SP-300

HIGH END POTENTIOSTAT/GALVANOSTAT

Breakthrough technology in a new generation of **S**uper-**P**otentiostats...

Fast, sensitive, stable and modular...
a remarkable combination!!!

BioLogic
Science Instruments

- RENEWABLE ENERGY SOURCES
- FUNDAMENTAL ELECTROCHEMISTRY
- CORROSION
- SENSORS
- BATTERIES
- MATERIALS

SP-300 MARKS A NEW STEP IN THE COMBINATION OF HIGH PERFORMANCES AND FLEXIBILITY

SP-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. 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 standard potentiostat in the **SP-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 **SP-300** in a wide variety of experimental conditions.

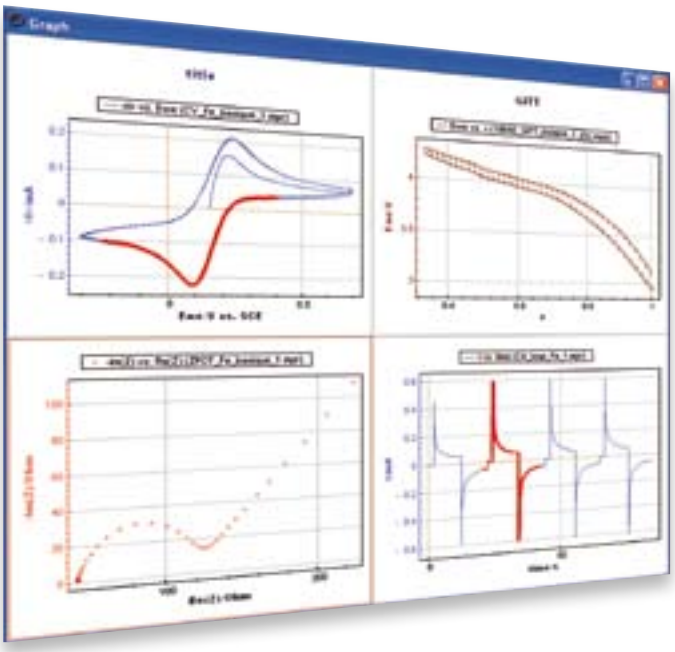
The **SP-300** is a floating instrument, allowing it to be used with grounded cells, autoclaves, and in glove boxes. Additionally, on-site corrosion experiments can be performed.

"Impedance experiments up to 7 MHz!!!"

Electrochemical Impedance Spectroscopy (EIS) measurements can be added as on 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, allowing testing on dielectric materials to be performed.

A novel 48 V/1 A booster kit has been developed to address applications requiring higher voltages, such as EV (Electric Vehicle) 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 same experiment thanks to a unique connection made to the cell.

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



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

The **SP-300** is controlled 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.

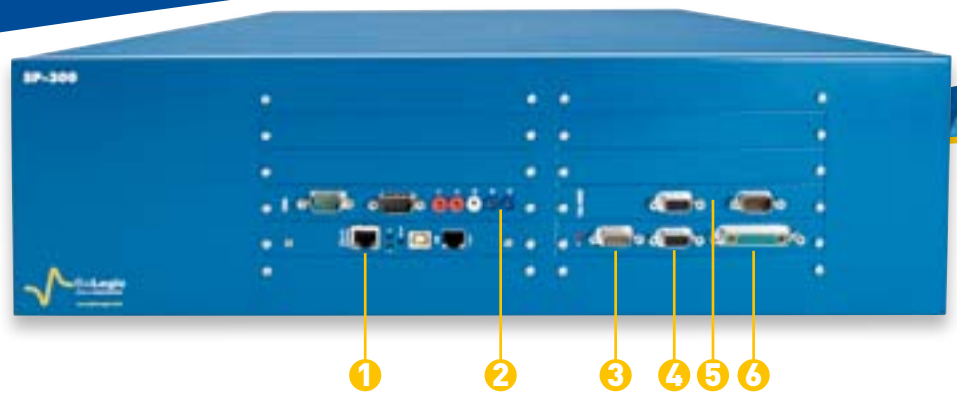
"Wide range of techniques and applications"

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.

