# VMP-300

MULTICHANNEL POTENTIOSTAT/GALVANOSTAT/FRA


BioLogic
Science Instruments

## The ultimate electrochemical workstation

- CORROSION
- ENERGY STORAGE/BATTERY
- FUNDAMENTAL ELECTROCHEMISTRY
- SENSORS
- PHOTOVOLTAIC/SOLAR CELL
- MATERIALS

# **VMP-300** THE MOST MODULAR WORKSTATION ON THE MARKET


The **VMP-300** is the ultimate multichannel electrochemical workstation. It announces a new step in the combination of high performance and versatility.

**VMP-300** is a high-end research grade and fully flexible multipotentiostat.

The **VMP-300** is the most modular chassis of our product range offering 16 slots for potentiostats/galvanostats/FRA boards and/or booster boards.

The channel and booster boards can be combined in the chassis either to have many channels or to reach high currents. As a multichannel workstation, each channel is completely independent from the others making the unit a multi-users workstation.

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

Electrochemical Impedance Spectroscopy (EIS) measurements can be added as an option to the **VMP-300**. The built-in FRA has a wide frequency range up to 7 MHz. It can be available on each potentiostat board.

The **VMP-300** is supplied with a built-in calibration board in an additional slot. This allows the user to run a calibration routine any time he needs to ensure reliable and accurate measurements.

Low current sensitivity can be improved using the Ultra Low Current option (down to 1 pA range with 76 aA resolution). This option may be added on each of the 16 channels.

As a fully versatile system, the chassis can accomodate booster kits that can be selected in our extended range (1 A, 2 A, 4 A, 10 A). These current boosters can be connected in parallel to reach high current level such as 150 A with 15 boosters of 10 A.

The **EC-Lab®** software, supplied with the potentiostat, is a multi-featured software package. It provides a wide range of techniques and applications that can be sequenced and/or linked to design any experiment imaginable. A variety of analysis tools is available for electro-analytical and corrosion data, as well as equivalent circuit modeling for impedance data interpretation.


## UNIQUE FEATURES

- Compliance: ±12 V
- Control voltage: ±10 V
- EIS measurement: 10 µHz - 3 MHz (1%, 1°)
  10 µHz - 7 MHz (3%, 3°)
- Maximum current: ±500 mA
- Current ranges: 1 A to 1 µA
- Current resolution: 760 fA (standard board)
- Floating mode
- Analog filtering
- Calibration board
- Full stability control mode (9 bandwiths)

## OPTIONS

- Low current: additional ranges 100 nA to 1 pA with a resolution of 76 aA
- Linear scan generator: 1 MV/s, acquisition 1 µs
- Current boosters: 1 A/48 V
  2 A/30 V
  4 A/[-4;14] V
  10 A/[0;5] V
- Additional potentiostat/galvanostat/FRA

# 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 **VMP-300**'s ultra low current option is a big advantage in detecting very low concentrations.

## CORROSION

The **VMP-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 **VMP-300** can measure extremely low corrosion rates. With the floating mode, measurements can be carried out on grounded cells, such as pipelines and in autoclaves.

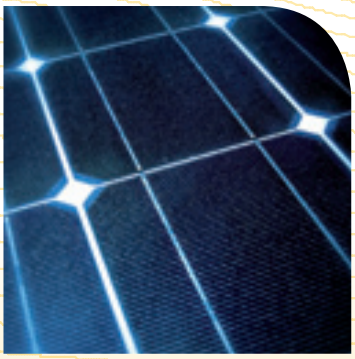
The **VMP-300** exhibits extremely high resolution and accuracy in current and potential measurements. Combined with a high acquisition speed, the **VMP-300** is well-suited for making Electrochemical Noise Measurements using dedicated techniques (ZRA - ZVC).


## BATTERIES/FUEL CELLS

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 **VMP-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 **VMP-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 **VMP-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 CELLS

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 **VMP-300** and its high voltage/current capabilities is an important tool in developing photovoltaic cells and components.

