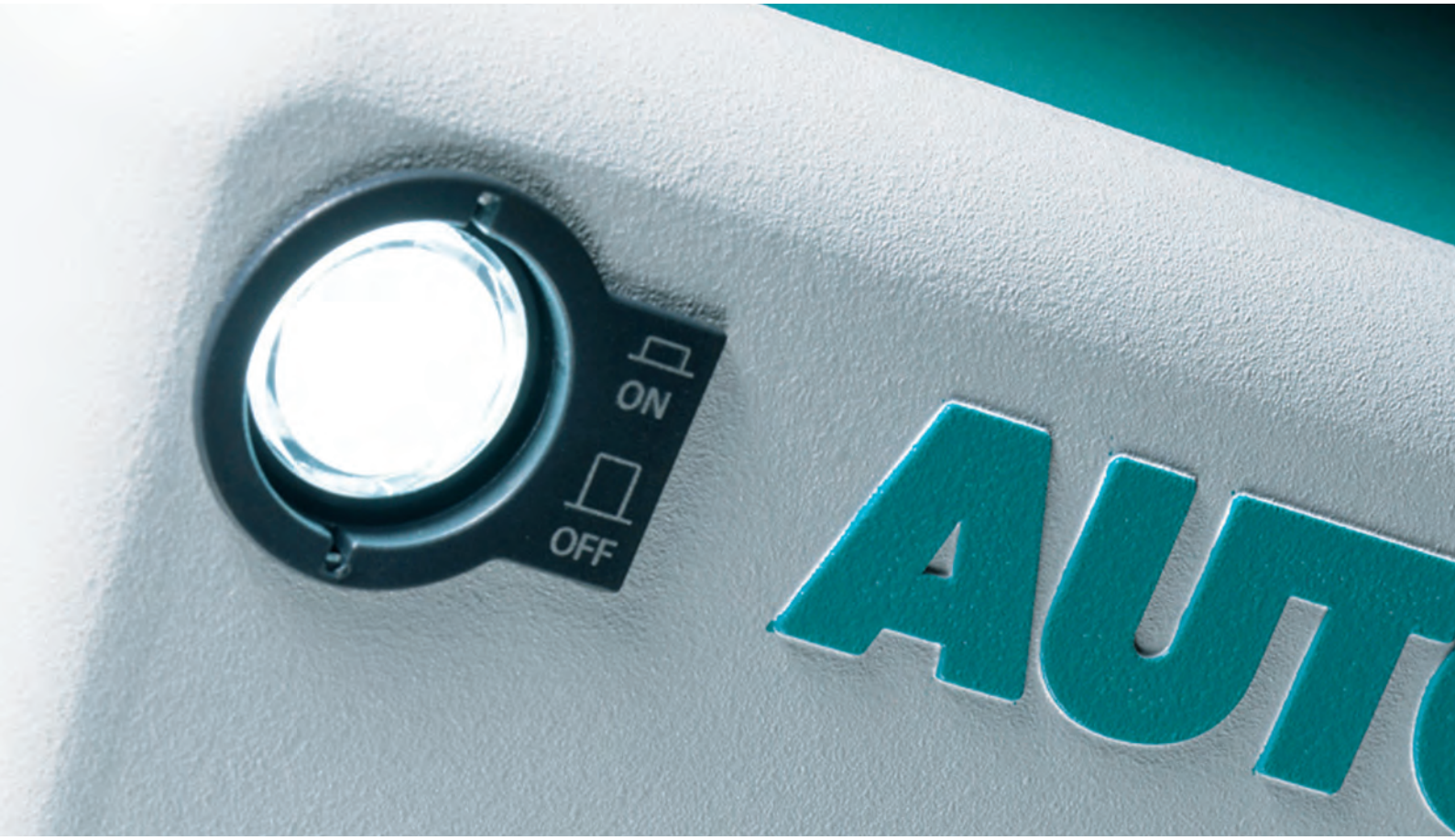
Metrohm Autolab



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.

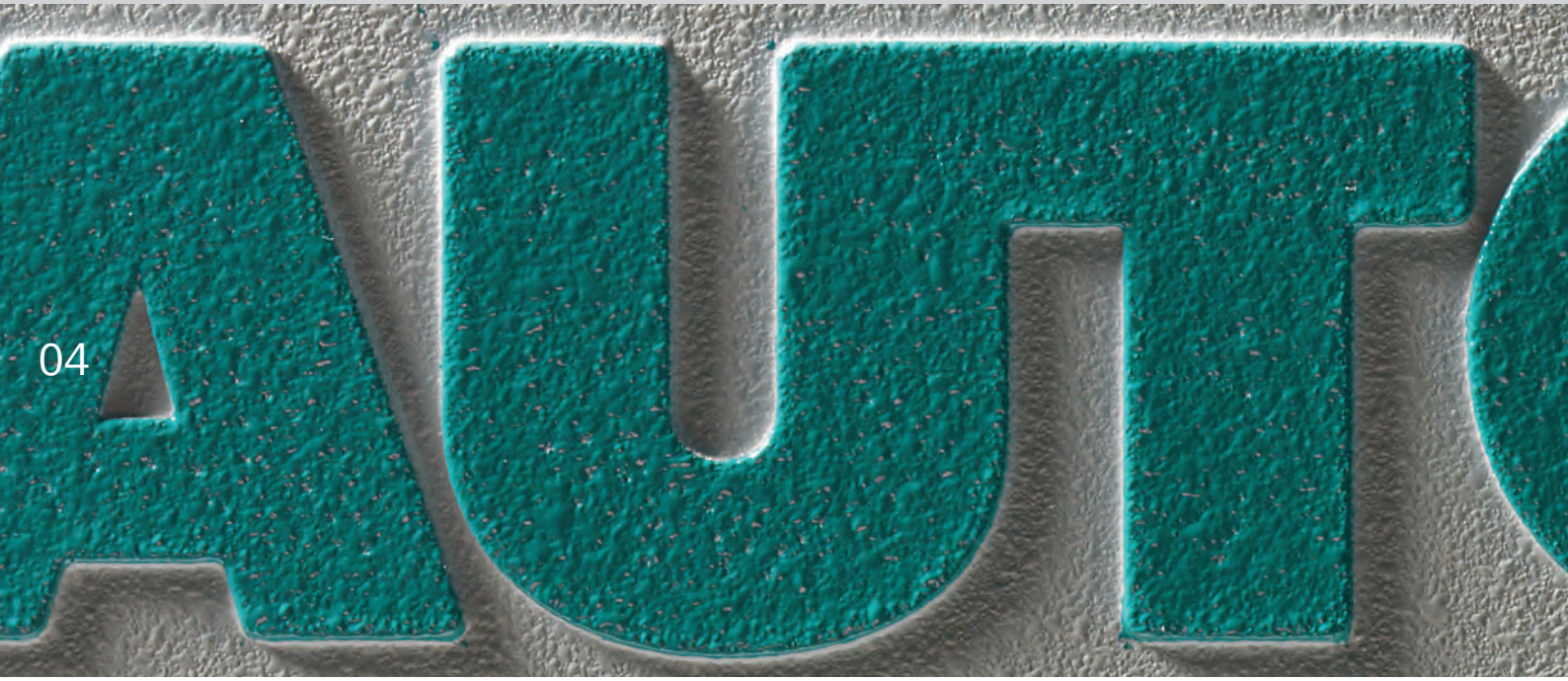
Metrohm Autolab is an ISO9001 certified company.