UNIQUE FEATURES

- Compliance and control voltage: ±48 V
- EIS measurement up to: 3 MHz (1%, 1°)
  7 MHz (3%, 3°)
- Current ranges: 1 A to 1 µA (9 ranges)
  100 nA and 10 nA ranges with gain
- Current resolution: 760 fA (standard board)
- Floating Mode
- Analog filtering
- Calibration board
- Full stability control mode (9 bandwiths)

MODULES



STANDARD CONFIGURATION

1 COMMUNICATION BOARD

The communication board of the **SP-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 **SP-300**, even for remote access. Data is stored in a large on-board buffer (700,000 data points) and downloaded continuously. In the event of a loss of communication connection, the **SP-300** is also able to reconnect the instrument to the network automatically and restore data transmission to the controlling computer.

2 CALIBRATION BOARD

Using the built-in calibration board, the user initiates a routine to perform a full calibration on the **SP-300** potentiostat, and on the voltage 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 **SP-300** has 9 available performance bandwidths that are used to prevent oscillations that can occur with high impedance cells. As a result, the **SP-300** exhibits excellent electronic stability while making with high speed measurements.

The standard board has three 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.

"Floating mode"

And an additional 9-pin connector provides for analog inputs/outputs, TTL signals and E and I monitoring.

The floating mode of the **SP-300** (with 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. Control of the experiment is provided by the **SP-300**'s 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 offers several analog and digital inputs/outputs.
They can be used to input external signals, control an external device, synchronize an **SP-300** experiment with other devices and to add an external safety stop-on signal.

There are E and I monitor inputs to record the analog cell voltage and current.

5 HIGH VOLTAGE BOOSTER BOARD (48 V/1 A)

"On renewable energy sources" The **SP-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 with the booster board.

6 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.

A patented "drift correction" algorithm is available to compensate for changes that might occur on unstable cells. In combination with the multi-sine technique, one can minimize the effect from a changing electrode on the acquired data.

OPTIONS

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. This option is 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.

BI-POTENTIOSTAT

The **SP-300** is able to accommodate an additional potentiostat/galvanostat/FRA board. This unit becomes a real bi-potentiostat workstation including two independent channels.

Each channel can be used separately by two different users but also together in the same electrochemical cell. Both channels can be equipped with an ultra low current option. An additional slot in the chassis remains free for a 48 V/1 A booster that can be used with a selected channel.

APPLICATIONS

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 **SP-300**, with its high current/voltage booster (1 A/48 V) option, is the perfect solution.

"new energy sources"

SP-300 draws upon Bio-Logic's experience and long history 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 technique to study aging of batteries in real operating conditions. **EC-Lab®** software, supplied with the **SP-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.

CORROSION

The **SP-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 **SP-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 **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).

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.

"Exploring material limits"

Fast potential scans can be used to highlight intermediate reaction species. For low current measurements, the excellent sensitivity of the **SP-300**'s ultra low current option is a big advantage in detecting very low concentrations.

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 performances of these devices, as well as their price. The **SP-300** and its high voltage/current capabilities is an important tool in developing photovolatic cells and components.

COATING/PLATING

The study of protective coatings requires measurements of very high impedance. The **SP-300**'s low current option allows impedance up to 10 TOhms to be measured. Dielectric materials in general pose challenging measurement conditions for potentiostats.

"9 high stability bandwidths"

With the **SP-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 **SP-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.

"a very good sensitivity"

