Model 636A

Electrodde Rotator

Operating and Service Manual

Part No. 220892
Manual Revision F

072025
Printed in USA

WARRANTY

Princeton Applied Research* warrants each instrument of its own manufacture to be free of defects in material and workmanship. Obligations under this Warranty shall be limited to replacing, repairing or giving credit for the purchase price, at our option, of any instrument returned, shipment prepaid, to our Service Department for that purpose within ONE year of delivery to the original purchaser, provided prior authorization for such return has been given by an authorized representative of Princeton Applied Research.

This Warranty shall not apply to any instrument, which our inspection shall disclose to our satisfaction, to have become defective or unworkable due to abuse, mishandling, misuse, accident, alteration, negligence, improper installation, or other causes beyond our control. This Warranty shall not apply to any instrument or component not manufactured by Princeton Applied Research. When products manufactured by others are included in Princeton Applied Research equipment, the original manufacturer's warranty is extended to Princeton Applied Research customers.

Princeton Applied Research reserves the right to make changes in design at any time without incurring any obligation to install same on units previously purchased.

THERE ARE NO WARRANTIES THAT EXTEND BEYOND THE DESCRIPTION ON THE FACE HEREOF. THIS WARRANTY IS IN LIEU OF, AND EXCLUDES ANY AND ALL OTHER WARRANTIES OR REPRESENTATIONS, EXPRESSED, IMPLIED OR STATUTORY, INCLUDING MERCHANTABILITY AND FITNESS, AS WELL AS ANY AND ALL OTHER OBLIGATIONS OR LIABILITIES OF PRINCETON APPLIED RESEARCH, INCLUDING, BUT NOT LIMITED TO, SPECIAL OR CONSEQUENTIAL DAMAGES. NO PERSON, FIRM OR CORPORATION IS AUTHORIZED TO ASSUME FOR PRINCETON APPLIED RESEARCH ANY ADDITIONAL OBLIGATION OR LIABILITY NOT EXPRESSLY PROVIDED FOR HEREIN EXCEPT IN WRITING DULY EXECUTED BY AN OFFICER OF PRINCETON APPLIED RESEARCH.

SHOULD YOUR EQUIPMENT REQUIRE SERVICE

A. Contact the Customer Service Department (865-482-4411) or your local representative to discuss the problem. In many cases it will be possible to expedite service by localizing the problem.

B. If it is necessary to send any equipment back for service, we need the following information.

1. Model number and serial number.
2. Your name (instrument user).
3. Your address.
4. Address to which the instrument should be returned.
5. Your telephone number and extension.
6. Symptoms (in detail, including control settings).
7. Your purchase order number for repair charges (does not apply to repairs in warranty).
8. Shipping instructions (if you wish to authorize shipment by any method other than normal surface transportation).

C. U.S. CUSTOMERS - Ship the equipment being returned to:

Advanced Measurement Technology, Inc.
801 S. Illinois Avenue
Oak Ridge, TN 37831
ATTN: Customer Service

PHONE: 865-482-4411
FAX: 865-483-2133

D. CUSTOMERS OUTSIDE OF U.S.A. C To avoid delay in customs clearance of equipment being returned, please contact the factory or the nearest factory distributor for complete shipping information.

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SAFETY INSTRUCTIONS AND SYMBOLS

This manual contains up to three levels of safety instructions that must be observed to avoid personal injury and/or damage to equipment or other property. These are:

DANGER Indicates a hazard that could result in death or serious bodily harm if the safety instruction is not observed.

WARNING Indicates a hazard that could result in bodily harm if the safety instruction is not observed.

CAUTION Indicates a hazard that could result in property damage if the safety instruction is not observed.

Please read all safety instructions carefully and make sure they are understood fully before attempting to use this product.

In addition, the following symbol might appear on the product:

ATTENTION – Consult the manual in all cases where this symbol is marked to determine the nature of the potential hazards and any actions that must be taken to avoid them.

DANGER – Hazardous voltage

Protective earth (ground) terminal

Please read all safety instructions carefully and make sure they are understood fully before attempting to use this product.

SAFETY WARNINGS AND CLEANING INSTRUCTIONS

DANGER Opening the cover of this instrument is likely to expose dangerous voltages. Disconnect the instrument from all voltage sources while it is being opened.

WARNING Using this instrument in a manner not specified by the manufacturer may impair the protection provided by the instrument.

Cleaning Instructions

To clean the instrument exterior:

- Unplug the instrument from the ac power supply.
- Remove loose dust on the outside of the instrument with a lint-free cloth.
- Remove the remaining dirt with a lint-free cloth dampened in a general-purpose detergent and water solution. Do not use abrasive cleaners.

CAUTION To prevent moisture inside of the instrument during external cleaning, use only enough liquid to dampen the cloth or applicator.

- Allow instrument to dry completely before reconnecting it to the power source.

Harmful or Corrosive Substances

The operator of the 636A Electrode Rotator should have prior experience working in a chemical laboratory and knowledge of the safety issues associated with working in a chemical laboratory. Electrochemical experiments may involve the use of harmful or corrosive substances, and the operator should wear personal protective equipment (PPE) while working with these substances. At a minimum, the operator should wear the following PPE items to avoid contact with harmful or corrosive substances:

- Eye protection (safety goggles, face shield, etc.)
- Laboratory coat (flame- and solvent-resistant)
- Solvent-resistant gloves
- Closed-toe shoes

Additional personal protective clothing and equipment may be required depending upon the nature of the chemicals used in an experiment. A complete discussion of chemical laboratory safety practices is beyond the scope of this user guide, and the reader is directed to the **CHEMICAL SAFETY BIBLIOGRAPHY** below for additional information.

CHEMICAL SAFETY BIBLIOGRAPHY

1. American Chemical Society Committee on Chemical Safety Hazards Identification and Evaluation Task Force, Identifying and Evaluating Hazards in Research Laboratories: Guidelines Developed by the Hazards Identification and Evaluation Task Force of the ACS Committee on Chemical Safety; American Chemical Society, 2013.
2. National Research Council (US), Division of Earth and Life Studies, Board of Chemical Sciences and Technology, Committee on Prudent Practices in the Laboratory, Prudent Practices in the Laboratory: Handling and Management of Chemical Hazards, Updated Version; National Academies Press, 2011.
3. American Chemical Society Committee on Chemical Safety. Safety in Academic Chemistry Laboratories; 7th ed.; American Chemical Society: State College, PA, 2003; Vol. 2.


636A
Princeton Applied Research

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1. GENERAL

1.1 INSTRUMENT MARKINGS

Labels located on the 636A Electrode Rotator control box and motor unit bear information about the make, model, and serial number of the instrument. These labels also indicate any certifications or independent testing agency marks that pertain to the instrument.

Figure 1. Instrument Markings

1	**Environmental Labels**	These labels indicate that the instrument has an Environment Friendly Use Period (EFUP) of forty years and that the instrument should be treated as recyclable electronic equipment at the end of its useful life.
2	**Serial Number Label**	This label indicates the model and serial number of the instrument.
3	**NRTL Mark**	636A systems that bear the ETL/Intertek mark are listed by Intertek to UL/IEC 61010-1:2010Ed.3+A1. Intertek is a Nationally Recognized Testing Laboratory (NRTL) recognized by the United States Occupational Safety and Health Administration (OSHA).
4	**European CE Mark**	636A systems that comply with one or more EU directives bear the CE mark. See the “CE Declaration of Conformity” attached to the end of this user guide for more details.

1.1.1 Serial Number

For purposes of uniquely identifying a particular instrument, there is a label on the back panel of the 636A control box that indicates the model number and the serial number. A matching serial number is also found on a similar label located on the motor unit. In laboratories with multiple 636A rotators, it is important to keep the control unit together with the matching motor unit because the two components are calibrated together as a system.

1.1.2 Model Numbers

The 636A Electrode Rotator may be identified using the Princeton Applied Research part number(s) shown below. Part numbers for electrodes and other accessories compatible with the 636A are described in more detail later.

Table 1. 636A Instrument Model Number and Model Name

Model: 636A Electrode Rotator	Part Number: 233660

1.2 ICONS

Special icons are used to call attention to safety warnings and other useful information found in this document shown below.

Table 2. Special Icons Used in this Document

	**STOP:** For a procedure involving user action or activity, this icon indicates a point in the procedure where the user must stop the procedure.
	**NOTE:** Important or supplemental information.
	**TIP:** Useful hint or advice.
	**WAIT TIME:** Describes an operation or process that requires an unusually long time to complete.

