

SP-200 / SP-240

PORTABLE POTENTIOSTATS/GALVANOSTATS/FRAS



Compact and powerful electrochemical workstations...

- CORROSION
- RENEWABLE ENERGY SOURCES
- FUNDAMENTAL ELECTROCHEMISTRY
- SENSORS
- ON-SITE EXPERIMENTS
- MATERIALS

SP-200 SERIES A UNIQUE COMBINATION OF HIGH PERFORMANCE AND PORTABILITY

Bio-Logic

expands the range of single potentiostats with a series of two portable workstations. Designed and manufactured upon Bio-Logic's long history of flexible and modular potentiostat, the SP-200 series incorporates the latest technology to ensure excellent performance.

The standard potentiostat board in the **SP-200 series** provides 12 V compliance, ± 10 V reference control, and a maximum current of ± 500 mA. A range of nine intelligent bandwidths ensures the stability of the **SP-200 series** in a wide variety of experimental conditions.

The **SP-240** includes a ± 4 A booster kit providing $[-3, +14]$ V compliance with $[-3, +10]$ V reference control and a maximum current of 4 A.

The **SP-200 series** is floating. Additionally, on-site corrosion experiments can be performed thanks to its portability. With its many unique features and excellent specifications, the **SP-200 series** is perfect for any application in electrochemistry.

Electrochemical Impedance Spectroscopy (EIS) measurements can be added as an option to the **SP-200 series**. The built-in FRA has a frequency range of 10 μ Hz up to 7 MHz (limited to 1 MHz with the 4A option).

Low current sensitivity can be improved using the ultra low current option (down to 1 pA range with 76 aA resolution).

The **SP-200 series** 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.

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 are available for electro-analytical and corrosion data, as well as equivalent circuit modeling for impedance data interpretation.



UNIQUE FEATURES

	SP-200	SP-240
■ Compliance:	± 12 V	$-3, +14$ V
■ Control voltage:	± 10 V	$-3, +10$ V
■ EIS measurement:	3 MHz (1%, 1°) 7 MHz (3%, 3°)	1 MHz
■ Current ranges:	500 mA	4 A to 1 μ A
■ Current resolution	760 fA (standard board)	
■ Low current	(additional ranges 1 μ A to 1 pA with resolution 76 aA)	
■ Floating mode		
■ Analog filtering		
■ Calibration board		
■ Full stability control mode	(9 bandwidths)	
■ Option: linear scan generator	(1 MV/s)	

APPLICATIONS



CORROSION / COATING

The **SP-200**'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-200** 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-200** exhibits extremely high resolution and accuracy in current and potential measurements. Combined with a high acquisition speed, the **SP-200** 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.

For low current measurements, the excellent sensitivity of the **SP-200**'s ultra low current option is a big advantage in detecting very low concentrations.

Fast potential scans can be used to highlight intermediate reaction species. The linear scan generator combined with a hardware ohmic drop compensation is well adapted to reach very fast scan rates.

NANOTECHNOLOGY/SENSORS

SP-200 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 electromagnetic 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.

FUEL CELLS/BATTERIES

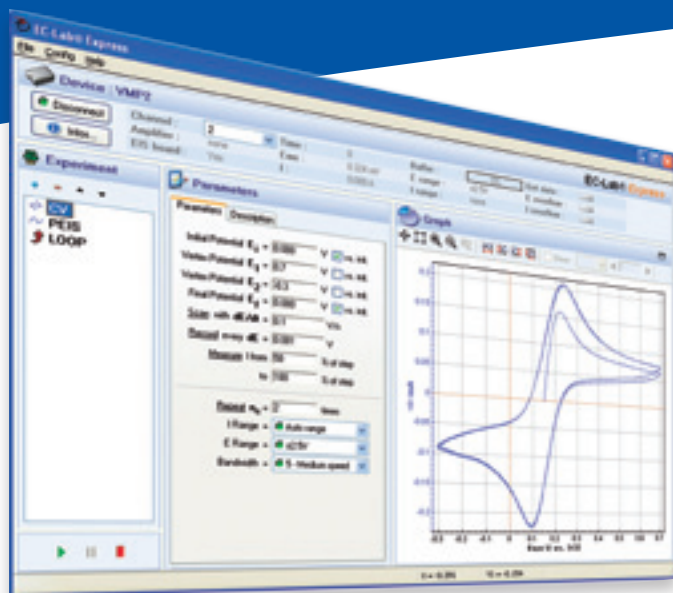
Research interest in new energy sources for electric vehicles (EVs) and hybrid electric vehicles (HEVs) is rapidly growing especially in fuel cell and battery R&D activity. Researchers in these fields require an instrument that can measure and apply high currents. The **SP-240**, with its high current booster option, is the perfect solution.

