MODULAR POTENTIOSTAT/GALVANOSTAT

SP-300

Breakthrough technology in a new generation of Super-Potentiostats...

BioLogic
Science Instruments

APPLICATIONS

- Renewable energy sources
- Fundamental electrochemistry
- Corrosion
- Sensors
- Batteries
- Materials

SP-300 marks a new step in the combination of high performance and modularity

SP-300 is a state-of-the-art modular research grade potentiostat/galvanostat/FRA with remarkable specifications. Drawing upon Bio-Logic's long history of flexible and modular potentiostat design, the breakthrough technology incorporated in the SP-300 results in exceptional performance.

The **SP-300** chassis offers two slots. The first one is used by a potentiostat. The second one remains available for an option such as an additional potentiostat board to reach a bipotentiostat configuration. A booster kit can also be selected in our range of four internal boosters (1, 2, 4, 10 A).
The standard potentiostat in the **SP-300** provides ±12 volts compliance, ±10 V reference control, and a maximum current of ±500 mA.
A range of 9 intelligent bandwidths ensures the stability of the **SP-300** in a wide variety of experimental conditions.
The **SP-300** is a floating instrument, allowing it to be used with grounded cells, autoclaves, and in glove boxes. Additionally, on-site corrosion experiments can be performed.
The **SP-300** is supplied with a built-in calibration board. This allows the user to run a calibration routine any time they need 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).
Electrochemical Impedance Spectroscopy (EIS) measurements can be added as an option to the **SP-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.
The **EC-Lab®** software, supplied with the potentiostat, is a full featured software package for advanced users. It provides a wide range of techniques and applications that can be sequenced and/or linked to design any experiment the user can imagine. A variety of analysis tools are available for electro-analytical and corrosion data, as well as equivalent circuit modeling for impedance data interpretation.

Applications

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 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 time 1 µs
- Internal boosters:
  ±1 A/±48 V, ±2 A/±30 V,
  ±4 A/[-3;14] V, ±10 A/[0;5] V

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.
The linear scan generator combined with a hardware ohmic drop compensation is well adapted to reach very fast scan rates and highlight intermediate reaction species.

Nanotechnology/sensors

SP-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 measurement using the ultra low current option is able to explore the electrochemical characteristics of nano-devices.

Electrolysis

Electrolysis processes are very important in different fields of electrochemical research. Bulk electrolysis (working electrodes with big surface areas) or hydrogen generation often require several amperes. Electrosynthesis and electroplating are also other applications requiring high current. The **SP-300**, with its high current booster option, is the perfect solution.

Batteries/fuel cells

Research interest in new energy sources for electric vehicles (EVs) and hybrid electric vehicles (HEVs) is rapidly growing. Researchers in these fields require an instrument that can measure and apply high currents. The **SP-300**, with its high current booster option, is the perfect solution. Bio-Logic is experienced in providing instruments to investigate intercalation compounds and batteries. A major feature of the **SP-300** is the ability to switch from potential control to galvanic control in a very short time. EIS capability is an important tool to study aging of batteries in real operating conditions. A multi-sine EIS technique in **EC-Lab®** software allows measurements to be made quickly to avoid changes during the experiment.

Photovoltaic/solar cells

A major area in renewable energy research is in capturing the energy of sunlight. 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 **SP-300** and its high voltage/current capabilities are suitable tools in developing photovoltaic cells and components.

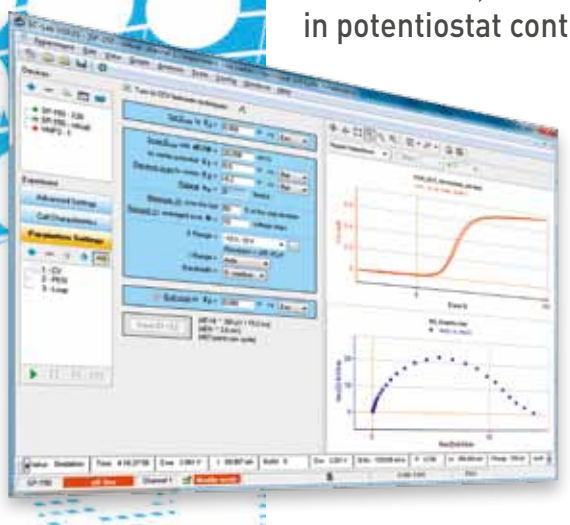
Corrosion/coating

The **SP-300**'s ultra low current option is ideal for corrosion experiments especially very low corrosion rates determination. With the floating mode, measurements can be carried out on grounded cells, such as pipelines or in autoclaves. The **SP-300** exhibits extremely high resolution and accuracy in current and potential measurements. Combined with a high acquisition speed, the **SP-300** is well-suited for making Electrochemical Noise Measurements using dedicated techniques (ZRA - ZVC).

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.

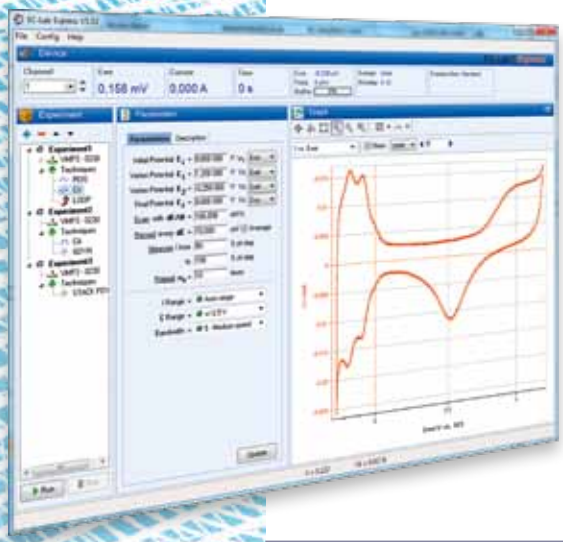
EC-Lab® software contains more than 70 techniques. These techniques can address applications in voltammetry, EIS, corrosion and energy source development. A powerful technique builder can execute a series of different modular techniques, wait and loop options to create complex experimental sequences.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

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.