Table 3. Safety Warning Icons Used in this Document

	**WARNING:** Indicates information needed to prevent injury or death to a person or to prevent damage to equipment.
	**ROTATING SHAFT HAZARD:** Indicates information needed to prevent injury or death to a person due to a high-speed rotating shaft.
	**RISK OF ELECTRICAL SHOCK:** Indicates information needed to prevent injury or death to a person due to electrical shock.
	**RISK FROM LASER LIGHT:** Indicates information needed to prevent eye injury due to laser beam light.

Table 4. Other Safety Warning Icons Used in this Document

	**CAUTION:** Indicates information needed to prevent damage to equipment.
	**RISK OF ELECTROSTATIC DAMAGE:** Indicates information needed to prevent damage to equipment due to electrostatic discharge.
	**CHEMICAL INCOMPATIBILTY:** Indicates chemical incompatibility information needed to prevent damage to equipment.
	**TEMPERATURE CONSTRAINT:** Indicates when an operation or use of equipment is limited to a specified temperature range.

1.3 SAFETY LABELS

The following specific safety warnings are found on labels attached to the motor unit and on the inside of the control unit.

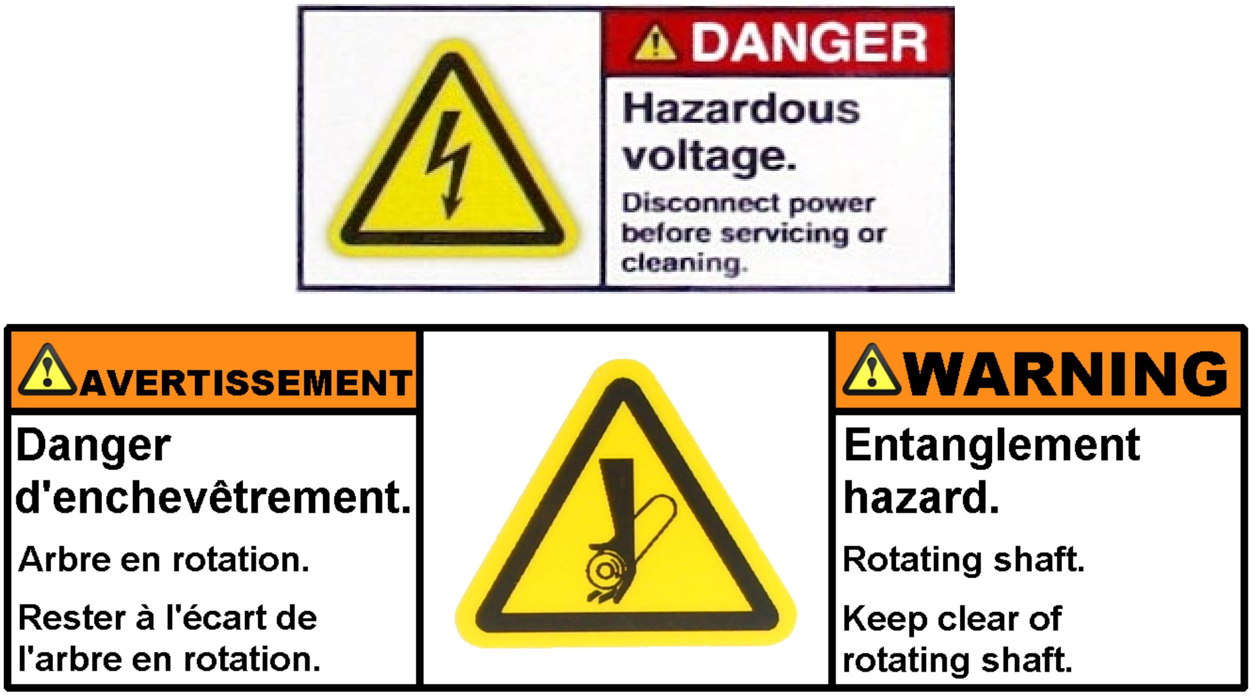


Figure 2. Safety Warning Labels

1.4 GENERAL SAFETY WARNINGS

The following safety warnings pertain to general use of the rotator. More specific safety warnings are found in later sections of this document that pertain to operations and procedures involving the rotator.

WARNING:

Failure to connect the third prong of the power cord to a proper earth ground may impair the protection provided by the system.

WARNING:

Risk of electric shock.

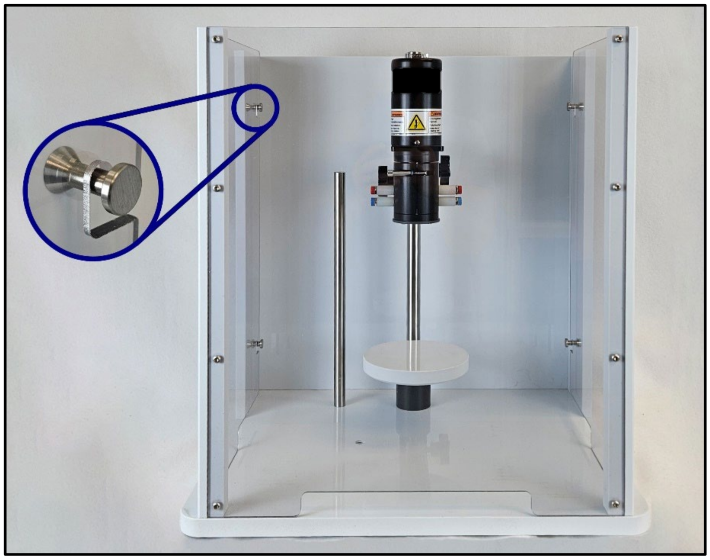
Disconnect all power before servicing the rotator.

WARNING:

Rotating shaft.

Do not turn on the rotator or rotate the electrode shaft unless the enclosure window is secured to all four pins as shown below.

Use extreme caution when operating the rotator at rotation rates above **2000 RPM**.



CAUTION:

Do not exceed the maximum rotation rate for an electrode.

Each type of rotating electrode has a specific maximum rotation rate limitation. Consult the documentation for the specific electrode being used to learn the maximum rotation rate for that electrode.

WARNING:

Rotating shaft. Entanglement hazard.

Turn off the power to the rotator and disconnect the power cord from the power source before installing or removing the electrode shaft or before installing or removing an electrode tip on the end of the shaft.

WARNING:

Do not turn on the rotator or rotate the electrode shaft if the shaft is not securely mounted in the motor coupling.

Inspect the shaft to be certain that it is securely mounted.

WARNING:

Do not turn on the rotator or rotate an electrode tip if the electrode tip is not securely mounted in the electrode shaft.

Inspect the electrode tip to be certain that it is securely mounted.

WARNING:

Do not use or attempt to rotate an electrode shaft that has been dropped, bent, or otherwise physically damaged.

Inspect the shaft to be certain that it is not damaged.

WARNING:

Do not use or attempt to rotate an electrode tip that has been dropped or otherwise physically damaged.

Inspect the electrode tip to be certain that it is not damaged.

WARNING:

Do not use an electrode shaft that appears to wobble, vibrate, or tilt away from the axis of rotation while rotating. Such a shaft is either improperly installed or physically damaged. Turn off the rotator, disconnect electrical power, and remove the shaft immediately.

WARNING:

Do not use an electrode tip that appears to wobble, vibrate, or tilt away from the axis of rotation while rotating. Such an electrode tip is either improperly installed or physically damaged. Turn off the rotator, disconnect electrical power, and remove the electrode tip immediately.

WARNING:

Laser radiation.

Many optical tachometers use a laser beam as a light source. Do not look directly at the laser beam. Do not point the laser beam into the eye.

CAUTION:

When raising or lowering the motor unit along the main support rod, be sure to hold the motor unit carefully so that it does not unexpectedly fall and break the glass cell located below the motor unit.

CAUTION:

A detachable main power cord is provided with the rotator. Do not replace this cord with an inadequately rated cord.

1.5 ELECTROSTATIC DISCHARGE AND EMC INFORMATION

Electrostatic discharge (ESD) is the rapid discharge of static electricity to ground. An ESD event occurs when two bodies of different potential approach each other closely enough such that static charge rapidly passes from one object to the next. Sensitive electronics in the path of discharge may suffer damage. Damaging ESD events most often arise between a statically charged human body and a sensitive electronic circuit. The human body can easily accumulate static charge from simple movement from one place to another (i.e., walking across a laboratory).

Instrument users must always be aware of the possibility of an ESD event and should employ good practices to minimize the chance of damaging the instrument. Some examples of good ESD prevention practices include the following:

- Self-ground your body before touching sensitive electronics or electrodes. Self-grounding may be done by touching a grounded metal surface such as a metal pipe.
- Wear a conductive wrist-strap connected to a good earth ground to prevent a charge from building up on your body.
- Wear a conductive foot/heel strap or conductive footwear in conjunction standing on a grounded conductive floor mat.
- Increase the relative humidity in the air to minimize static generation.