SP-240 draws upon Bio-logic's experience and long history in providing instruments to investigate intercalation compounds and batteries. A major feature of the **SP-240** 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-240** includes a multi-sine EIS technique that allows measurements to be made quickly to avoid changes during the experiment. A patented algorithm will correct for "drift" that may still occur during the experiment.

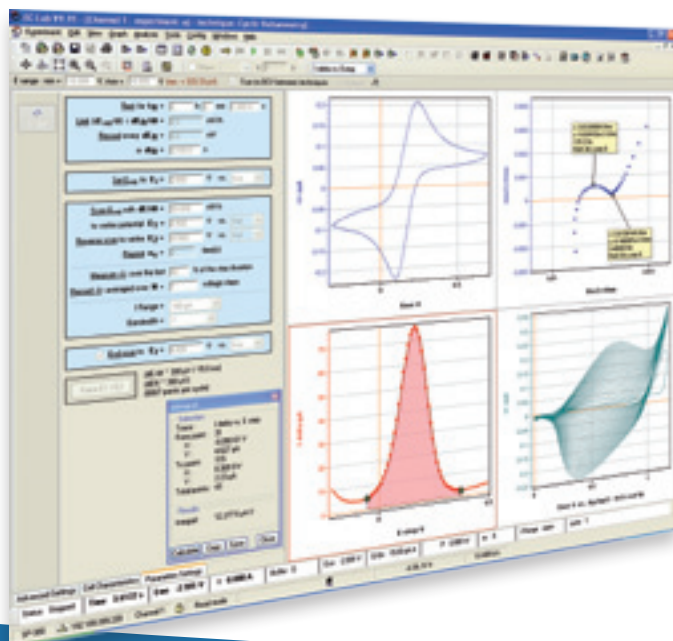
PHOTOVOLTAIC/SOLAR CELLS

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 performances of these devices, as well as their price. The **SP-240** and its high voltage/current capabilities is an important tool in developing photovoltaic cells and components.



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® 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 μ s. Coupled to the linear scan generator option, the software allows a data sampling of one million sample/second during a voltage scan of several thousand volts per second.

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 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[®] Graphics

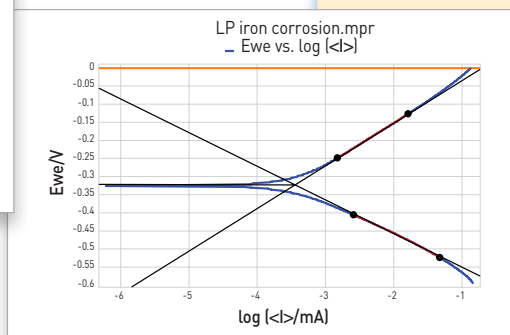
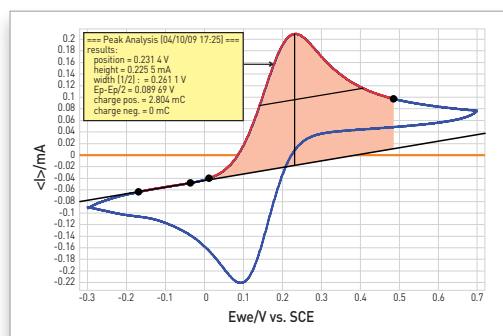
A comprehensive graphics package

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 electro-analytical analysis tools (such as peak find/height, convection wave, integral, Tafel fit, R_p 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 eight simple elements (R, C, L, Q, W, G, Wd, M). A batch processing feature allow 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 **Pascal** and **Veepro**[®] test program and **LabView**[®] examples are also provided.



