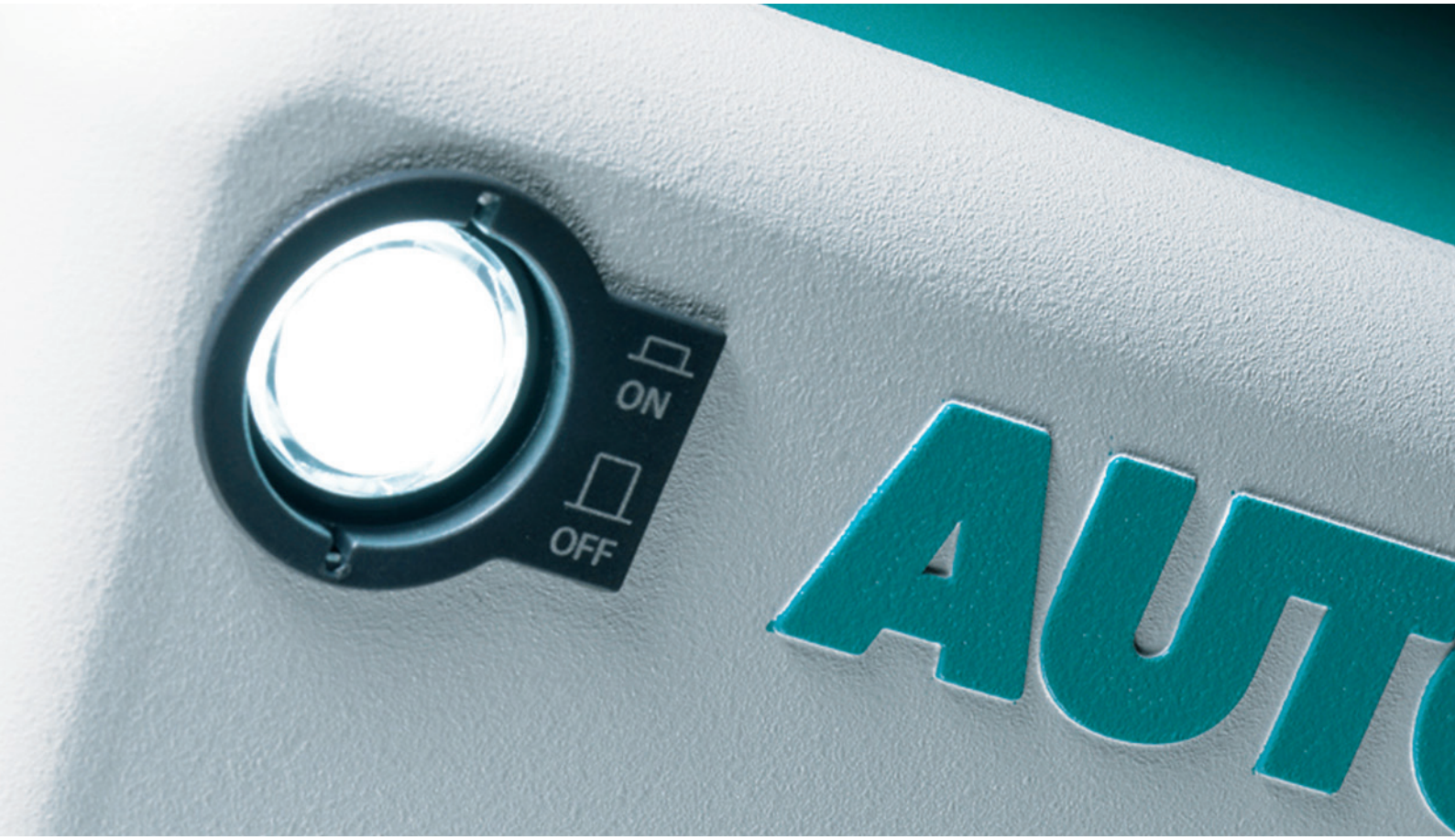
Metrohm Autolab



Instruments for electrochemical research

Metrohm
Autolab B.V.

Metrohm Autolab

- Founded in 1986
- Based in Utrecht, The Netherlands
- Since 1999 part of the Metrohm Group
- Introduced the first computer controlled potentiostat/galvanostat
- Develops and produces the high quality Autolab range of products
- Strong background in electrochemistry
- Supported by the worldwide Metrohm distribution network
- Three years factory warranty on all instruments
- Dedicated to research

International presence

Eco Chemie – Metrohm Autolab

Eco Chemie was founded in 1986 and is since 1999 a member of the Metrohm group of companies. In 2009 the company name changed to Metrohm Autolab to reflect the customer oriented combination of the worldwide Metrohm sales and support organization and the high quality Autolab series of instruments developed by Eco Chemie.

Metrohm Autolab is an ISO 9001 certified company.

Metrohm Autolab based in Utrecht, The Netherlands, designs and manufactures Autolab instruments, accessories, and software for electrochemistry.

Known for innovation, the Autolab was the first commercial digital potentiostat/galvanostat, that was completely computer controlled. Our latest software package NOVA has again set a high standard for powerful electrochemical research software.

With our background and knowledge in electrochemistry and our worldwide distributor network, our mission is to serve the research community all over the world by supplying state of the art instruments and unrivalled support. All Metrohm Autolab instruments are covered by a three year factory warranty.

3 year
instrument warranty

Metrohm Autolab – part of the global Metrohm Group

Metrohm Autolab is a member of the global Metrohm Group. Since the first days of the Autolab company, Autolab products have been designed to be as open as possible in order to facilitate their integration within electrochemical experimental setups.

Autolab products can be combined easily with many Metrohm instruments, notably for automation. This further extends the possibilities of the products offered by both companies and provides the means to setup unique automated electrochemical workstations.

The Autolab N series

The N series are state of the art, high end modular Potentiostat/Galvanostat instruments. Each device in this product range benefits from over two decades of experience in design and production.

Regardless of the field of application, the instruments in the N series are designed to address any electrochemical measurement. The modular concept provides the means for the instrument to grow with your needs of today and tomorrow.

Autolab instruments are known worldwide for their very high quality and reliability. Metrohm Autolab only uses the best and most robust components in the design of their products, which in turn makes the instruments in the N series the ideal choice for your research.

PGSTAT128N
12 V / 800 mA

PGSTAT302N
30 V / 2000 mA

PGSTAT100N
100 V / 250 mA

High performance

Autolab/PGSTAT302N

Autolab/PGSTAT302N is a modular high power potentiostat/galvanostat with a maximum current of 2 A (with BOOSTER20A 20 A) and compliance voltage of 30 V. The PGSTAT302N is the benchmark for high speed digital potentiostat/galvanostat instruments.

With a bandwidth of over 1 MHz, the PGSTAT302N can be fitted with all the available Autolab modules, making it not only the fastest but also the most versatile member of the Autolab N series. Analog and digital inputs and outputs for interfacing and controlling external devices are available.

Optional modules

- BOOSTER10A
- BOOSTER20A
- FRA32M
- ECI10M
- ADC10M
- SCAN250
- ECD
- FI20
- ECN
- pX1000
- EQCM
- BA
- MUX

Key features	
• Electrode connections	2, 3, and 4
• Potential range	+/- 10 V
• Compliance voltage	+/- 30 V
• Maximum current	+/- 2 A (20 A with BOOSTER20A)
• Current ranges	1 A to 10 nA, in 9 decades (expandable to 100 pA with ECD module)
• Potential accuracy	+/- 0.2%
• Potential resolution	0.3 µV
• Current accuracy	+/- 0.2%
• Current resolution	0.0003% (of current range)
• Input impedance	> 1 TOhm
• Potentiostat bandwidth	1 MHz
• Computer interface	USB
• Control software	NOVA

Modular design

Autolab/PGSTAT128N

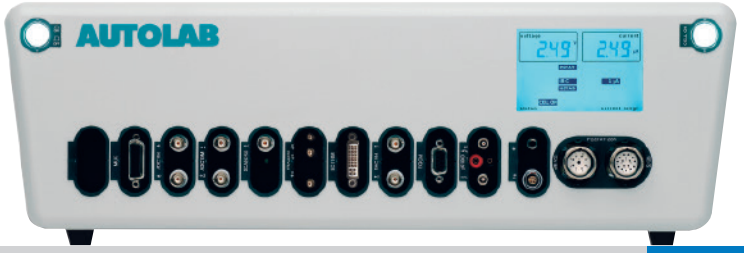
The entry level member of the modular Autolab instruments family, the Autolab/PGSTAT128N is a low noise and fast potentiostat/galvanostat capable of measuring maximum 800 mA (10 A with BOOSTER10A), with a compliance voltage of 12 V. The Autolab/PGSTAT128N is a high performance low cost option for electrochemical measurements in small cells. This budget instrument is the ideal choice for all low current applications where performance is important.

The users can customize and enhance the capabilities of the Autolab/PGSTAT128N by adding one or more of the optional modules or accessories. Analog and digital inputs and outputs for interfacing and controlling external devices are available.

Optional modules

- BOOSTER10A
- FRA32M
- ECI10M
- ADC10M
- SCAN250
- ECD
- FI20
- ECN
- pX1000
- EQCM
- BA
- MUX

Key features	
• Electrode connections	2, 3, and 4
• Potential range	+/- 10 V
• Compliance voltage	+/- 12 V
• Maximum current	+/- 800 mA (10 A with BOOSTER10A)
• Current ranges	1 A to 10 nA, in 9 decades (expandable to 100 pA with ECD module)
• Potential accuracy	+/- 0.2%
• Potential resolution	0.3 µV
• Current accuracy	+/- 0.2%
• Current resolution	0.0003% (of current range)
• Input impedance	> 1 TOhm
• Potentiostat bandwidth	500 kHz
• Computer interface	USB
• Control software	NOVA



High voltage applications

Autolab/PGSTAT100N

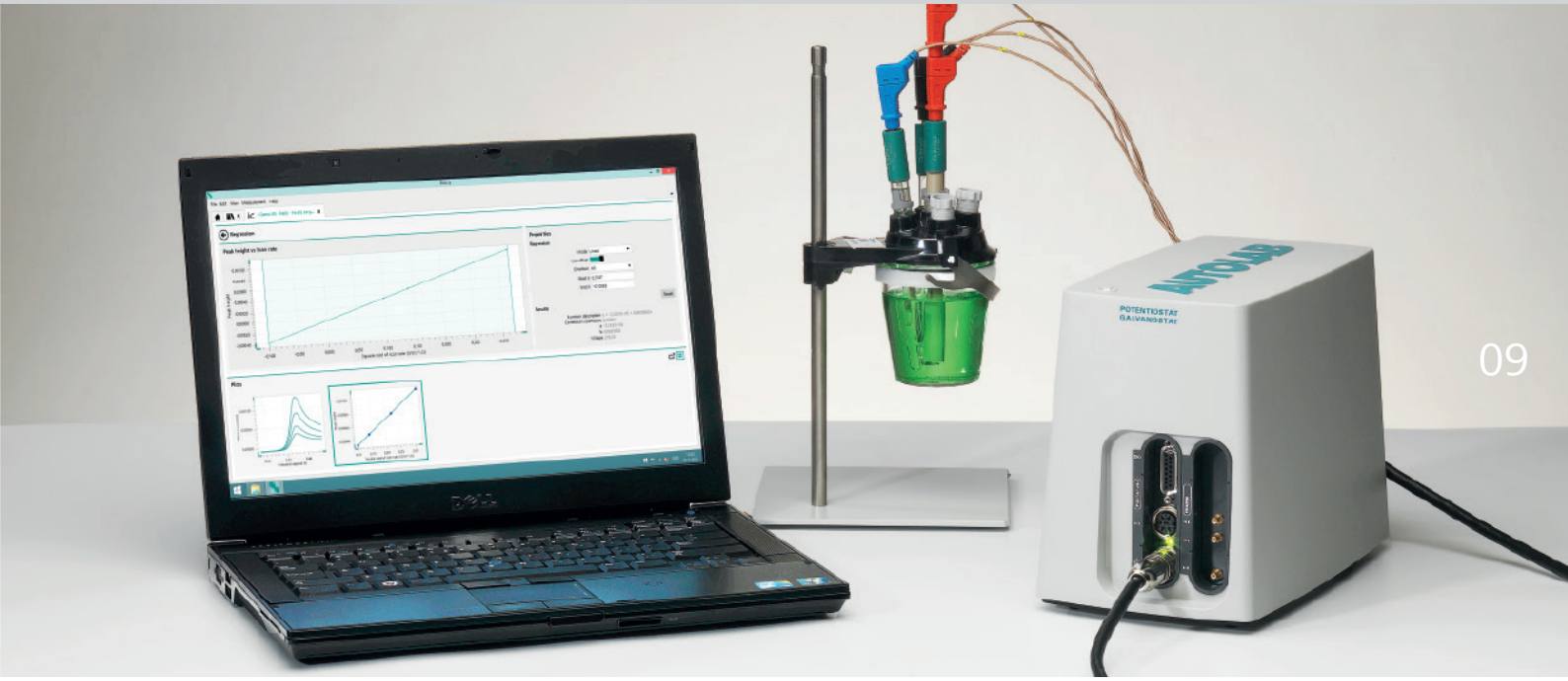
A high voltage potentiostat/galvanostat with a compliance voltage of 100 V and maximum current of 250 mA (10 A with BOOSTER10A), the Autolab PGSTAT100N is designed to address the needs of scientists doing electrochemical measurements in extreme conditions such as organic electrolytes, soil, concrete etc.