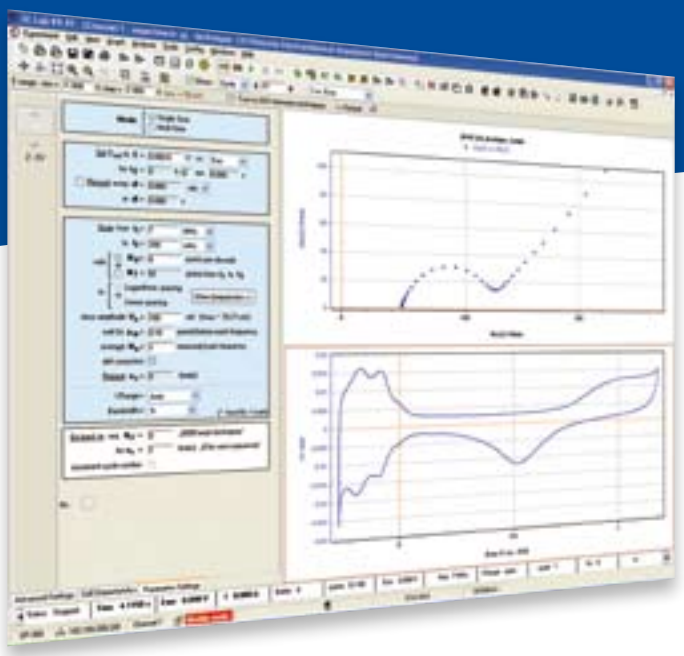
NANOTECHNOLOGY

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

EC-LAB SOFTWARE



EC-Lab® software package consits of:

- the powerful **EC-Lab®** monitoring software. With many advanced features it is designed for all your experiments from easy to advanced setup,
- the graphic package provided with this software includes powerful analysis tools and advanced fitting/modeling algorithms.

A comprehensive software package

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

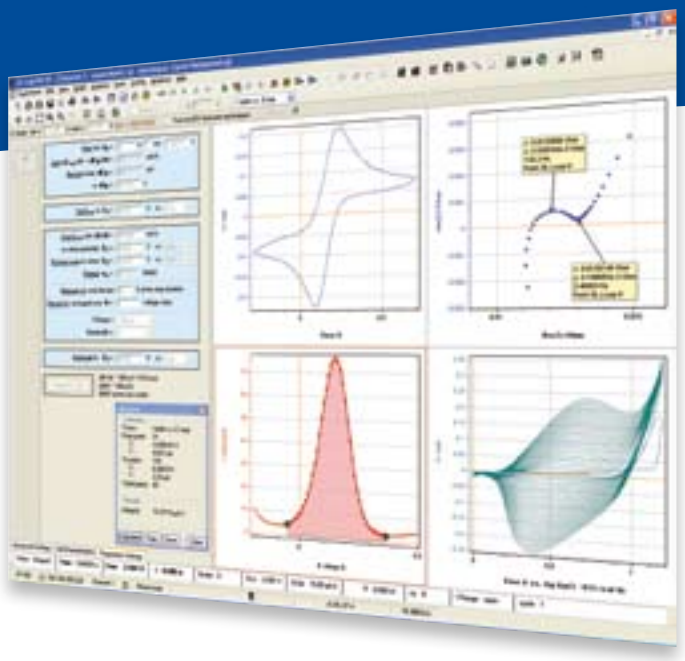
Display mode

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. Many 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.

Software calibration

SP-300 is provided with a built-in calibration board. **EC-Lab®** software includes a software routine to perform a comprehensive calibration designed to keep the instrument within factory specifications. This software tool is also a perfect way to diagnose unusual behavior of the instrument.



Experimental sequence builder

EC-Lab® software contains more than 50 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 linkable sequences of that experiment with different parameters.

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.

Limit Detection and Protection

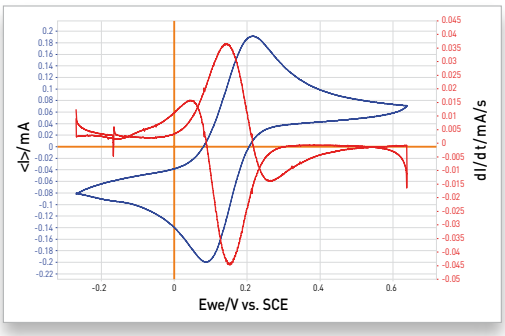
Several experimental limit parameters are available to protect the electrochemical cell. These limits can be set for either for all the experiments in a series or for individual techniques. Special techniques have been added to monitor the external analog input voltage which can be calibrated to a temperature, frequency value, or rotation speed. This allows the experiment to terminate (or to 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, rotating ring-disk electrode or spectrophotometer. **EC-Lab®** has an advanced "External device configuration" menu can be configured to control and record data from these separate instruments, such as QCM frequency and resistance.

Data Importation

EC-Lab® is able to import data from many other companies' potentiostat control software. The files are then able to be analyzed with our powerful fitting and modeling tools.