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



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

Modular design

Autolab/PGSTAT128N

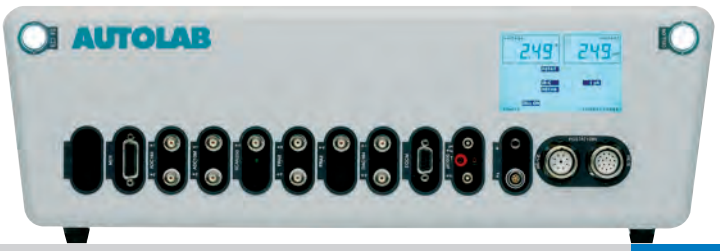
The entry level member of the modular Autolab instruments family, the Autolab/PGSTAT128N is a low noise and fast potentiostat/galvanostat capable of measuring maximum 800 mA (10 A with BOOSTER10A), with a compliance voltage of 12 V. The Autolab/PGSTAT128N is a high performance low cost option for electrochemical 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
- 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 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
- 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
• Special option	Dynamic iR-compensation

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 101 series

The 101 series provides entry level solutions for single research grade potentiostats/galvanostat or multi channel instruments. Designed without compromising on quality and specifications, the 101 series instruments offer good performance at a convenient price.

The PGSTAT101 is the single channel compact instrument, ideal for electrochemical measurements on small samples and for educational purposes.

The Multi Autolab with M101 modules is a modular multi channel based on the PGSTAT101 system. It can accommodate M101 modules and additional optional modules.

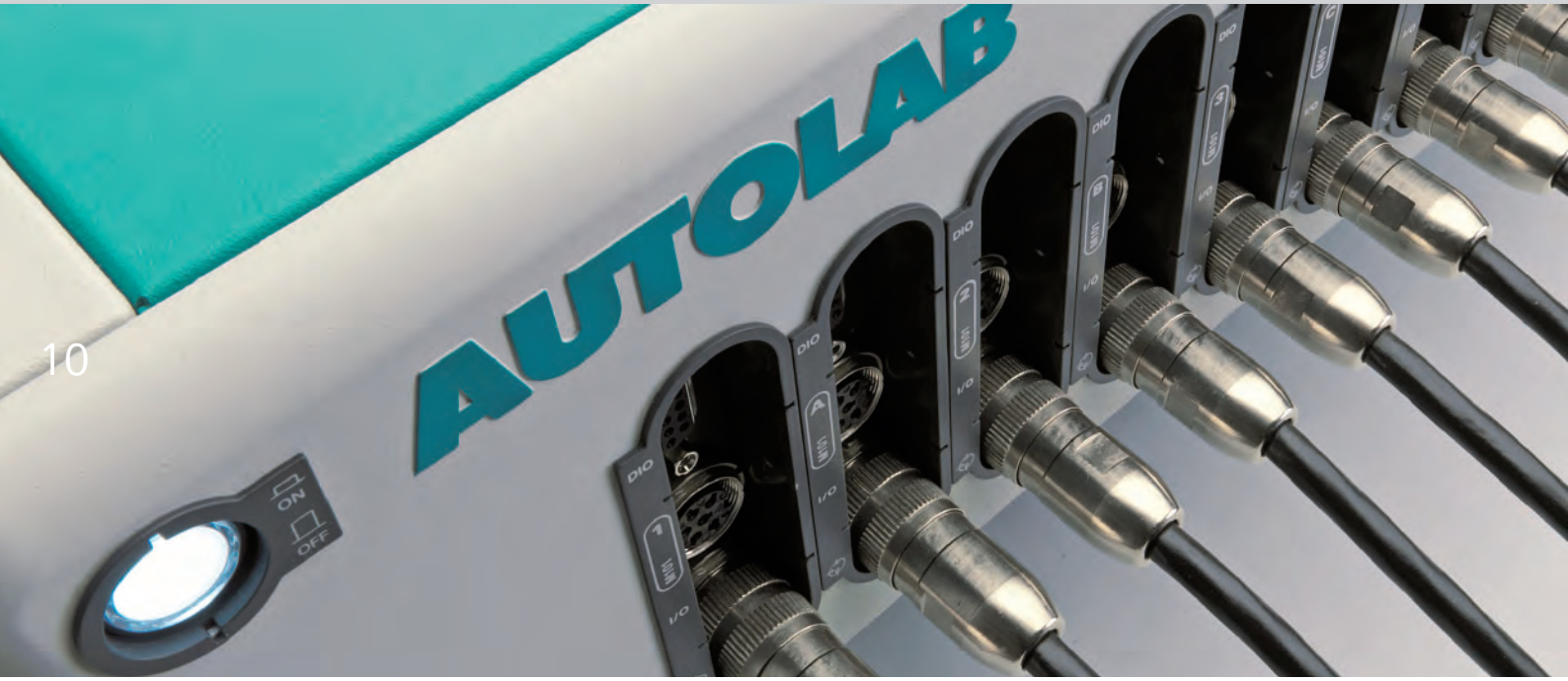
Entry level

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



Multi channel ...