The 636A Electrode Rotator has been tested and found to be compliant with FCC Part 15, Subpart B and European EMC standards EN 61326-1:2013, ESD 61000-4-2:2009.

1.6 HAZARDOUS MATERIALS DISCLOSURE

Disclosure tables in both English and Mandarin Chinese are provided below that detail information pertaining to the list of hazardous substances classified under the Restriction of Hazardous Substances Directive (RoHS), as well as in accordance with Chinese Standard SJ/T 11364, Marking for the Restricted Use of Hazardous Substances in Electronic and Electrical Products.

Hazardous Material Disclosure Table						
233660						
Part Name	Hazardous Substances					
	Lead (Pb)	Mercury (Hg)	Cadmium (Cd)	Hexavalent Chromium (Cr (VI))	Polybrominated biphenyls (PBB)	Polybrominated diphenyl ethers (PBDE)
Main PCB	X	O	O	O	O	O
Display PCB	O	O	O	O	O	O
Encoder PCB	X	O	O	O	O	O

This table is prepared in accordance with the provisions of SJ/T 11364

O: indicates that said hazardous substance contained in all of the homogeneous materials for this part is below the limit requirements of GB/T 26572.

X: indicates that said hazardous substance contained in at least one of the homogeneous materials for this part is above the limit requirements of GB/T 26572.

Note: the unit meets EU RoHS requirements; China does not have the exemptions for hazardous materials in components as does the EU; therefore, there may be the above noted materials present in the unit.

Figure 3. Hazardous Material Disclosure Table - English

有害物质披露表

233660

	有害物质					
	铅 (Pb)	汞 (Hg)	镉 (Cd)	六价铬 (Cr (VI))	多溴联苯 (PBB)	多溴二苯醚 (PBDE)
主电路板	X	O	O	O	O	O
显示电路板	O	O	O	O	O	O
编码电路板	X	O	O	O	O	O

本表格依据 SJ/T 11364 的规定编制 。

O： 表示该有害物质在该部件所有均质材料中的含量均在 GB/T 26572 规定的限量要求以下 。

X： 表示该有害物质至少在该部件的某一均质材料中的含量超出 GB/T 26572 规定的限量要求 。

注： 该部件符合欧盟RoHS指标 ； 但是中国 不像欧盟那样 对零部件的有害物质有豁免，
所以该部件可能包含表中列出的物质 。

Figure 4. Hazardous Material Disclosure Table - Chinese

1.7 ENVIRONMENTAL CONDITIONS

The 636A is designed to be safe at least under the following conditions:

- Indoor use: Pollution Degree 2 – dry location uses only
- Altitude up to 2000 m
- Temperatures from 5°C to 40°C (41°F to 104°F)
- Maximum relative humidity of 80% for temperatures up to 31°C (88°F) decreasing linearly to 50% relative humidity at 40°C (104°F)
- AC Mains supply voltage fluctuations up to ±10% of the nominal voltage (100 – 240 VAC)
- Overvoltage Category II (as defined in IEC 61010-1)

1.8 BRIEF DESCRIPTION

Princeton Applied Research’s Model 636A Rotating Disk Electrode is a solid-state-controlled servosystem designed to rotate an electrode in an electrochemical cell at a constant speed or at a speed that is modulated by a sine, square or other type waveform. The outstanding acceleration characteristics of the system allow the electrode speed to follow the input signal with little error. This feature is particularly desirable for use in hydrodynamically modulated applications.

1.9 HIGHLIGHTS

- Accurate speed control
- High performance system: rapid acceleration
- Speed may be modulated from an external source (square wave, sine wave, etc.)
- Bi-polar power supply improves dynamic performance

- Chemical resistant base and cell shelf
- Cell shelf position is easily adjusted
- Use with Disk or Ring-Disk type electrodes
- Silver carbon contact brushes for low resistance and long life
- Voltage output proportional to rotational speed
- Speed range to 11,000 RPM
- Ideal for use in hydrodynamically modulated systems
- Low cost, high quality, highly reliable system

1.10 DETAILED DESCRIPTION

Princeton Applied Research's Model 636A Rotating Disk Electrode is a solid-state-controlled servosystem, capable of rotating an electrode at speeds from 5 to 11,000 RPM. The rotational speed may be precisely set via a 10-turn pot located on the front panel and indicated on a 4 ½ digit display.

The 8-pin connector marked as **I/O** on rear panel allows the operator to apply an external signal to the rotator and causes 1000 RPM of the electrode per volt applied. A positive voltage applied at the PIN 1 of this connector produces counterclockwise rotation at the electrode end of the rotator.

The 8-pin connector also gives a voltage indication of the electrode rotational speed with a Rate Monitor signal value of 1.00 volt per 4000 RPM.

An outstanding feature of the Model 636A is its ability to accelerate and decelerate very rapidly, making possible the application of any waveform the operator desires.

The outstanding dynamic performance of the Model 636A RDE system is due to the use of high speed, low inertia, permanent magnet DC motor and a high voltage, bi-polar power supply. The positive power supply voltage is approximately 25% greater than the motor's rating.

The body of the rotator may be easily raised or lowered; a cell shelf is provided whose height is easily adjusted. These features facilitate the introduction and removal of the cell. The base is made of chemically resistant material.

Model 636A has been designed to accommodate both Disk and Ring-Disk type electrodes. Electrical connections are made to the electrode by silver carbon brushes - two each for the disk and ring - to provide consistent, reliable contact.

1.11 SPECIFICATIONS

MOTOR SPECIFICATIONS	
Motor Power	20W
Supply Voltages	+30VDC, -24VDC
Motor Type	Brushed DC motor
Rate Control Method	Analog closed loop Temperature-compensated tachometer mounted on motor shaft
Maximum Continuous Torque	30.4mN-m

Motor Protection	2 Amp thermal-type circuit breaker; current-limited power supplies
Modulation Boundaries	See Section **Error! Reference source not found.** for details
ELECTRICAL	
Power Requirements	AC Mains: 100-240 VAC,±10%; 50/60 Hz; 2 A
Electrode Connections	Disk electrode: two YELLOW banana jacks on motor unit Ring electrode: two BLUE banana jacks on motor unit
Controls	Front panel: power switch, external/manual control switch, Run/Pause button Back panel: button to reset circuit breaker, 8-pin connector with external stop signal, external voltage in, and voltage out
Grounding Connections	Chassis connection on back panel 8-pin connector
ROTATION RATE	
Rate Limits	**0** to **11,000** RPM
Rate Accuracy	**100** to **2,000** RPM: accurate to within ±2 counts of display reading **2,000** RPM and above: accurate to within ±**1** count and ±**0.1%** of display reading
Rate Display	4 ½-digit display indicates rotation rate (RPM)
Rate Control (front panel)	10-turn rotation rate control knob
Start/Stop (front panel)	Push-button toggle with LED indicators for “pause” and “run”
Control Switch (front panel)	Slide switch with LED indicator; light is on for external control, off for manual control
Rate Control (external)	Rate control via input signal on external I/O port Available input control ratios: **1, 3, or 4 RPM/mV**, jumper selectable. Default **-4** RPM/mV
Start/Stop (external)	Digital motor stop signal on external I/O port Available TTL logic: active high or active low; jumper selectable
Rate Output	Voltage output accessible from back panel 8-pin connector Output ratio is always **1 RPM/mV**
PHYSICAL SPECIFICATIONS	
Shipping Information	Shipping weight: 60lbs (27Kgs) Shipping dimensions: 24 x 24 x 24 in (61 x 61 x 61 cm)
Instrument Dimensions	Control unit: 10.8 x 9.8 x 4.3 in (27 x 25 x 11 cm) Rotator enclosure: 18.8 x 15.5 x 21.0 in (48 x 40 x 54 cm)
Materials	Enclosure base and sides: white polypropylene Enclosure window: clear polycarbonate Cell platform: white polypropylene

	Center post/Support rod: 303SS
Operating Temperature	10 to 40^{o}C (50 to 104^{o}F)

1.11.1 Acceleration and Modulation Performance

A modulated input signal can be summed with a baseline control signal to perform hydrodynamically modulated electrochemical techniques. Typically, a small sinusoidal waveform is applied to the input port on the back panel of the control box, and this sinusoidal modulation is superimposed on top of the baseline rotation rate. The 636A Electrode Rotator can track and follow these input signals within a specific range of maximum frequencies depending on the signal amplitude. The below figure shows the input signal modulation boundaries for amplitudes that are either 1%, 4%, or 10% of the baseline RPM.

