VSP

5 CHANNELS POTENTIOSTAT/GALVANOSTAT

BioLogic
Science Instruments

A versatile multichannel instrument designed for...
... ALL your electrochemical applications

- ENERGY DEVICES
- FUNDAMENTAL ELECTROCHEMISTRY
- CORROSION
- SENSORS
- PLATING

The **VSP** is a modular potentiostat **with research grade specifications.** The **VSP** chassis offers five slots. They can be occupied by a wide range of options such as: a low current board, a 4 Amps booster, up to 5 potentiostat/ galvanostat board with or without EIS capability.

Each potentiostat installed in the **VSP** can be connected to an external current booster channel (2, 5,10, 20, 80 or 100 amps). All this versatility, plus its ability to switch from potential control to current control in 10 µs, makes it the perfect choice for any electrochemical application.

The **VSP** is controlled from a PC by a USB or an Ethernet connection. Using the Ethernet connection, the **VSP** can be installed on a Local Area Network to allow multiple users to access the instrument.

Each channel has two analog inputs and an analog output to manage external instruments, such as a rotating electrode, or a quartz crystal microbalance, and record the generated data.

The **VSP** is supplied with **EC-Lab®** software package. With over 70 techniques that can be sequenced, and with a variety of analysis tools, including EIS modeling with Levenberg-Marcquardt and Simplex algorithms, the **VSP** is truly the ultimate electrochemical workstation.

GENERAL SPECIFICATIONS

- Current ranging from 10 µA up to 1 A with a 760 pA resolution (76 fA on the 1 nA range of the low current option)
- 20 V adjustable reference voltage
- Resolution: 300 µV programmable down to 5 µV by adjusting the dynamic range
- Acquisition time: 200 µs
- Simultaneous EIS measurement on WE and CE electrodes*
- N'Stat mode to perform experiments with several working electrodes

VERSATILE OPTIONS

- EIS option (10 µHz to 1 MHz) on each channel
- Low-current option (1 nA range)
- Up to 5 independent channels
- ±4 A built-in kit
- External boosters available from 2 A up to 100 A.
- Load boxes: 150 A@50 V.

* With EIS option

APPLICATIONS

ENERGY SOURCES AND STORAGE

The design and the performance of the **VSP** benefit from the long history of previous EC-Lab® instrument generations (MacPile and VMP) in the fields of intercalation compounds, battery and super-capacitors study. Many techniques are available for battery cycling in both current and potential control modes. Techniques are now available that allow the simultaneous evaluation of the different elements of a stack.

FUNDAMENTAL ELECTROCHEMISTRY

Fundamental research in electrochemistry is one of the most demanding applications with respect to instrumentation. This type of research is aimed at exploring material limits, and therefore requires the most advanced instrument capabilities.
The **VSP** is designed to help scientists perform critical research in electrochemistry such as electron transfer kinetic studies or electrochemical analysis of compounds at low trace levels. Fast potential scans can be used to highlight intermediate species of a reaction. For low current measurements, the excellent sensitivity of the **VSP** is a big advantage.

SENSORS

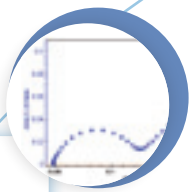
Potentiometric sensors (ion selective electrodes) and amperometric sensors (thin film micro-electrodes or modified electrodes) require good sensitivity to low currents. The **VSP**, with its "low-current" option, offers a 76 fA resolution on the 1 nA current range.
The multichannel capability of the **VSP** is an important feature in multi-sensor research applications requiring the use of DNA chips or screen printed electrodes. Differential and pulsed techniques along with impedance measurements and EC-Lab® software analysis tools are especially useful in the development of electrochemical biosensors.

