



**Princeton
Applied
Research**

273A Potentiostat/Galvanostat

With compliments

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The Benchmark for Electrochemical Research Instrumentation

The Model 273A's advanced design, superior quality, and high reliability make it unmatched by any potentiostat in the world. Whether you control your experiments from the front panel or from your computer, the Model 273A lets you make almost any electrochemical measurement you want.

Easy Front Panel Operation

A pushbutton front panel gives you unusual versatility and convenience in defining your experiments. With the touch of a button, you can key in setups for cyclic staircase voltammetry, Tafel plot corrosion measurements-or a variety of other pulse and staircase techniques. A graphic LED display gives you an instant picture of the progress of a measurement; an alphanumeric LCD display gives you a continuous readout of current and potential values during a measurement.

With another touch of a button, you can start automatic current ranging or current interrupt iR compensation. Standard BNC connectors on the front and rear panels make it easy for you to send signals to an analog recorder or an oscilloscope.

Powerful Computer-Based Experiments

As easy as it is to run experiments from the Model 273A front panel, running from a computer adds flexibility, automation, data storage and manipulation, and powerful calculation and plotting capability to your experimental toolbox. With both GPIB (IEEE-488) and serial (RS-232C) connectors on the Model 273A rear panel, running experiments from your computer is a snap.

But the most important advantage of computer control is that you can use Princeton Applied Research's Electrochemical Command Set, created specifically for electrochemical applications. A set of more than 100 commands lets you completely define an electrochemical experiment from pre-measurement operations to data acquisition and transfer. Your computer sends the commands to the Model 273A, which then performs the entire experiment automatically. You can set up your experiment to transfer data back to your computer for plotting or for additional calculations.

If you don't have time to develop your own software, you can pick from several different optional applications packages.

Princeton Applied Research Applications Software: Powerful Tools for Electrochemistry

The Model 273A comes with the versatile Virtual Potentiostat-32 software package which lets you control every function of the potentiostat, from the simple setting of a potential to a multi-cycle cyclic voltammetry experiment. Besides giving you a way to control the potentiostat from the computer, VP-32 helps you learn how to run electrochemical experiments and gain experience with the Model 273A Command Set. More advanced users can develop their own techniques from scratch.

We offer other proven, easy-to-use software that:

- Automates the collection and interpretation of data for kinetic and mechanistic studies, coatings evaluation, and other electrochemical impedance applications.
- Helps you apply various electrochemical corrosion measurement techniques such as potentiodynamic polarization, Tafel plots, polarization resistance, cyclic polarization, potentiokinetic reactivation, potentiostatic, galvanostatic, and galvanic corrosion studies, and open circuit vs. time measurements.
- Provides a complete selection of electrochemical techniques to quickly and thoroughly evaluate a reduction/oxidation system. These methods include cyclic and square-wave voltammetry, chronoamperometry, chronocoulometry, and a variety of pulse techniques,

For more information on any of our software packages, refer to the back of this brochure. If you would like to discuss your electrochemistry needs with our experts, just give us a call.

273A

Potentiostat/Galvanostat

The remarkable performance of the Model 273A reflects Princeton Applied Research's long experience in analog electronics. Many of its features are optional extras for other potentiostats. Look at some of the characteristics that make it the world's finest potentiostat:

High Compliance Voltage for Rapid, Accurate Potential Control

With its 100 V compliance and 1 A output capability, the Model 273A is capable of rapidly and accurately controlling the potential in virtually any electrochemical cell. This high compliance voltage ensures accurate potential control in high resistance cells, such as those with dilute electrolytes or non-aqueous solvents.

Low Noise Electronics Assures Sensitivity and Repeatability

Electronic noise, the ultimate limitation in all measurements, has many sources. The Model 273A is designed to minimize the noise generated at each of these sources. Our engineers have selected all amplifiers and other critical components for low noise specifications. They have also carefully laid out the digital and analog grounds, shielded all critical circuitry, and placed components to avoid picking up stray electromagnetic radiation and cross-talk.

As even the most carefully designed system will sense cell noise, our engineers have taken steps to minimize its effect. You can select either of two low-pass filters to further reduce cell noise.

High Speed Current Measurement

Princeton Applied Research engineers have designed the Model 273A's current measurement circuitry to minimize the effects of stray capacitance and maximize current measurement speed. The current-to-voltage converter is a four-terminal device yielding current measurements that are highly accurate, unlikely to drift, and independent of cell cable impedance. You can collect data every 50 microseconds, or hook up an oscilloscope to monitor the analog current signal at thousands of volts per second.