For example, when applying a baseline rotation rate of 2500 RPM, and superimposing a sine wave modulation signal with an amplitude of 1% of the baseline (±25 RPM peak), the maximum frequency that can be applied is 100 Hz. Similarly, with the same baseline rotation rate, if the superimposed signal amplitude is 10% of the baseline (±250 RPM peak), the maximum possible input frequency is 70 Hz. These data are shown along the boundaries of the 1% and 10% regions as shown in the figure below. The remaining data show the combinations of baseline rotation rates and maximum frequencies that are possible for sinusoidal signal amplitudes that are either 1%, 4%, or 10% of the baseline RPM.

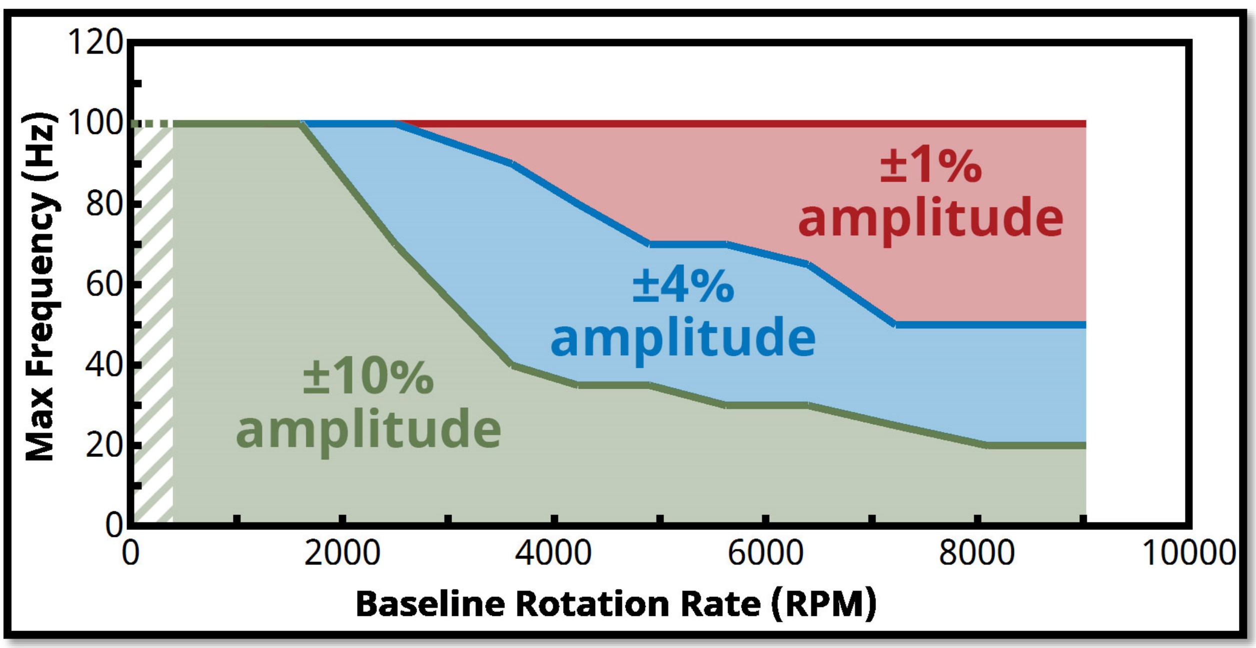


Figure 5. 636A Input Signal Modulation Boundaries

Tests were carried out to determine the performance which may be expected of Model 636A. Note that these figures are given as general information and are not necessarily exact specifications for all conditions under which the rotator may be operated.

NOTE: It is suggested that the operator determines the performance under his/her operating conditions.

Note that the data shown in the figure above are without an added load on the rotator; that is, these data represent the fastest possible frequencies that can be applied to modulated input signals intrinsic to the 636A. Beyond these frequencies, circuit protection features will throttle the output signal and make modulation experiments inaccurate. Additionally, actual limits when using a shaft and a real electrochemical setup may vary slightly due to added load on the motor.

The modulation boundary limits for the 636A were interrogated in accordance with published standards, including the popular Electrochemical Methods: Fundamentals and Applications textbook by Bard and Faulkner, as well as the famous works of (among others) Albery, Bruckenstein, Deslouis, and Tribollet (select bibliography is provided below).

1. AJ Bard and LR Faulkner, Electrochemical Methods: Fundamentals and Applications, 3rd Edition, John Wiley & Sons, New York (2022), Section 10.5, pp 435-442.

2. K Tokuda, S Bruckenstein, and B Miller, J. Electrochem. Soc., 122 (1975) 1316.

3. C Deslouis, I Epelboin, C Gabrielli, and B Tribollet, J. Electroanal. Chem., 82 (1977) 251-269.

4. WJ Albery, AR Hillman, and S Bruckenstein, J. Electroanal. Chem., 100 (1979) 687-709.

5. C Deslouis, C Gabrielli, PS Fanchine, and B Tribollet, J. Electrochem. Soc., 129 (1982) 107.

6. C Deslouis and B Tribollet, Electrochim. Acta, 35 (1990) 1637-1648.

The tests were performed with an electrode inserted, and four brushes in contact with the electrode shaft.

Response to a step input applied at the 8-pin I/O connector:

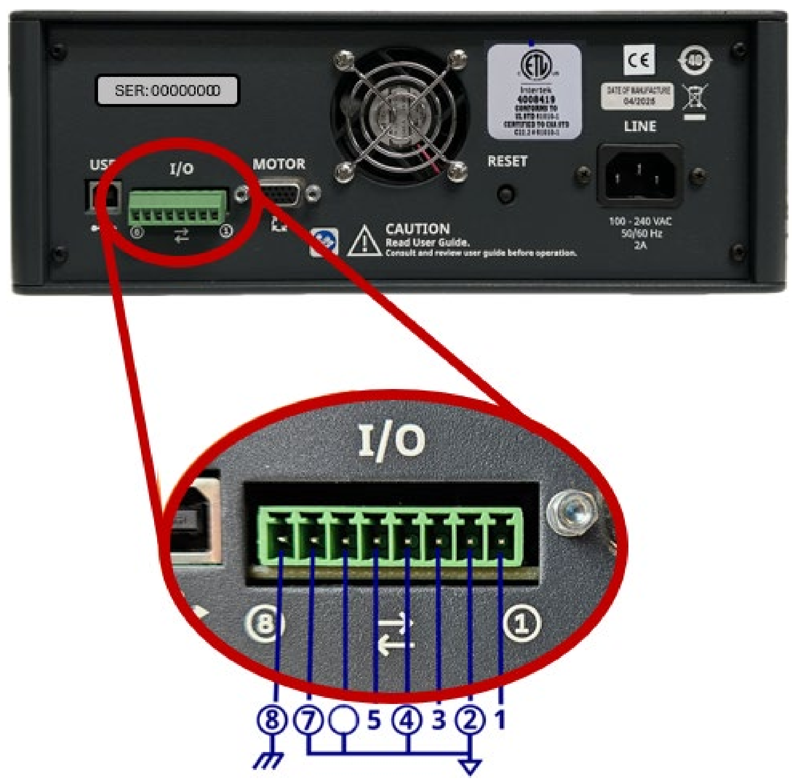
Start Speed	End Speed	Rise Time
0 rpm	1 k rpm	4 ms
0 rpm	5 k rpm	10 ms
0 rpm	10 k rpm	30 ms

Table 5. Performance Measurements

Frequency response to a sine wave signal of 1 volt peak to peak (1000 RPM peak to peak) applied to the unit running at a base speed of 2000 RPM: -3db point at 100 Hz.

1.12 REAR PANEL 8-PIN I/O CONNECTOR

The External I/O Port on the back panel of the 636A Control Unit can be used both to monitor the rotation rate (via a voltage output signal) and/or to control the rotation rate (via a voltage input signal). There are eight pins on the External I/O Port as shown below. The control signal for the rotation rate is typically generated by a Potentiostat.



1	**Rate Control (input)**	Input voltage signal used to control rotation rate
3	**Rate Monitor (output)**	Output voltage signal used to monitor rotation rate
5	**Motor Stop**	Digital signal used to turn motor off
2, 4, 6, and 7	**DC Common**	0 V reference point on control unit circuit board
8	**Chassis Ground**	Connection to metal case surrounding unit circuitry

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2. OPERATION

CAUTION Disconnect all power before servicing

WARNING Risk of electric shock

CAUTION Disconnection of the Protective Earth Conductor may impair the protection provided by the system

WARNING Use of the 636A should be in an enclosed chamber or surrounded by a shielding device to prevent bodily harm if an electrode or arbor becomes unstable, loose, and is thrown from the system

2.1 INITIAL INSPECTION

Inspect the packing case and rotator for any damage; notify the carrier and Princeton Applied Research in case of any apparent damage.