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 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

... with modularity

The Multi Autolab with M101 can be complemented by optional modules. Each individual M101 module can be coupled to one additional optional module. The maximum number of optional modules in a Multi Autolab is six.

Each M101 potentiostat/galvanostat controls its dedicated optional module in this case.

The following modules are available for the Multi Autolab:

- FRA32M
- EQCM
- BA
- pX1000
- MUX

Compact design

µAutolab III and µAutolab III/FRA2

The most basic in the Autolab family of instruments, the µAutolab Type III in combination with the powerful NOVA software, can be used for most electrochemical techniques.

The instrument has a built in analog integrator, analog and digital inputs and outputs, making it a versatile instrument despite its non-modular nature.

The µAutolab Type III fitted with the FRA2 module is an ideal choice for those who are looking for a low cost and compact but high performance electrochemical impedance analyzer. Fully integrated with the easy to use software, the users can perform impedance measurements over the frequency range of 10 µHz - 500 kHz.

Key features	
• Electrode connections	2, 3
• Potential range	+/- 5 V
• Compliance voltage	+/- 12 V
• Maximum current	+/- 80 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	500 kHz
• Computer interface	USB
• Control software	NOVA

Special instruments ...

PGSTAT302F

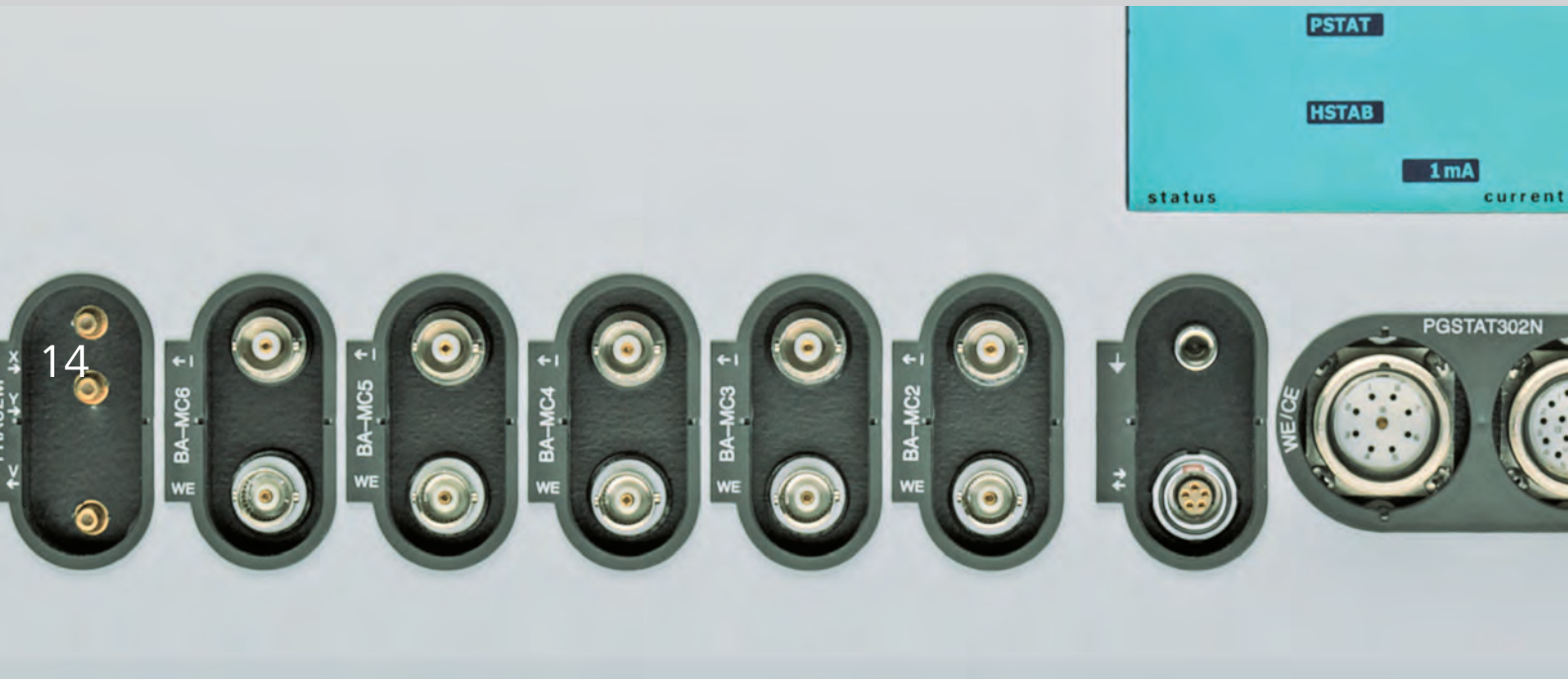
The PGSTAT302F is a special version of the PGSTAT302N which can be switched from the regular «grounded mode» to so-called «floating mode». In grounded mode, the PGSTAT302F can be used with normal electrochemical cells, while in floating mode, the PGSTAT302F can be used with grounded cells or electrochemical 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.

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

Optional module

- FRA32M



... 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

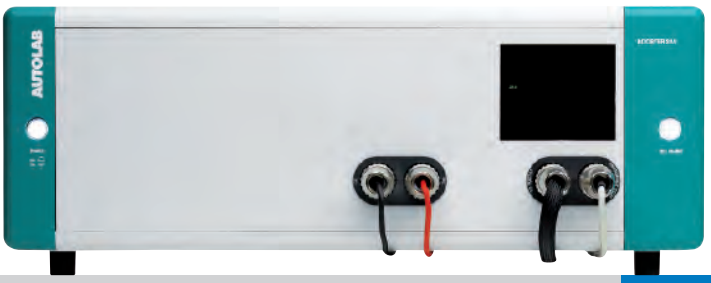
The BOOSTER10A module increases the maximum current of the Autolab/PGSTATS to 10 A. The maximum current of the PGSTAT302N can be increased to 20 A with BOOSTER20A.