External Differential Electrometer

An electrometer is a high-impedance amplifier that measures the potential difference between the reference electrode and the working electrode. The Model 273A uses an external differential electrometer, which has these advantages:

- It allows you to use two electrodes to control the potential across an interface such as a membrane.
- It minimizes problems due to the resistance, inductance, and stray capacitance of the cell cable.
- It can be configured to provide a remote sensing contact for the working electrode and eliminate potential error caused by contact resistance.
- It always controls the potential, even when the current overloads.

HOW COMPLIANCE VOLTAGE AFFECTS YOUR EXPERIMENT

Compliance voltage is the voltage applied by the counter electrode to bring the working electrode to the programmed potential. Because of the solution resistance in your cell, it is often much higher than the working electrode potential desired. The compliance voltage is determined by the cell resistance and the current flowing in the cell:

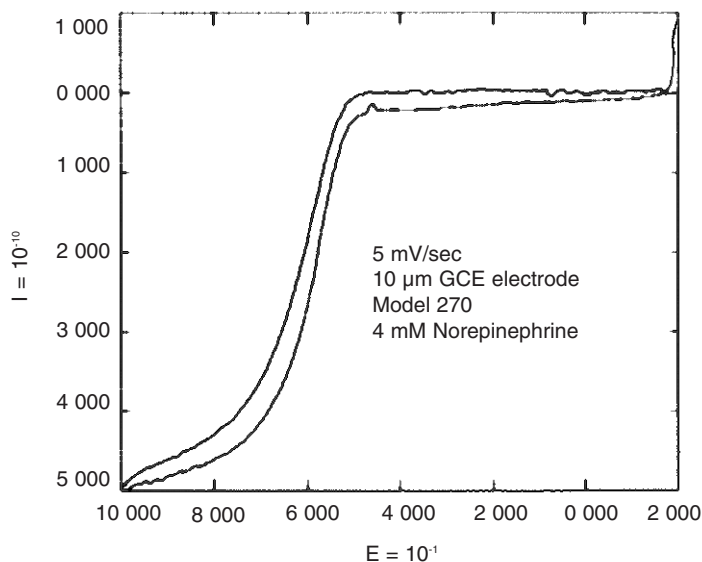
$$E_{\text{compliance}} = i_{\text{cell}} R_{\text{cell}}$$

Thus, if a current of 50 mA flows in a cell with 700 Ω resistance, the potentiostat must provide a compliance voltage of at least 35 volts. If the cell resistance is high and the cell capacitance is large, excess compliance voltage results in faster charging of the cell capacitance. Thus, a high compliance voltage gives the potentiostat the ability to respond rapidly to step transitions in the control potential.

Advanced Solid State Technology

High-power VMOS transistors in the power output stage make the Model 273A a faster, more reliable potentiostat. During a current overload, VMOS transistors are not prone to thermal runaway so the Model 273A is less likely to have a failure in the power output stage than potentiostats using lower quality components.

High-speed switching using VMOS devices not only is faster than mechanical switching, it also eliminates transients due to contact bounce. The Model 273A prevents large voltage transients in the cell by using VMOS devices for the cell on switch.



ADVANCED FEATURES OF THE MODEL 273A POTENTIOSTAT

- **Waveform Generation.** Versatile waveforms are a snap with our two built-in, microprocessor-controlled D/A converters. Design simple scans and steps from the front panel, or use a computer to define the waveform of your dreams. If you can imagine it, the 273A can run it.
- **Digital Coulometer.** No need for optional accessories—just hook up your cell and go. The LCD displays the integrated current value in coulombs at all times, if desired. You need a high performance coulometer for short-timescale chronocoulometry experiments? Well, it's still standard! The 273A can handle both long-timescale bulk electrolyses and short-timescale pulse experiments.
- **Versatile Output.** You can output your data to an X-Y recorder. Pick from output connectors for current, potential, charge, and log current. All of these values can also be monitored with the LCD display. And you avoid the high expense of the log recorder needed with other systems.
- **Wide Range of Current Measurement Capabilities.** From the front panel, select from current ranges between 100 nA and 1 A or Autoranging. With computer control, add 10 nA and 1 nA current ranges as well. With current resolutions of down to 2 pA, the Model 273A is perfect for microelectrode work; our optional electrochemical analysis software automatically takes full advantage of this capability.
- **Filters.** Two selectable low-pass filters discriminate against high-frequency noise. They're convenient for experiments at very low current levels, but can be turned off for better accuracy at high scan rates.
- **iR Compensation.** Both positive feedback and current interrupt iR compensation are standard. Choose positive feedback for fast scan rates when uncompensated solution resistance is known, or current interrupt for convenient measurement of uncompensated solution resistance and higher accuracy at slow scan rates. You can also choose no compensation.
- **Rack Mounting.** May be mounted in a standard 19 inch (47.5 cm) rack assembly.
- **Battery Backup.** Assures that all parameters retain the values in effect at the end of the previous operating session. If desired, the default values can be restored.
- **273A/92 Electrochemical Impedance Interface Option.** Allows superposition of an externally generated ac excitation signal on the dc signal generated by the Model 273A. It also allows dc suppression and output signal offset for improved accuracy in electrochemical impedance spectroscopy experiments.
- **307A Interface Option.** This accessory allows the Model 273A to be used with our popular Model 303A Static Mercury Drop Electrode.

