiostats.
With the **VSP-300**'s choice of 9 stabilizing bandwidth settings, even the most challenging materials can be examined.

Sensors

Electrochemical sensor research requires a potentiostat with very good sensitivity.
The **VSP-300**, with its "ultra low-current" option, offers a 76 aA current resolution on the 1 pA range making the instrument especially attractive to researchers testing sensors.
With analog filtering capabilities, it is perfectly suited for this type of measurement.

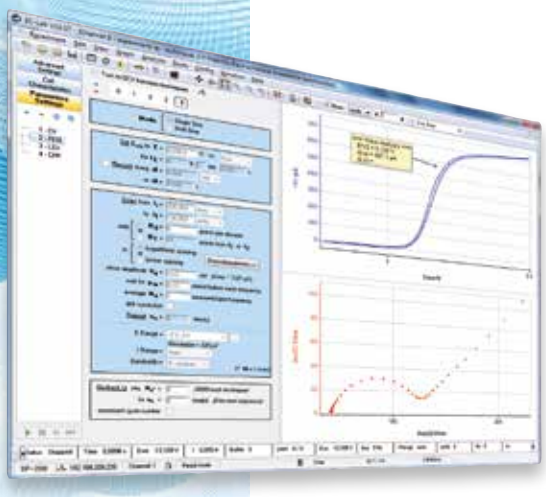
Nanotechnology

VSP-300 used with an ultra low current option is well suited for nanotechnology research and measurements on ultramicro-electrodes.
Currents as low as a few fA can be measured with precision.
Hardware filtering allows the user to remove unwanted electro-magnetic noise which can affect the quality of the data.
EIS measurements using the ultra low current option is able to explore the electrochemical characteristics of nano-devices.

EC-Lab® software

A comprehensive software package

EC-Lab® is an advanced software package for performing electrochemical measurements. With more than 15 years of development and constant improvement in techniques and features, **EC-Lab®** software has become the benchmark in potentiostat control software.



EC-Lab®: modular and powerful for advanced users

Experimental sequence builder

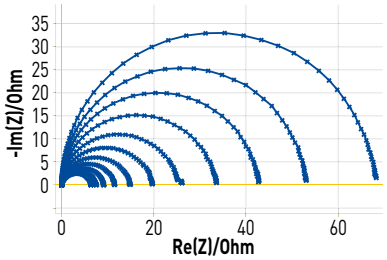
EC-Lab® software contains more than 80 techniques. These techniques can address applications in voltammetry, EIS, corrosion and energy source development. A powerful technique builder can execute a series of different modular techniques, wait and loop options to create complex experimental sequences. Even within each technique, the user can create up to 100 linked sequences of the experiment with different parameters.

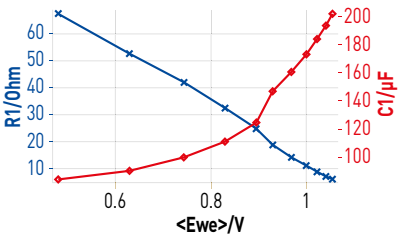
External device control

Some electrochemical experiments require potentiostats to work with other instruments such as a QCM, a rotating ring-disk electrode or a spectrophotometer. **EC-Lab®** has an advanced “External device configuration” menu that can be configured to control and record data from these separate instruments, such as QCM frequency or temperature.

Limit detection and cell protection

Several experimental limit parameters are available to protect the electrochemical cell. These limits can be set either for all the experiments in a series or for individual techniques. Special techniques have been added to monitor the external analog input voltage which can be calibrated to a temperature, frequency value, or rotation speed. This allows the experiment to terminate (or skip to the next technique in a series) when a pre-set voltage is reached.