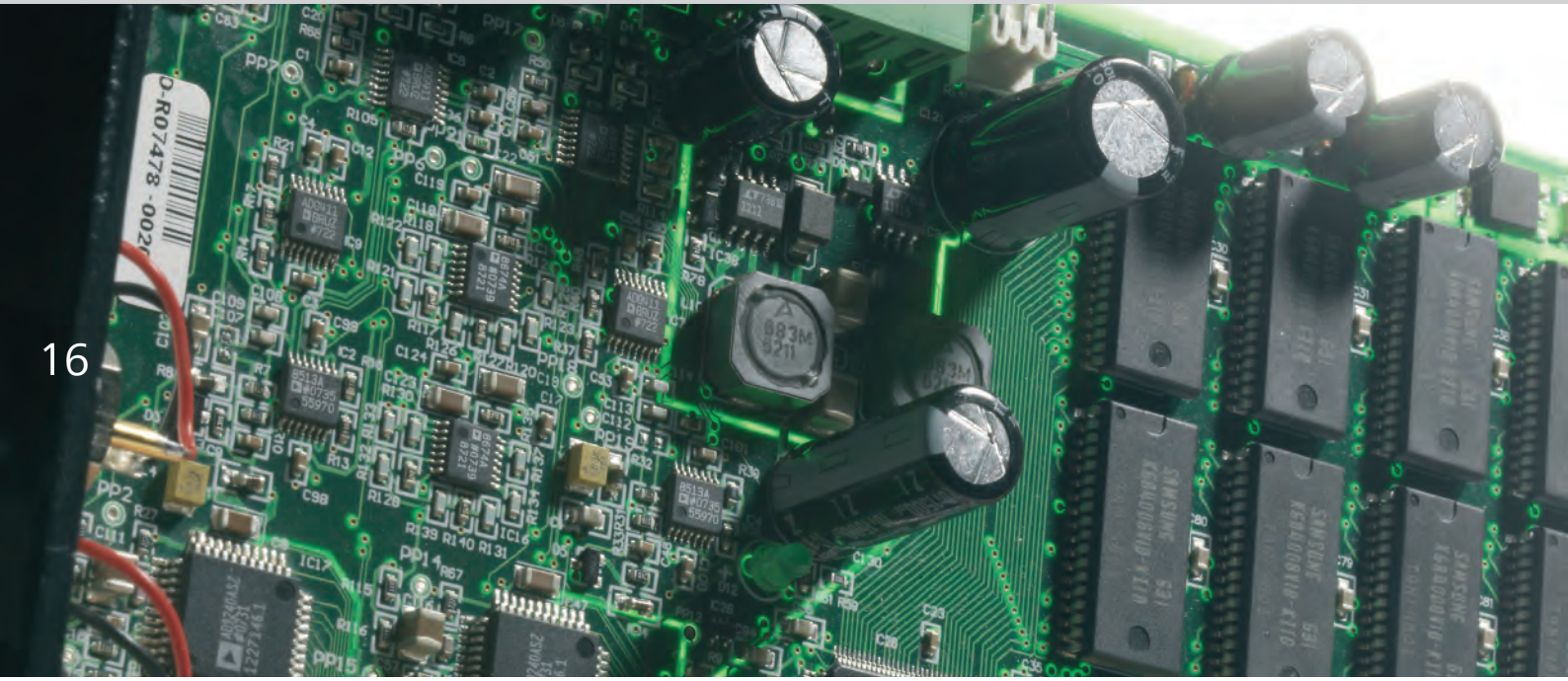
With its fast response time, the Autolab booster has been optimized to perform electrochemical impedance measurements, in combination with the FRA32M module, on fuel cells, batteries and super-capacitors. The booster is able to handle active as well as passive cells.

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		
• 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	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.

Application areas

- Analytical electrochemistry
- Battery, fuel cells and super-capacitor
- Biotechnology
- Chemical Mechanical Polishing (CMP)
- Coatings research (organic and inorganic)
- Conducting polymers and membranes
- Corrosion prevention/control
- Dielectric materials
- Electrocatalysis
- Electrodeposition
- Materials analysis and testing
- Nanotechnology
- Semiconductor
- Sensor development

Key features	
• Frequency range	10 µHz - 32 MHz
• Frequency range in combination with PGSTAT	10 µHz - 1 MHz
• Frequency resolution	0.003%
• Input range	+/- 10 V
• 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, Multi BA

... allowing versatile custom built instruments for research

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

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.

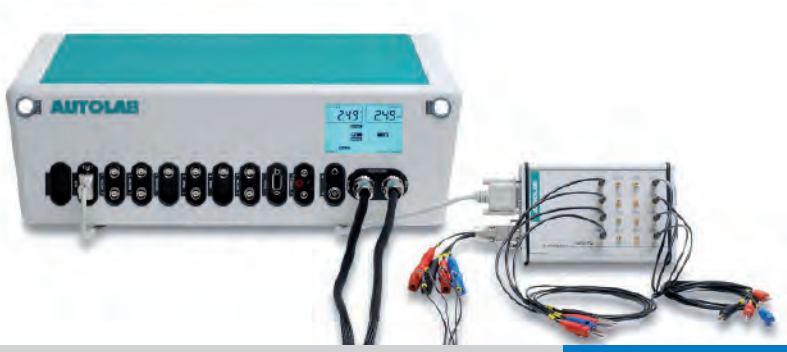
MUX.MULTI4

Sequential measurements can be performed on complete electrochemical cells (i.e. independent working, counter, sense and reference electrodes). The users can run up to 64 cells sequentially with increments of 4.

MUX.SCNR16

Sequential measurements can be performed on cells that share the same counter, reference and sense electrodes but different working electrodes. The users can run up to 255 working electrodes sequentially with increments of 16.

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



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

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 compatibiliy	PGSTAT128N, PGSTAT302N, PGSTAT100N, Multi Autolab, Multi BA

FI20

The FI20, filter and integrator module, allows the Autolab users to do coulometric and chrono-coulometric experiments. The analog integrator 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.