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Model 273A Front Panel

A. SCAN SETUP Section: The keypad in this section lets you define a staircase or a pulse waveform. Setup is simple: Select the parameter by pressing the appropriate pushbutton, key in the desired number, and press ENTER.

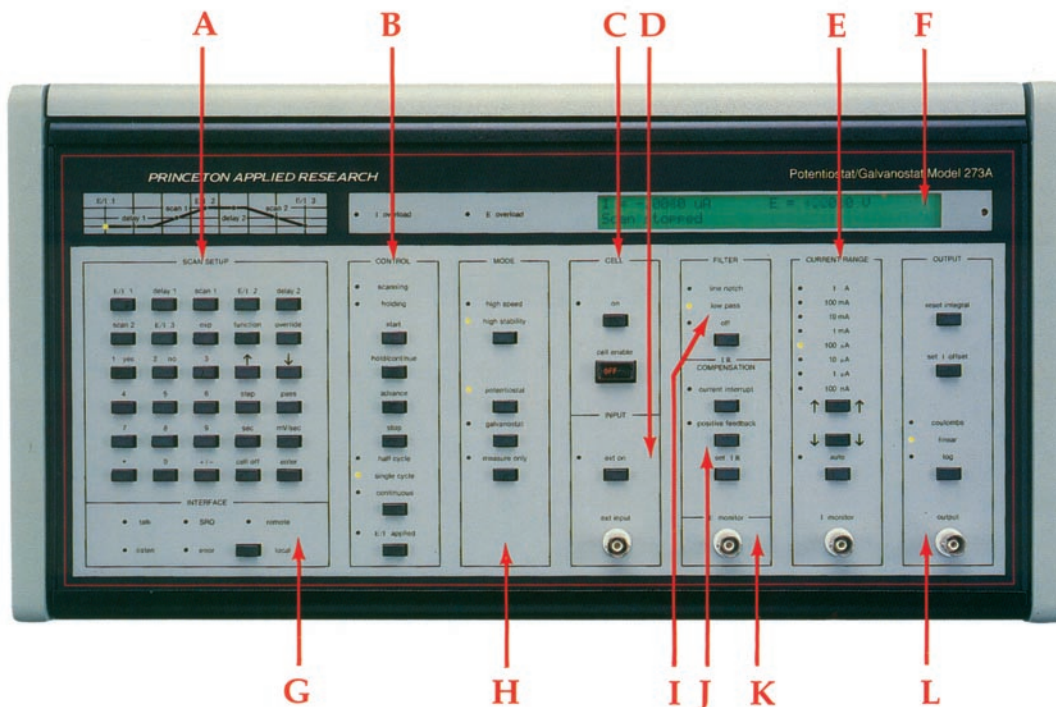
B. CONTROL Section: This section lets you start, stop, hold, or continue your measurements. The ADVANCE key lets you skip to the next part of your experiment. Other pushbuttons let you select half-cycle, full-cycle, or continuous-cycle measurements. Pressing E/I APPLIED applies a programmed potential or current to the cell.

C. CELL Section: To provide an extra margin of safety, both switches in this section must be set to apply the programmed potential or current to the cell. The CELL ENABLE switch allows you to override computer control of the cell at any time. The CELL ON/OFF button controls a solid state, transient-free switch without the contact bounce of mechanical switches.

D. INPUT Section: For rapid-scan cyclic voltammetry, connect an external waveform programmer to the BNC connector in this section. The Princeton Applied Research Model 175 Universal Programmer provides scans of up to 10,000 V/s.

E. CURRENT RANGE Section: This section lets you select from among eight current ranges - from 1 A to 100 nA fullscale - as well as autoranging. LEDs indicate the option currently selected. Under software control, you can access 10 nA and 1 nA current ranges with resolutions as low as 2 pA! The I monitor BNC lets you connect to the 1 V full-scale output of the current-to-voltage converter.

F. DISPLAY: A graphic LED display gives you an instant picture of the progress of a measurement. Current and potential overload indicators warn you of any overload conditions. The alphanumeric LCD displays a continuous readout of current, potential, or charge. It also displays help and error messages, and you can use it to view or change experimental settings.