SOFTWARE: GRAPHIC TOOLS

EC-LAB® Graphics

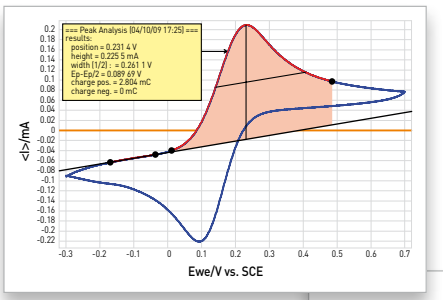
A comprehensive graphics package

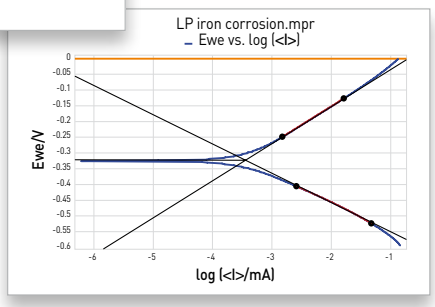
EC-Lab®'s graphic package is provided with the software and includes a powerful 3-Dimension plot feature and a tool to create unique graph templates.

Using our advanced "trace processing" function, 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 minimizations algorithms available for use in understanding impedance plot information. The user can define and build his own circuit model using a range of eight simple elements (R, C, L, Q, W, G, Wd, M). A batch processing feature allow fitting of multiple cycles in an impedance experiment.





SPECIFICATIONS

CHANNEL BOARD

General Functions

Potentiostat	Yes
Galvanostat	Yes
Impedance analyzer	Yes
Coulometer	Yes
Linear scan generator	Yes
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	±500 mA, ±100 mA, ±10 mA, ±1mA, ±100 µA, ±10 µA, ±1 µA (7 ranges)
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	±500 mA, ±100 mA, ±10 mA, ±1 mA, ±100 µA, ±100 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

IR Compensation

Resistance determination	EIS
Compensation mode	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 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, weight	150 x 525 x 505 (mm, H x W x D), 23 kg
Power	85-264 V, 47-440 Hz

SPECIFICATIONS

1 A/48 V BOOSTER

Booster

Compliance voltage	±49 V
Compliance current	±1 A
Control voltage	±48 V
Bandwidth (-3 dB)	> 2 MHz
Slew Rate (no load)	> 15 V/µs
Rise/Fall Time (no load)	< 250 ns
Floating Mode	Yes

IMPEDANCE ANALYZER (EIS)

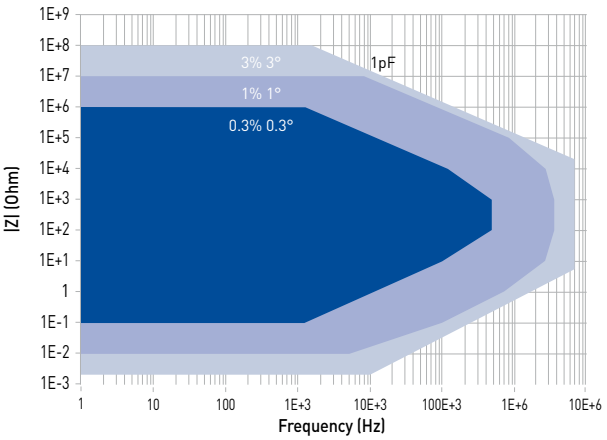
Impedance

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

Specifications are subject to change

EIS CONTOUR PLOT

For channel board alone



ULTRA LOW CURRENT

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

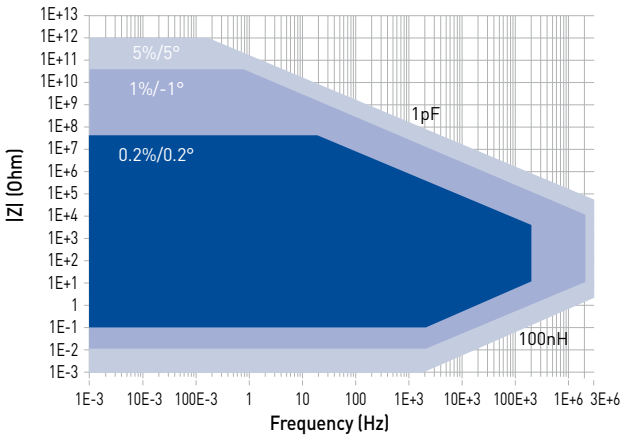
Current Measurement

Ranges	±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

With ultra low current option



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