MULTICHANNEL POTENTIOSTAT/GALVANOSTAT/EIS

VMP-300

The ultimate electrochemical workstation

BioLogic
Science Instruments

APPLICATIONS

- Corrosion
- Energy storage/battery
- Fundamental electrochemistry
- Sensors
- Photovoltaic/solar cell
- Materials

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.

VMP-300

The **VMP-300** is the most modular chassis of our product range offering 16 slots for potentiostats/galvanostats/EIS 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 EIS 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 80 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.

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:
  800 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 80 aA
- Analog ramp generator:
  1 MV/s, acquisition 1 µs
- Current boosters: 1 A/48 V,
  2 A/30 V,
  4 A/[-4;14] V,
  10 A/[-1;6] V
- Additional potentiostat/galvanostat/EIS

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.

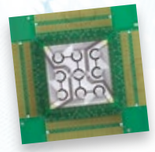
EIS capability is an important technique to study aging of batteries in real operating conditions. **EC-Lab®** software, supplied with the **VMP-300** includes a Multi Sine EIS technique which allows measurements to be made quickly to avoid changes during the experiment. And a patented algorithm will 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 80 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.

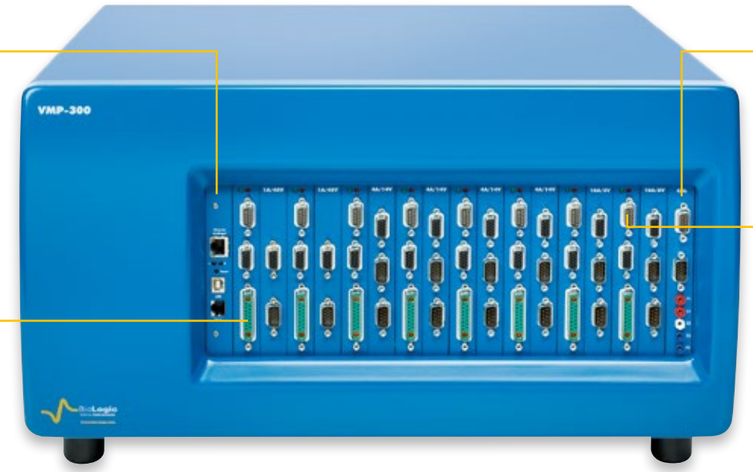
Standard configuration

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.

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.



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.

Auxiliary voltage inputs/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

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 Transform based Multi Sine technique to reduce experimental acquisition time.

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.

Boosters

The **VMP-300** has up to fifteen 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.

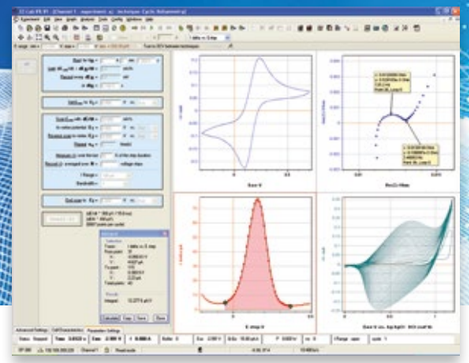
Ultra Low Current

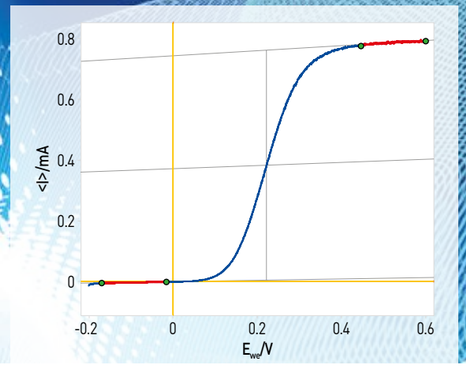
An Ultra Low Current option is available for each channel of the **VMP-300** resulting in 16 channels. This module lowers the base current range from 1 µA to 1 pA, thus the resolution of the low current option is 80 aA on the 1 pA full scale range. It consists of a cell cable with a high sensitivity electrometer in-line that is located close to the cell.

Analog Ramp Generator

The analog ramp 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.

EC-Lab® software package





EC-Lab®: powerful and comprehensive advanced software

Impedance spectroscopy
General electrochemistry
Electro-analytical
Corrosion
Battery
Super-capacitor
Fuel cell
Photovoltaic cell

A comprehensive software package

EC-Lab® is an advanced software package for performing electrochemistry 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.

Display mode

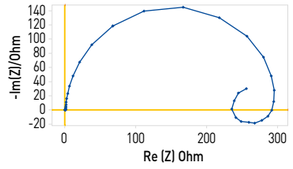
Two view modes are available in **EC-Lab®**. The setup of experiments can be done with a technique menu, or by inputting parameter values into a spreadsheet. Most of the experimental parameters can be modified "on the fly" during the experiment, with the changes stored into the raw data file.
The appearance of the software interface is able to be adapted to create the best working environment for the user.

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 features to create complex experimental sequences. Even within each technique, the user can create up to 100 linkable sequences of that experiment with different parameters. When a certain level of the experiement is reached, an email can be sent to the user.

EIS measurements

EIS measurements can be made in both controlled potential and controlled current modes from 10 µHz to a remarkable 7 MHz. The patented "drift correction" algorithm and multiple stability parameters allow users to acquire the high quality data from their EIS measurements.