G. INTERFACE Section: When the Model 273A is connected to a computer through the GPIB (IEEE-488) interface, the LED indicators in this section let you monitor communications with the computer. The LOCAL pushbutton lets you switch back to entering parameters from the front panel of the Model 273A.

H. MODE Section: This section allows you to choose between potentiostatic, galvanostatic, or measure-only modes.

I. FILTER Section: If high-frequency noise becomes a problem, this section lets you apply either of two available low-pass filters.

J. IR COMPENSATION Section: If you have high uncompensated solution resistance in your cell, this section lets you select either positive feedback or current interrupt IR compensation. The SET IR pushbutton allows adjustment of the positive feedback IR compensation level.

K. E MONITOR Section: The BNC connector in this section lets you send an analog voltage to an X-Y recorder.

L. OUTPUT Section: The RESET INTEGRAL and SET I OFFSET pushbuttons are used for integrating current. This section also lets you send an analog output to another device. A pushbutton lets you specify the output as current, log current, or coulombs.

273A

Potentiostat/Galvanostat

Specifications

The following specifications apply at the nominal line voltage $\pm 10\%$ and at a temperature of 25°C (77°F) unless otherwise stated.

POWER AMPLIFIER

Compliance Voltage: $>\pm 100\text{ V}$

Maximum Output Current: $>\pm 1.0\text{ A}$

Slew Rate: $10\text{ V}/\mu\text{S}$ (high speed)

Bandwidth, Open Loop, Unity Gain: $>2.5\text{ MHz}$

Voltage Temperature Stability: $<50\text{ }\mu\text{V}/^{\circ}\text{C}$

DIFFERENTIAL ELECTROMETER

Input Impedance: $>10^{10}\text{ }\Omega$ in parallel with $<50\text{ pF}$

Input Bias Current: $<20\text{ pA}$ at 25°C

Maximum Input Voltage

Differential: $\pm 10\text{ V}$

Reference Input: $\pm 11\text{ V}$

Common Mode Rejection

$>70\text{ dB}$ at 100 Hz

$>60\text{ dB}$ at 100 kHz

Bandwidth

Small Signal: $>8\text{ MHz}$

Full Signal: $>400\text{ kHz}$

Offset Voltage: $<10\text{ }\mu\text{V}$

Offset Temperature Stability: $<10\text{ }\mu\text{V}/^{\circ}\text{C}$

IR COMPENSATION

Positive Feedback

Range: $20\text{ M}\Omega$ to $2\text{ }\Omega$ depending on current range

Resolution: 0.05% of current range

Current Interrupt

Digital Potential Error Correction: 12 bit DAC

Total Interruption Time: $<200\text{ }\mu\text{S}$

Switching Time, ON/OFF: $<1\text{ }\mu\text{S}$ ($1\text{ k}\Omega$ resistive cell)

CURRENT MEASUREMENT

Ranges: 8 decades, 1 A to 100 nA

Accuracy (dc) at Monitor

10 μA to 1 A: Better than 0.2% of range

100 nA and 1 μA Ranges: Better than 0.5% of range $\pm 5\text{ nA}$ max ($\pm 1\text{ nA}$ typical)

Frequency Response (small signal)

1 mA Range: -3 dB at $>1\text{ MHz}$,

1 k Ω source impedance

10 μA Range: -3 dB at $>75\text{ kHz}$,

100 k Ω source impedance

POTENTIAL/CURRENT CONTROL

Digital/Analog Converters (DACs)

Bias DAC

Resolution: 14 bits

Range: $\pm 8\text{ V}$ (potentiostat) $\pm 200\%$ of full-scale current (galvanostat)

Modulation DAC

Resolution: 14 bits

Range (Potentiostat): $\pm 2\text{ V}$, $\pm 0.2\text{ V}$, and $\pm 0.02\text{ V}$

Range (Galvanostat): $\pm 200\%$, $\pm 20.00\%$, and $\pm 2.000\%$ of full-scale current

Accuracy

Applied Potential: 0.2% of reading $\pm 2\text{ mV}$

Applied Current: 0.2% of full-scale current

SYSTEM

Rise Time (10% to 90% on high-speed setting)

No Load: $<750\text{ ns}$

1 Ω , 1 A: $<3\text{ }\mu\text{s}$

10 k Ω , 100 μA : $<2\text{ }\mu\text{s}$

Noise and Ripple: typically $<25\text{ }\mu\text{V rms}$ referred to external input

COMPUTER INTERFACES

RS-232C

IEEE-488 (GPIB)

WEIGHT: 31 kg (68 lb)

DIMENSIONS

48 cm W x 30 cm H x 51 cm D

(19" W x 12" H x 20" D)