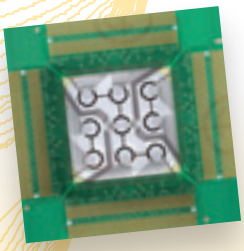
## COATING/PLATING

The study of protective coatings requires measurements of very high impedance.

The **VMP-300**'s low current option allows impedance up to 10 TOhms to be measured.

Dielectric materials in general impose challenging measurement conditions for potentiostats.

With the **VMP-300**'s choice of nine stabilizing bandwidth settings, even the most challenging materials can be examined.

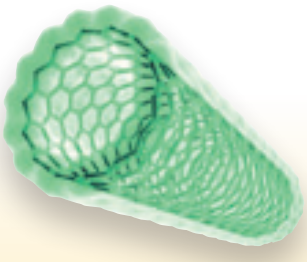


## SENSORS

Electrochemical sensor research requires a potentiostat with very good sensitivity.

The **VMP-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

**VMP-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 femto amps 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.

The CE to ground mode is very useful for experiments on sensor chips. This is a specific mode for electrochemical cells with several working electrodes (up to 16), one counter and one reference electrode.

# MODULES


## STANDARD CONFIGURATION

### 1 **Communication** board

The communication board of the unit 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 unit, even for remote access. Data is stored in a large on-board buffer (700,000 data points) and downloaded continuously. In a 16 channel configuration, 16 users can perform experiments at the same time.

### 2 **Calibration** board

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

### 3 **Potentiostat/galvanostat** board

The Potentiostat/Galvanostat in the **VMP-300** has 9 available performance bandwidths. As a result, the system exhibits excellent electronic stability while making high speed measurements.

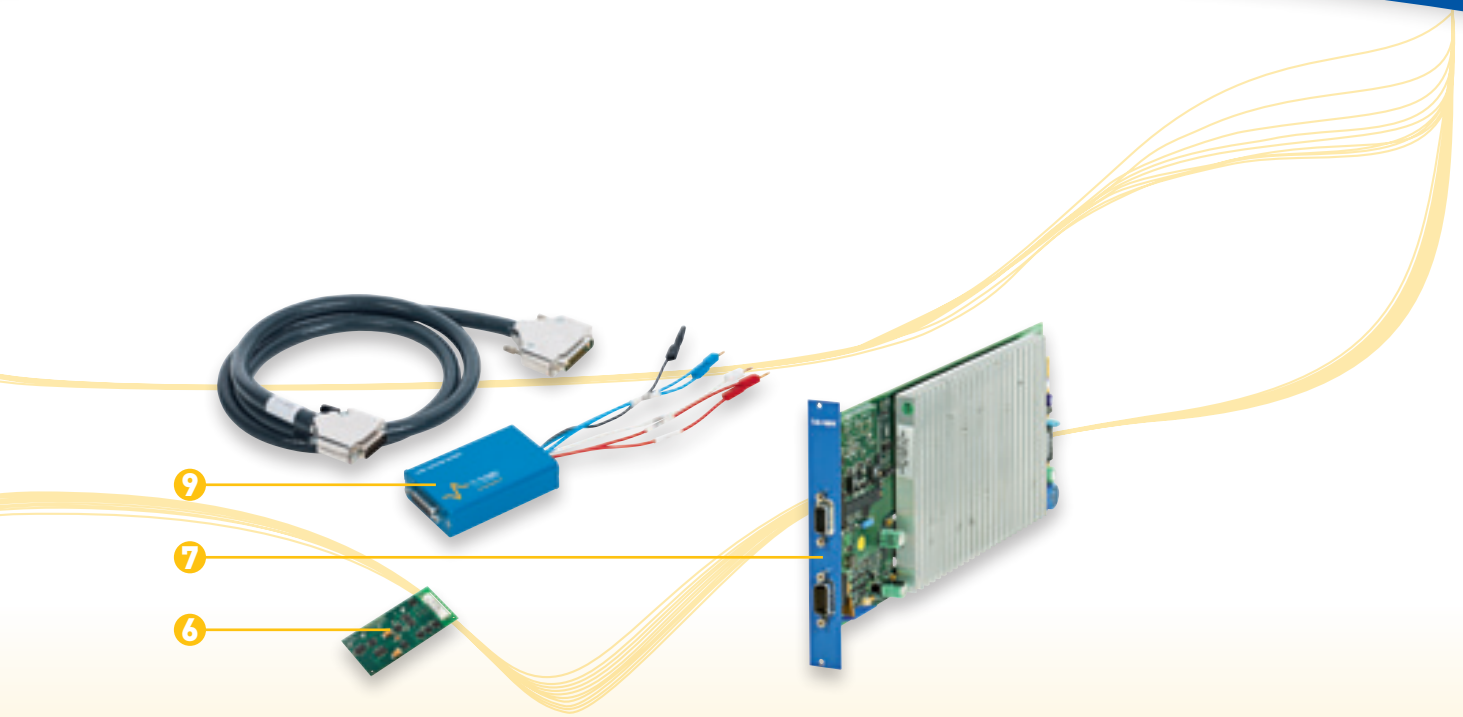
The floating mode (with earth isolated power supply) allows experiments to be run on grounded cells, on pipelines or autoclaves. An exclusive feature of the **VMP-300** is the on-board operating system. Control of the experiment is provided by the digital board, even when communication with the computer is lost.