CORROSION

The **VSP**'s low current option is ideal for corrosion experiments. With an input impedance of 10^{14} ohms (with 1 pF in parallel), the **VSP** is able to measure low corrosion rates and to provide EIS data on high impedance coatings.
EC-Lab® offers many standard corrosion techniques and data analysis tools (Tafel and Rp fits) to study corrosion (uniform, pitting...). Using the **VSP** in a multi-electrode mode (N'Stat configuration) is an excellent feature that allows users to acquire the statistics necessary for localized corrosion evaluations.

OPTIONS

IMPEDANCE



The **VSP** can be outfitted with potentiostats capable of performing Electrochemical Impedance Spectroscopy (EIS). This option provides an integrated sine wave generator and frequency response analyzer built onto the plug-in potentiostat module. The frequency range is from 10 µHz to 1 MHz. The potentiostat input impedance is 10^{12} Ohms in parallel with 20 pF. Thus, the **VSP** is suitable for EIS measurements in corrosion experiments or in battery testing and intercalation compounds study. With a low current option, the input impedance increases to 10^{14} Ohms in parallel with 1 pF ideal for thin film study. With the 4 A option or external boosters, impedance can be performed on energy devices.

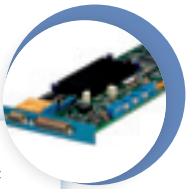
BOOSTERS/LOADS

The **VSP** chassis is designed to receive a ±4 A current booster option. This option uses two slots in the chassis. It requires an available potentiostat/galvanostat channel board. In addition, external boosters or load boxes (installed in a separate chassis) are available to work with any potentiostat channels of the **VSP**. Booster channels come in ±2 A, ±5 A, ±10 A, ±20 A, ±80 A, ±100 A versions. These boosters and loads are used for applications requiring high currents such as battery or fuel cell testing, electrochemical synthesis, electroplating and some corrosion applications.

LOW CURRENT

The low current option can be added in series with a potentiostat channel and requires one slot. It extends the current ranges down to 1 nA full scale with a resolution of 76 fA. Electro-analytical detection can be performed to sub-picoAmp levels. The use of EIS measurements can be extended to the applications of thin film and high impedance coatings.

ADDITIONAL CHANNELS



The **VSP** can accommodate up to 5 independent potentiostat channels. Each of them can be impedance capable and is independent from the others.

HARDWARE CONFIGURATIONS

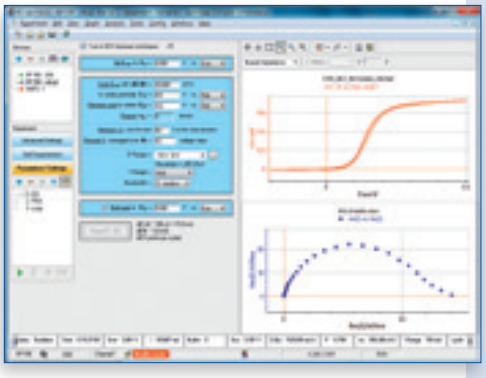
(The VSP chassis is provided with 5 slots to receive one 4 A option or two low current options maximum)

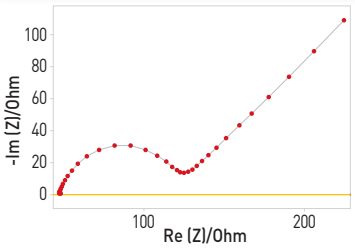
Configurations	Potentiostat board (P)	Low current option (LC)	4 A option (4 A)	Slot #1	Slot #2	Slot #3	Slot #4	Slot #5
Dual channels with LC and 4 A option	2	1	1	(P)	(LC)	(P)	(4 A)	(4 A)
Single channel with LC option	1	1		(P)	(LC)	unused	unused	unused
Single channel with 4 A option	1		1	(P)	unused	(4 A)	(4 A)	unused
Dual channels with LC option	2	2		(P)	(LC)	(P)	(LC)	unused
Multichannel without option	Up to 5			(P)	(P)	(P)	(P)	(P)

EC-Lab®: modular and powerful

Over 70 techniques are proposed.
The user can create new protocols
with the "technique builder".