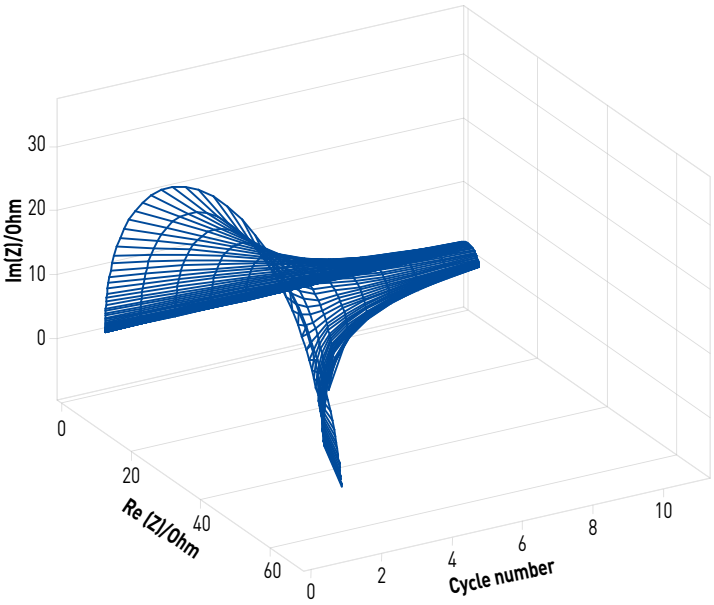


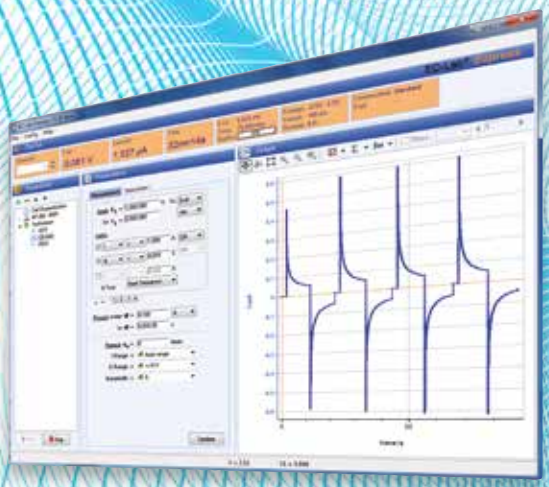


EC-Lab® Express: easy to learn software for new users

More than 45 techniques with up to 100 sequences can be linked in **EC-Lab® Express** software.

This software is very easy-to-use. The settings and graph are shown on one screen view. An experiment selector enables the user to quickly switch between techniques.





Graphic tools

- Line Fit...
- Circle Fit...
- Integral...
- Min Max...
- Filtering...
- Fourier Transform...
- RP Fit...
- Tafel Fit...
- Electrochemical Noise...
- Corr Sim...
- VASP Fit...
- CASP Fit...
- Mott-Schottky...
- Z Fit...
- Z Sim...
- Kramers-Kronig...
- Process Data (Cycles, R, QCM mass...)
- Photovoltaic Analysis...
- Peak Analysis...
- Wave Analysis...
- CV Fit...
- Linear Interpolation...

EC-Lab® graphics

EC-Lab® Graphics

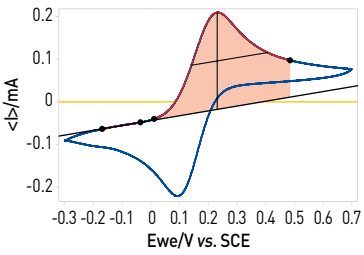
A comprehensive graphics package.

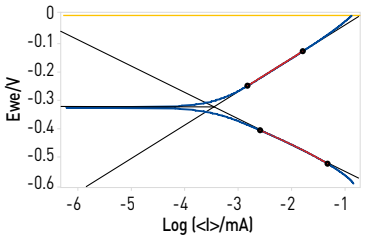
EC-Lab's graphic package is provided with the software and includes a powerful tool to create unique graph templates.

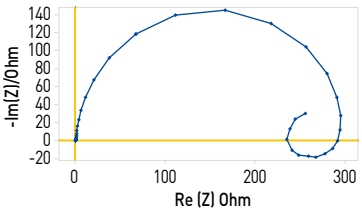
With the advanced graph properties, the user can create new variables for each axis. This enables mathematical functions to be performed on data plotted on any axis.

Powerful analysis tools (such as peak find/height, convection wave, integral, Tafel fit, Rp determination) are available in **EC-Lab**®. These analyses incorporate classical fit routines (linear, circular) and algorithms.
All the analysis results are stored in a separate file.