The modular PGSTAT100N is especially adapted for experiments in electrolytes with low conductivity. The user can customize and enhance the capabilities of the PGSTAT100N by adding one or more of the available optional modules or accessories. Analog and digital inputs and outputs for interfacing and controlling external devices are available.

Optional modules

- BOOSTER10A
- FRA32M
- ADC10M
- SCAN250
- ECD
- FI20
- BA

Key features	
• Electrode connections	2, 3, and 4
• Potential range	+/- 10 V
• Compliance voltage	+/- 100 V
• Maximum current	+/- 250 mA (10 A with BOOSTER10A)
• Current ranges	100 mA to 10 nA, in 8 decades (expandable to 100 pA with ECD module)
• Potential accuracy	+/- 0.2%
• Potential resolution	0.3 µV
• Current accuracy	+/- 0.2%
• Current resolution	0.0003% (of current range)
• Input impedance	> 100 GOhm
• Potentiostat bandwidth	400 kHz
• Computer interface	USB
• Control software	NOVA



The Autolab compact series

The compact series combines strong performance with a minimum footprint. These small instruments are designed to fit the requirements for most electrochemical experiments.

Two products are provided in this series: the compact PGSTAT101 and modular PGSTAT204.

PGSTAT101
10 V / 100 mA

PGSTAT204
20 V / 400 mA

Entry level

Autolab/PGSTAT101

The entry level in the Autolab range of electrochemical instruments, the Autolab/PGSTAT101 in combination with the powerful NOVA software, can be used for most of the standard electrochemical techniques. Autolab/PGSTAT101 is an affordable potentiostat/galvanostat without compromising on quality and specifications, making it an ideal instrument for students and educational purposes.

The small footprint allows you to place a high quality potentiostat/galvanostat on a crowded workbench. Analog and digital inputs and outputs for interfacing and controlling external devices are available. The Autolab/PGSTAT101 comes with an internal dummy cell and a built-in analog integrator.

Key features	
• Electrode connections	2, 3, and 4
• Potential range	+/- 10 V
• Compliance voltage	+/- 10 V
• Maximum current	+/- 100 mA
• Current ranges	10 mA to 10 nA, in 7 decades
• Potential accuracy	+/- 0.2%
• Potential resolution	3 µV
• Current accuracy	+/- 0.2%
• Current resolution	0.0003% (of current range)
• Input impedance	> 100 GOhm
• Potentiostat bandwidth	1 MHz
• Computer interface	USB
• Control software	NOVA

Compact yet modular

Autolab/PGSTAT204

The Autolab PGSTAT204 combines a small footprint with modular design. The instrument includes a base potentiostat/galvanostat with a compliance voltage of 20 V and a maximum current of 400 mA (10 A with BOOSTER10A). The potentiostat can be expanded at any time with one additional module, for example the FRA32M electrochemical impedance spectroscopy (EIS) module.

The PGSTAT204 is an affordable instrument which can be located anywhere in the lab. Analog and digital inputs/outputs are available to interface with external equipments. The PGSTAT204 includes a built-in analog integrator.

Optional modules

- BOOSTER10A
- FRA32M
- pX1000
- MUX
- BA
- EQCM

Key features	
• Electrode connections	2, 3, and 4
• Potential range	+/- 10 V
• Compliance voltage	+/- 20 V
• Maximum current	+/- 400 mA (10 A with BOOSTER10A)
• Current ranges	100 mA to 10 nA, in 8 decades
• Potential accuracy	+/- 0.2%
• Potential resolution	3 µV
• Current accuracy	+/- 0.2%
• Current resolution	0.0003% (of current range)
• Input impedance	> 100 GOhm
• Potentiostat bandwidth	1 MHz
• Computer interface	USB
• Control software	NOVA

The Autolab Multi channel series

The Multi Autolab series consists of modular multi channel instruments. Each instrument can accomodate up to 12 individual potentiostat/galvanostat modules.

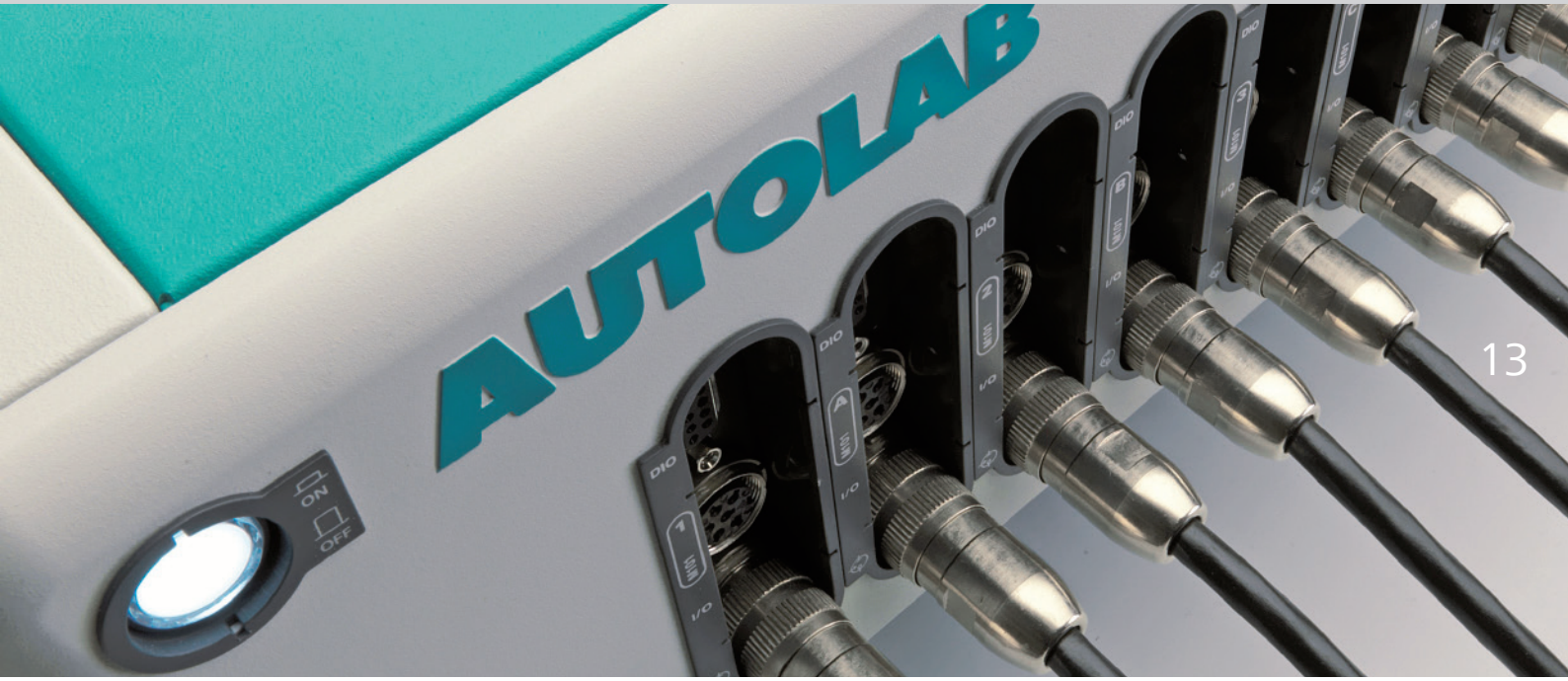
Additionnally, extra modules can be added to the instrument providing the means to customize each channel for a specific electrochemical measurement.

Two Multi Autolab systems are provided in this series: the M101 and the M204.

The Autolab Multi channel series instruments are controlled through NOVA software.

Multi Autolab/M101
10 V / 100 mA

Multi Autolab/M204
20 V / 400 mA



Multi Channel with modularity

The Multi Autolab with M101 is a multi channel version of the compact PGSTAT101. Up to 12 individual M101 modules can be located inside the Multi Autolab, allowing simultaneous independent measurements on as many electrochemical cells.

The individual channels can be adressed from up to three individual computers using the built-in hub. Additionally, measurements on different channels can be synchronized at any time.

Each M101 potentiostat/galvanostat is fitted wiht an internal dummy cell and a built-in integrator and can be coupled to one additional optional module.

Optional modules

- FRA32M
- pX1000
- MUX
- BA
- EQCM

Key features	
• Electrode connections	2, 3, and 4
• Potential range	+/- 10 V
• Compliance voltage	+/- 10 V
• Maximum current	+/- 100 mA
• Current ranges	10 mA to 10 nA, in 7 decades
• Potential accuracy	+/- 0.2%
• Potential resolution	3 µV
• Current accuracy	+/- 0.2%
• Current resolution	0.0003% (of current range)
• Input impedance	> 100 GOhm
• Potentiostat bandwidth	1 MHz
• Computer interface	USB
• Control software	NOVA

High power Multi Channel

The Multi Autolab with M204 is the multi channel version of the modular PGSTAT204. Up to 12 individual M204 modules can be located inside the cabinet. It is also possible to combine the potentiostat/galvanostat M204 modules with optional modules for added functionality.

Each M204 potentiostat/galvanostat is fitted with a built-in integrator.

The instrument provides the possibility to control the individual potentiostat/galvanostat modules from up to three computers, using the built-in hub.

To extend the maximum current, each M204 module can be coupled to a BOOSTER10A module.

Key features	
• Electrode connections	2, 3, and 4
• Potential range	+/- 10 V
• Compliance voltage	+/- 20 V
• Maximum current	+/- 400 mA (10 A with BOOSTER10A)
• Current ranges	100 mA to 10 nA, in 8 decades
• Potential accuracy	+/- 0.2%
• Potential resolution	3 µV
• Current accuracy	+/- 0.2%
• Current resolution	0.0003% (of current range)
• Input impedance	> 100 GOhm
• Potentiostat bandwidth	1 MHz
• Computer interface	USB
• Control software	NOVA

Optional modules

- BOOSTER10A
- FRA32M
- pX1000
- MUX
- BA
- EQCM

Instruments for special applications

Autolab provides a series of instruments for special applications.

The PGSTAT302F is a modified version of the PGSTAT302N, which can be operated in floating mode or in normal mode.

The PGSTAT302N/MBA and the PGSTAT128N/MBA are derived from their N series counterparts. These instruments can be fitted with up to five additional working electrodes sharing a common counter and reference electrode.

PGSTAT302F
30 V / 2 A

PGSTAT302N/MBA
30 V / 2 A / 50 mA

PGSTAT128N/MBA
12 V / 800 mA / 50 mA

Special instruments ...