Three analog filters are available to remove unwanted noise during an experiment: 50 kHz, 1 kHz and 5 Hz.

### 4 **Auxiliary voltage** input/outputs

The 9-pin connector on the potentiostat board offers several analog and digital inputs/ outputs.
They can be used to input external signals, control an external device, synchronize a **VMP-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 inputs are available to record the analog cell voltage and current.




# OPTIONS

## 5 **Electrochemical impedance** spectroscopy

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 **VMP-300** can utilize a fast Fourier-based multi-sine technique to reduce experimental acquisition time.

## 6 **Linear scan** generator

The linear scan generator is an optional module. It is automatically detected and provides an analog voltage scan up to 1 MV/s with an acquisition time down to 1 µs.

## 7 **Boosters**

The **VMP-300** has up to 15 slots available to accomodate a 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 **VMP-300** chassis can be connected together in parallel to increase the maximum current.

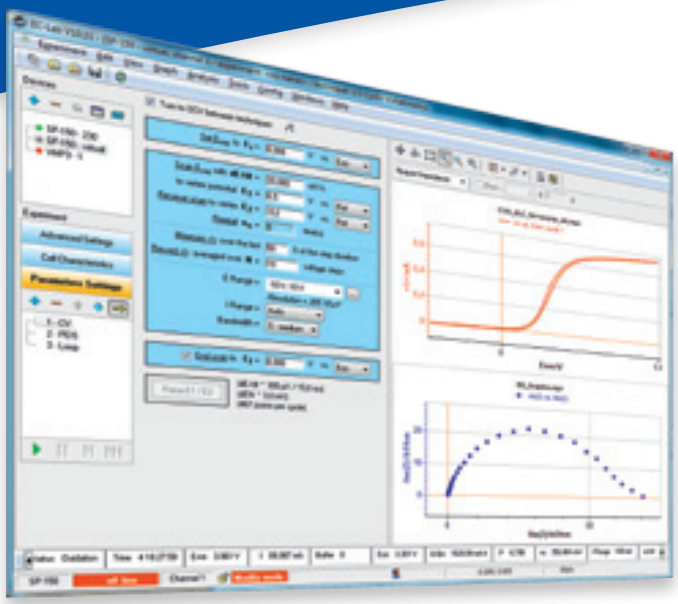
## 8 **Additional** potentiostat

The **VMP-300** can accommodate up to 16 potentiostat boards with or without EIS capability. Each of them can be with a low current option.

## 9 **Ultra low** current

An ultra low current option is available for each channel of the **VMP-300** resulting in 16 channels. This module lowers 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. It consists of a cell cable with a high sensitivity electrometer in-line that is  located close to the cell.