Figure 6. Shipping Package

Figure 6 above displays the following:

1. Electronic control unit
2. Enclosure frame
3. Enclosure window
4. Carton box (right) with body-motor assembly, cables, and accessories

Check the shipment against the packing list. Included with the rotator system should be one of each:

- Electronic Control Unit (ECU)
- Enclosure Frame
- Enclosure Window
- Body-Motor Assembly
- Cable Communications
- Power Cord

- Instruction Manual

2.2 MAJOR SYSTEM COMPONENTS

The major system components of Model 636A are shown in Figure 7.

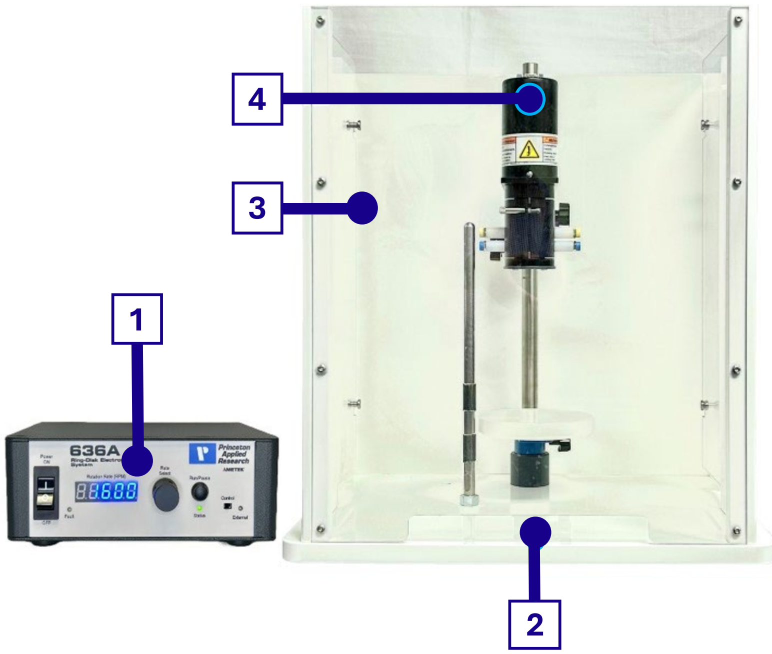


Figure 7. Major Components of Model 636A Rotator System

1. **Electronic Control Unit (ECU)** – The ECU contains motor control electronics.
2. **Enclosure Frame** – The enclosure frame and base are fabricated from white polypropylene.
3. **Enclosure Window** – The transparent enclosure window is fabricated from clear polycarbonate.
4. **Body-Motor Assembly** – The body-motor assembly holds the motor and brushes and is mounted on the center post where it can slide vertically.

The 636A electronic control unit (ECU)includes the following components (Figure 8).

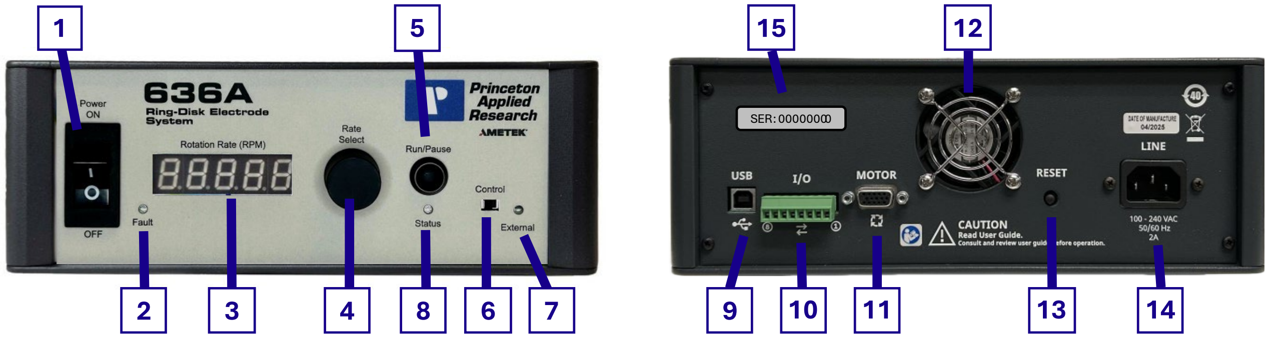


Figure 8. 636A Electronic Control Unit Components

1. **Power Switch** – Main power switch (with circuit breaker).
2. **Fault Indicator LED** – When illuminated, this LED indicates there is a problem occurring that needs to be investigated.
3. **Rotation Rate Display** – 4 ½ digit display of the rotation rate (RPM).
4. **Rate Control Knob** – 10-turn knob used to manually adjust the rotation rate.
5. **Run/Pause Button** – This button is a toggle control that alternates between pausing the rotation of the motor and allowing it to continue running.
6. **Control Switch** – This switch toggles the rotator between manual and external control modes.
7. **External Control Indicator LED** – When illuminated, this LED indicates the 636A rotation rate can only be controlled via external input.
8. **Status Indicator LED** – This LED provides information regarding the rotator status specifically related to its Run/Pause state.
9. **External USB Port** – This USB port optionally allows serial communication with other devices.
10. **External I/O Port** – This 8-pin connector allows the 636A to be connected to and controlled by an auxiliary instrument (such as a potentiostat).
11. **Motor Cable Connector** – Accepts one end of the motor control cable.
12. **Cooling Fan** – This fan cools the control unit electronics during operation.
13. **Circuit Reset Button** – This button resets the motor protection circuitry.
14. **Power Cord Connector** – Connects to external electrical power cord.

15. **Serial Number Label** – This label indicates the make, model, and serial number of the rotator.

2.3 SYSTEM SET-UP/INSTALLATION

The system should be placed on a flat bench or a desk and there should be access to appropriate AC voltage outlets. Additionally, the area for system placement should be large enough to accommodate the rotator components and any additional instruments required for performing the desired experiments (e.g. computers, monitors, function generators, potentiostats, etc.).

The Body-Motor Assembly should be placed on a level area that is easily accessible to facilitate electrode/cell set-up and operation. Place the Electronic Control Unit (ECU) close to the Body-Motor Assembly so that the supplied cable may be connected to each of the assemblies.

Plug the “D” style cable end into the appropriate “D” style connector on the rear panel of the ECU and then tighten the two screws to secure the connection. Be certain that the connector is fully inserted.

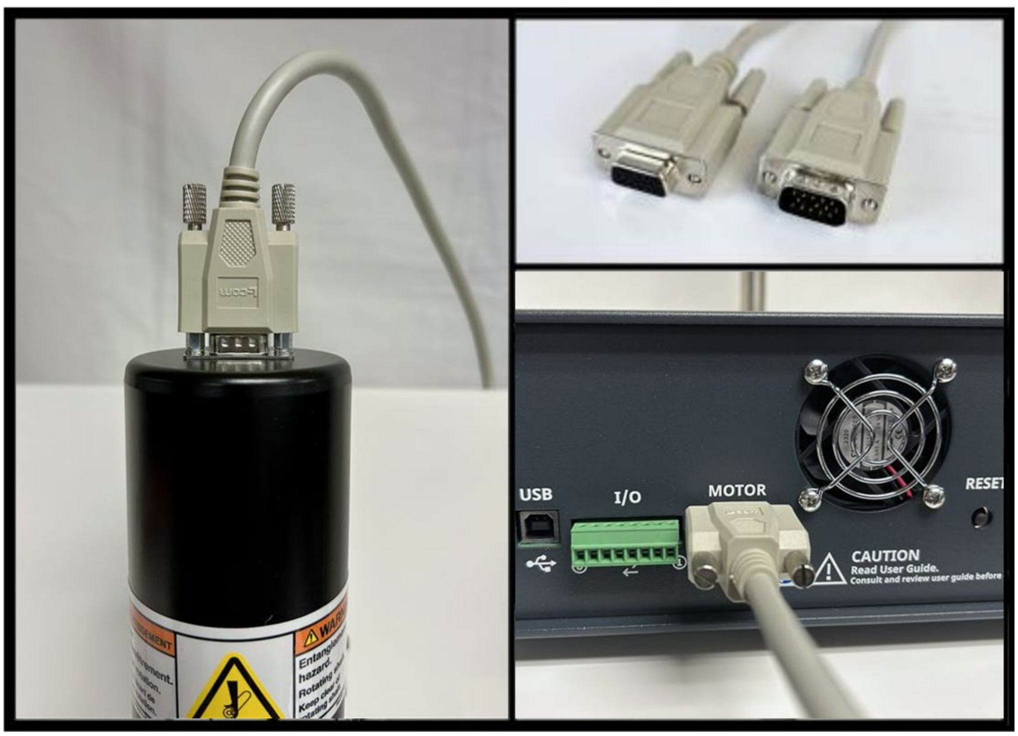


Figure 9. Connections Between 636A Electronic Control Unit and Body Motor Assembly

Plug the other end of the cable into the “D” style connector located on the top of the Body-Motor Assembly and tighten the two screws to secure the connection. Be certain that the connector is fully inserted.