EC-Lab's EIS modeling package utilizes the equivalent circuit approach. There are over 150 standard circuits and two minimization algorithms available for understanding impedance plot information.
The user can define and build his/her own circuit model using a range of 13 simple elements (R, C, L, La, Q, W, G, Ga, Gb, Wd, M, Ma, Mg).
A batch processing feature allows fitting of multiple cycles in an impedance experiment.







OEM package

Bio-Logic has developed an OEM package and **LabView**® drivers which are available for our customers.
This package includes almost all the DC and AC techniques present in **EC-lab**® **Express**.
A **Delphi**® and **Veepro**® test program and **LabView**® examples are also provided.

Specifications

CHANNEL BOARD

General functions

Potentiostat	yes
Galvanostat	yes
Impedance analyzer	option
Coulometer	yes
Analog ramp generator	option
Floating mode	yes
IR compensation	software or hardware positive feedback
Analog filtering	yes
External input/outputs	yes
Cell connection	2, 3, 4 or 5 terminal leads (+ ground)

Control amplifier

Compliance	±12 V
Maximum current	±500 mA continuous
Gain-bandwidth compensation	9 programmable stability factors
Highest unity gain bandwidth	1.4 MHz
Slew rate (no load)	> 20 V/µs
Rise/fall time (no load)	< 500 ns

Voltage control

Ranges	adjustable from ±10 V down to ±30 mV
DC level shift	±10 V, 300 µV resolution
Accuracy	< ±1 mV ±0.03% of setting
Lowest resolution	1 µV

Current control

Ranges	±500 mA, ±100 mA, ±10 mA, ±1mA, ±100 µA, ±10 µA, ±1 µA (7 ra nges)
Accuracy	< ±0.1% of range ±0.03% of setting
Resolution	0.0033% of range

Voltage measurement

Ranges	±10 V, ±5 V, ±2.5 V, ±250 mV, ±25 mV
DC level shift	±10 V, 300 µV resolution
Accuracy (DC)	< ±1 mV ±0.03% of reading
Maximum resolution	< 0.0033% of range
Bandwidth (-3 dB)	8 MHz
Filtering	50 kHz, 1 kHz and 5 Hz, low-pass 4 poles Sallen-Key filters
Data sampling	1,000,000 samples/s

Current measurement

Ranges	9 ranges (auto/auto limited/manual) ±1 A down to ±10 nA (±100 nA, ±10 nA with gain)
Accuracy (DC)	< ±0.1% of range ±0.03% of reading
Maximum resolution	0.0033% of range
Bandwidth (-3 dB)	8 MHz
Filtering	50 kHz, 1 kHz and 5 Hz, low-pass 4 poles Sallen-Key filters
Data sampling	1,000,000 samples/s

Electrometer

Input impedance	1 TΩ ‖ 25 pF typical
Input bias current	< 10 pA
Bandwidth (-3 dB)	8 MHz
Common mode rejection ratio	> 60 dB at 100 kHz

Ground to chassis impedance

Floating mode	10 MΩ ‖ 10 nF typical
Grounded mode	< 10 kΩ

IR compensation

Resistance determination	EIS
Compensation mode	software or hardware positive feedback
Compensation range	programmable from 0 to 100% of the current range resistor

Auxiliary inputs/outputs

External input	can be used to apply an external waveform directly to the control amplifier
2 analog inputs	automatic ±2.5 V, ±5 V, ±10 V ranges -16 bits resolution
1 analog output	±10 V range 16 bits resolution
2 digital inputs	TTL level: trigger input and open input
1 digital output	TTL level: trigger output
2 monitor outputs	cell current and compensated working electrode potential

General

Dimensions	337 x 254 x 517 mm (H x W x D)
Weight	20 kg
Power	85-264 V, 47-440 Hz

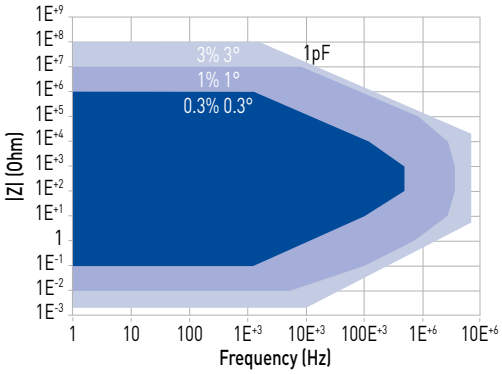
ANALOG RAMP GENERATOR (optional)