POWER REQUIREMENTS

100–130 V or 200–260 V, 50–60 Hz,

350 watts maximum

Recommended Options and Accessories

PowerCV Cyclic Voltammetry Software

PowerSTEP Chronoamperometry and Chronopotentiometry Software

PowerCORR Corrosion Measurement Software

PowerSINE Electrochemical Impedance Software

Model 273A/92 Electrochemical Impedance Option

Model 303A Static Mercury Drop Electrode

Model 307A Interface for Model 303A

Model 377A Coulometry Cell System

Model 616 Rotating Disk Electrode

Model 636 Ring/Disk Electrode

Model G0224 Gold Microelectrode

Model G0225 Platinum Microelectrode

Model G0226 Glassy Carbon Microelectrode

Model K0047 Corrosion Cell Kit

Model K0206 Rack Mounting Kit

Model K0235 Flat Cell Kit

Model K0264 Microcell Kit

Model K0269 Faraday Cage Kit

These accessories are available separately or as part of a complete system. All software operates with Windows 95/98/2000/NT/XP. For the latest features, prices, and availability, contact your local salesman or the factory.

Specifications subject to change
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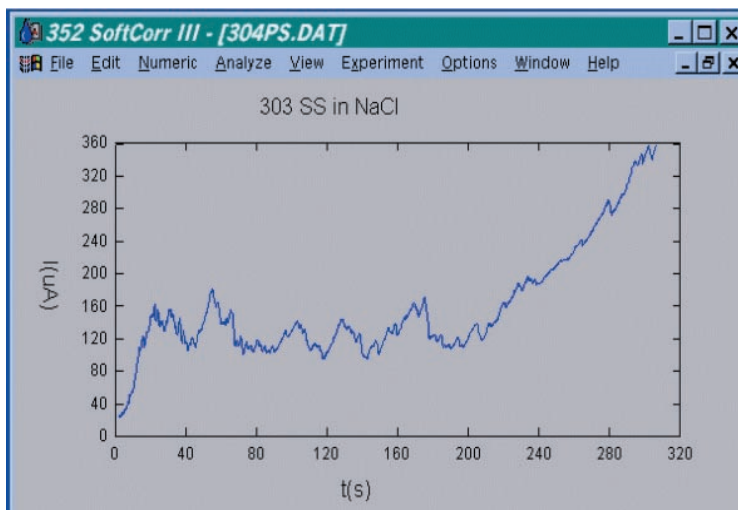
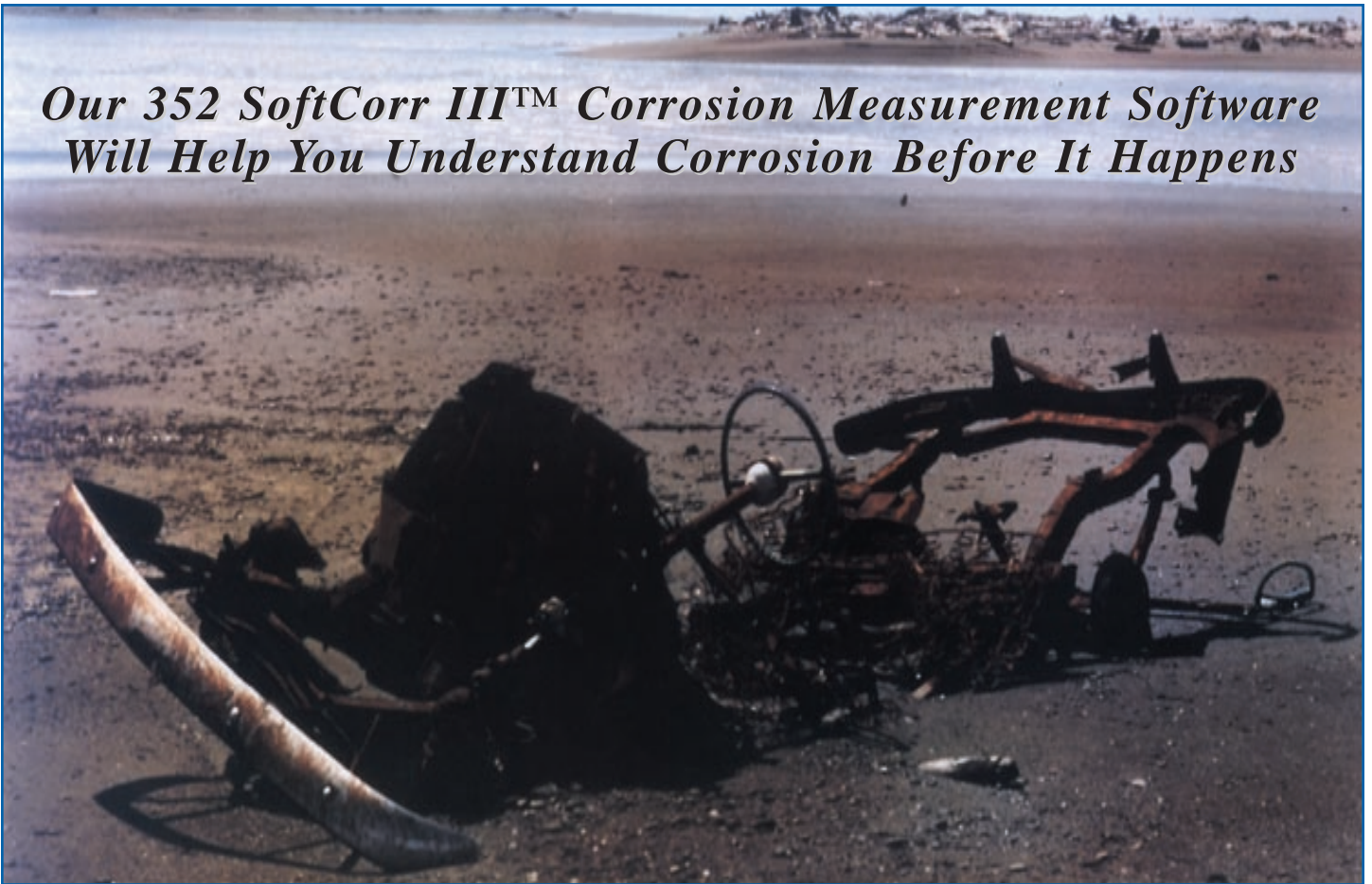
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Our 352 SoftCorr III™ Corrosion Measurement Software Will Help You Understand Corrosion Before It Happens