PGSTAT302F

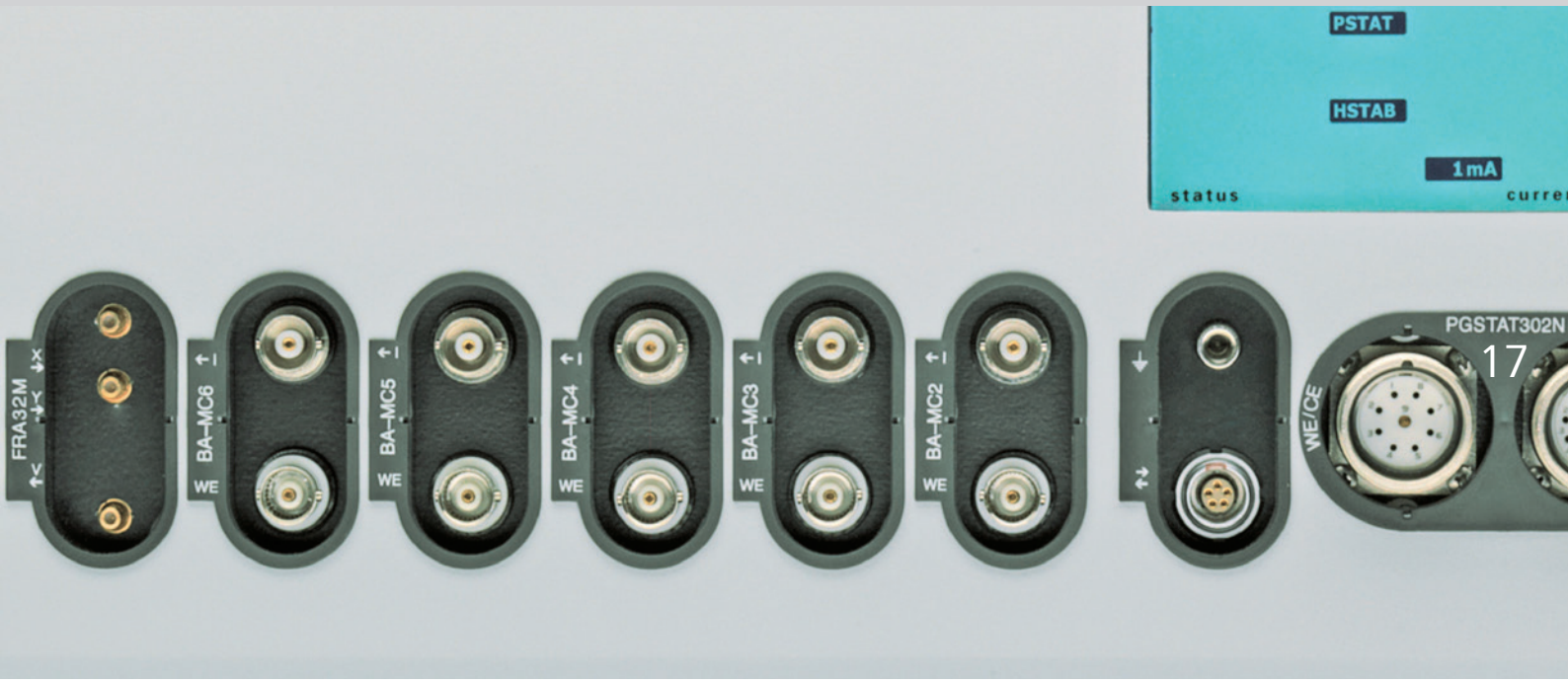
The PGSTAT302F is a special version of the PGSTAT302N which can be switched from the regular «grounded mode» to so-called «floating mode». In grounded mode, the PGSTAT302F can be used with normal electrochemical cells, while in floating mode, the PGSTAT302F can be used with grounded cells or electrochemical cells in which the working electrode is connected to ground (e.g. pipelines, autoclaves, etc.).

This instrument can be fitted with the FRA32M impedance analyzer module.

Optional module

- FRA32M

Key features	
• Electrode connections	2, 3, and 4
• Potential range	+/- 10 V
• Compliance voltage	+/- 10 V
• Compliance voltage (grounded)	+/- 30 V (special cables required)
• Maximum current	+/- 2 A
• Current ranges	1 A to 10 nA, in 9 decades
• Potential accuracy	+/- 0.2%
• Potential resolution	0.3 µV
• Current accuracy	+/- 0.2%
• Current resolution	0.0003% (of current range)
• Input impedance	> 1 TOhm
• Potentiostat bandwidth	100 kHz
• Computer interface row	USB (isolated)
• Control software	NOVA



... for special applications

PGSTAT128N Multi BA and PGSTAT302N Multi BA

This is a special version of the PGSTAT128N or PGSTAT302N in which up to 6 working electrodes are available, providing electrochemical measurents on up to 6 different electrodes in the same cell at the same time, sharing the same reference and counter electrode.

Key features	PGSTAT128N Multi BA	PGSTAT302N Multi BA	BA
• Electrode connections	2, 3, and 4		1 each
• Potential range	+/- 10 V		+/- 10 V
• Compliance voltage	+/- 12 V	+/- 30 V	–
• Maximum current	+/- 800 mA	+/- 2 A	+/- 50 mA
• Current ranges	1 A to 10 nA, in 9 decades		10 mA to 10 nA, in 7 decades
• Potential accuracy	+/- 0.2%		+/- 0.2%
• Potential resolution	0.3 µV		0.3 µV
• Current accuracy	+/- 0.2 %		+/- 0.2%
• Current resolution	+/- 0.0003% (of current range)		+/- 0.0003% (of current range)
• Input impedance	> 1 TOhm		–
• Potentiostat bandwidth	500 kHz	1 MHz	–
• Computer interface	USB		–
• Control software	NOVA		–

Optional modules

- FRA32M
- BA (Maximum 5)

Unique possibilities ...

BOOSTER10A and BOOSTER20A

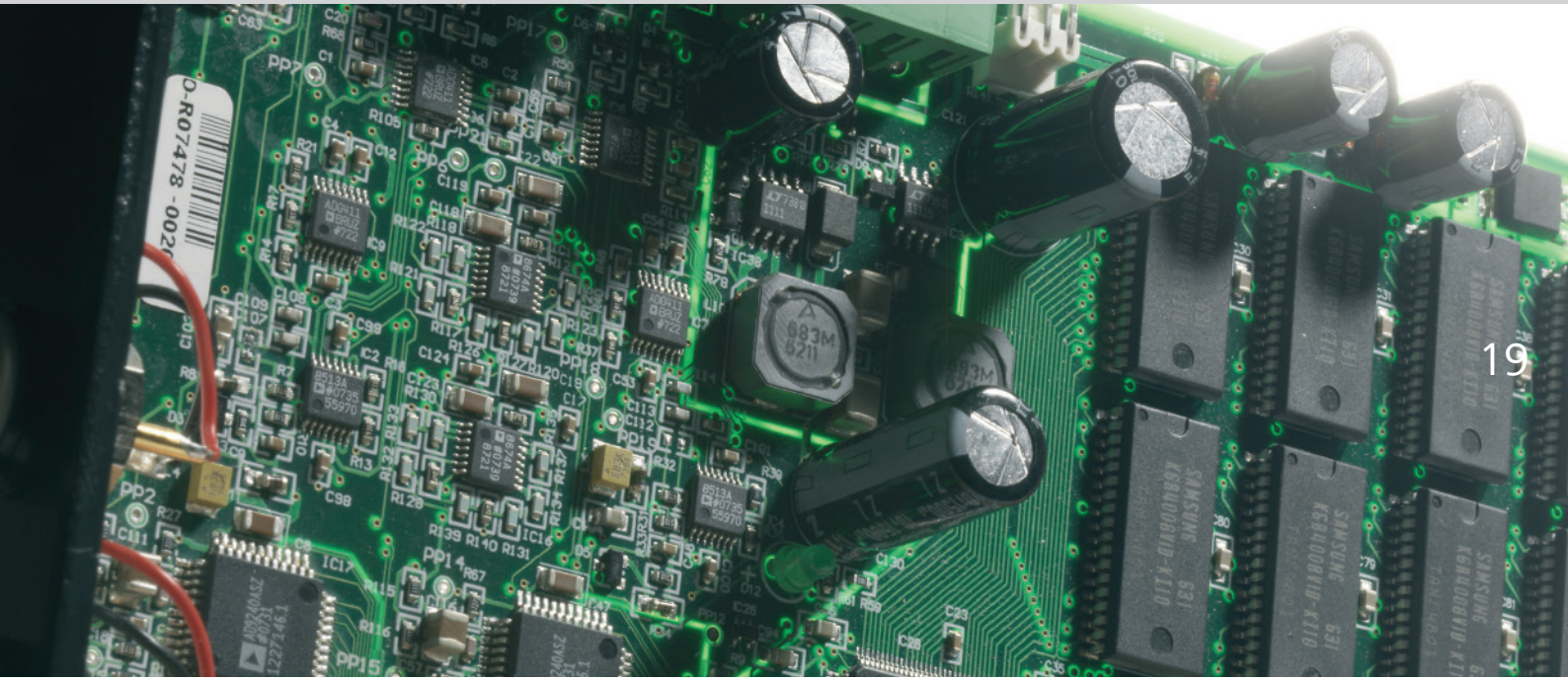
The BOOSTER10A module increases the maximum current of the Autolab/PGSTATS to 10 A. The maximum current of the PGSTAT302N can be increased to 20 A with BOOSTER20A.

With its fast response time, the Autolab booster has been optimized to perform electrochemical impedance measurements, in combination with the FRA32M module, on fuel cells, batteries and super-capacitors. The booster is able to handle active as well as passive cells.

Application areas

- DC and AC electrochemical measurements on large area electrodes
- Determination of charge/discharge characteristics of super-capacitors
- Electrochemical impedance at high current densities
- Measurements of the i-V and power characteristics of energy storage devices

Key features	BOOSTER10A	BOOSTER20A
• Maximum power	150 W	350 W
• Maximum compliance voltage	+/- 20 V	+/- 20 V
• Maximum applied voltage	+/- 10 V	+/- 10 V
• Maximum current	+/- 10 A	+/- 20 A
• Resolution	0.0003%	0.0003%
• Accuracy	+/- 0.5%	+/- 0.2%
• Operation mode	Potentiostat/ galvanostat	Potentiostat/ galvanostat
• Bandwidth - Potentiostatic - Galvanostatic	 4 kHz 2.5 kHz	 18 kHz 40 kHz
• Emergency off switch	n.a.	yes
• Instrument compatibility	PGSTAT128N, PGSTAT302N, PGSTAT100N, PGSTAT204, M204	PGSTAT302N



... with high performance, high quality modules ...

FRA32M

Electrochemical impedance spectroscopy (EIS) is a powerful technique for the characterization of electrochemical systems. It has widespread use in a large number of applications.

The Autolab users can perform EIS measurements with the FRA32M module in potentiostatic and galvanostatic control, over a wide frequency range of 10 µHz to 1 MHz. In addition to the classical EIS, the NOVA software also allows the users to modulate other outside signals such as rotation speed of a rotating disk electrode or the intensity of a light source to perform Electrohydrodynamic or Photo-modulated impedance spectroscopy.

The FRA32M module comes with a powerful fit and simulation software for the analysis of impedance data.

Key features	
• Frequency range	10 µHz - 32 MHz
• Frequency range in combination with ECI10M	10 µHz - 10 MHz
• Frequency range in combination with PGSTAT	10 µHz - 1 MHz
• Frequency resolution	0.003%
• Input range	+/- 10 V
• Frequency range in combination with ECI10M	10 µHz - 10 MHz
• Signal types	1 sine, 5 sine, 15 sine
• Input channels	E and i from the potentiostat/ galvanostat or X and Y external signals
• AC amplitude	0.2 mV to 0.35 V rms in potentiostatic mode 2 mV to 3.5 V rms (optional) 0.0002 - 0.35 times current range in galvanostatic mode
• Data presentation	Nyquist, Bode, Admittance, Dielectric, Mott-Schottky
• Data analysis	Fit and Simulation, Find circle, Element subtraction, Kramers-Kronig
• Instrument compatibility	PGSTAT128N, PGSTAT302N, PGSTAT100N, PGSTAT302F, Multi Autolab/M101, Multi Autolab/M204, Multi BA, PGSTAT204

... allowing versatile custom built instruments for research

ECI10M

With the ECI10M, the maximum frequency that can be reached during electrochemical impedance spectroscopy measurements is extended up to 10 MHz.

The ECI10M consists of a module, installed in the Autolab potentiostat/galvanostat and coupled to the FRA32M module and an external interface designed to be placed in close proximity of the electrochemical cell in order to minimize the effects from the electrode cables.

The small form factor of the external interface allows measurements in a glove box or Faraday cage.

The ECI10M uses the Automatic Amplitude Correction algorithm (AAC) to ensure that the amplitude applied on the cell corresponds to the required amplitude at all times, thus maximizing the resolution while respecting the linearity and stability conditions during the measurement.

Key features	
• Electrode connections	2, 3, and 4
• Potential applied	+/- 10 V
• Compliance voltgae	+/- 10 V
• Maximum current	+/- 100 mA
• Current ranges	100 mA to 10 nA, 8 decades
• Potential accuracy	+/- 0.2%
• Potential resolution	0.3 µV
• Current accuracy	+/- 0.2%
• Current resolution	0.0003 % (of current range)
• Input impedance	> 100 GOhm
• Bandwidth	15 MHz
• Frequency range	10 MHz - 10 µHz
• Frequency resolution	0.003%
• Maximum amplitude	700 mV (RMS)
• Instrument compatibility	PGSTAT128N, PGSTAT302N

ADC10M

The ADC10M module is an ultra-fast sampling module that increases the sampling rate of the Autolab from 50 kSamples/s to 10 MSamples/s giving the possibility to acquire fast transients with interval times down to 100 ns. When combined with the SCAN250 module, ultra-fast cyclic voltammetry measurements can be performed with scan rates up to 250 kV/s, making it a powerful tool for studying fast kinetic processes.

The ADC10M module samples the potential and the current of the main potentiostat or up to 2 external signals.

Key features	
• Sampling rate	10 MSamples/s (100 ns)
• Data size	1 million points per channel
• Number of channels	2
• Instrument compatibility	PGSTAT128N, PGSTAT302N, PGSTAT100N

SCAN250

The staircase method for cyclic voltammetry is widely used in digital instruments. The measured currents due to the charging of the double layer are reduced if the duration of the step is sufficiently long. This results in data that can be treated as originating from faradaic processes only.

When the processes exhibit very fast transient behavior, such as hydrogen adsorption, digital sweep can lead to loss of information regarding the adsorption process.