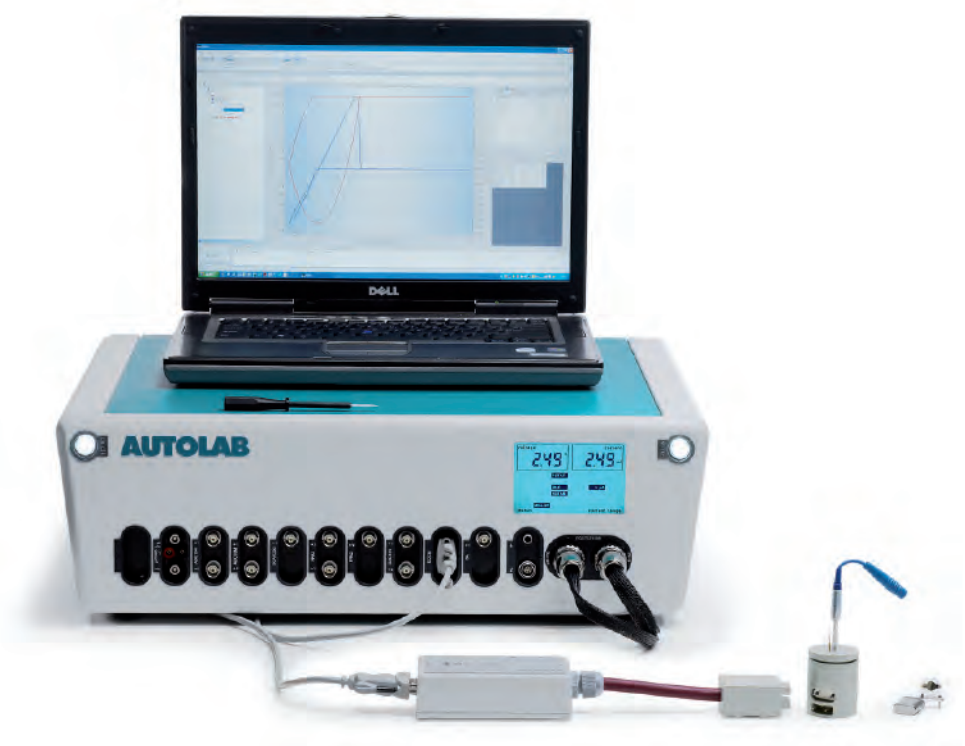
Key features	
• Input range	+/- 10 V
• Measurement resolution	30 µV
• Measurement accuracy	+/- 2 mV
• Input impedance	> 1 TOhm // 8 pF
• Temperature accuracy	+/- 0.5 ˚C
• Temperature resolution	0.015 ˚C
• Instrument compatibility	PGSTAT128N, PGSTAT302N, Multi Autolab

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



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.

Modules	PGSTAT128N	PGSTAT302N	PGSTAT100N	Multi Autolab	PGSTAT302F	PGSTAT128N Multi BA PGSTAT302N Multi BA
BOOSTER10A	•	•	•	n.a.	n.a.	n.a.
BOOSTER20A	n.a.	•	n.a.	n.a.	n.a.	n.a.
FRA32M	•	•	•	•	•	•
ADC10M	•	•	•	n.a.	n.a.	n.a.
SCAN250	•	•	•	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.
ECD	•	•	•	n.a.	n.a.	n.a.
FI20	•	•	•	n.a.	n.a.	n.a.
pX1000	•	•	n.a.	•	n.a.	n.a.
EQCM	•	•	n.a.	•	n.a.	n.a.

NOVA, powerful and flexible ...

Autolab NOVA software

NOVA is the data acquisition and analysis software package for all the Autolab potentiostat/galvanostats with USB interface.

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, can be done in a few mouse clicks.

The following techniques are available:

Voltammetric analysis

- Sampled DC
- Normal pulse
- Differential pulse
- Differential normal pulse
- Square wave
- Control of Hg drop electrode

Cyclic and linear sweep voltammetry

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

Chrono methods

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

Impedance spectroscopy

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

Tools and accessories

- Manual control
- iR-compensation
- Rotating disc electrode (RDE) control
- Repeat loops
- Cut-offs
- Open circuit potential (OCP) measurements
- Analog input and output
- Digital DIO (TTL) triggering
- Additional signals (Delta frequency, 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.

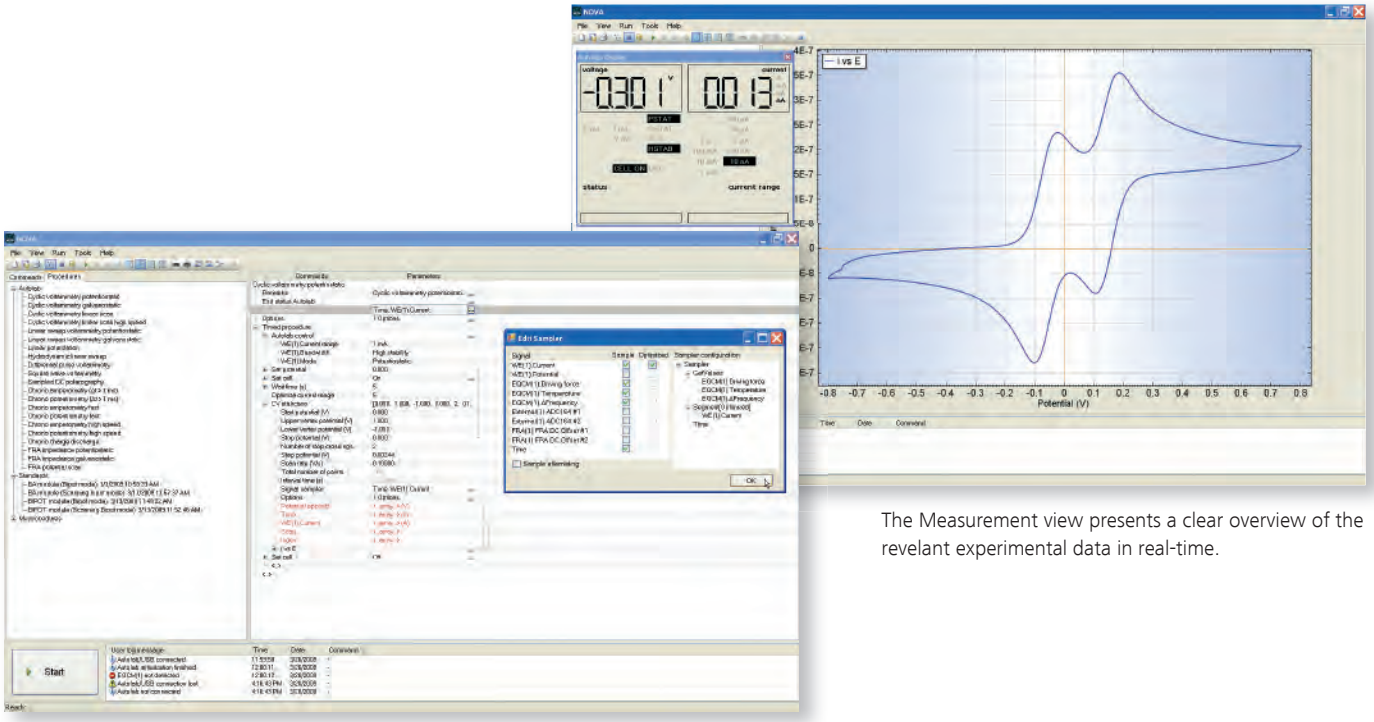
Procedure parameters can be linked providing the means to build dynamic procedures, in which parameters are updated real time depending on the measurement progress. Convenient tools like repeat loops, cut-offs and data analysis instructions can be used in the procedure editor, making routine experiments 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. Sampling of data points can be switched on periodically during long measurements.