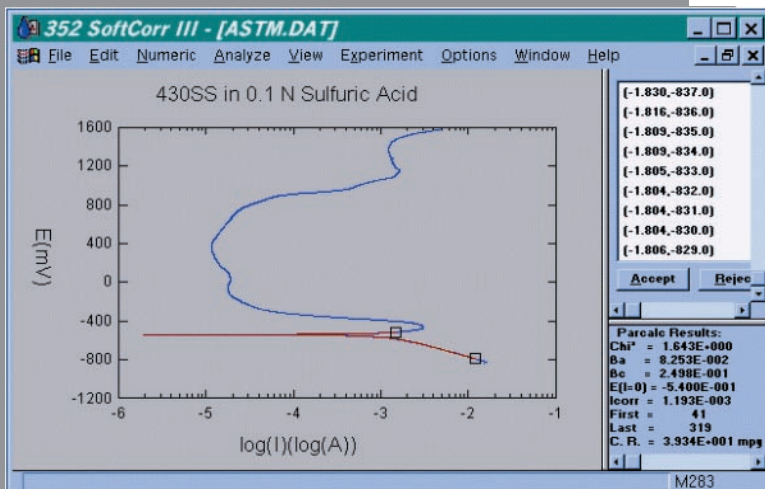
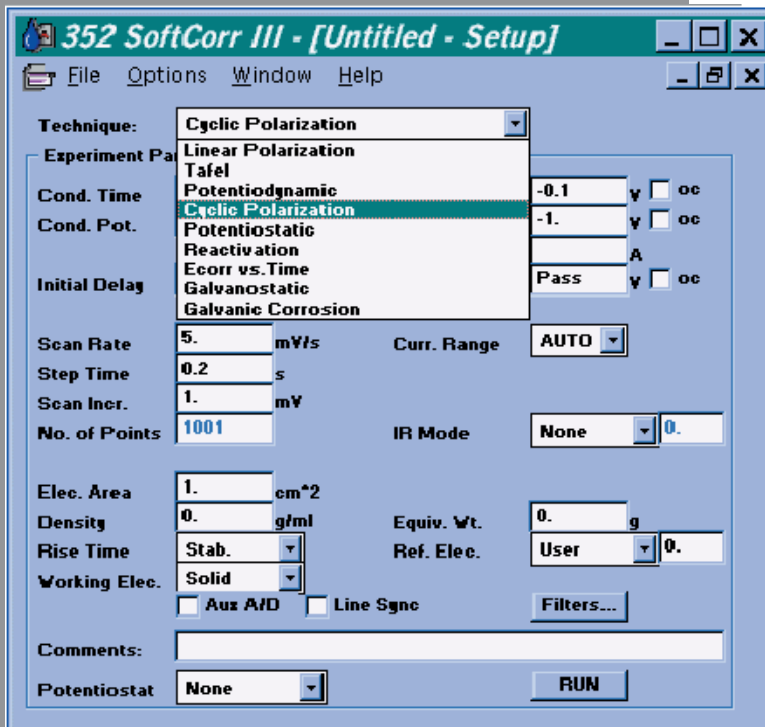
- Nine Different Corrosion Tests
- Virtual Potentiostat Software
- Control Multiple Potentiostats Simultaneously
- Autoexecute: Unattended, Sequenced Experimental Control
- Reference Potentials vs. Open Circuit
- Multitasking
- Copy and Paste
- Win95, and 3.1x Compatible

Electrochemical Current Noise generated by metastable pitting of 303 SS in 1000 ppm NaCl. Sample was held potentialstatically at 600 mV vs. open circuit.