The SCAN250 module, which has the capability of applying a true analog sweep to the sample, was specially designed to overcome this problem. The SCAN250 module combined with ADC10M is a very powerful tool for studying fast transients.

Key features	
• Scan range	+/- 5 V relative to initial potential
• Range of scan rates	10 mV/s to 250 kV/s
• Number of scans	32,000
• Instrument compatibility	PGSTAT128N, PGSTAT302N, PGSTAT100N

BA

The BA is a dual-mode bipotentiostat module that converts the Autolab into a double channel potentiostat. Measurements on 2 working electrodes can be performed sharing the same counter and reference electrode. In the standard mode, a fixed potential is applied to the second channel (second Working Electrode) while applying a potential step or a sweep to the first channel (first Working Electrode). In the scanning bipotentiostat mode, a potential offset with respect to the first channel is applied to the second channel.

Key features	
• Number of channels	1 (5 for Multi BA)
• Potential range	+/- 10 V
• Current ranges	10 mA to 10 nA, in 7 decades
• Current accuracy	+/- 0.2%
• Current resolution	0.0003% (of current range)
• Maximum current	+/- 50 mA
• Modes	Bipotentiostat and scanning bipotentiostat
• Instrument compatibility	PGSTAT128N, PGSTAT302N, PGSTAT100N, Multi Autolab/M101, Multi Autolab/M204, Multi BA, PGSTAT204

ECN

During localized corrosion, electrochemical noise is generated by a combination of stochastic (random) processes, such as breakdown of passive films and repassivation. Electrochemical noise (ECN) is an in-situ technique for measuring these localized corrosion processes on bare or coated metal samples.

During measurements with the ECN module no external perturbation (potential or current) is applied to the electrode. The potential and current signals are measured as a function of time.

Key features	
• Input range	+/- 2.5 V
• Measurement resolution	0.8 µV (gain 100)
• Measurement accuracy	300 µV
• Input bias current	< 25 fA (for DC measurements)
• Input impedance	> 100 GOhm
• Offset compensation	+/- 10 V
• Instrument compatibility	PGSTAT128N, PGSTAT302N

ECD

The lowest current range available on the standard modular Autolab is 10 nA. At this current range, the Autolab has a current resolution of 30 fA. When doing measurements on microelectrodes some times an even higher resolution is needed.

Originally designed for electrochemical detection in HPLC and FIA, the ECD module makes the measurement of such low currents possible. The ECD module provides 2 additional current ranges of 1 nA and 100 pA giving a minimum current resolution of 300 aA.

Key features	
• Current ranges	100 µA to 100 pA, in 7 decades
• Current measuremrent	+/- 0.5%
• RC Filter time constants	0.1 s, 1 s, and 5 s
• Compensation of	current offset +/- 1 µA maximum
• Instrument compatibility	PGSTAT128N, PGSTAT302N, PGSTAT100N

MUX

The MUX modules allow the Autolab users to perform electrochemical experiments on multiple cells sequentially. The cell to perform a measurement on can be selected either manually or automatically. This allows for easy automation of routine electrochemical measurements leading to increased productivity. Autolab offers 2 types of MUX modules.

MUX.MULTI4

Sequential measurements can be performed on up to 64 complete electrochemical cells, with increments of 4.

MUX.SCNR8

Sequential voltage measurements can be performed on up to 128 stacked cells, sharing the same counter and working electrode, with increments of 8.

MUX.SCNR16

Sequential measurements can be performed on up to 255 individual working electrodes in the same electrochemical cell, with increments of 16.

Key features	MUX.MULTI4	MUX.SCNR8	MUX.SCNR16
• Cell connection	Independent RE, CE, WE, S	Independent RE, S	Independent WE
• Number of channels	4 to 64 with increments of 4	8 to 128 with increments of 8	16 to 255 with increments of 16
• Maximum current	2 A		
• Maximum compliance voltage	30 V		
• Instrument compatibility	PGSTAT128N, PGSTAT302N, Multi Autolab/M101, Multi Autolab/M204		

FI20

The FI20, filter and integrator module, allows the Autolab users to do coulometric and chrono-coulometric experiments. The analog integrator and the built-in integrator of the PGSTAT101/M101 and PGSTAT204/M204 gives the users the possibility to measure charge instead of current and can be used both in cyclic voltammetry as well as in potential step experiments.

With this module it is easy to separate the capacitive current from the faradaic current. In addition the integrator is effective in reducing signal noise by averaging it out. The third order Sallen-Key filter with selectable RC-times between 0 and 500 ms, can be used to filter out noise. The module is also useful in cases where the background noise (50 or 60 Hz for example) cannot be removed by using measures like a Faraday cage.

Key features	
• Type of filter	Third order Sallen-Key
• RC Filter time constants	0.1 s, 1 s, and 5 s
• Integration times	0.01 s, 0.1 s, 1 s, and 10 s
• Front panel analog output	Current and charge
• Instrument compatibility	PGSTAT128N, PGSTAT302N, PGSTAT100N

pX1000

With the pX1000 module installed in the Autolab instrument the user can measure the pH or the pX in parallel with an electrochemical measurement. The user can connect any pH, pX or «double» electrode to the module. The pX1000 also provides the connections for a Pt1000 temperature probe.

In case an electrode other than a pH electrode is used, the output is given as the voltage difference that is measured between the electrodes, making it possible to connect a detection electrode to perform coulometric titration.

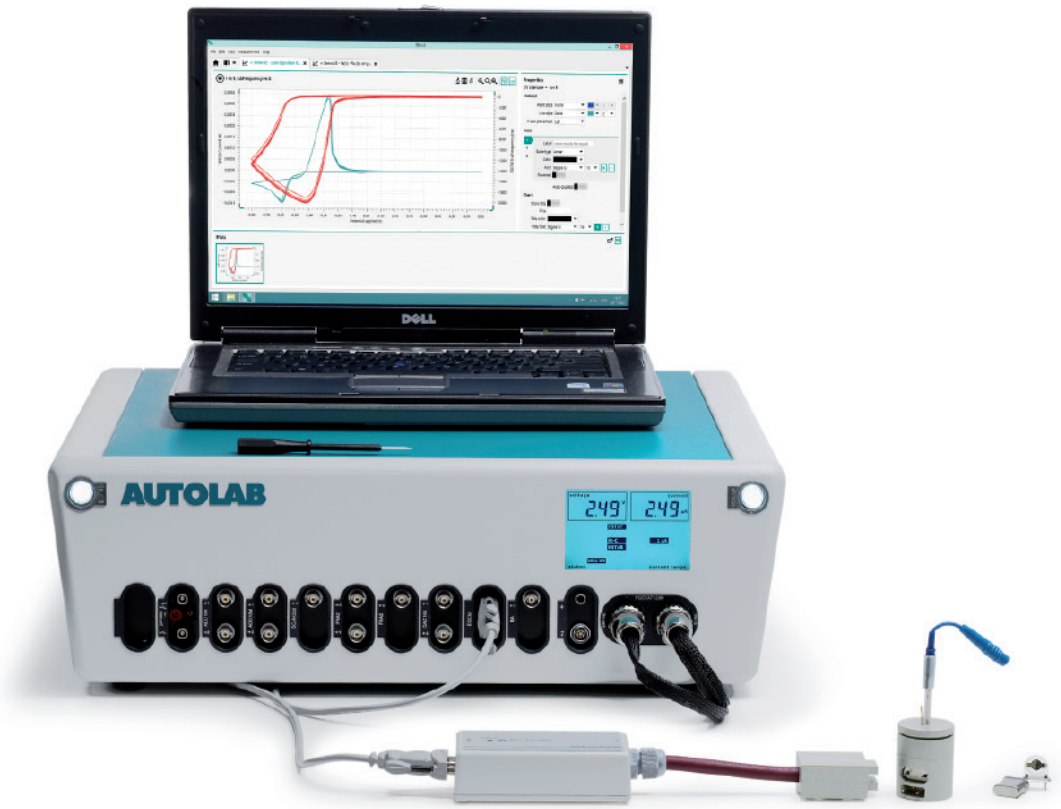
Key features	
• Input range	+/- 10 V
• Measurement resolution	0.3 µV (gain 1000)
• Measurement accuracy	+/- 2 mV
• Input impedance	> 1 TOhm // 8 pF
• Temperature accuracy	+/- 0.5 ˚C
• Temperature resolution	0.015 ˚C
• Instrument compatibility	PGSTAT128N, PGSTAT302N, Multi Autolab/M10, Multi Autolab/M204, PGSTAT204

EQCM

The EQCM module provides the means to perform Electrochemical Quartz Crystal Microbalance experiments. The EQCM module measures a mass change per unit area by recording the change in resonant frequency of a quartz crystal oscillator.

Measurements in the sub µg/cm^2 are possible. The EQCM can be fitted with 6 MHz, AT-cut crystals. The module comes with a dedicated electrochemical cell.

Key features	
• Oscillation frequency	6 MHz
• Resolution	0.07 Hz
• Relative accuracy	1 Hz
• Sampling rate	50 S/s
• Frequency range	80.000 Hz
• Instrument compatibility	PGSTAT128N, PGSTAT302N, Multi Autolab/M101, Multi Autolab /M204, PGSTAT204



Module comptability

The BOOSTER10A and BOOSTER20A come in a seperate housing and thus do not occupy module positions in the Autolab. The maximum number of additional modules in the Autolab is 8 and 1 for the PGSTAT204.

Modules	PGSTAT128N	PGSTAT302N	PGSTAT100N	Multi Autolab/ M101	PGSTAT302F	PGSTAT128N Multi BA PGSTAT302N Multi BA	PGSTAT204 Multi Autolab/M204
BOOSTER10A*	•	•	•	n.a.	n.a.	n.a.	•
BOOSTER20A*	n.a.	•	n.a.	n.a.	n.a.	n.a.	n.a.
FRA32M	•	•	•	•	•	•	•
ECI10M	•	•	n.a.	n.a.	n.a.	n.a.	n.a.
ADC10M	•	•	•	n.a.	n.a.	n.a.	n.a.
SCAN250	•	•	•	n.a.	n.a.	n.a.	n.a.
MUX	•	•	n.a.	•	n.a.	n.a.	•
BA	•	•	•	•	n.a.	•	•
ECN+	•	•	n.a.	n.a.	n.a.	n.a.	n.a.
ECD	•	•	•	n.a.	n.a.	n.a.	n.a.
FI20	•	•	•	n.a.	n.a.	n.a.	n.a.
pX1000+	•	•	n.a.	•	n.a.	n.a.	•
EQCM	•	•	n.a.	•	n.a.	n.a.	•

(*) (+) These modules are mutually exclusive

Total solutions ...

Autolab RDE

The Autolab RDE (Rotating Disk Electrode) is a high end RDE. The unit has a high performance motor reaching 10,000 rpm, and a liquid Hg contact for very low noise measurements. The PCTFE electrode shaft has been designed to fit in Metrohm cell lids.

Easily exchangeable electrode tips can be mounted on the shaft, 10 mm diameter tips with an active surface diameter of 3 mm and 5 mm are available in Gold, Silver, Glassy Carbon and Platinum. Empty tips are available if the user wants to use his own 5 mm diameter material.

The rotation speed of the RDE is controlled by a motor control unit. The low noise Hg contact makes the Autolab RDE suitable for measurements at very low currents or electrochemical impedance measurements.

Autolab RRDE

The Autolab RRDE (Rotating Ring Disc Electrode) extends the design of the Autolab RDE with a double mercury contact, allowing friction-less electrical contact to the disc and ring.

The RRDE can be operated up to 10,000 RPM and can be fitted with the Autolab RRDE electrode tips. The RRDE electrode tips consist of a 5 mm disc of platinum, gold or glassy carbon, with a concentric platinun ring at a distance of 375 µm, leading to a theoretical collection efficiency of 24.9%.