Scan ranges	1 V/s, 100 V/s, 10 kV/s, 1 MV/s
Scan resolution	0.0015% FSR* (down to 15 µV/s)
Minimum scan range	±10 mV
Voltage range	±10 V
Accuracy	< ±0.1% of range
Number of cycles	1 to 65535

* FSR: Full Scale Range

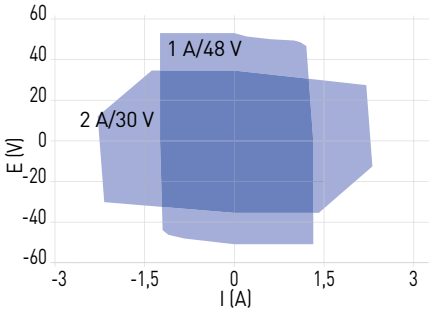
Specifications

EIS CONTOUR PLOT

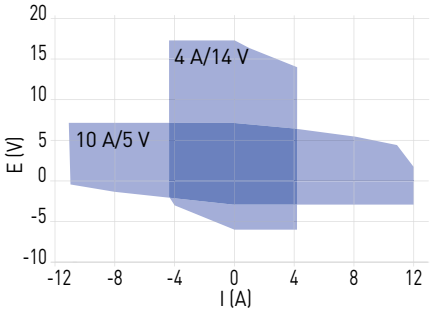


OPERATING AREAS

1 A/48 V and 2 A/30 V



4 A/14 V and 10 A/5 V



IMPEDANCE ANALYZER (optional)

Impedance

Frequency range	10 µHz to 7 MHz
Frequency resolution	< 10 ppm of the setting
Sinus amplitude	0.5 mV to 2.5 V with 1 mV resolution 0.1% to 100% of the current range with resolution of 0.004% of the range
Accuracy	see contour plot
Mode	single sine, multi sine, FFT analysis

BOOSTER (optional)

Boosters	1 A/48 V	2 A/30 V	4 A/14 V	10 A/5 V
Compliance voltage	±49 V	±30 V	-3 V ; +14 V	-1 ; +6 V
Control voltage	±48 V	±30 V	-3 V ; +10 V	-1 ; +6 V
Compliance current	±1 A	±2 A	±4 A	±10 A
Current accuracy	0.1% range	0.1% range	0.1% range	0.3% range
EIS frequencies	10 µHz - 2 MHz	10 µHz - 1 MHz	10 µHz - 1 MHz	10 µHz - 1 MHz
Bandwidth (-3 dB)	>2 MHz	>3 MHz	>4 MHz	>8 MHz
Slew rate (no load)	>15 V/µs	50 V/µs	50 V/µs	50 V/µs
Rise/fall time (no load)	<250 ns	<200 ns	<200 ns	<200 ns
Floating mode	yes	yes	yes	yes
Parallel ability	no	yes	yes	yes

ULTRA LOW CURRENT (optional)

Cell control

Maximum current	±1 A continuous
Maximum current resolution	0.004% of the range (76 aA max)
Applied current accuracy	< ±0.1% of range ±0.03% of setting for±500 mA to ±100 nA ranges < ±0.1% of range ±1% of setting for ±10 nA range to ±1 nA ranges < ±0.2% of range ±2% of setting for ±100 pA range

Current measurement

Ranges	13 ranges (auto/auto limited/manual) ±1 A down to ±1 pA (±10 pA, ±1 pA with gain)
Maximum resolution	0.004% of the range (76 aA max)
Accuracy (+20°C ⩽ T ⩽ +30°C)	< ±0.1% of range ±0.03% of setting for ±500 mA to ±100 nA ranges < ±0.1% of range ±1% of setting for ±10 nA range to ±1 nA ranges < ±0.2% of range ±2% of setting for ±100 pA range < ±1% of range ±2% of setting for ±10 pA range < ±10% of range ±2% of setting for ±1 pA range

Electrometer

Impedance	100 TΩ ‖ 6 pF typical
Bias current	< 1 pA (300 fA typical)
Bandwidth	5 MHz
EIS accuracy	1 MHz (1%, 1°)

Specifications are subject to change

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