Princeton Applied Research

352 SoftCorr III

Corrosion Measurement Software



The 352 SoftCorr III Corrosion Measurement Software continues the long tradition of corrosion software from Princeton Applied Research.

The proven power of the software, coupled with enhanced flexibility, increases its value to you and your work. Copy and Paste your data or graphs directly from the software into your favorite spread-sheet or word processor. Work on your upcoming presentation while the software runs a Tafel experiment (for the next paper) in the background.

This software will allow you to reference your initial, final, and vertex potentials vs. open circuit or vs. a variety of different reference electrodes.

Acquire auxiliary data from an external instrument such as a Quartz Crystal Analyzer or a temperature control unit simultaneously with the E and I data from your experiment.

Use our Autoexecute technique to automate your experiments and increase your efficiency dramatically. This technique will allow you to run a series of experiments (the same or different) without operator intervention. These experiments can be time delayed or run consecutively. One example of its use: you can setup an autoexecute to run multiple potentiostatic holds, followed by one or more linear polarization scans, followed by another potentiostatic hold. The possibilities and combinations are limited only by the application and your imagination.

This software allows you to operate multiple potentiostats simultaneously! It will control any Princeton Applied Research digital potentiostat, including the VersaStat, 6310, 263A, 273A, and 283.

Powerful Corrosion Software Coupled with Windows Agility

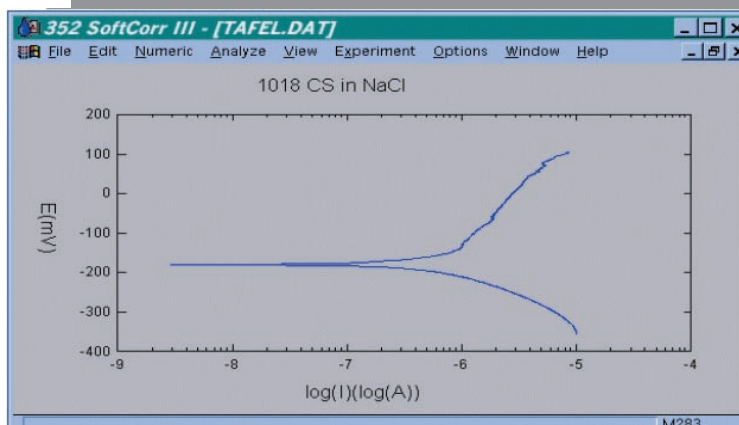
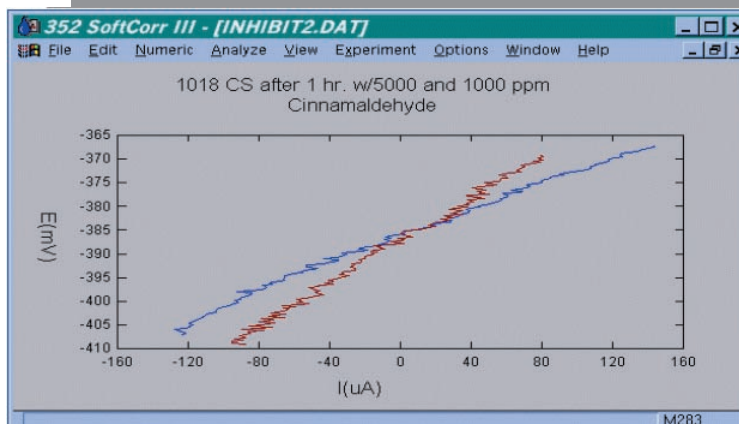
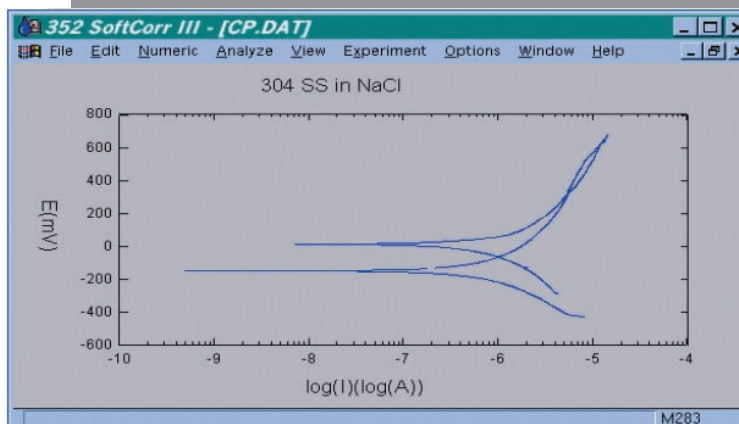
Experimental setup and data acquisition have been simplified in this package. Analysis is also just as easy. The powerful QuickCalc™, PARCalc™, and RpCalc™ analysis routines have also been made easier. The results from the analysis can be seen in the same window as your plot. Tafel slopes, E_{Corr} and I_{Corr} values, X^2 , and the Corrosion Rate are at your fingertips.