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.

EC-Lab® graphics: an extended range of analysis

Display...

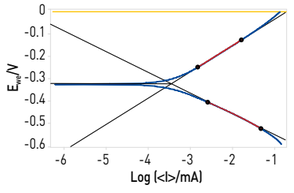
EC-Lab®'s graphic package provided with the software includes a powerful 3-Dimension plot feature and a tool to create unique graph templates. Using our advanced "Process" function, the user can create new variables for each axis. This enables mathematical functions to be performed on data plotted on any axis (x, y1 and y2).

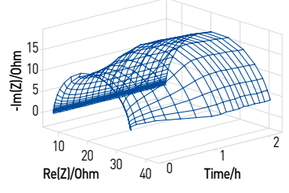
... fitting...

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, polynomial, multi-exponential) and algorithms.
All the analysis results are stored in a separate file. **EC-Lab®**'s EIS modeling package, Z Fit, utilizes the equivalent circuit approach. There are over 150 standard circuits and two minimizations 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, Q, W, G, W_d, M, G_a, G_b, L_a, M_a, M_q).
The last elements can be assimilated to a transmission lines.A batch processing feature allows the fitting of multiple cycles in an impedance experiment.

... & simulation

Several tools are available to simulate CV curve, Tafel plot or EIS data. They can be used as training tools. CV Sim allow the user to create data with different mechanisms such as single (E) or multi (up to EEEEE) electron transfer. Electron transfer reaction can also be mixed with chemical reaction electron transfer to simulate an EC mechanism.





General electochemistry
- Peak Analysis...
- Wave Analysis...
- CV Sim...

Corrosion
- R_p Fit...
- Tafel Fit...
- Electrochemical Noise...
- Corr Sim...
- VASP Fit...
- CASP Fit...

EIS
- Z Fit...
- Z Sim...
- Mott-Schottky...
- Kramers-Kronig...

Battery process
- Process data (capacity, efficiency, energy...)

Photovoltaic
- Photovoltaic analysis (fill factor, efficiency...)

Mathematic
- Polynomial Fit...
- Multi-Exponential Fit...
- Line Fit...
- Subtract Files...
- Integral...
- Min Max...
- Filter...
- Fourier Transform...
- Linear Interpolation...

Specifications

Channel board

General functions

Potentiostat	yes
Galvanostat	yes
Impedance analyzer	yes (option)
Coulometer	yes
Analog ramp 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	0.004% of range (0.8 pA)

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	0.004% of range (0.8 pA)
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	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

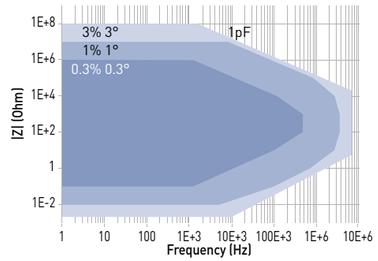
Chassis

Dimensions (W x D x H)	534 x 565 x 315 mm
Weight	30 kg
Power supply	85-264 V, 47-63 Hz
Power	1,500 W

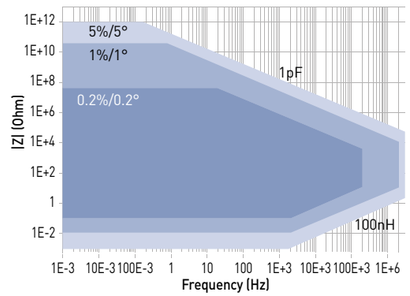
Impedance analyzer (optional)

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

EIS contour plot for channel board with standard cable



EIS contour plot for channel board with Ultra Low Current option



Ultra Low Current (optional)

Cell control

Maximum current resolution	0.004% of the range (80 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 (80 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	see contour plot

Analog Ramp Generator (optional)

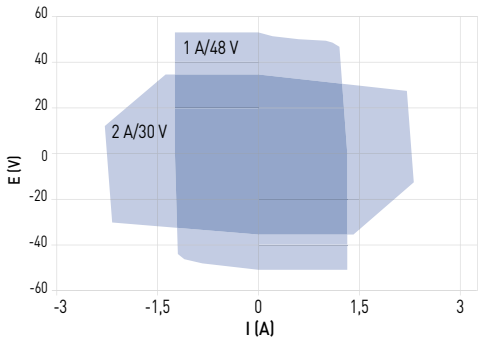
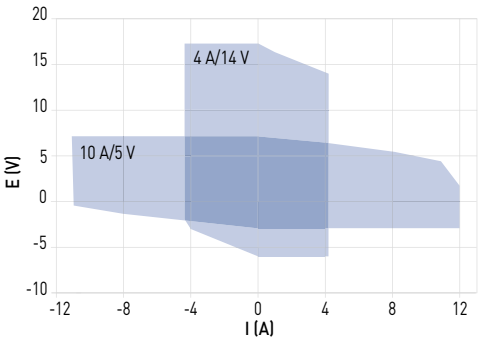
Scan ranges	1 V/s, 100 V/s, 10 kV/s, 1 MV/s
Scan resolution	0.0015% FSR* (down to 15 µV/s)
Voltage range	±10 V
Accuracy	< ±0.1% of range
Number of cycles	1 to 65535

* FSR: Full Scale Range

Specifications

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	14;-3 V	-1;6 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
Operating areas				

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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