Plug the power cord into the appropriate connector on the rear panel of the ECU. It is suggested that the power switch located on the rear panel of the ECU is in the “OFF” position before connecting the power cord to the appropriate AC voltage source. Plug the power cord into an AC power outlet of the appropriate voltage. This outlet should have a good quality earth ground.

CAUTION Disconnect all power before servicing

WARNING Risk of electric shock

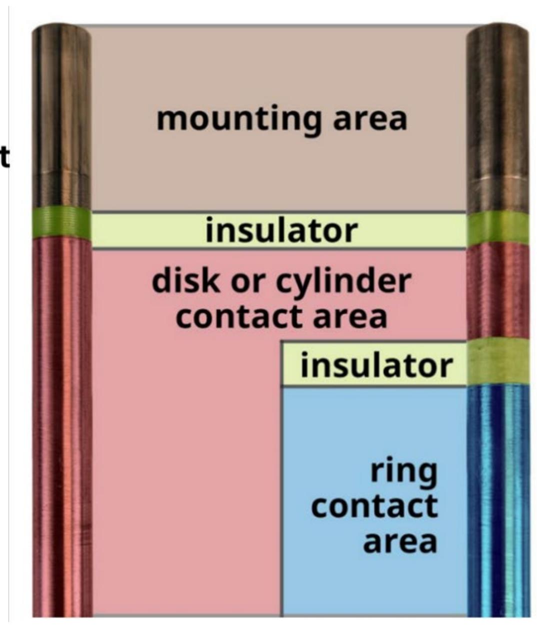
CAUTION Disconnection of the Protective Earth Conductor may impair the protection provided by the system

The rotator is now electrically set-up and ready for the operator to introduce the electrode and the chemical cell into the system.

2.4 ELECTRODE COUPLING INSTRUCTIONS

Princeton Applied Research's Model 636A rotator is manufactured with a precision electrode coupling. The electrode shaft normally rotates in a clockwise direction as viewed from the top of the rotator. The upper end of a standard shaft has a 1⁄4 " (6.35 mm) outer diameter. When properly mounted in the rotator, the upper 2.7" (68 mm) of the shaft is inside the motor unit, while the remaining length of the shaft extends down below the motor unit.

RDE and RCE Shaft



RRDE Shaft

Figure 10. Contact Areas at the Top of the Rotating Electrode Shafts

The rotator accepts shafts for use with Rotating Disk Electrodes (RDE), Rotating Cylinder Electrodes (RCE), or Rotating Ring-Disk Electrodes (RRDE). Electrical connection is accomplished using one or more silver-carbon brushes to contact metal surfaces on the upper portion of the rotating shaft. Each shaft is specially designed to provide one or two current paths down to the end of the shaft where the electrodes are located. These current paths are electrically isolated from the mounting area at the top of the shaft. To obtain maximum performance from the rotator, proper mounting of the electrode to the rotator is critical.

The uppermost portion of the shaft is used to mount the shaft into the rotator (see Figure 10). This mounting area is electrically isolated from the remainder of the shaft so that the electrode connections remain isolated from the rotator chassis. An insulating spacer just below the mounting area isolates the mounting area from the electrode contact area. For an RDE or RCE shaft (see Figure 10, left), the entire metal exterior of the shaft below the insulating spacer is in electrical contact with the disk (or cylinder) electrode. For an RRDE shaft (see Figure 10, right), there are two insulating spacers. The portion of the shaft between the two insulating spacers provides electrical contact with the disk electrode. The lower portion of the shaft (below the lower insulating spacer) provides electrical contact with the ring electrode.

Figure 11. Brush Chamber of 636A Body Motor Assembly

The shaft is connected to the rotator motor via a brass motor coupling located inside the brush chamber (Figure 11). Two clamshell doors surround the brush chamber. These doors are securely latched during rotator operation and push two pairs of contact brushes against the rotating shaft. The upper (yellow) pair of brushes contacts the disk (or cylinder) while the lower (blue) pair contacts the ring on a rotating ring-disk electrode.

In order to obtain maximum performance from the rotator, proper mounting of the electrode to the rotator (Figure 12) is critical.

1. Invert the orientation of the motor unit so that it is upside-down. Open the “clamshell” by loosening the latch on the front of the rotator body.
2. Loosen each of the screws (2) on the electrode coupling inside the rotator body with the hex driver tool (5/64", provided). Do NOT remove these screws entirely.
3. Carefully insert the electrode through the bottom bearing fully into the coupling. The shaft should be pushed as far as possible into the motor coupling so that the contact brushes are properly aligned with the electrical contact areas on the upper portion of the rotating shaft (see Figure 13).
4. Hold the electrode in the coupling while lightly tightening one screw. Rotate coupling (still holding electrode) and firmly tighten second screw. Rotate coupling and firmly tighten first screw.

CAUTION To avoid damage to the electrode be certain that it is securely clamped in the rotator before releasing it.

5. If an interchangeable tip electrode arbor has been employed, the electrode tip is attached by sliding it onto the end of the arbor with the set screw in the tip in line with the machined flat on the arbor. Tighten set screw lightly with a 1/16" hex wrench. (Do not overtighten.)