Additionally, NOVA is fully customizable, allowing the user to define the acquisition parameters, the transfer function for any form of impedance, offsets and multipliers for the analog inputs and outputs of the instrument and build new commands.

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



The Measurement view presents a clear overview of the revelant experimental data in real-time.

The Setup view provides a powerful and flexible procedure building environment.

Powerful data presentation

During electrochemical experiments, recorded data points can be displayed in a dedicated interface of the software. Up to 4 plots can be used to display measured data points or results of data analysis. Comparison with previous experiments is possible while experiments are in progress.

The Autolab display window provides a clear overview of the experimetal data and the instrument settings during experiments and can be used to manually control the instrument.

Data points are saved automatically 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.

This robust data management system prevents accidental loss of data files and provides an easy way of backing up important experiments.

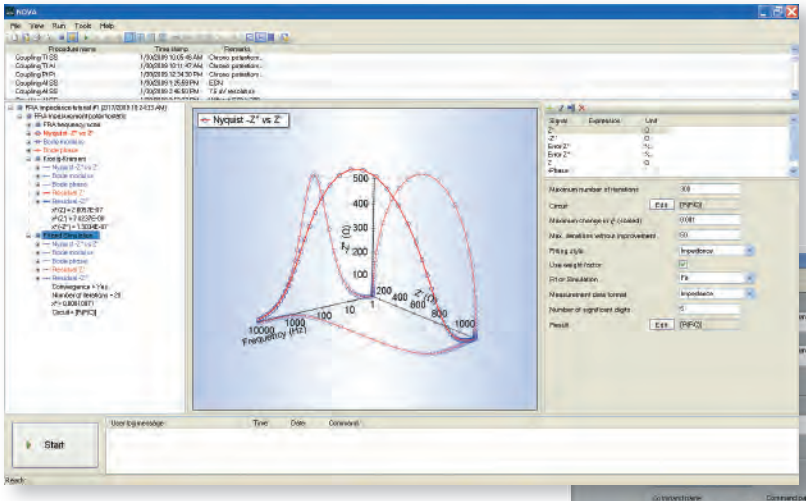
Advanced data analysis

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

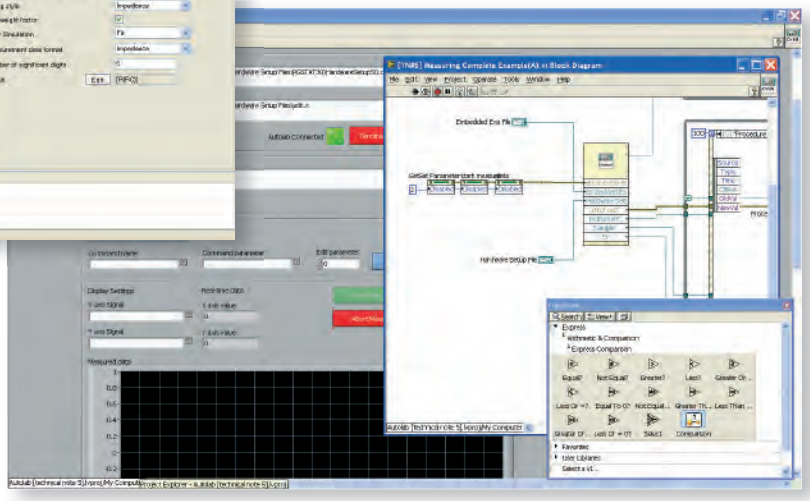
Plotting tools like individual axis scaling, multiple Y-axes, plot additions, zooming and overlays help the user display the relevant information in clear, publication-ready graphs. Each plot can be directly pasted into a paper or a presentation.

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.

Analysis progress can be saved to the database at any time. Peak search results, plot settings, calculated data points, additional plots are added to the database its original entries, turning each measurement into a complete workbook that you can share with co-workers.



Powerful data analysis and plotting tools are available in the Analysis view.



The SDK can be used to control the Autolab from external applications.

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 XP, Vista or Windows 7 (32 bit). Presently only 32 bit OS is supported. Up to 16 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.