Line Fit...



Circle Fit...



RP Fit...



Tafel Fit...



Integral...



Min Max...



Peak Analysis...



Wave Analysis...



Mott-Schottky...



Filtering...



Electrochemical Noise...



Fourier Transform...



Corr Sim...



Z Fit...



Z Sim...



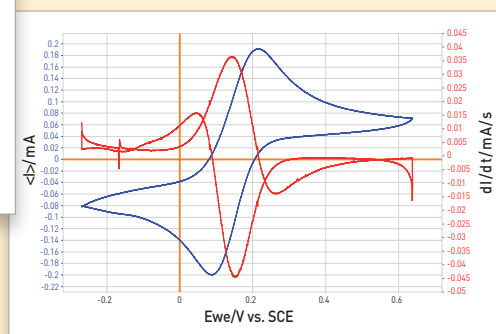
Kramers-Kronig...

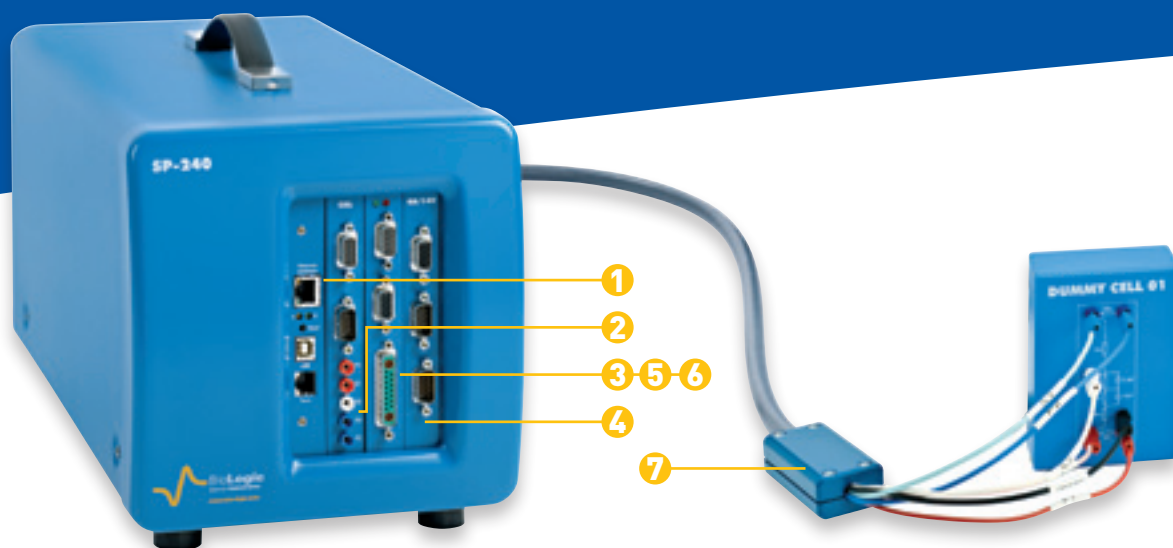


Traces Processing...



Process Data
(Cycles, R,
QCM mass...)





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.

2 CALIBRATION BOARD

Using the built-in calibration board, the user initiates a routine to perform a full calibration on the **SP-200 series**, 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 **SP-200 series** 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-200 series** 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 4 A / 14 V BOOSTER

The 4 A booster kit provided with the **SP-240** offers a control voltage from -3 V up to 10 V under 4 A. The polarization range is ideal for electrolysis or battery testing. This booster board can be calibrated together with the potentiostat board using the calibration board.