Specifications	
• Speed control	Manual and software
• Motor speed range	100 - 10,000 RPM
• Manual speed setting	100 - 10,000 RPM in 1 RPM steps
• Acceleration/ deceleration	4,000 RPM/s
• Maximum current	500 mA
• Contact (RDE)	Sealed Hg pool
• Contact (RRDE)	Double sealed Hg pool
• Electrode tips (RDE 10 mm Ø)	3 mm active area in Ag, Au, Pt, and GC 5 mm active area in Ag, Au, Pt, GC, and empty
• Electrode tips (RRDE 11.6 mm Ø)	5 mm active area disc in Pt, Au or GC and 750 µm ring in Pt

... with a wide range of Autolab and Metrohm accessories

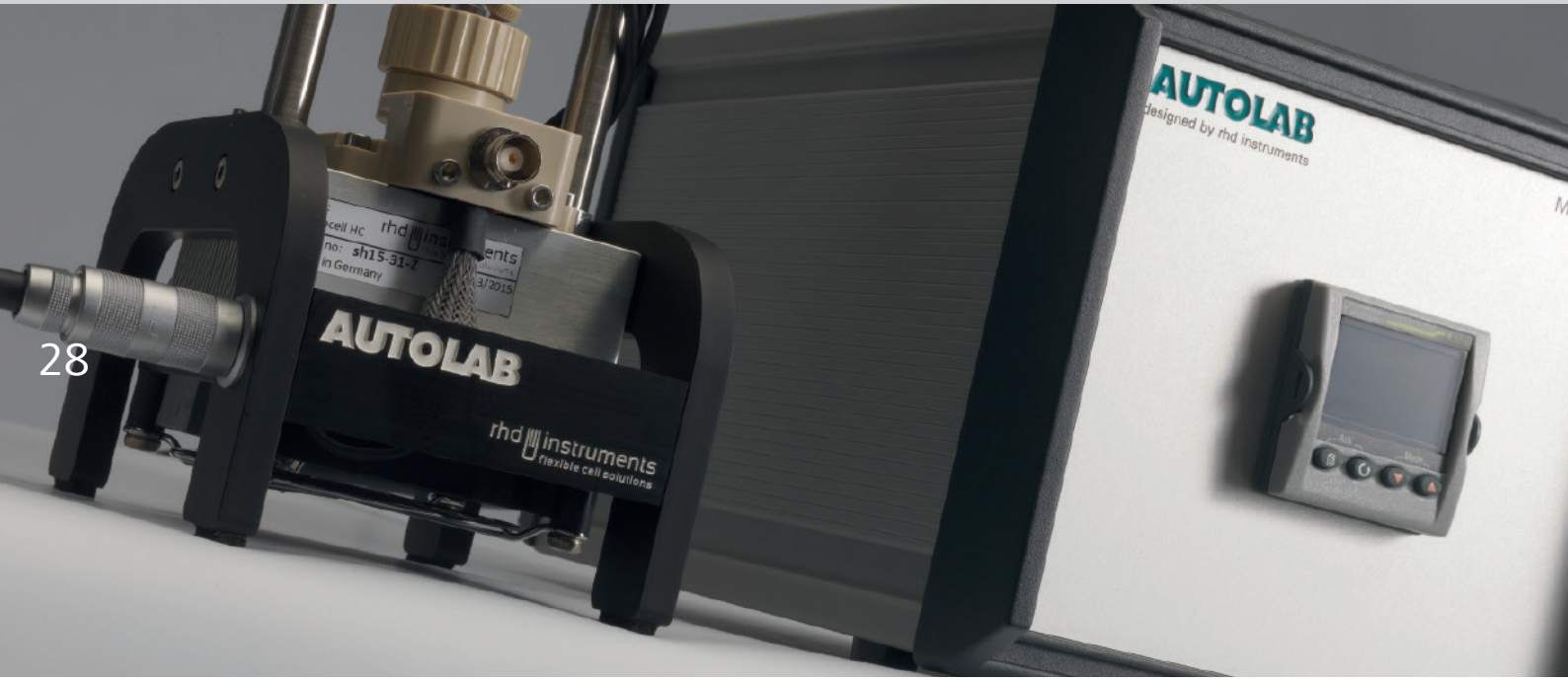
Autolab Optical bench: Software programmable light source and bench

The Metrohm Autolab optical bench provides the means to study the electrochemical behavior of photovoltaic cells, like dye sensitized solar cells. The light source used in this setup is a highly focused LED. The bench includes a software programmable LED Driver which can be used to control the light source output.

The light source itself is fitted with a quick release system, allowing a fast exchange of the light source and wavelength. It is supplied with a default 627 nm light source.

The following items are part of Optical bench kit.

LED Driver	Autolab LED Driver, 700 mA output
Optical bench	Complete optical bench
LDC655	LED Cover, deep red, 655 nm
LDC627	LED Cover, red, 627 nm, included with the LED Driver
LDC617	LED Cover, red-orange, 617 nm
LDC590	LED Cover, amber, 590 nm
LDC530	LED Cover, green, 530 nm
LDC505	LED Cover, cyan, 505 nm
LDC470	LED Cover, blue, 470 nm
LDCCW	LED Cover, cool white
LDCWW	LED Cover, warm white
LDCNW	LED Cover, neutral white



Flexible cell solutions

Autolab Microcell HC

The Autolab Microcell HC system is the ideal solution for fast and reliable temperature-controlled experiments. Consisting of a temperature controller and a cell stage with Peltier element, the Autolab Microcell HC is designed to accomodate a large choice of specially designed electrochemical cells.

The temperature controller itself is integrated in the NOVA software, allowing manual and remote control of the sample temperature. This combination allows you to perform electrochemical measurements, using all the available techniques, in order to determine relevant parameters like impedance and conductivity in a wide range of temperature. Special cells for batteries are available, as well as cells for ionic liquids, Van der Pauw measurements or hyphenation with spectroscopy measurements.

The Autolab Microcell HC is designed in collaboration with RHD Instruments GmbH. The electrochemical cells designed for the Autolab Microcell HC system fit all experimental requirements. For volatile and non-volatile samples, small or large volumes, batteries, surfaces, spectroelectrochemical measurements, gel-like samples.

Specifications	
• Temperature range	-40 °C - 100 °C
• Temperature accuracy	+/- 0.1 °C
• Temperature control	Peltier
• Temperature control rate	60 °C/minute
• Interface	Serial
• Minimum sample volume	70 µl

Mesurement cells and options

All the cells designed for the Autolab Microcell system are fitted with a gold-plated thermo block with Pt100 temperature sensor. The cells are made in PEEK for optimal chemical compatibility. These cells can be assembled by hand in a normal laboratory environment or in a glove box. Each cell is designed to fit on the Autolab Microcell HC holder, allowing for fast exchange of the cell.

Closed TSC1600 and TSC70

The TSC1600 and TSC70 are general purpose cells with a volume of 1600 µl and 70 µl, respectively. These cells can be used to perform conductivity measurements on ionic liquids, determine the stability window of these electrolytes or determine the HOMO-LUMO gap of OLED dyes in organic solvents.

Closed TSC SW

The Closed TSC SW cell has been designed for conductivity measurements of moisture, air and light sensitive polyelectrolytes, polymer salt solutions and gels. It can also be used for conductivity measurements of ion conducting glasses.

TSC Battery (standard/extended)

The TSC Battery has been designed for battery applications and is available in two versions: a standard version suitable for plane substrates, like the active materials, separators or solid ion conducting materials and an expanded version that allows the use of elemental lithium as electrode material. These cells can be fitted with elemental lithium as a pseudo-reference electrode or with a micro-reference electrode. Furthermore, additional electrolyte can be added to the cell through lateral inlets.

TSC Surface

The TSC Surface is designed for electrochemical measurements on flat samples and can be used to study the electrochemical interface between a well defined working electrode and solution and the kinetics of electron transfer reactions. This cell, like all other cells is suitable for measurements with ionic liquids, but it can also be used with aqueous and organic solvents and for corrosion measurements.

Cooling box

For measurements at very low temperatures, or measurements in a condensing atmosphere, a cooling box with a suitable cable feedthrough is available.

Electrodes

A range of electrodes is available. Besides reference electrodes (Ag/AgCl) and counter electrodes (Platinum or Glassy Carbon), electrode tips are available in different sizes and different materials.

In combination with the Metrohm electrode tip holder, these tips will provide the user a range of different working electrodes. An empty Kel-F electrode tip is available for those who want to use their own materials

Specifications	
Material	**Size**
• Platinum, Gold, Silver, Glassy Carbon	3 mm and 5 mm
• Other materials	5 mm
• Empty tip	5 mm

Faraday cage

The Autolab Faraday cage has been designed to allow the users to protect their electrochemical cell setup from electro-magnetic interference from external sources such as computer monitors, other instruments in the lab or power lines.

In many cases the main source of external electrical interference is the line frequency (50/60 Hz) which can corrupt electrochemical data, particularly when small signals are being measured.

An earth terminal is available in the Faraday cage to connect to the Autolab to prevent ground loops.

Specifications	
• External dimensions	(W×D×H) 38×21×38 cm^3
• Internal dimensions	(W×D×H) 34×19×34 cm^3

Microelectrodes

A range of microelectrodes is available for sensor research. They are available in 5 different materials. The electrodes are configured to fit the Metrohm universal electrode tip holder making it easy to exchange tips. The electrodes are specially designed by sealing small diameter wires in glass and polishing them to mirror finish.

Specifications	
Material	**Size**
• Platinum	10, 20, 25, 50, 100, 200, 300, and 500 µm
• Gold	10, 25, 40, 100, 200, 300, and 500 µm
• Palladium	25, 60, 100, 200, 300, and 500 µm
• Silver	25, 30, 60, 100, 200, 300, and 500 µm
• Iridium	75 µm

Flat cell

The flat cell has been designed to measure corrosion properties of large flat coated or bare metal samples immersed in an electrolyte solution. It consists of a glass vessel fitted with a PVC holder. The holder allows quick and easy exchange of test samples. The exposed surface area of the sample is 16.9 cm^2. The leakage of the electrolyte from the sample holder is prevented by the use of a Viton O-ring and 3 wing nuts.

The cover of the flat cell is made of PVDF and allows the placement of a reference electrode, counter electrode and a gas inlet/outlet. The flat cell is supplied with a large area stainless steel counter electrode and Ag/AgCl reference electrode.

Corrosion cells

The corrosion cells have been designed to measure the corrosion properties of circular samples immersed in an electrolyte. Metrohm Autolab provides a 400 ml version with the sample holder on the side and a 1 litre version with a sample holder on the top according to ASTM standards.

Both cells can be connected to a waterbath and come with sample holder, reference electrode, 2 counter electrodes, thermo-meter and gas inlet. The reference electrode is positioned close to the sample by using a Luggin capillary.

Specifications	400 ml cell	1 litre cell
• Sample diameter	14 mm	16 mm
• Exposed surface	0.785 cm^2	1.0 cm^2
• Sample holder	POM	PP
• Seal	Viton	Natural rubber

Cell setup

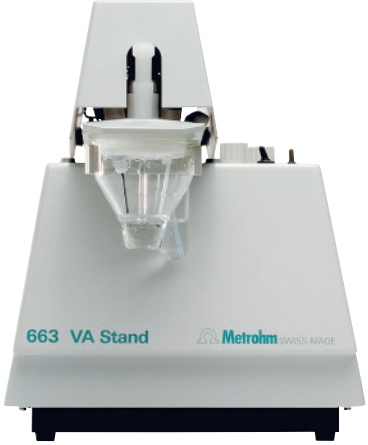
Metrohm Autolab instruments supplies cells with cell stands, counter electrodes, working electrodes and reference electrodes made by Metrohm for setting up electrochemical experiments.

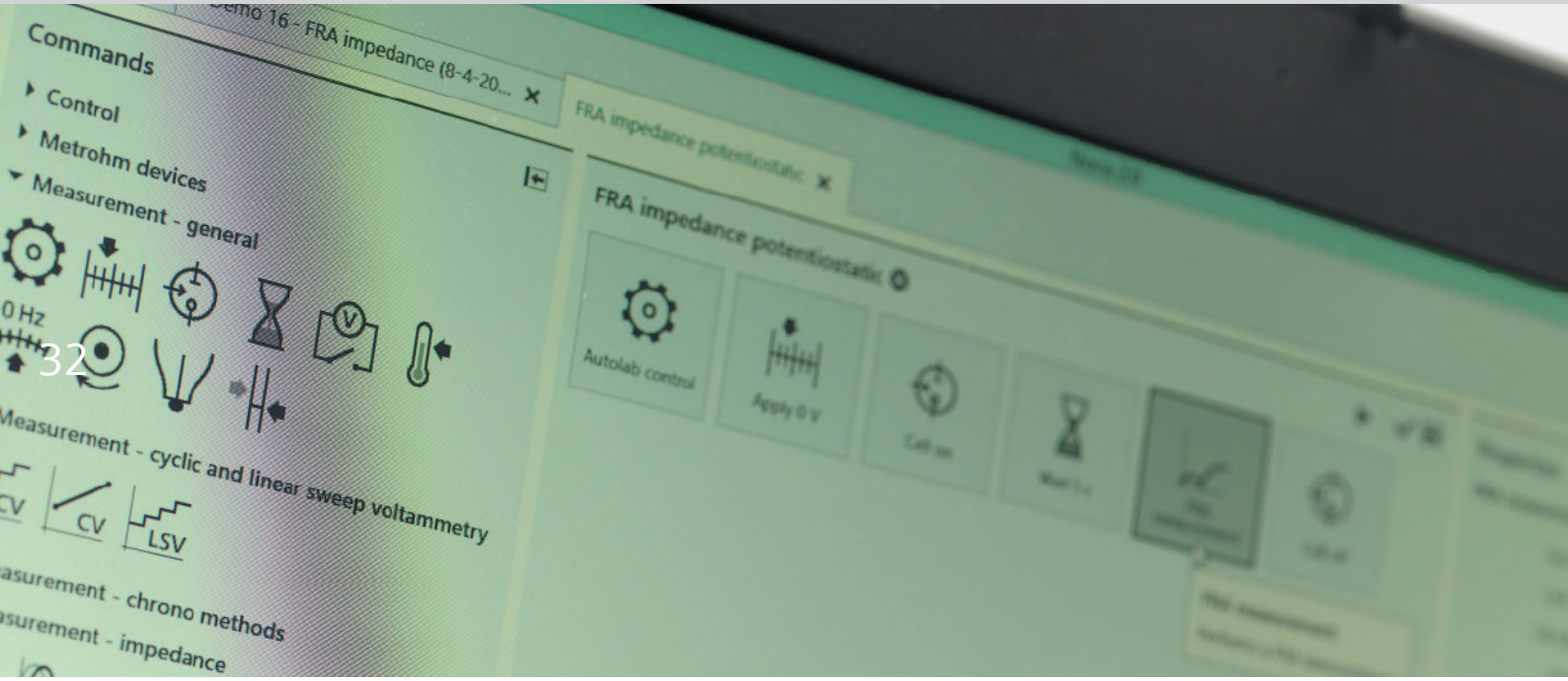
Specifications	
• Cell vessels	1 ml, 5 ml, 20 - 90 ml, thermostatic 50 - 150 ml
• Cell stand	Base plate with stand rod
• Disk working electrodes	3 mm Ø in GC, Au, Pt, and Ag
• Counter electrodes	Pt sheet, Pt rod, GC rod
• Reference electrodes	Ag/AgCl with electrolyte vessel, Ag/AgCl double junction

Metrohm 663 VA Stand

The Metrohm 663 VA Stand forms the wet chemical part of a polarographic and voltammetric system that can be controlled by the Autolab potentiostat in conjunction with the IME663 interface.

