classic.

The Pine Research Instrumentation **MSR Rotator** is the academic and industry standard for rotating electrode systems. With a rotation range from 100 to 10,000 RPM, the MSR Rotator is the trusted choice for rotating disk, rotating ring-disk, and rotating cylinder electrochemsitry. Pine offers a wide variety of electrodes, cells, and accessories for a complete hydrodynamic electrochemical system.

VERSATILE APPLICATIONS

One instrument for rotating disk (RDE), rotating ring-disk (RRDE), and rotating cylinder (RCE) electrochemistry for both large (liters) and small volume (milliliters) systems.

HIGH QUALITY ELECTRODES

Precision rotating electrodes are *made by hand*, individually *tested*, and made from chemically resistant polytetrafluoroethylene (Teflon®, PTFE) or polyether ether ketone (PEEK).

CUSTOMIZABLE ACCESSORIES

Nearly every aspect of rotating electrode products can be customized to suit your specific needs. Pine offers custom products in quantities from one to one thousand.

DURABLE AND SMART DESIGN

Pine manufactures long working length shafts and electrodes. These long shafts make it possible to work with larger volume while simultaneously protecting the motor electronics from corrosive vapors.

RESEARCH COMMUNITY STANDARD

Serving the electrochemistry, engineering, and corrosion fields since 1967, the Pine MSR Rotator is the premier choice of scientists for RDE, RRDE, and RCE.

INDEPENDENTLY TESTED

The MSR Rotator complies with one or more EU directives and bears the CE Mark. The MSR Rotator is also listed by ETL to UL 61010-1.

UNPARALLELED SUPPORT

The MSR Rotator, featured in countless journal publications, has a wide body of research support and applications. The instrument is supported with Pine's tradition of customer support and service.
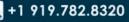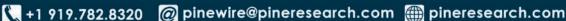
PINE
research

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Standard Electrochemical Methods:

Basic Methods
Open Circuit Potential (OCP)
Bulk Electrolysis (BE)
Potentiostatic Methods
Chronoamperometry (CA)
Double Potential Step Chronoamperometry (DPSCA)
Cyclic Step Chronoamperometry (CSCA)
Galvanostatic Methods
Chronopotentiometry (CP)
Ramp Chronopotentiometry (CRP)
Staircase Potentiometry (SCP)
Cyclic Step Chronopotentiometry (CSCP)
Voltammetric Methods
Cyclic Voltammetry (CV)
Linear Sweep Voltammetry (LSV)
Staircase Voltammetry (SCV)
Differential Pulse Voltammetry (DPV)
Square-Wave Voltammetry (SWV)
Normal Pulse Voltammetry (NPV)
Stripping Voltammetry
Stripping Voltammetry (ASV)
Differential Pulse Stripping Voltammetry (DPSV)
Square Wave Stripping Voltammetry (SWSV)

Rotating Methods (optional)
Rotating Disk Voltammetry (RDE)
Rotating Disk Koutecky-Levich Series (KL-RDE)
Rotating Disk Electrolysis (BE-RDE)
Rotating Disk Chronopotentiometry (CP-RDE)
Rotating Disk Ramp Chronopotentiometry (RCP-RDE)
Spectroelectrochemical Methods (optional)
Spectroscopy (SPEC)
Spectroelectrochemistry (SPECE)
Corrosion Methods (optional)
Linear Polarization Resistance (LPR)
Rotating Cylinder Voltammetry (RCE)
Rotating Cylinder Electrolysis (BE-RCE)
Rotating Cylinder Eisenberg Study (EIB-RCE)
Rotating Cylinder Polarization Resistance (LPR-RCE)
Rotating Cylinder Open Circuit Potential (OCP-RCE)
Rotating Cylinder Chronopotentiometry (CP-RCE)
Rotating Cylinder Ramp Chronopotentiometry (RCP-RCE)

wavenow
Part Number: AFTP1

Measured Current
Practical Range: 80 nA§ to 100 mA
Ranges: ±100 mA, ±5 mA, ±200 µA, ±10 µA
Autoranging: Yes
Resolution (at each range): 3.4 µA, 170 nA, 6.8 nA, 340 pA
Accuracy: ± 0.2% setting; ±0.05% of range
ADC Input: 16 bits
Filter: 2.5 kHz (2-pole, low pass filter)
Leakage Current: 10 pA at 25°C

Applied Current (galvanostat mode)
Ranges (four ranges): ±100 mA, ±5 mA, ±200 µA, ±10 µA
Resolution (at each range): 3.1 µA, 156 nA, 6.25 nA, 313 pA
Accuracy: ± 0.2% setting; ±0.05% of range
DAC Output: 16 bits

Power Amplifier (CE control amplifier)
Compliance Voltage: > ± 12.5 V
Output Current : ±100 mA (maximum)
Speed Settings: 3
Unity Gain Bandwidth: > 20 kHz (on "fast" speed)
Rise Time: 180 V/msec (on "fast" speed)

wavenow^xy
Part Number: AFTP3

Measured Current
Practical Range: 80 nA§ to 100 mA
Ranges: ±100 mA, ±5 mA, ±200 µA, ±10 µA
Autoranging: Yes
Resolution (at each range): 3.4 µA, 170 nA, 6.8 nA, 340 pA
Accuracy: ± 0.2% setting; ±0.05% of range
ADC Input: 16 bits
Filter: 2.5 kHz (2-pole, low pass filter)
Leakage Current: 10 pA at 25°C