Two view modes are available in flow charts and in columns. Many parameters can be modified during the run, with the changes stored into the raw data file. Analysis tools (peak, convection wave, integral), with classical fits (linear, circular and processes are available with both **EC-Lab®** modes. The user can also define and build his own circuit model.
Active data can be shown in multiple graph windows, each with a double y-axis view. The axes (unit, scaling), color and style, and other graphic properties can be modified easily. The user can use multiple graph windows to show the active experiment while analyzing previously stored data.





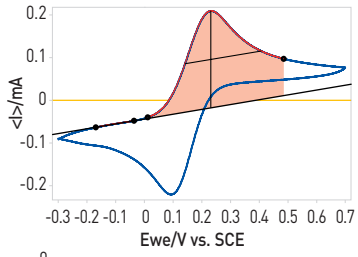
EC-Lab® graphics

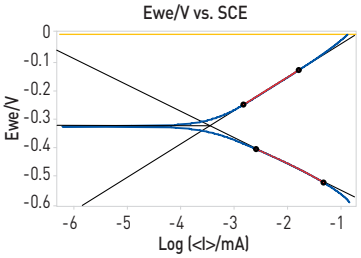
A comprehensive graphics package

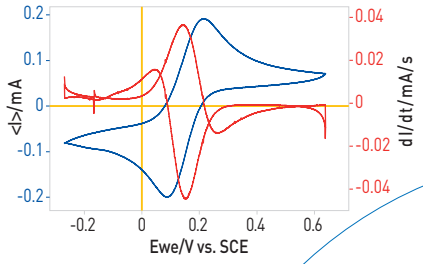
EC-Lab's graphic package is provided with the software and includes a powerful tool to create unique graph templates. Using our advanced graph properties, the user can create new variables for each axis. This enables mathematical functions to be performed on data plotted on any axis.

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 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, L_a, Q, W, G, G_a, G_b, Wd, M, M_a, M_g). A batch processing feature allows fitting of multiple cycles in an impedance experiment.







TECHNIQUES

Voltammetric techniques
OCV, CV, CVA, CA, CP, SV, LASV, ACV

Impedance spectroscopy
GEIS, PEIS, SGEIS, SPEIS (Mott-Schottky)

Pulsed techniques
DPV, SWV, DPA, DNPV, NPV

Technique builder
Modular Potentio/Galvano, Loop, Trigger in/out, Wait

Ohmic drop determination
MIR, ZIR, Current Interrupt

Bipotentiostat
CV-CA, CP-CA, CA-CA

Batteries
GCPL (1 to 7), PCGA, CLD, CPW, APGC, Urban cycle simulation, ModuloBat

Corrosion
Linear and Cyclic Polarization, Generalised Corrosion, Pitting, ZRA, ZVC, Corrosimetry, VASP, CASP

Fuel cell/photovoltaic
I-V characterization, CLD, CPW

ANALYSIS

- Linear Fit
- Tafel Fit with minimization
- Circular Fit
- Rp Determination
- Min/Max Determination
- Integral Calculation
- Derivative Calculation
- Peak Analysis
- Wave Analysis (convection)
- Mott-Schottky
- Impedance data Fitting
- Pseudocapacitance
- Impedance Simulation
- Kramers-Kronig
- Statistical Processes
- File subtraction
- Numerical filtering
- Fourier Transform
- Interpolation
- Electrochemical Noise Analysis
- CV simulation/Fit

OEM package

Bio-Logic has developed an OEM package and **LabView®** drivers which are available for our customers. This package includes almost 30 DC and AC techniques. A **Pascal** and **Veepro®** test program and **LabView®** examples are also provided.