# EC-LAB® SOFTWARE PACKAGE



## A comprehensive software package

**EC-Lab**® is an advanced software package for performing electrochemical measurements. With more than 10 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

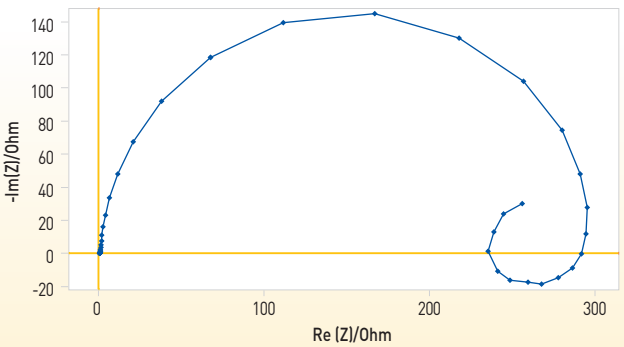
**EC-Lab**® software contains more than 70 techniques. These techniques can address applications in voltammetry, EIS, corrosion and energy source development. A powerful technique builder can execute a series of different modular techniques, wait and loop options to create complex experimental sequences. Even within each technique, the user can create up to 100 linked sequences of the experiment with different parameters.

### Experiment and safety limits

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.

### 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.




## OEM package

**Bio-Logic** has developed an OEM package and **LabView**® drivers which are available for our customers. This package includes almost 35 DC and AC techniques.

A **Pascal** and **Veepro**® test program and **LabView**® examples are also provided.

# 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

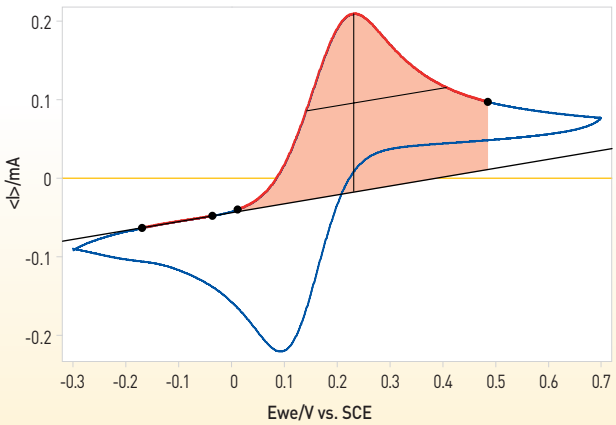
### A comprehensive graphic package

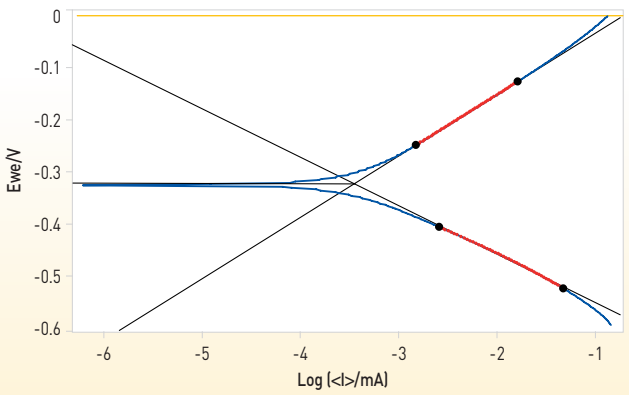
**EC-Lab**'s graphic package is provided with the software and includes a powerful tool to create unique graph templates.

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 electro-analytical 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 use in understanding impedance plot information. The user can define and build his own circuit model using a range of thirteen 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.



# SPECIFICATIONS

## CHANNEL BOARD

### General Functions

| | |
|---|---|
| Potentiostat | yes |
| Galvanostat | yes |
| Impedance analyzer | yes (option) |
| Coulometer | yes |
| Linear scan generator | yes (option) |
| Floating mode | yes |
| IR compensation | yes |
| 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 | ±1 A, ±100 mA, ±10 mA, ±1mA, ±100 µA, ±10 µA, ±1 µA (7 ranges) |
| Additional ranges | ±100 nA, ±10 nA with gain |
| 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/second |

### Current measurement

| | |
|---|---|
| Ranges | ±1 A, ±100 mA, ±10 mA, ±1 mA, ±100 µA, ±10 µA, ±1 µA |
| Additional ranges | ±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/second |