The size of the mercury drop and the stirrer speed are controlled manually from the VA Stand. The 663 VA Stand is equipped with an Ag/AgCl reference electrode and a Glassy Carbon counter electrode. The VA Stand can be operated in DME, HDME and SMDE mode. The system can be equipped with a rotating disk electrode operating at speeds of 0,500, 1,000, 1,500, 2,000 and 3,000 rpm. The disk electrodes are of 2 mm diameter.





NOVA, powerful and flexible ...

Autolab NOVA software

NOVA is the data acquisition and analysis software package for all the Autolab potentiostat/galvanostat instruments.

Developed by electrochemists for electrochemists and integrating over two decades of user experience as well as the latest software technology, NOVA software brings power and flexibility to the Autolab users.

NOVA is designed to answer demands of both experienced electrochemists and newcomers alike. Setting up experiments, acquiring data points and performing data analysis to produce publication-ready graphs, only takes a few mouse clicks.

The following techniques are available:

Cyclic and linear sweep voltammetry

- Staircase cyclic and linear sweep voltammetry
- True linear scan cyclic voltammetry
- High-speed linear scan cyclic voltammetry

Impedance spectroscopy

- Electrochemical impedance spectroscopy
- External transfer function analysis (IMVS, IMPS, EHD, ...)
- Potential scan, current scan, time scan, Mott-Schottky

Chrono methods

- Chrono methods ($\Delta t > 1$ ms)
- Chrono methods high speed ($\Delta t > 100$ ns)
- Recurrent pulsing methods

Voltammetric analysis

- Sampled DC
- Normal pulse
- Differential pulse
- Differential normal pulse
- Square wave
- Potentiometric stripping analysis
- AC voltammetry

Tools and controls

- Manual control of the instruments
- iR drop compensation
- Rotating (ring) disc electrode (RRDE) control
- Repeat loops
- Cutoffs
- Open circuit potential (OCP) measurements
- Analog input and output
- Digital DIO (TTL) triggering
- Additional signals (Δfrequency, bipotentiostat, ...)
- Import/export ASCII, GPES, FRA

Application development

- LabVIEW drivers and ready-to-use VIs
- Generic interface for .NET applications

… data acquisition and analysis software for Autolab users

Flexible procedure editor

NOVA comes with a library of procedures available for most electrochemical experiments. Alongside these electrochemical methods, an extensive list of commands is provided. Commands are used to customize existing procedures or as individual building blocks to construct any electrochemical procedure, from the most simple to the most advanced.

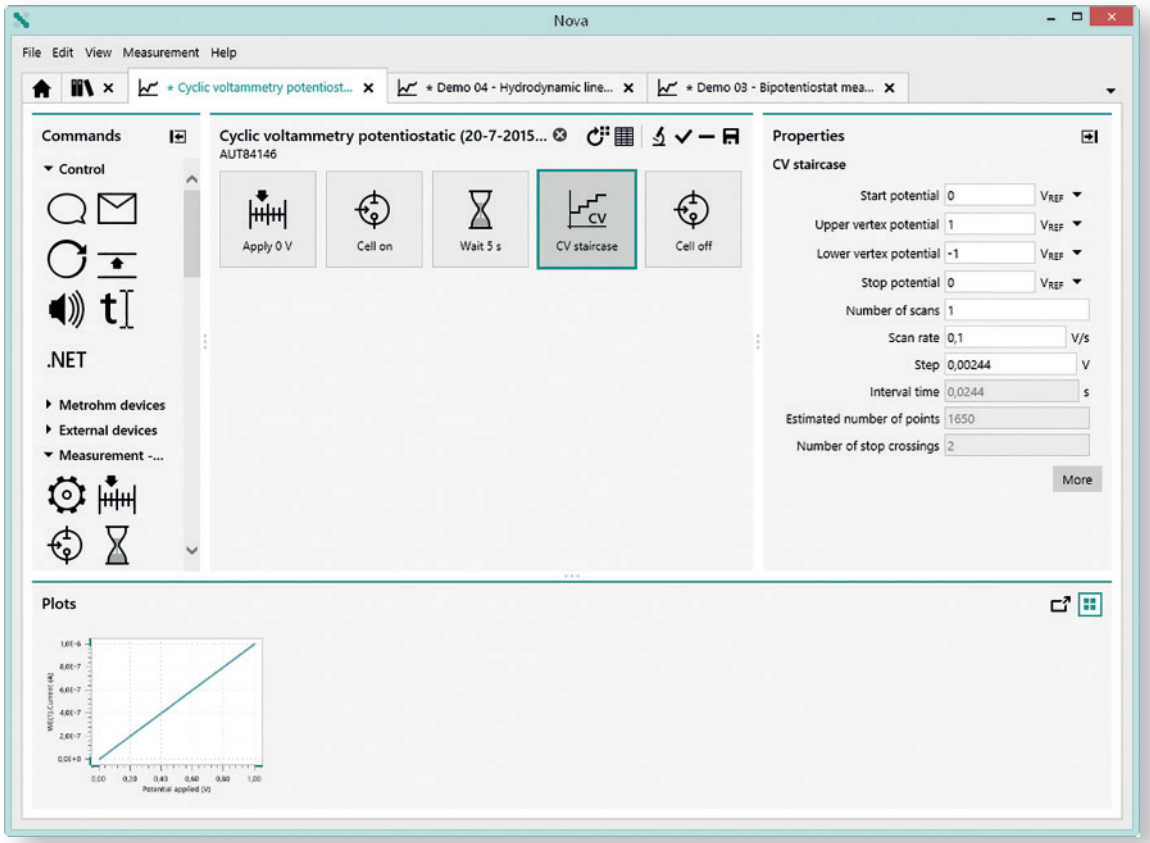
NOVA is controlled by interacting and placing individual items, represented by a convenient tile, in a sequence. This provides a simple and clear overview of the individual steps in a procedure.

Procedure properties can be linked providing the means to build dynamic procedures, in which parameters are updated real time depending on the measurement progress. Convenient tools like repeat loops, cutoffs and data analysis instructions can be used in the procedure editor, making routine experiments easy.

Sampling and data aquisition settings can be defined for each measurement, ensuring that the relevant data is always recorded under optimal conditions.

NOVA can be used to perform any number of experiments sequentially, without interruption, on each of the instruments connected to the computer.

It is designed as a generic electrochemical interface and it can easily be adapted to any kind of application.



Powerful data presentation

During electrochemical experiments, recorded data points can be displayed in a dedicated interface of the software. Plots can be used to display, in 2D or 3D, measured data points or results of data analysis. Comparison with previous experiments is possible while experiments are in progress.

The software provides a clear overview of the experimetal data and the instrument settings during experiments. The software also provides full manual control of the instrument as well as all the ancillary equipment connected to the computer.

Data points are saved in the database at the end of the measurements. Each experiment is logged by time and date and additional comments can be added to each entry. Data analysis progress can be appended to the data.

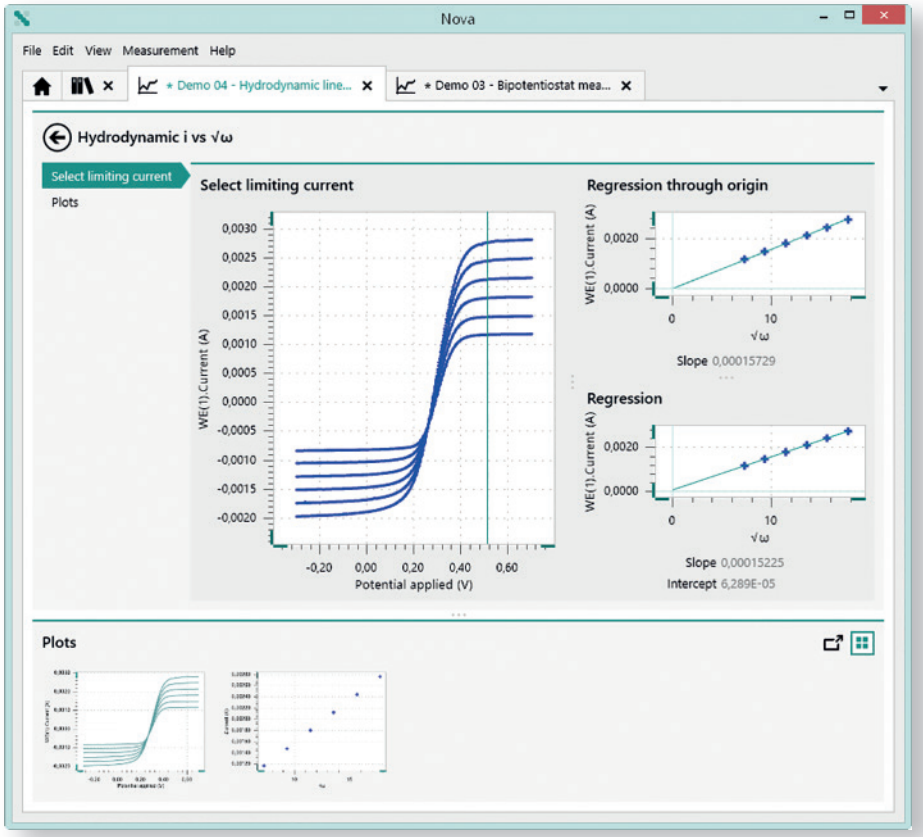
Advanced data analysis

NOVA includes a dedicated data analysis environment, featuring advanced 2D and 3D plotting, a large number of data analysis tools and an electrochemical spreadsheet.

Plotting tools like individual axis scaling, multiple Y-axes, plot additions, zooming and overlays help the user display the relevant information in clear, publication-ready graphs. Each plot can be directly pasted into a paper or a presentation.

Powerful data analysis tools can be combined with a built-in electrochemical spreadsheet to analyze the data, perform calculation and create new plots without having to export the files to a third-party software.

NOVA merges procedure editing and data analysis together. Any addition, modification or analysis of data can be immediately carried over to a new procedure in order to include the changes in the next measurement. This unique feature drastically reduces the time required to setup the experimental conditions.



Your data, anywhere and everywhere

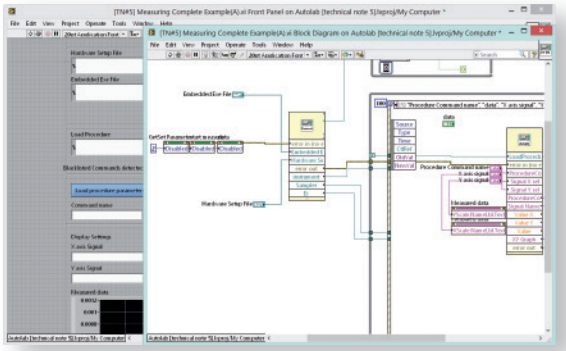
NOVA is designed for the current generation of Windows computers and runs on any Windows based device, from traditional desktop computers to Windows based tablets.

NOVA can be used with a mouse and keyboard interface or using a touch based interface.