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 **SP-200** 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 that can be purchased as an upgrade. It is automatically detected and provides an analog voltage scan up to 1 MV/s.

7 ULTRA LOW CURRENT

An ultra low current option is available for the **SP-200 series**. This option lowers the base current range from 1 μ A 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.

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/ μ s
Rise/Fall Time (no load)	< 500 ns

Voltage control

Ranges	Adjustable from ± 10 V down to ± 30 mV
DC Level Shift	± 10 V, 300 μ V resolution
Accuracy	$< \pm 1$ mV $\pm 0.03\%$ of setting
Lowest resolution	1 μ V

Current control

Ranges	± 500 mA, ± 100 mA, ± 10 mA, ± 1 mA, ± 100 μ A, ± 10 μ A, ± 1 μ A (7 ranges)
Accuracy	$< \pm 0.1\%$ of range $\pm 0.03\%$ 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 μ V resolution
Accuracy (DC)	$< \pm 1$ mV $\pm 0.03\%$ 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 μ A, ± 10 μ A, ± 1 μ A
Additional ranges	± 100 nA, ± 10 nA with gain
Accuracy (DC)	$< \pm 0.1\%$ of range $\pm 0.03\%$ 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 T Ω 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 M Ω 10 nF typical
Grounded mode	< 10 k Ω

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 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	SP-200	225x167x410 mm (HxWxD), 6 kg
	SP-240	225x205x410 mm (HxWxD), 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 μ V/s)
Voltage range	± 10 V
Accuracy	$< \pm 0.1\%$ of range
Number of cycles	1 to 65535

* FSR: Full Scale Range

4 A/14 V BOOSTER (SP-240 ONLY)

Booster

Compliance voltage	+14; -3 V
Compliance current	±4 A
Control voltage	+10; -3 V
Bandwidth (-3 dB)	> 8 MHz
Slew Rate (no load)	> 7 V/μs
Rise/Fall Time (no load)	< 100 ns
Floating Mode	Yes
Current accuracy	0.1% range ±0.007% setting

IMPEDANCE ANALYZER (OPTIONAL)

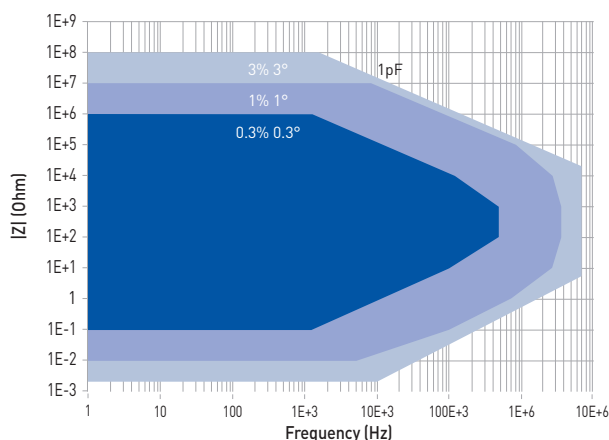
Impedance

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

Specifications are subject to change

CONTOUR PLOT

EIS for channel board alone



ULTRA LOW CURRENT (OPTIONAL)

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

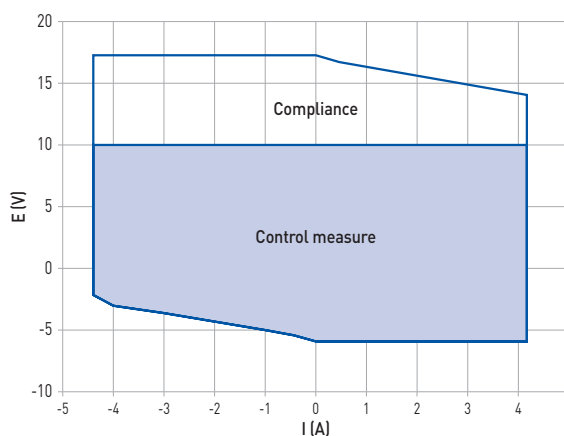
Current Measurement

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

Operating area (booster 4A)



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