### 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

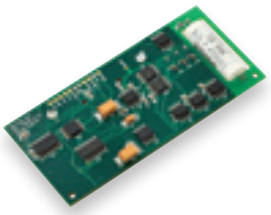
| | |
|---|---|
| Resistance determination | EIS |
| Compensation mode | hardware or software positive feedback |
| Compensation range | programmable from 0 to 100% of the current range resistor |

### 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-bit resolution |
| 1 analog output | ±10 V range 16-bit 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 |

## CHASSIS

| | |
|---|---|
| Dimensions | 315x534x565 mm (HxWxD) |
| Weight | 30 kg |
| Power supply | 85-264 V, 47-63 Hz |
| Power | 1,500 W |

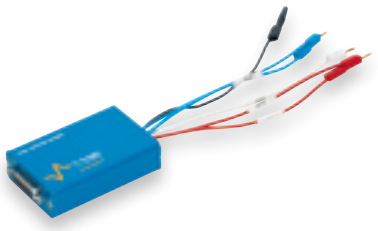


## LINEAR SCAN GENERATOR (OPTIONAL)

### Linear Scan

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

* FSR: Full Scale Range



## 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<br>0.1% to 100% of the current range<br>with resolution of 0.004% of the range |
| Accuracy | see contour plot |
| Mode | single sine, multisine, FFT analysis |

## ULTRA LOW CURRENT (OPTIONAL)

### Cell Control

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

### Current Measurement

| | |
|---|---|
| Ranges | ±100 pA, ±1 nA, ±10 nA, ±100 nA |
| Additional ranges with gain | ±1 pA, ±10 pA |
| Maximum resolution | 0.004% of the range (76 aA max) |
| Accuracy<br>(+20°C ⩽ T ⩽ +30°C) | < ±0.1% of range ±0.03% of setting<br>for ±500 mA to ±100 nA ranges<br>< ±0.1% of range ±1% of setting<br>for ±10 nA range to ±1 nA ranges<br>< ±0.2% of range ±2% of setting for ±100 pA range<br>< ±1% of range ±2% of setting for ±10 pA range<br>< ±10% of range ±2% of setting for ±1 pA range |

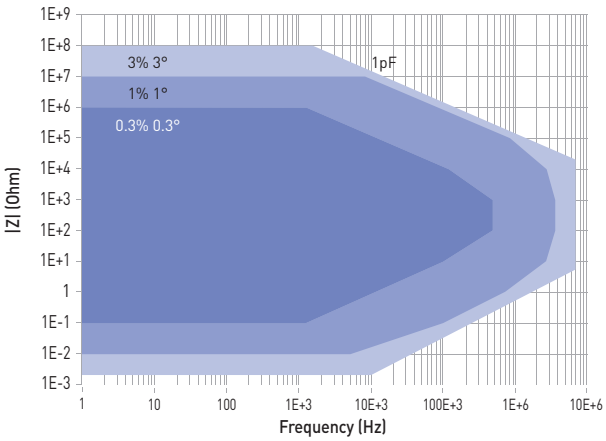
### Electrometer

| | |
|---|---|
| Impedance | 100 TΩ \|\| 6 pF typical |
| Bias current | < 1 pA (300 fA typical) |
| Bandwidth | 5 MHz |
| EIS accuracy | see contour plot |