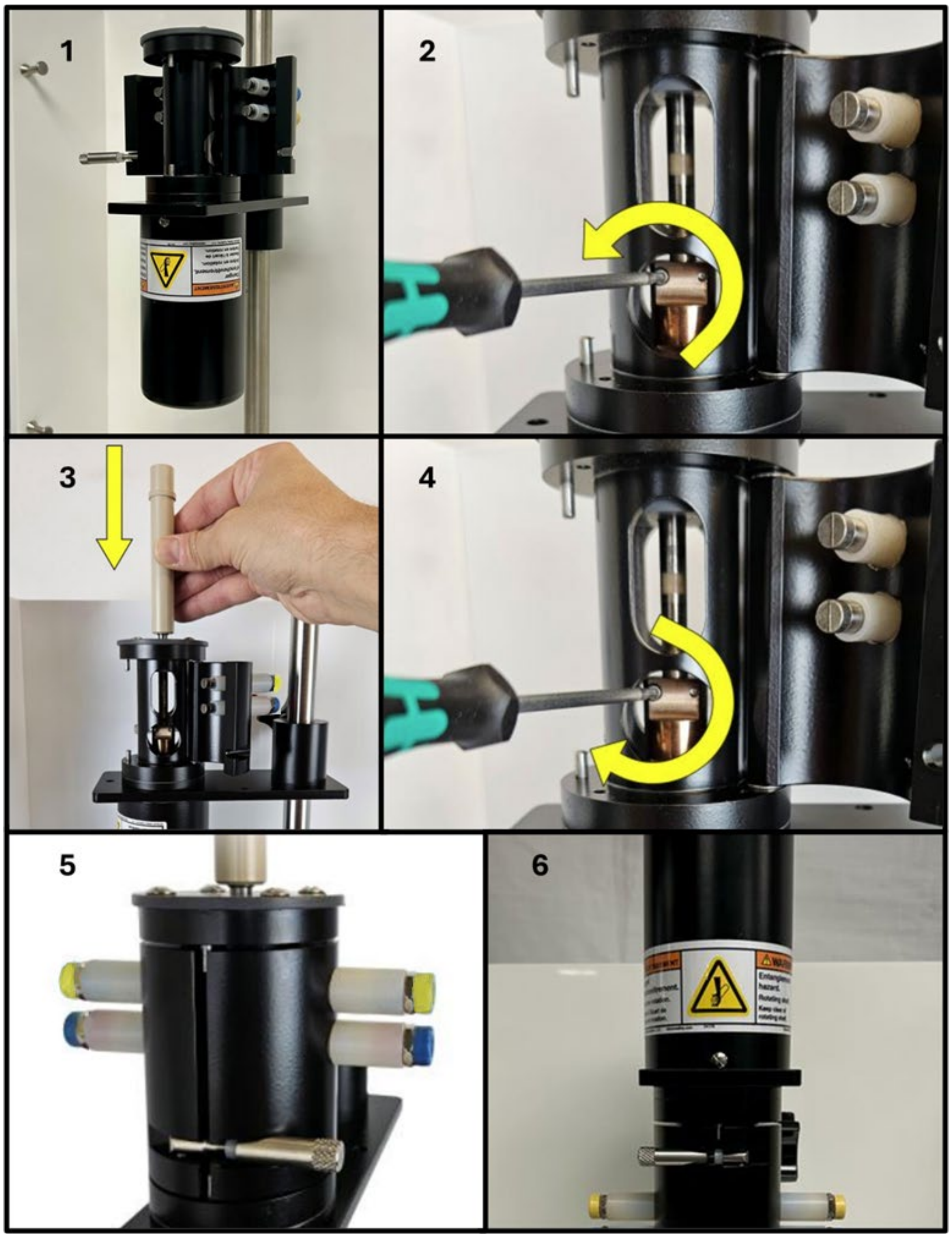


Figure 12. Installation of the Rotating Shaft

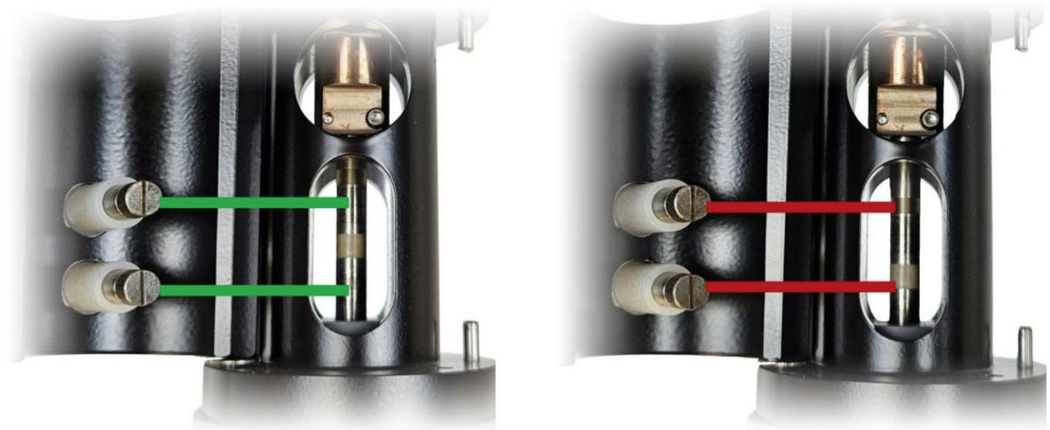


Figure 13. Proper (Left) and Improper (Right) Shaft Insertion Positions

NOTE: It is recommended that a small amount of silicon grease be applied to the arbor tip to prevent the electrode tip from seizing.

2.5 CONTROL AND SIGNAL ELECTRICAL CONNECTIONS

There are many configurations in which the Model 636A Rotator may be employed. This section will describe the connections for a simple potentiostat based system that utilizes the rotator, a ring/disk electrode and a bi-potentiostat.

The potentiostat should be set up per the manufacturer's instructions.

If the speed of the rotator is NOT to be externally controlled or monitored, no connections need to be made to the External I/O Port in the back panel.

2.5.1 Rotation Rate Control

The primary mechanism for turning the motor on and off is the Run/Pause button on the front panel of the control unit (see Figure 14). This button is located above an LED Status light that indicates whether the rotator is currently in the "run" state (light is green, Figure 14 Left) or the "pause" state (light is red, Figure 14 Right).

Figure 14. 636A Electronic Control Unit Front Panel Display

The rotator always reverts to the "pause" state when the 636A Electronic Control Unit turns on. Therefore, the motor will never automatically begin rotating the moment it is turned on regardless of the rate control knob position or displayed RPM.

The rate control knob should be used to select the desired rotation rate. Press the Run/Pause button to begin rotation. Then, after verifying that the electrochemical cell, signal cables, motor connection cable, tubing, and other accessories are securely positioned, measurements can be made at higher rotation rates as needed.

2.5.2 External Control and Monitoring of the Rotation Rate

If the 636A rotation rate is to be externally controlled, the control switch on the front panel of the control unit must be toggled to the right position, which will cause the external control indicator LED on the front panel to become illuminated and yellow (Figure 15). On the other hand, external rate control signals applied to the external I/O port have no effect on the rotation rate when 636A Electronic Control Unit is not being controlled by an external source (i.e., when the external control indicator LED is not illuminated, and the control switch is in the left position), Additionally, toggling the control switch either from left-to-right or right-to-left will place the rotator back into the “pause” state and stop rotation.

Figure 15. External Control Switch and LED Indicator Set for External Control

To control the rotation rate externally controlled, Pin 2 (or other DC common pins) of External I/O Port should be connected to the common point on the controlling device, which could be a function generator, certain potentiostats, programmable voltage source, computer-based DAC system, etc.). The output of the controlling device should be connected to PIN1. A positive applied voltage causes CCW rotation at the electrode end of the rotator.

To monitor the rotation rate with an external device, Pin 4 (or other DC common pins) of External I/O Port should be connected to the common point on the monitoring device, which could be an oscilloscope, certain potentiostats, DVM, computer-based A/D system, etc. The input of the monitoring device should be connected to PIN 3 of External I/O Port.

2.5.3 Cell Connections

For a Princeton Applied Research supplied electrode, the connection to the disk section of the electrode is via either or both of the two yellow jacks located on the “clam-shell” style section of the rotator’s Body-Motor Assembly; the potentiostat’s “WE” or first working electrode connection is normally made to these jacks (NOTE: the use of both of these jacks reduces electrical noise as compared to the use of a single jack).

For a Princeton Applied Research supplied electrode, the connection to the ring section of the electrode is via either or both of the two blue jacks located on the “clam-shell” style section of the rotator’s Body-Motor Assembly; the potentiostat’s “WE2” or second working electrode connection is normally made to these jacks (NOTE: the use of both of these jacks reduces electrical noise as compared to the use of a single jack).

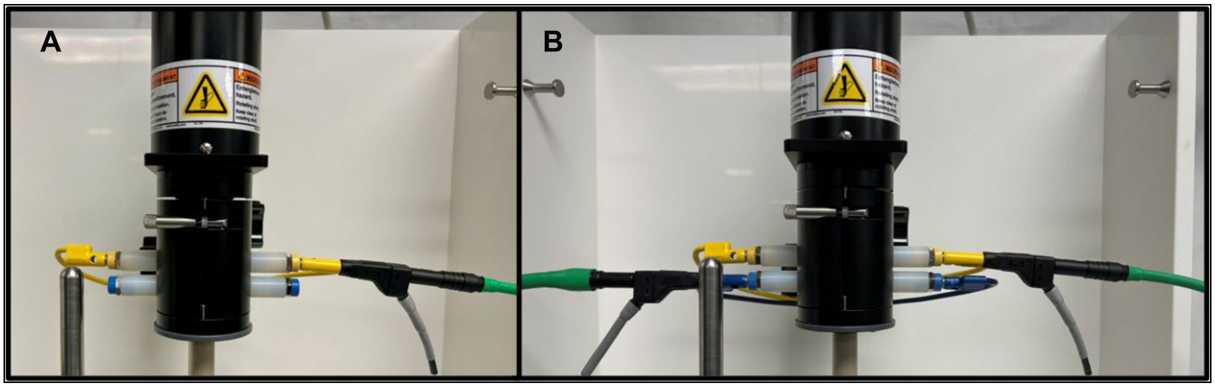


Figure 16. Brush Connections

In Figure 16, A displays brush connections for a Rotating Disk (RDE) or Rotating Cylinder Electrode (RCE). B displays the brush connections for a Rotating Ring-Disk Electrode (RRDE).

This completes the electrical signal connections to the rotator. There are other connections that must be made to the cell system, generally including the counter electrode and the reference electrode. Please see your potentiostat manual for connection instructions.

2.6 CHEMICAL CELL INTRODUCTION

Once the unit has been set up as described above, and the electrode has been properly mounted into the rotator coupling, the chemical cell may be introduced into the system.

The rotator has an adjustable cell shelf that facilitates the introduction of the electrode into the chemicals. The height of the shelf and/or the rotator body may be easily raised or lowered as follows:

- Rotate the appropriate knob (located on the rear of the item near the vertical shaft) CCW with one hand, while securely holding the item with the other hand
- Gently move the shelf (or body assembly) up or down
- When the item is positioned as desired, rotate the knob CW to tighten

CAUTION Be careful so that the item does not rapidly "fall" when the tension of the knob is loosened.

2.7 OPERATION

The unit may now be operated. Adjust the round speed control knob on the front panel to the full CCW position. This is done so that the rotational speed will be zero or very low when power is applied. Apply AC power to the unit by pressing the top of the ON/OFF rocker switch located on the front panel of the ECU. The 4 ½ digit display should come "ON" and display a low number, such as "0000" +/- 10 counts. The Status LED should be red, indicating the rotation is paused.

Adjust the round speed control knob CW to increase the speed of rotation of the electrode; CCW to decrease the speed of rotation. Press the Run/Pause button to start the rotation once the desired rotation rate is set.

The electrode rotates in a CCW direction when driven by the internal source and is viewed from the electrode end of the rotator.