Autolab key features

- Multi sine technique for quick 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 analog and digital inputs/outputs allow the combination of electrochemical methods with other techniques (FTIR, STM etc.)
- The MUX module allows the automation of routine corrosion measurements by running up to 64 cells sequentially

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

Accessories

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

Software methods

- Linear sweep voltammetry – Identification of corrosion processes
- Chrono methods – Identification of pit initiation
- Electrochemical Impedance Spectroscopy – Detection of coating failure – Identification of corrosion mechanisms

Analysis

- Tafel slope analysis – Automatic calculation of kinetic rate constants
- Corrosion rate analysis – Automatic calculation of polarization resistance and corrosion currents and rates
- Fit and Simulation – Fitting of complex equivalent circuits

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

Semiconductor electrochemistry

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

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

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

Modules

- FRA32M – Characterization of Schottky junctions

Autolab key features

- Preprogrammed method for EIS experiments at different applied potentials
- Data transfer to Excel, overlaying multiple plots during measurement Mott-Schottky plots

Accessories

- Faraday cage

Software methods

- Impedance spectroscopy – Investigation of semiconductor interfaces

Analysis

- Fit and Simulation – Fitting of equivalent circuits

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.

Modules

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

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

Accessories

- Electronic load interface – Connection to third-party electronic loads and programmable power supplies

Software methods

- Cyclic voltammetry – Identification of kinetic processes
- Impedance spectroscopy – Characterization of electron transfer kinetics and mass transport

Analysis

- Tafel slope – Automatic calculation of kinetic rate constants
- Fit and Simulation – Fitting of complex equivalent circuits

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 PGSTATS provide the most suitable tools for the accurate characterization of interfacial processes, determination of thermodynamics and kinetics as well as reaction mechanisms.

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

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

Software methods

- Cyclic voltammetry, Chrono methods – Identification of kinetics
- Impedance spectroscopy – Characterization of the double layer

Analysis

- Tafel slope – Determination of reaction mechanisms and kinetic constants
- Fit and Simulation – Fitting of complex equivalent cicuits

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.

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

Accessories

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

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.)
- Data transfer to Excel, overlaying multiple plots during measurement
- 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

Software methods

- Cyclic voltammetry – Identification of kinetic processes
- Chrono-amperometry, Chrono-potentiometry – Identification of kinetic processes
- Voltammetric methods – Detection and quantitative analysis on electrodes
- Potentiometric stripping analysis – Quantitative analysis on microelectrodes

Analysis

- Tafel slope – Automatic calculation of kinetic rate constants
- Peak search – Fully automated with NOVA software

... 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.).

Modules

- FRA32M – Characterization of electrodeposition mechanisms
- ADC10M – Measurements of transients and ohmic drop with current interrupt
- BOOSTER10A/20A – Measurements on large area electrodes
- EQCM – Electrogravimetric characterization of deposits

Autolab key features

- Preprogrammed voltammetric methods and data analysis tools (peak search, smooth, baseline correction etc.)
- Possibility to control pump valves (using the DIO port) combined with voltammetric methods and data analysis tools making the automation of a measurement sequence easy.
- Recurrent potential/current steps for pulse plating applications

Accessories

- Reference and counter electrodes

Software methods

- Cyclic voltammetry – Identification of kinetic processes
- Chrono-amperometry, Chrono-potentiometry – Fabrication of multi-layers with pulse plating

Analysis

- Tafel slope – Automatic calculation of kinetic rate constants

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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 success 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 combination with other chemical and/or physical methods to artificially modify and create functional surfaces.

Modules

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

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

Accessories

- Microelectrodes
- Faraday cage

Software methods

- Cyclic voltammetry – Identification of kinetic processes
- Chrono-amperometry, Chrono-potentiometry – Fabrication of nanostructures
- Impedance spectroscopy – Characterization of functional surfaces

Ultra-fast electrochemistry

In the last two decades, ultra-fast cyclic voltammetry and ultra-fast chrono-amperometry have developed into a very active research domain. The use of ultra-microelectrodes has found applications in a wide range of research fields, in particular for studying the kinetics of heterogeneous electron transfer reaction and coupled homogeneous chemical reaction, as well as for in-vivo bio-electrochemistry.

For these applications, very high scan rates and very high sampling rates are often required. The PGSTAT together with the ultra-fast sampling ADC10M module and the ultra-high speed SCAN250 linear scan generator provide a tailor-made solution for studying electrochemical reaction with interval times in the sub-micro second range and at scan rates up to 250 kV/s.

Modules

- ADC10M – Ultra-fast methods
- SCAN250 – True linear scans

Accessories

- Reference and counter electrodes
- Ultra-microelectrodes • Faraday cage

Autolab key features

- ADC10M for ultra-fast chrono methods, acquire fast transients with interval times down to 100 ns
- True linear scans up to 250 kV/s possible with SCAN250

Software methods

- High speed cyclic voltammetry – Identification of kinetic processes
- Ultra-fast chrono-amperometry, Chronopotentiometry – Identification of kinetic processes – Measurement of charge
- Voltammetric methods – Detection and quantitative analysis on sensors
- Impedance spectroscopy – Determination of interfacial capacitance

Analysis

- Tafel slope – Automatic calculation of kinetic rate constants
- Fit and Simulation – Fitting of complex equivalent circuits

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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 surface plasmon resonance (SPR) techniques allow rapid, in-situ measurement of adsorption and kinetic processes on the sub milli second time scale. The electrochemistry based biosensors allow in-vivo measurements of active species resulting in rapid diagnostics and development of new drugs.

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

Accessories

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

Software methods

- Cyclic voltammetry – Identification of kinetic processes

Autolab key features

- Combination of electrochemistry with SPR measurements is possible
- 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
- The possibility to control pump valves combined with voltammetric methods and data analysis tools makes the automation of a measurement sequence easy

- Chrono-amperometry, Chrono-potentiometry – Identification of kinetic processes – Measurement of charge
- Voltammetric methods – Detection and quantitative analysis on sensors
- Potentiometric stripping analysis – Quantitative analysis on microelectrodes
- Impedance spectroscopy – Measurements at open circuit potential or applied potential

Analysis

- Tafel slope – Automatic calculation of kinetic rate constants
- Fit and Simulation – Fitting of complex equivalent circuits

Total solutions ...

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

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.

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	Sealed Hg pool
• Electrode tips (10 mm Ø)	3 mm Active area in Ag, Au, Pt, and GC 5 mm Active area in Ag, Au, Pt, GC, and empty

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

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	PTFE

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 following functions can be controlled from the Autolab NOVA software:

- Purge on/off
- New drop
- Stirrer on/off

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.