SPECIFICATIONS

Cell control

Connection	2, 3, 4 or 5 terminals (+ ground)
Compliance	20 V adjustable from ±10 V to 0-20 V
Maximum current	±400 mA continuous
Maximum potential resolution	300 µV on 20 V programmable down to 5 µV on 200 mV
Maximum current resolution	0.004% of the dynamic range (760 pA on the 10 µA range)
Accuracy (DC)	< 0.1% FSR*
Rise time	(10% - 90%) < 2 µs (no load)
Acquisition time	20 µs

Current measurement

Ranges	Automatic on every range ±10 µA to ±1 A (7 ranges)
Maximum resolution	0.004% of the range (760 pA on the 10 µA range)
Acquisition speed	200,000 samples/second
Accuracy (DC)	< 0.1% FSR*

Potential measurement

Ranges	±2.5 V, ±5 V, ±10 V, ±10 V adjustable
Maximum resolution	0.0015% FSR*, down to 75 µV
Acquisition speed	200,000 samples/second
Accuracy (DC)	< 0.1% FSR*

Electrometer

Inputs	3 potential measurements
Impedance	> 10^{12} ohms in parallel with < 20 pF
Bias current	< 5 pA

Additional inputs/outputs and features

2 Analog inputs	16-bit resolution with automatic ±2.5 V, ±5 V, ±10 V ranges
1 Analog output	±10 V
Trigger input/output	One each/TTL Level

General

Dimensions	435 x 335 x 95 mm
Weight	8.0 kg
Power	85-264 V, 47-440 Hz
PC configuration	Pentium IV, Windows 2000, XP or Vista, Seven, 8

EIS OPTION

Impedance

Frequency range	10 µHz to 1 MHz
Amplitude	0.5 mV to 0.5 V 0.1% to 50% of the current range
Accuracy	see contour plot
Mode	single sine, multi sine, FFT analysis

* FSR: Full Scale Range
Specifications subject to change

LOW CURRENT OPTION (LC)

Cell control

Maximum current	±100 mA continuous
Maximum current resolution	0.004% of the dynamic range, programmable:76 fA on the 1 nA range
Applied current accuracy	< 1% FSR* on the 1 nA range < 0.5% FSR* on the 10 nA range < 0.1% FSR* on the other ranges

Current measurement

Ranges	±1 nA, ±10 nA, ±100 nA, ±1 µA
Maximum resolution	0.004% of the range down to 76.3 fA
Accuracy	< 1% FSR* on the 1 nA range < 0.5% FSR* on the 10 nA range < 0.1% FSR* on the other ranges

Electrometer

Impedance	10^{14} ohms in parallel with 1 pF
Bias current	60 fA typical, 150 fA max at 25 °C
Bandwidth	1 MHz

4 A BOOSTER KIT

Cell control

Maximum current	±4 A continuous
Potential ranges	±10 V at 4 A
Rise and fall time 10% to 90%	Potentio mode: 15 µs Galvano mode: 100 µs

Measurement

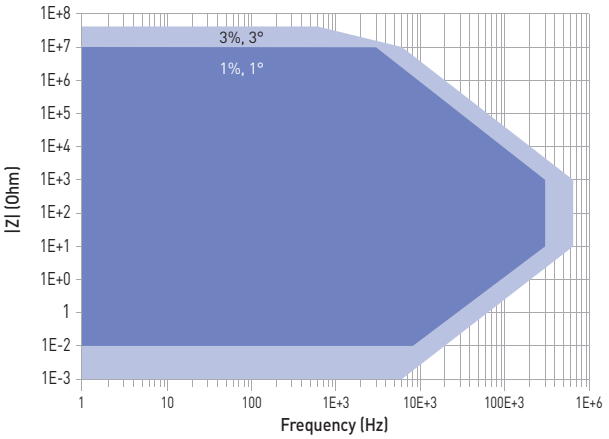
Potential accuracy (DC)	< 0.1% FSR*
Current accuracy (DC)	< 0.2% FSR*
Current noise	1 mA peak to peak (0-100 kHz) at 4 A
Potential noise	0,6 mV peak to peak (0-100 kHz)

Electrometer

Impedance	10^{10} ohms
Inputs	3 potential leads with 2 differential voltages
Bandwidth	1 MHz

IMPEDANCE CONTOUR PLOT

For standard channel board alone



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