Autolab SDK

Alongside NOVA, Metrohm Autolab also supplies the Autolab SDK. The Autolab Software Development Kit (SDK) is designed to control the Autolab instrument from different external applications such as LabVIEW, Visual Basic for Applications (VBA), scripting etc. With the Autolab SDK the external application can be used to measure complete procedures or control individual Autolab modules.

The Autolab SDK is compatible with NOVA procedures but can be used as a stand-alone application.



Requirements

NOVA is compatible with all the Autolab instruments with a USB interface and is based on the Microsoft .NET framework.

The following PC configuration is recommended: Processor 2 GHz or higher, 80 GB HDD, 2 GB RAM, USB port, Windows 7, 8 or 10. Up to 127 Autolab instruments can be controlled from one PC.

The Autolab SDK is compatible with LabVIEW and with any other software supporting .NET assemblies.

Tailored solutions

Corrosion

Corrosion is a process involving deterioration or degradation of materials that results in huge economical losses.

As corrosion processes are electrochemical in nature and involve two or more reactions, electrochemical techniques using sophisticated instruments are required to study them.

The Autolab instruments along with the NOVA software offer the corrosion practitioners a wide array of tools for studying these processes.

Dedicated modules

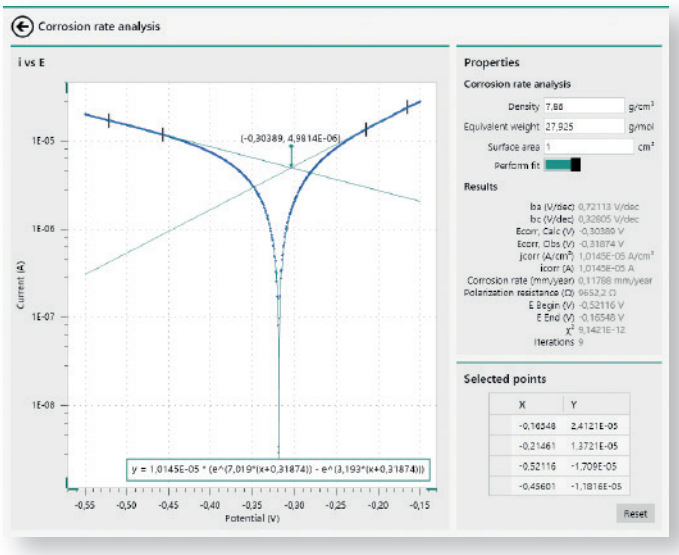
- FRA32M – Corrosion testing and research
- ECN – Characterization of coatings
- MUX.MULTI4 – Sequential measurements on up to 64 cells
- pX1000 – Critical pitting temperature measurements
- EQCM – Determination of mass change

Dedicated accessories

- Reference and counter electrodes
- Corrosion cell
- Flat cell
- Normal cells
- Faraday cage
- Rotating disc electrode (RDE)

Autolab key features

- Multi sine technique for fast low frequency measurements
- Automatic determination of corrosion rate in NOVA software
- High compliance voltage (100 V) of the PGSTAT100N allows corrosion measurements on cells with high ohmic drop (in concrete, non-aqueous media, ...)
- Galvanic coupling, electrochemical noise and zero-resistance amperometry (ZRA) measurement
- The MUX module allows the automation of routine corrosion measurements by running up to 64 cells sequentially



The Autolab instruments can be customized to be used in ...

Energy

Electrochemical processes are the basis of a wide range of energy conversion devices such as fuel cells, batteries, solar cells, and super-capacitors. Modern electrochemical instruments are key to the success of research in energy storage devices which is focused on improving efficiency, reducing energy use and lowering costs.

DC techniques such as linear sweep voltammetry have been used for determining the i-V and power characteristics of fuel cells and batteries. In recent years EIS has been successfully applied to the study of fuel cells, batteries and super-capacitors. One of the advantages of EIS over DC techniques is the possibility of using very small amplitude signals without significantly disturbing the properties being measured.

The Autolab FRA32M system in combination with BOOSTER10A or BOOSTER20A makes it possible to perform EIS measurements at high currents.

Dedicated modules

- FRA32M – Fuel cell characterization and research, measurement of very small impedances (< 1 mOhm)
- BA – Bipotentiostat module

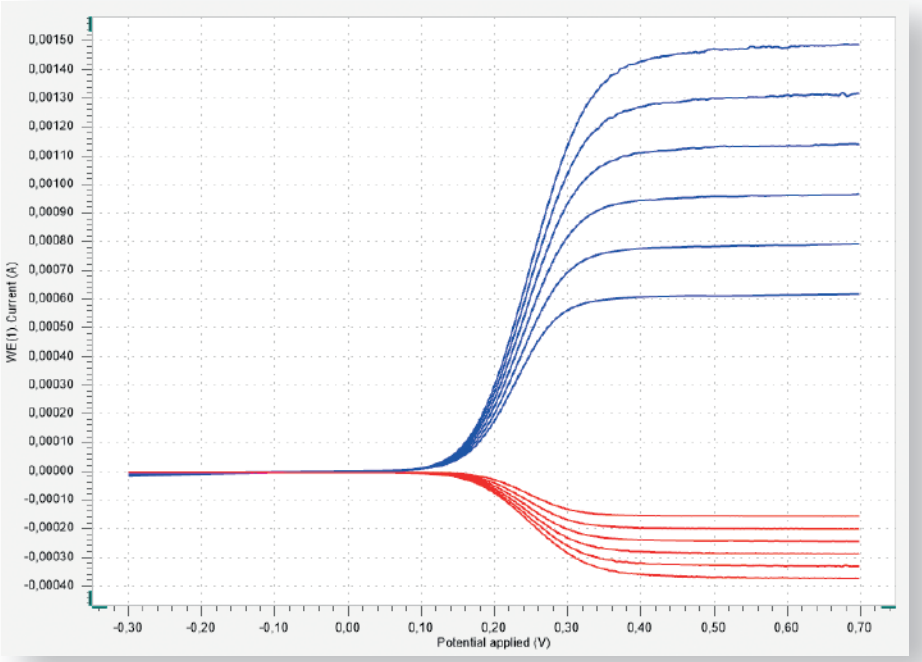
Autolab key features

- High frequency (20 kHz) FRA32M measurements at high currents (20 A)
- Very small errors in phase angle on low impedance cells (< 1 mOhm)
- ADC10M/SCAN250 module for fast analog scans allowing measurement of fast processes (hydrogen adsorption)
- Measurements on active cells possible
- 4-Electrode configuration allows measurements across membranes
- Connection to electronic loads and programmable power supplies for DC and FRA measurements possible

- ADC10M/SCAN250 – Fast scans for hydrogen adsorption measurements
- BOOSTER10A/20A – DC and AC measurements on small stacks or large area electrodes (currents up to 20 A), can also be used as load for active cells

Dedicated accessories

- Electronic load interface – Connection to third-party electronic loads and programmable power supplies
- Autolab RRDE – rotating ring disc electrode



Interfacial electrochemistry

Studies of the electrochemical interface are of fundamental interest for all electrochemical processes. The characterization of the double layer structure, adsorption phenomena, surface diffusion, nucleation and growth and electron transfer kinetics necessitates versatile and accurate instrumentation. Combination with external devices (STM, FTIR, RAMAN etc.) is often required.

The Autolab PGSTAT provides the most suitable tools for the accurate characterization of interfacial processes, determination of thermodynamics and kinetics as well as reaction mechanisms.

Dedicated modules

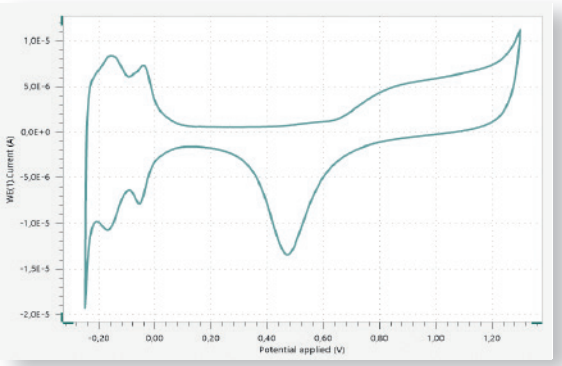
- SCAN250 – True linear analog scan generator
- ADC10M – Fast sampling A/D converter for chrono measurements
- ECD – Low current measurements
- EQCM – Electrochemical quartz crystal microbalance
- FRA32M – AC characterization of the double layer

Dedicated accesories

- RDE • Double junction reference electrode
- Faraday cage

Autolab key features

- Cyclic voltmmetry using a linear scan generator (SCAN250) for accurate measurements of the capacitive contributions
- Fast transient chrono measurements with the ADC10M for accurate determination of adsorption and deposition kinetics
- Digital and analog I/O for combination with external devices
- 4-Electrode configuration for measurements at the liquid-liquid interface
- Low current measurements at microelectrodes with the ECD module



Analytical and environmental electrochemistry

Research in analytical and environmental electrochemistry is driven by the demand for faster, cheaper, smaller, and more sensitive means to monitor the chemical, biological, and physical processes using sensors.

These chemical sensors are used widely in fields such as environmental monitoring, industrial process control, aeronautical and space systems, medical diagnosis etc.

The research in the development of new sensors is focused on reducing cost, size, and power consumption of the sensors and their ability for real-time, in situ measurement using sophisticated electrochemical methods.

Dedicated modules

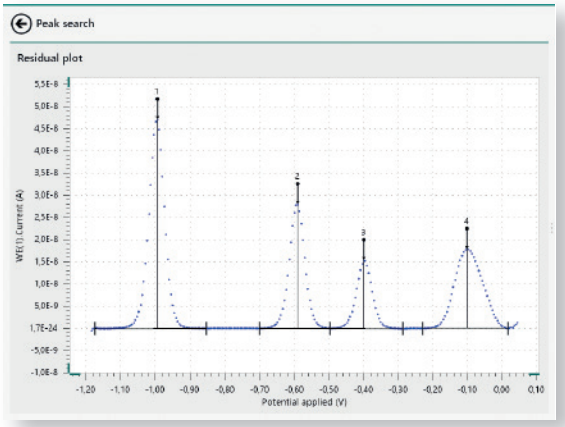
- pX1000 – Coulometric titration
- ECD – Trace metal analysis
- Multi BA – Measurements on sensor arrays simultaneously
- MUX.MULTI4 – Measurements on sensor arrays in sequence
- FRA32M – Characterization of sensors

Dedicated accessories

- Reference and counter electrodes • Microelectrodes
- Normal cells • Faraday cage • 663 VA Stand
- Metrohm Dosino and Sample processor

Autolab key features

- ECD module allows measurement of very small signals on micro-electrodes
- Preprogrammed voltammetric methods and data analysis tools (peak search, smooth, baseline correction etc.)
- Possibility to combine Metrohm liquid and sample handling instruments with any NOVA software method and data analysis making the automation of a measurement sequence easy



... a wide range of industries and research applications

Electrodeposition

Electrodeposition is used extensively in areas such as printed circuit boards (PCB), magnetic alloys, coatings for hard disk drives, wear resistant coatings, corrosion resistant alloys, metal composites, decorative coatings. Research in this field is focused on understanding fundamental aspects of electrochemical deposition of metals and alloys, structure and properties of deposits, and technological applications of electrochemically produced metals and alloys.

Electrochemical techniques are used widely for the understanding of underlying kinetic and interfacial processes (charge distribution across interface and structure of double layer etc.).

Dedicated modules

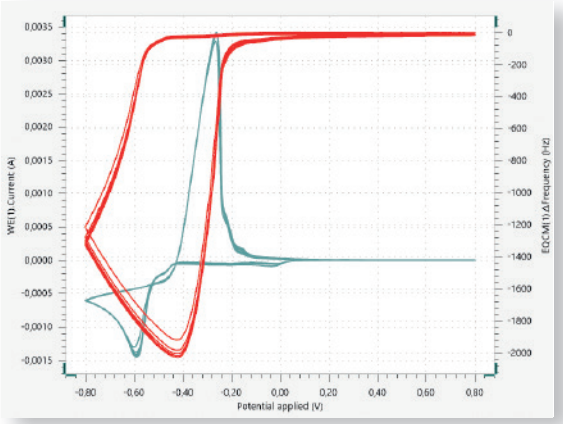
- FRA32M – Characterization of electrodeposition mechanisms
- BOOSTER10A/20A – Measurements on large area electrodes
- EQCM – Electrogravimetric characterization of deposits

Dedicated accessories

- Reference and counter electrodes

Autolab key features

- Preprogrammed voltammetric methods and data analysis tools (peak search, smooth, baseline correction etc.)
- The EQCM module provides measurements in the sub µg/cm^2 range
- Recurrent potential/current steps for pulse plating applications



Biotechnology/Biosensors

In recent years electrochemical techniques are being used increasingly to characterize biosensors and biochemical processes. Electrochemical techniques are being applied for the study of protein-electrode interfaces, self assembled monolayers (SAMs) and surfactant films.