Autolab Spincoater

The Autolab Spincoater is an affordable table top spin-coating system that can be used to coat uniform layers of for example polymers or metal oxides on a substrate.

The system has a bowl with a diameter of 13.5 cm. Rotation speed can be controlled manually from 100 - 10,000 rpm with an accuracy of 2 rpm in steps of 100 rpm.

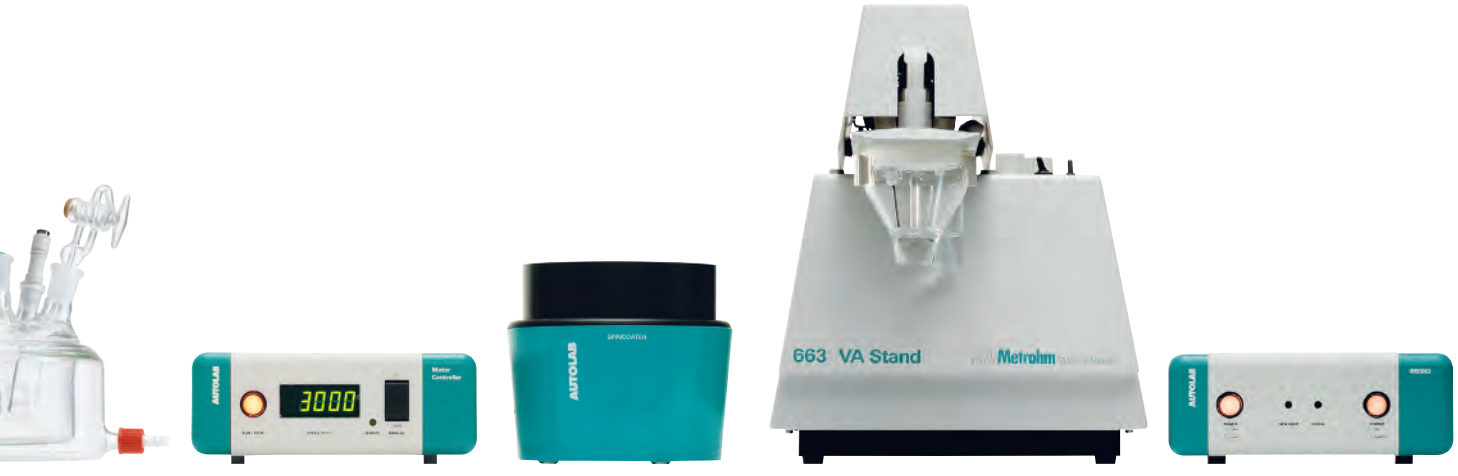
Specifications	
• Standard sample size	25 mm Ø disk (special size available on request)
• Motor speed range	100 - 10,000 RPM
• Manual speed setting	100 - 10,000 RPM in 100 RPM steps
• Acceleration/deceleration	4,000 RPM/s

IME

IME's are used to connect a mercury drop electrode system to the Autolab instrument and to control it with the NOVA software. There are 2 types available:

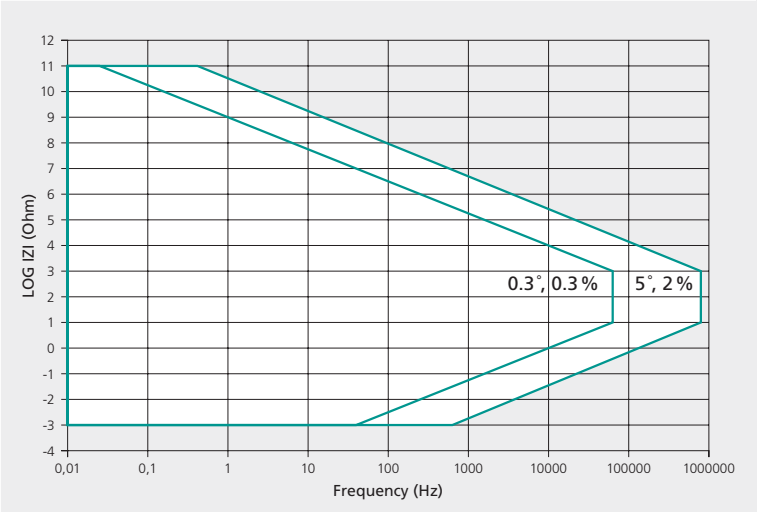
- IME303
- IME663

The IME303 is used to control the PAR303 mercury drop electrode and can also be used with most home made electrodes. The IME663 is used to control the Metrohm 663 VA Stand.



Specifications	µAutolabIII(FRA2)	PGSTAT101/M101	PGSTAT128N	PGSTAT302N	PGSTAT100N
• Modular	no	no	yes	yes	yes
• Maximum current	± 80 mA	± 100 mA	± 800 mA	± 2 A	± 250 mA
• Compliance voltage	± 12 V	± 10 V	± 12 V	± 30 V	± 100 V
• Potentiostat	yes	yes	yes	yes	yes
• Galvanostat	yes	yes	yes	yes	yes
• Potential range	± 5 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	200 V/s	200 V/s	250 V/s 250 kV/s with SCAN250/ ADC10M	250 V/s 250 kV/s with SCAN250/ ADC10M	250 V/s 250 kV/s with SCAN250/ ADC10M
• Current ranges	10 nA to 10 mA (in 7 ranges)	10 nA to 10 mA (in 7 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	500 kHz	1 MHz	500 kHz	1 MHz	400 kHz
• Potentiostat rise/fall time	1 µs	< 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	n.a. n.a.	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 or 3	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.	n.a.	10 A	10 A, 20 A	10 A
• Interfacing USB	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	48	12	48	48	48
• Dimensions (W×D×H)	27×27×9 cm^3	9×21×15 cm^3	52×42×16 cm^3	52×42×16 cm^3	52×42×16 cm^3
• Weight	3.6 kg	2.1 kg	16 kg	18 kg	21 kg
• Power requirements	144 W	85 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	250 V/s
• 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, 350 mV AC amplitude (rms).

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Subject to change
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