# High Grade Potentiostat - Galvanostat System for Electrochemical Impedance Spectroscopy up to 1 MHz

- potentiostat - galvanostat system with superimposed frequency stimulus for electrochemical impedance spectroscopy, cyclic voltammetry and time domain characterisation
- unique solution for the precise characterisation of both conductive (i.e., high current) and insulating(i.e., low current) samples
- simultaneous measurement of dc voltages and currents at up to four electrodes
- 2-, 3- and 4-terminal configurations
- high impedance differential voltage inputs with driven shields
- operates in direct voltage mode as a high resolution impedance / dielectric analyzer
- precision gain phase measurements included

**Applications:**
- **Battery Research**
- **Corrosion**
- **Coatings**
- **General Electrochemistry**
- **Dielectric and Impedance Spectroscopy**

# NOVOCONTROL

# POT/GAL 30 V/2 A

## High Performance EIS

Novocontrol's advanced modular Alpha-A system features highest quality broadband impedance and electrical material measurements in the frequency domain over an ultra wide impedance range. It is widely accepted as the most accurate and versatile analysis tool for dielectric, conductivity and impedance spectroscopy and sets the benchmark for overall performance and flexibility in this area. In combination with a POT/GAL test interface, the same extraordinary performance becomes available for electrochemical applications, too. As a result, almost all kinds of materials, i.e., from the best isolators to metallic conductors, can be characterized by a single powerful measurements system. This is a significant improvement in instrumentation for electrochemical impedance spectroscopy (EIS) compared to previous designs that necessitate the use of several systems setups for the characterisation of, e.g., strong electrolytes which experience high currents and isolating materials with currents in the pA range. In addition, typical electrochemical experiments, e.g., cyclic voltammetry and DC measurements in the time domain, are fully supported.

## Components

For these purposes, POT/GAL extends the Alpha-A mainframe by

- a counter electrode power amplifier,

- a high input impedance reference electrodes differential input amplifier,

- a high accuracy working electrode current input converter with reference technique,

- a control loop for defined cell polarization, potentiostat voltage and galvanostat current,

- a four channel digitizer for signal measurements at 4 electrodes,

- firmware for system control by high level remote commands.

## Particular Features

- Improves general performance of EIS systems by high accuracy, broadband and wide impedance range performance.

- Supports higher harmonic measurements for non linear EIS both on instrument and WinDETA application software level.

### Principle of EIS

Counter Electrode • Double Layer Capacity • Working Electrode

Electrolyte Solution

Reference Electrode

Udc

Uac • Vref • Is
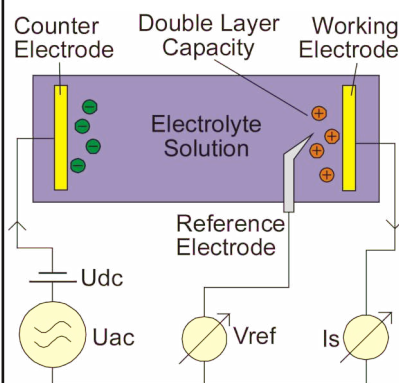
A polarization voltage Udc, superimposed by a small ac voltage Uac is applied to the sample. The response current Is* and the voltage Vref* across the electrochemical double layer capacity are measured by amplitude and phase and thus the double layer impedance $Z^* = Vref^* / Is^*$ is determined. In potentiostat or galvanostat mode, Udc is continuously adjusted in order to keep the dc part of Vref or Is at a defined, i.e., constant level.

- High impedance (> 1 TΩ | 10 pF) differential reference electrode voltage inputs for measurements of isolating materials in 3- and 4-electrode configuration. User selectable driven shield technology reduces cable capacity effects.

- Direct control mode with disabled potentiostat and galvanostat functions as a high quality impedance spectroscopy system with extended voltage and current ranges.

- Automatic dc level shifters at the working and reference electrode inputs compensate dc voltage and current offsets in order to accurately measure the small superimposed ac signals for EIS.

- All system functions are controlled by simple high level commands via the Alpha-A mainframe GPIB port. This feature allows easy integration in your own software or combination with other automated equipment like, e.g., temperature, pressure, or atmosphere control.

- As an additional protection of the sample, the high power counter electrode signal output supports additional fast voltage and current limits which are independent of the main control loop. Both voltage and current limits are continuously adjustable and operate simulta-

## Key Specifications

POT/GAL 30V-2A + Alpha-A Mainframe

### Counter Electrode Polarization

Voltage: ±30 Vp dc and / or ac resolution 1 mV dc, 20 µV ac
Current: ±2 A dc and / or dc resolution ±1/32768 of current range, 0.1 pA min.
Maximum output power: 60 W
Output Resistance:
1 Ω .. 1kΩ in factors of 10
Bandwidth: dc .. 1 MHz
Continuously adjustable simultaneous voltage and current limits:
1 V .. 40 V and 2 mA .. 2 A
Supplies 2 A continuous current into a shorted load without overheating.

### Reference Voltage Inputs

Single or differential configuration with selectable driven shields
Range: ±30 Vp, 20 µV resolution
Input impedance: > $10^{12}$ Ω | 10 pF
Bandwidth: dc .. 10 MHz

### Working Electrode Current Input

Ranges 20 pA .. 2 A in factors of 10
Resolution $10^{-5}$ of range,
0.1 pA min.
Bandwidth dc .. 10 MHz

### Impedance Measurement

Frequency Range 3 µHz .. 1 MHz
Impedance range $10^{-4}$ Ω .. $10^{13}$ Ω
Phase accuracy < 6m°
tan(δ) accuracy < $10^{-4}$
Phase resolution < 0.6m°
tan(δ) resolution < $10^{-5}$

### Main Control Loop

Potentiostat, Galvanostat and Direct Voltage modes
Dc accuracy 1 mV
Time constants 0.3 ms .. 3 s in factors of 3.33
Bandwidth dc .. 10 MHz
Electrolyte Rs compensation
Automatic Rs detection by high frequency EIS, Rs compensation or correction

neously both in potentiostat and galvanostat mode.

- Supports real-time measurements of up to 150 impedance data points per second (option) and 1500 voltage-current data points per second in time domain mode.