Changing the end points for your analysis is simple. Just click on the endpoint and drag it to any point on the curve. The software can also draw lines on your graph to assist in determination of cathodic or anodic limiting reactions.

Virtual Potentiostat software is also included with SoftCorr III. Virtual Potentiostat gives you the look and feel of a potentiostat front panel. The power locked into the firmware of your potentiostat can be released via the Virtual Potentiostat software and give you full control of your potentiostat as if you were programming an actual front panel.

At your option, we will provide some extra tools with the SoftCorr III and Virtual Potentiostat software. These tools will provide you with the complete package for solving your corrosion problems.

'Corrosion Manager' is a modeling program that performs calculations using standard electrochemical oxidation and reduction reactions, producing a corrosion 'model.' A primer written by Dr. Steve Tait entitled "An Introduction to Electrochemical Corrosion Testing for Practicing Engineers and Scientists" is also included. Completing the package is a series of laboratory experiments compiled by the University of Virginia.



352 SoftCorr III Software Specifications

Parameter	273/273A	263A/91	283	VersaStat II
Conditioning Time	0 – 32767 s	0 – 32767 s	0 – 32767 s	0 – 32767 s
Conditioning Potential	±8 V	±8 V	±8 V	±8 V
Passivation Time	0 – 32767 s	0 – 32767 s	0 – 32767 s	0 – 32767 s
Initial Delay, Drift	0.01 mV/s to 100 mV/s	0.01 mV/s to 100 mV/s	0.01 mV/s to 100 mV/s	0.01 mV/s to 100 mV/s
Initial Delay, Time	0 – 32767 s	0 – 32767 s	0 – 32767 s	0 – 32767 s
Initial/Final Potential	±10 V	±10 V	±10 V	±8 V
Fixed Current Range	1 nA – 1 A	1 na – 100 mA*	1 pA – 100 mA	100 nA – 100 mA
Max. Current	1 A	200 mA	100 mA	250 mA
Min. Measureable	2 pA	2 pA	20 fA	200 pA
Scan Rate, Max.	160 V/s	267 V/s	267 V/s	30 V/s
Scan Rate, Min.	10 µV/s	10 µV/s	10 µV/s	10 µV/s
Scan Increment	2.5 mV – 20 mV	2.5 mV – 20 mV	2.5 mV – 20 mV	2.5 mV – 20 mV
Step Time, Max.	1000 s	1000 s	1000 s	1000 s
Step Time, Min.	50 µs	30 µs	30 µs	300 µs
No. of Points/Curve	1 – 4096	1 – 4096	1 – 4096	1 – 4096
Rise Time	Speed or Stab.	Speed or Stab.	Speed or Stab.	N/A
616 Rotation Speed	0 – 8000 rpm	0 – 8000 rpm w/98	0 – 8000 rpm	N/A
Step 1 Time, Min.	50 µs	30 µs	30µs	300 µs
Step 1 Time, Max.	2 Ms	2 Ms	2 Ms	2 Ms
Time/Data Point, Max.	1000 s	1000 s	1000 s	1000 s
Time/Data Point, Min.	50 µs	30 µs	30 µs	300 µs
Vertex Potential 1	±10 V	±10 V	±10 V	±8 V
Filters	5.3 Hz I & E 590 Hz I & E	5.3 Hz I & E 590 Hz I & E I/E	5.3 Hz I & E 590 Hz I & E I/E	I/E
Step 1 Current	21 nA – 1 A	21 nA – 100 mA 2A w/94	21 pA – 100 mA	210 nA – 200 mA
Current Interrupt (Max. IR E Correction)	±4 V (w/96 or /97)	±4 V	±4 V	±1 V
Stop On Parameter	User Spec.	User Spec.	User Spec.	User Spec.
Line Sync.	Yes/No	Yes/No	Yes/No	Yes/No

Computer Requirements: 386 DX or greater. Recommended 8 MB RAM. Windows 95 or 3.1x. National Instruments IEEE 488.2 PCII/IIA or PCMCIA GPIB interface card.

Specifications subject to change
022002

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