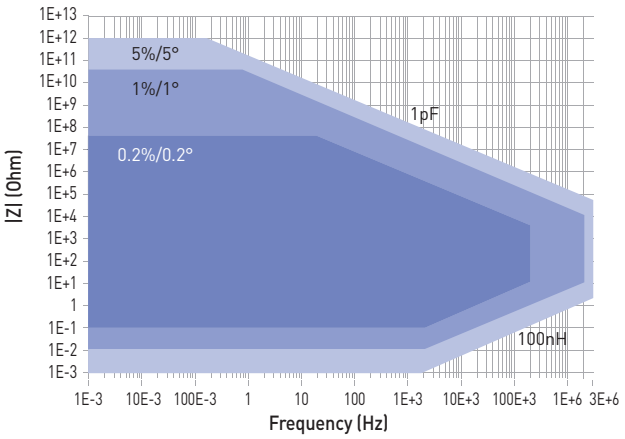
Specifications are subject to change

## EIS CONTOUR PLOT

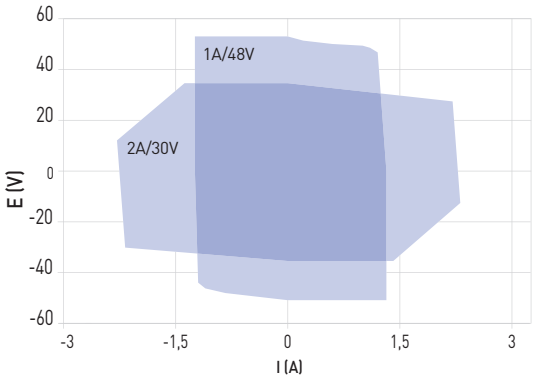
For channel board alone

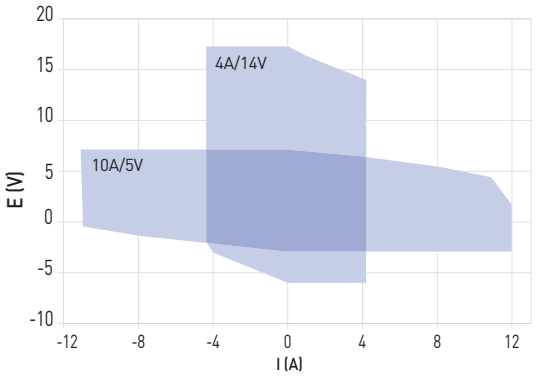



With ultra low current option



## OPERATING AREAS




## BOOSTER (OPTIONAL)

| Boosters | 1 A/48 V | 2A/30 V | 4 A/14 V | 10 A/5 V |
|---|---|---|---|---|
| Compliance voltage | ±49 V | ±30 V | 14;-3 V | 0;5 V |
| Compliance current | ±1 A | ±2 A | ±4 A | ±10 A |
| Control voltage | ±48 V | ±30 V | +10;-3 V | 0;5 V |
| 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 |
| Current accuracy | 0.1% range | 0.1% range | 0.1% range | 0.3% range |

Specifications are subject to change

## POSSIBLE CONFIGURATIONS

| Potentiostat boards | | Boosters in parallel | 1 A | 2 A | 4 A | 10 A | Max current | Max voltage | Slots used |
|---|---|---|---|---|---|---|---|---|---|
| Sixteen | multichannel | | | | | | 500 mA | 12 V | 16 |
| Eight | high voltage 48 V | | 8 | | | | 1 A | 48 V | 16 |
| | high current/high voltage (±30 V) | ■ | | 8 | | | 16 A | 30 V | 16 |
| | high current (32 A @ 14 V) | ■ | | | 8 | | 32 A | 14 V | 16 |
| | high current (80 A @ 5 V) | ■ | | | | 8 | 80 A | 5 V | 16 |
| | multichannel, max 40 A/max 30 V | ■ | | 4 | | 4 | 40 A | 30 V | 16 |
| Four | multichannel, multi-current | | 1 | 1 | 1 | 1 | 10 A | 48 V | 8 |
| | 10 A each | ■ | | | | 4 | 40 A | 5 V | 8 |
| | 4 A each | ■ | | | 4 | | 16 A | 14 V | 8 |
| Two | max 50 A/max 14 V | ■ | | | 5 | 5 | 50 A/20 A | 5 V/14 V | 12 |
| | max 50 A/max 30 V | ■ | | 5 | | 5 | 50 A/10 A | 5 V/30 V | 12 |
| | max 20 A/max 30 V | ■ | | 5 | 5 | | 20 A/10 A | 14 V/30 V | 12 |
| Single | 150 A @ 5 V | ■ | | | | 15 | 150 A | 5 V | 16 |
| | 60 A @ 14 V | ■ | | | 15 | | 60 A | 14 V | 16 |
| | 30 A @ 30 V | ■ | | 15 | | | 30 A | 30 V | 16 |

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