Voltammetric, electrochemical and impedance spectroscopy techniques allow rapid, in-situ measurement of adsorption and kinetic processes. The electrochemistry based biosensors allow in-vivo measurements of active species resulting in rapid diagnostics and development of new drugs.

Dedicated modules

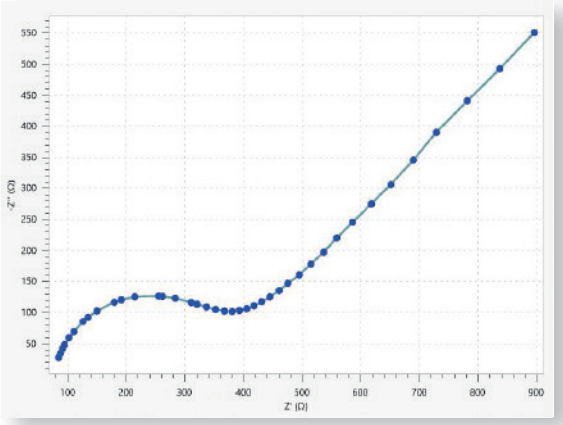
- FRA32M – Characterization of biosensors
- ECD – Low currents for microelectrode applications
- Multi BA – Simultaneous measurements on up to 6 working electrodes
- EQCM – Monitoring of biomolecular interactions

Dedicated accessories

- Reference and counter electrodes • Normal cells
- Faraday cage • RDE

Autolab key features

- ECD module allows measurement of very small signals on microelectrodes
- Multi BA module allows simultaneous measurements on up to 6 electrodes
- Preprogrammed voltammetric methods and data analysis tools
- Impedimetric sensor measurements with FRA32M module



Semiconductor electrochemistry

Semiconductor electrochemistry deals with many aspects, ranging from fundamental semiconductor physics to complex effects, such as charge transfer processes at semi conductor liquid surfaces or photoreactions at semi-conductor particles.

Its applications cover established as well as emerging fields in technology such as design and manufacture of in tegrated circuits, semiconductor devices, micro-mach-in ing, and micro-patterning.

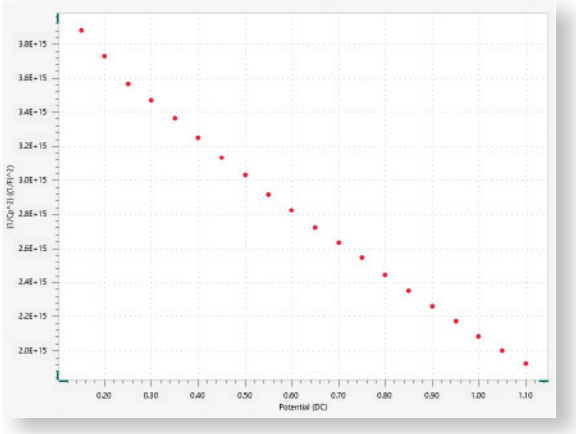
Characterization of semiconductor interfaces with elec-trochemical instruments is critical to the success of new semi-conductor devices.

Dedicated modules

- FRA32M – Characterization of Schottky junctions

Autolab key features

- Preprogrammed method for EIS experiments at different applied potentials
- One click production of Mott-Schottky plots



Nanotechnology

Nanotechnology is an inter-disciplinary research area where a broad range of expertise in material synthesis and characterization are combined. The key to the suc-cess in nanotechnology lies in the basic understanding of how to tailor the compositions and structures in the nanoscale structures to create new functional materials using sophisticated techniques.

Electrochemistry is being used increasingly in combina-tion with other chemical and/or physical methods to artificially modify and create functional surfaces.

Dedicated modules

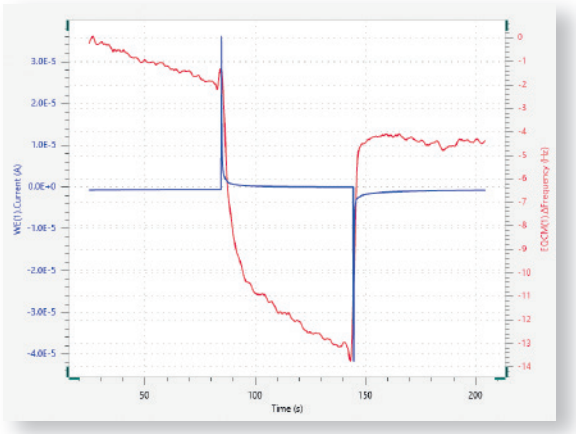
- FRA32M – Investigation of mechanisms at the nanoscale
- MUX.MULTI4/MUX.SCNR16 – Measurements on nanosensor arrays
- EQCM – Sub µg/cm^2 electrogravimetric measurements

Dedicated accessories

- Microelectrodes
- Faraday cage

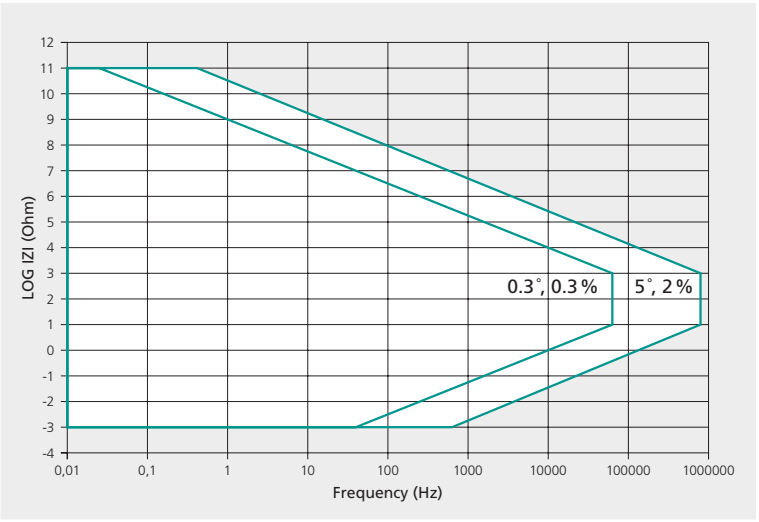
Autolab key features

- The analog and digital inputs/outputs allow the combination of electrochemical methods with other techniques (AFM, STM, SPM etc.)
- The femto ampere resolution with the ECD module facilitates measurements of very low currents
- The EQCM module provides measurements in the sub µg/cm^2 range



Specifications	PGSTAT101/M101	PGSTAT204/M204	PGSTAT128N	PGSTAT302N	PGSTAT100N
• Modular	no	yes	yes	yes	yes
• Maximum current	± 100 mA	+/- 400 mA	± 800 mA	± 2 A	± 250 mA
• Compliance voltage	± 10 V	+/- 20 V	± 12 V	± 30 V	± 100 V
• Potentiostat	yes	yes	yes	yes	yes
• Galvanostat	yes	yes	yes	yes	yes
• Potential range	± 10 V	± 10 V	± 10 V	± 10 V	± 10 V
• Applied potential accuracy	± 0.2% ± 2 mV	± 0.2% ± 2 mV	± 0.2% ± 2 mV	± 0.2% ± 2 mV	± 0.2% ± 2 mV
• Applied potential resolution	150 µV	150 µV	150 µV	150 µV	150 µV
• Measured potential resolution	3 µV (gain 100)	3 µV (gain 100)	0.3 µV (gain 1000)	0.3 µV (gain 1000)	0.3 µV (gain 1000)
• Maximum scan rate	1000 V/s with 15 mV step	1000 V/s with 15 mV step	1000 V/s with 15 mV step 250 kV/s with ADC10M/ SCAN250	1000 V/s with 15 mV step 250 kV/s with ADC10M/ SCAN250	1000 V/s with 15 mV step 250 kV/s with ADC10M/ SCAN250
• Current ranges	10 nA to 10 mA (in 7 ranges)	100 mA to 10 nA (in 8 ranges)	10 nA to 1 A (in 9 ranges)	10 nA to 1 A (in 9 ranges)	10 nA to 100 mA (in 8 ranges)
• Current accuracy	± 0.2% ± 0.2% of current range	± 0.2% ± 0.2% of current range	± 0.2% ± 0.2% of current range	± 0.2% ± 0.2% of current range	± 0.2% ± 0.2% of current range
• Applied current resolution	0.015% of current range	0.015% of current range	0.015% of current range	0.015% of current range	0.015% of current range
• Measured current resolution - at 10 nA range	0.0003% of current range 30 fA	0.0003% of current range 30 fA	0.0003% of current range 30 fA	0.0003% of current range 30 fA	0.0003% of current range 30 fA
• Potentiostat bandwidth	1 MHz	1 MHz	500 kHz	1 MHz	400 kHz
• Potentiostat rise/fall time	< 300 ns	< 300 ns	< 500 ns	< 250 ns	< 500 ns
• Input impedance of electrometer	> 100 GOhm // 8 pF	> 100 GOhm // 8 pF	> 1 TOhm // 8 pF	> 1 TOhm // 8 pF	> 100 GOhm // 8 pF
• Input bias current @ 25 °C	< 1 pA	< 1 pA	< 1 pA	< 1 pA	< 1 pA
• Bandwidth of electrometer	> 4 MHz	> 4 MHz	> 4 MHz	> 4 MHz	> 4 MHz
• iR-compensation - resolution	current interrupt and positive feedback 0.025%	current interrupt and positive feedback 0.025%	current interrupt and positive feedback 0.025%	current interrupt positive feedback and dynamic (optional) 0.025%	current interrupt and positive feedback 0.025%
• Electrode connections	2, 3 or 4	2, 3 or 4	2, 3, or 4	2, 3 or 4	2, 3 or 4
• Front panel display	n.a.	n.a.	E and i	E and i	E and i
• Analog outputs (BNC)	potential and current	potential and current	potential and current	potential and current	potential and current
• External voltage input	n.a.	n.a.	yes	yes	yes
• Analog integrator - time constants	yes 0.01 s, 0.1 s, 1 s, and 10 s	yes 0.01 s, 0.1 s, 1 s, and 10 s	FI20 module (optional) 0.01 s, 0.1 s, 1 s, and 10 s	FI20 module (optional) 0.01 s, 0.1 s, 1 s, and 10 s	FI20 module (optional) 0.01 s, 0.1 s, 1 s, and 10 s
• BOOSTER (10 A or 20 A)	n.a.	10 A	10 A	10 A, 20 A	10 A
• Interfacing	USB	USB	USB	USB	USB
• A/D converter	16-bit with gains of 1, 10, and 100	16-bit with gains of 1, 10, and 100	16-bit with gains of 1, 10, 100, and 1000	16-bit with gains of 1, 10, 100, and 1000	16-bit with gains of 1, 10, 100, and 1000
• External input/output signals	1/1	1/1	2/2	2/2	2/2
• D/A converter	16-bit, 3 channels	16-bit, 3 channels	16-bit, 4 channels	16-bit, 4 channels	16-bit, 4 channels
• Digital I/O lines	12	12	48	48	48
• Dimensions (W×D×H)	9×21×15 cm^3	15×26×20 cm^3	52×42×16 cm^3	52×42×16 cm^3	52×42×16 cm^3
• Weight	2.1 kg	4.1 kg	16 kg	18 kg	21 kg
• Power requirements	40 W	75 W	180 W	300 W	247 W

Specifications	PGSTAT302F
• Maximum current	± 2 A
• Compliance voltage	± 10 V
• Compliance voltage (grounded)	± 30 V (special cables required)
• Potentiostat	yes
• Galvanostat	yes
• Potential range	± 10 V
• Applied potential accuracy	± 0.2% ± 2 mV
• Applied potential resolution	150 µV
• Measured potential resolution	0.3 µV (gain 1000)
• Maximum scan rate	1000 V/s with 15 mV step
• Current ranges	10 nA to 1 A (in 9 ranges)
• Current accuracy	± 0.2% ± 0.2% of current range
• Applied current resolution	0.015% of current range
• Measured current resolution - at 10 nA range	0.0003% of current range 30 fA
• Potentiostat bandwidth	100 kHz
• Potentiostat rise/fall time	< 250 ns
• Input impedance of electrometer	> 1 TOhm // 8 pF
• Input bias current @ 25 °C	< 1 pA
• Bandwidth of electrometer	> 4 MHz
• iR-compensation - resolution	current interrupt and positive feedback 0.025%
• Electrode connections	2, 3 or 4
• Front panel display	E and i
• Analog outputs (BNC)	potential and current
• External voltage input	yes
• Interfacing USB	USB
• A/D converter	16-bit with gains of 1, 10, 100, and 1000
• External input/output signals	2/2
• D/A converter	16-bit, 4 channels
• Digital I/O lines	48
• Dimensions (W×D×H)	52×42×16 cm^3
• Weight (with FRA32M)	18 kg
• Power requirements	300 W



Typical accuracy contour plot of a PGSTAT302N/FRA32M – Potentiostatic mode.

Dedicated to research

www.metrohm.com/en/products/potentiostats

Subject to change
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