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.



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.

The acquisition time of **EC-Lab® Express** software has been reduced to 1 µs. Coupled to the linear scan generator option, the software allows a data sampling of one 1,000,000 sample/s during a voltage scan of several thousand volts per second.

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...
- KK ww
- Process Data (Cycles, R, QCM mass...)
- Photovoltaic Analysis...
- Peak Analysis...
- Wave Analysis...
- CV Fit...
- Linear Interpolation...

EC-Lab® graphics

EC-Lab® Graphics

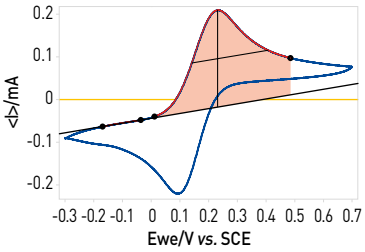
A comprehensive graphics package.

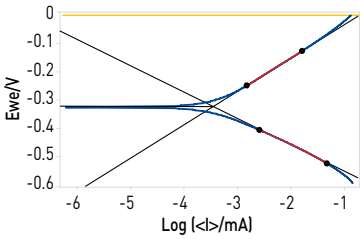
EC-Lab's graphic package is provided with the software and includes a powerful tool to create unique graph templates.

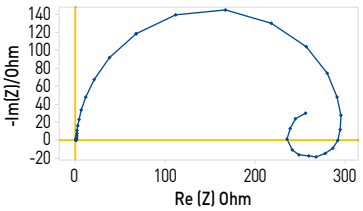
With the advanced graph properties, the user can create new variables for each axis. This enables mathematical functions to be performed on data plotted on any axis.

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.

Modules

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.

Calibration board

Using the built-in calibration board, the user initiates a routine to perform a full calibration of the **SP-300** and of the booster channel. This procedure checks and adjusts offsets and gain versus internal reference voltages and calibrates the current ranges.

Potentiostat/galvanostat board

The Potentiostat/Galvanostat in the **SP-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 **SP-300** is the on-board operating system. The 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.

Options

Booster (uses the 2nd slot)

The **SP-300** has one slot available to accomodate a current booster chosen among four differents boosters: ±1 A/±48 V, ±2 A/±30 V, ±4 A/[-3;14] V, ±10 A/[0;5] V.
This extended range allows all application areas of electrochemistry to be covered.

Bipotentiostat (uses the 2nd slot)

The **SP-300** can accommodate an additional potentiostat board with or without EIS capability.

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 **SP-300** can utilize a fast Fourier-based Multi-Sine technique to reduce experimental acquisition time.

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 down to 1 µs.

Ultra low current

An ultra low current option is available for the **SP-300**. This option 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.

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 filt ering	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/s

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/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

General

Dimensions	225 x 205 x 410 mm (H x W x D)
Weight	7.5 kg
Power	85-264 V, 47-440 Hz

LINEAR SCAN GENERATOR (optional)

Linear scan

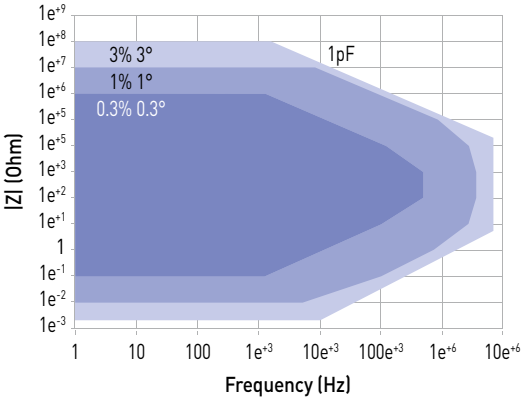
Scan ranges	1 V/s, 100 V/s, 10 kV/s, 1 MV/s
Scan resolution	0.0015% FSR* (down to 15 µV/s)
Voltage range	±10 V
Accuracy	< ±0.1% of range
Number of cycles	1 to 65535

* FSR: Full Scale Range

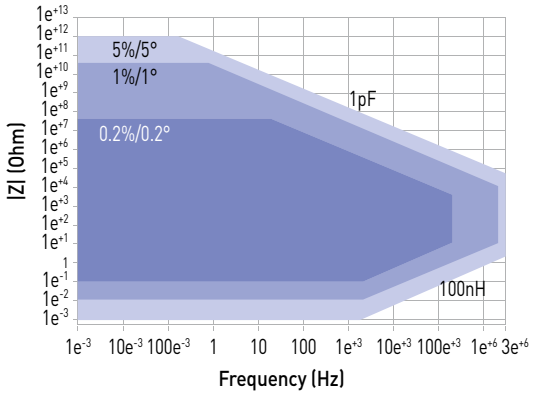
Specifications

EIS CONTOUR PLOT

For channel board alone



With ultra low current option



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	0 ; +5 V
Control voltage	±48 V	±30 V	-3 V ; +10 V	0 ; +5 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

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, 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 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	±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 (+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

Specifications subject to change

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