Applied Current (galvanostat mode)
Ranges (four ranges): ±100 mA, ±5 mA, ±200 µA, ±10 µA
Resolution (at each range): 3.1 µA, 156 nA, 6.25 nA, 313 pA
Accuracy: ± 0.2% setting; ±0.05% of range
DAC Output: 16 bits

Power Amplifier (CE control amplifier)
Compliance Voltage: > ± 12.5 V
Output Current : ±100 mA (maximum)
Speed Settings: 3
Unity Gain Bandwidth: > 20 kHz (on "fast" speed)
Rise Time: 180 V/msec (on "fast" speed)

wavenano
Part Number: AFTP2

Measured Current
Practical Range: 100 pA§ to 1 mA
Ranges: ±1 mA, ±50 µA, ±2 µA, ±100 nA
Autoranging: Yes
Resolution (at each range): 34 nA, 1.7 nA, 68 pA, 3.4 pA
Accuracy: ± 0.2% setting; ±0.05% of range
ADC Input: 16 bits
Filter: 2.5 kHz (2-pole, low pass filter)
Leakage Current: 10 pA at 25°C

Applied Current (galvanostat mode)
Ranges (four ranges): ±1 mA, ±50 µA, ±2 µA, ±100 nA
Resolution (at each range): 31 nA, 1.56 nA, 62.5 pA, 3.13 pA
Accuracy: ± 0.2% setting; ±0.05% of range
DAC Output: 16 bits

Power Amplifier (CE control amplifier)
Compliance Voltage: > ± 12.5 V
Output Current: ±1.0 mA (maximum)
Speed Settings: 3
Unity Gain Bandwidth: > 20 kHz (on "fast" speed)
Rise Time: 180 V/msec (on "fast" speed)

§ *Lower limit of the practical range is current level where noise begins to interfere with the signal unless special precautions are taken. With proper shielding the WaveNano can routinely measure signals as low as 100 pA.*

The Following Information Applies to the WaveNow,™ WaveNow^xy ™ and WaveNano™:

General
Power Required: 5.0 VDC, 2 A (low voltage DC device)
Power Adapter: 100 to 240 VAC, 300 mA, 50 to 60Hz
Field-Changeable Adapter Plugs: US, EU, UK, and Australia (included)
LED Indicators: Power, USB, and Status
Instrument Dimensions: 165 x 100 x 29 mm
Shipping Dimensions: 260x 260 x 360 mm
Instrument Weight : 200 g (7 oz)
Shipping Weight: 1.4 kg (3 lb)
Temperature Range: 10°C to 40°C
Humidity Range: 80% RH maximum, non-condensing

Control Modes and Connections
Operating Modes: potentiostat (POT), galvanostat (GAL), open circuit potential (OCP)
Cell Connections: working (K1), counter (CE), reference (REF), and working sense (K1SENSE)
Signal Ground Configuration: working electrode connects to signal ground through current range resistor; signal ground connects to USB ground
iR Compensation: No

Applied Potential (potentiostat mode)
Range: ±4.0 V; WaveNow^xy: ±10.0 V
Resolution: 125 µV per DAC bit WaveNow^xy: 312.5 µV
Accuracy: ±0.2% of setting; ±1.0 mV
Thermal Drift: < 0.01% / °C
DAC Output: 16 bits
Scan Rate (min): 10 µV / sec; WaveNow^xy: 25 µV / sec
Scan Rate (max): 10 V/sec

Measured Potential
Range: ±4.0 V; WaveNow^xy: ±10.0 V
Resolution: 136 µV per ADC bit; WaveNow^xy: 340 µV
Accuracy: ± 0.2% setting; ±0.05% of range
ADC Input: 16 bits
Filter: 2.5 kHz (2-pole, low pass filter)

Electrometer (reference electrode follower)
Input Impedance: > 10^{14} Ω in parallel with < 20 pF
Input Current: < 2 pA leakage/bias current
CMRR: > 50 dB at 10 kHz; 80 dB at 60 Hz
Bandwidth: > 800 kHz (3 dB)

Certification
The WaveNow™, WaveNow^xy™, and WaveNano™ potentiostat/galvanostat systems comply with one or more EU directives and bears the CE marking.

Additional Output Signals
(for rotation rate control)
Range: ±10.5 V
Resolution: 5.12 mV per DAC bit (12 bit)
Digital On/Off Signal: open drain (TTL compatible)
Output Impedance: < 10 Ω

Data Acquisition
Clock Resolution: 500 nsec (minimum time base)
Point Interval (min): 1000 µsec
Synchronization: simultaneous current & potential input
Raw Point Total: <10 million per experiment

External Ports
Cell Port: HD-15 female connector
Interface Port: USB Type-B connector
Rotator Control Port: 3-pin header connector

Accessories
Calibration Tools: HD–15 loopback cell (included)
Dummy Cell: external dummy cell (included)
Cell Cable: various designs available separately

CE