2.8 DESCRIPTION OF COMPONENT LIST

Electronic Control Unit: The control unit contains the drive circuitry, power supply, and control circuitry

AC Power Cord: Connect to a 3-prong AC outlet of proper voltage with a good quality earth ground

Power Switch: Controls the AC power to the control box

Speed Adjust: 10 turn Pot with 4 ½ digit display of speed

DC Common (external): Connected to DC common; used as common for measuring the rotator speed output and applying an external input (see below)

Rate Output: A voltage output from back panel PIN8 of External I/O Port appears at this point which is an indication of the rotator speed: 1 volt per 1000 RPM.

Rate Input (external control): A voltage may be applied to control rotation rate via input signal on PIN 2 of External I/O Port at a rate of 4000 RPM per volt applied. The voltage applied at this point is summed with the pot setting. The input impedance is 50K ohms. Do not exceed +/- 2.5 VDC applied

Ground Point: Connected to the ECU/Body Assembly frame and to ground through the protective earth conductor of the power cord

Circuit Breaker: A 2.0 amp thermal-type circuit breaker is connected in a series with the motor to protect the motor from overload

Body and Motor-Tach Assembly: This assembly contains the rotating components, frame, and base

Motor-Tach: DC motor and DC tachometer are an integral unit

Frame: Supports the motor-tach, bearings, etc. The cell holder and motor tach section may be adjusted up and down on the column

Base: Chemical resistant material; supports the frame

Electrode Coupling: Holds the electrode in place

Electrode Bearing Assembly: Supports the electrode at two places

Pick-up Brushes: Contact the electrode for electrical pick-up

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3. MAINTENANCE

CAUTION Disconnect all power before servicing

WARNING Risk of electric shock

CAUTION Disconnection of the Protective Earth Conductor may impair the protection provided by the system

3.1 GENERAL

Model 636A is covered by a six-month warranty. Attempts to recalibrate or modify the instrument by an unauthorized person may void the warranty. It is suggested that the factory be advised on all matters of improper operation.

3.2 NORMAL MAINTENANCE AND CLEANING

Normal regular maintenance of the rotator primarily consists of keeping the external surfaces of the system clean by wiping with a towel moistened with a mild, non-abrasive cleaner.

After many hours of operation, the electrode brushes may deposit silver-carbon “dust” in the areas near the brushes. This material may be simply wiped off with a slightly moistened, clean rag. It is not recommended to spray down the brush area with a solvent, as the solvent may remove the lubrication from the bearings.

The electrode brushes are field replaceable items. Please contact the factory for replacements and instructions.

The motor/tach is sealed, and no maintenance is possible or normally required. Faulty bearings in the motor/tach require replacement of the entire motor/tach unit.

The bearings that support the electrode (spindle bearings) last for many years under normal operating conditions. However, under certain operating conditions including such conditions as long-term high speeds or exposure to harsh chemical fumes, their life may be shortened. These bearings may be replaced in the field; contact the factory for replacements and instructions.

3.3 TECHNICAL ASSISTANCE

Princeton Applied Research
801 S. Illinois Ave.
Oak Ridge, TN 37830
865-425-1289

3.4 TROUBLESHOOTING

CAUTION Disconnect all power before servicing

WARNING Risk of electric shock

CAUTION Disconnection of the Protective Earth Conductor may impair the protection provided by the system

Some suggestions follow on how to proceed if problems occur.

3.4.1 Motor Fails to Rotate

1. Check the motor shaft and spindle for freedom of rotation.

2. Confirm that the unit is connected to a live outlet of the proper voltage, that the power switch is ON, and that the digital meter display is ON

3. Check the connection from the ECU to the motor-tach assembly. Push connection on and tighten appropriate screws fully

4. Check the circuit breaker. Reset if tripped.

5. The pot should not be set to full CCW position; rotate clockwise to increase speed.

6. Remove the top cover and ensure that the printed circuit board is fully inserted into the connector.

7. Faulty connection or wire - contact the factory.

8. Faulty circuitry or motor - contact the factory.

3.4.2 Motor Runs at High Speed with Any Pot Setting

1. Faulty connection or wire - contact the factory.

2. Faulty circuitry - contact the factory.

3.4.3 Excessive Noise

1. Spindle bearings are worn out - contact the factory.

2. Motor bearings worn - contact the factory.

3.4.4 Excessive Electrical Noise in the System

1. Connect DC Common to PIN 8 of the I/O Connector on the back panel; use only one point in the system as the common; eliminate ground loops.

CAUTION Exercise care when connecting to ground. This should be done only on a “floating” system. Contact the factory for more information.

2. Use shielded cables as connections to the brushes.

3. Clean the surface where the brushes contact the rotating rings.

3.4.5 The Breaker Trips

1. The breaker is a thermal type of breaker, sized to limit the average motor current to within the motor specification. Running the motor at a high modulation rate, or great amplitude changes, or a combination of the two, may cause tripping. It may be necessary to reduce the modulation rate and/or amplitude to prevent tripping the breaker.

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4. ELECTRODES

4.1 GENERAL

A variety of electrodes are available for the Model 636A. The user can choose from Platinum (Pt), Gold (Au), and glassy carbon (GC) for disk electrodes. A choice of Pt and glassy carbon for the disk and Pt and Au for the ring are available for ring-disk work.

While many users are interested in the behavior of a species in solution at an inert electrode, the corrosion scientists are concerned about the behavior of many different active electrodes. The needs of this group have been met by the use of our Quick-Change electrode assemblies. An investigator can choose a disk geometry or a cylinder geometry and have the electrode machined out of the metal of interest. The rotator is designed to accept different arbors to accommodate these two options.

4.2 ACCESSORIES

The Model 636A can be used either as a simple rotating disk electrode (like the Model 616), or as a rotating ring-disk. Reflecting the 636A's dual nature, there are two different sets of accessories, according to the intended use. Note that the Model 636A, as supplied, comes without an arbor, electrode, or accessories.

The available electrodes (part number and description) and accessories are listed below.

Rotating Disk Electrode

Permanent Disk Electrodes (5.0mm diameter)

RDE0004	Platinum, PTFE shroud
RDE0004PK	Platinum, PEEK shroud
RDE0005	Gold, PTFE shroud
RDE0005PK	Gold, PEEK shroud
RDE0008	Glassy Carbon, PTFE shroud
RDE0008PK	Glassy Carbon, PEEK shroud

RDE0027 Arbor for Rotating Disk and Cylinder Arbor (not compatible with Ring-Disk electrodes) is required.

Permanent Disk Electrodes (5.0mm diameter):

RDE0006	Platinum, PTFE shroud
RDE0006PK	Platinum, PEEK shroud
RDE0007	Gold, PTFE shroud
RDE0007PK	Gold, PEEK shroud
RDE0009	Glassy Carbon, PTFE shroud
RDE0009PK	Glassy Carbon, PEEK shroud

RDE0070 Arbor for Rotating Disk and Ring-Disk is required

Interchangeable Disk Electrodes (5.0mm diameter)
Desired disk electrodes can be installed and changed with the RDE ChangeDisk electrode tip, instead of permanent disk electrodes.

RDE0081	ChangeDisk RDE, PTFE shroud
RDE0081PK	ChangeDisk RDE, PEEK shroud

Rotating Cylinder Electrodes

ACQC01205 Quick Change Rotating Cylinder Electrode Tip
For **standard and customer-made Cylinder Electrodes** with 12.0 mm diameter. The material adjacent to the electrode surface is Teflon. The electrode body is Kel-F.

ACQC01243 Toolkit for ACQC01205 is required to properly insert, remove, and polish electrodes with the 12mm RCE systems.

Rotating Ring-Disk Electrode
Permanent Ring-Disk Electrodes (5.0 mm Disk diameter)

RDE0071	Disk - Pt Ring	0.18mm gap	PTFE shroud
RDE0071PK	Disk - Pt Ring	1mm gap	PEEK shroud
RDE0072	GC Disk - Au Ring	0.32mm gap	PTFE shroud
RDE0072PK	GC Disk - Au Ring	1mm gap	PEEK shroud
RDE0073	GC Disk - Pt Ring	0.32mm gap	PTFE shroud
RDE0073PK	GC Disk - Pt Ring	1mm gap	PEEK shroud
RDEAFE6R2GCGC	GC Disk – GC Ring	1mm gap	PEEK shroud
RDEAFE6R2AUAU	Au Disk – Au Ring	1mm gap	PEEK shroud

RDE0070 Arbor for Rotating Disk and Ring-Disk is required

Interchangeable Disk Electrodes
Desired disk electrodes can be installed and changed with the RRDE ChangeDisk electrode tip with a permanent Ring electrode.

RDE0082AU	Electrode tip with Au Ring	1.5mm gap	PTFE shroud
RDE0082AUPK	Electrode tip with Au Ring	1.5mm gap	PEEK shroud
RDE0082PT	Electrode tip with Pt Ring	1.5mm gap	PTFE shroud
RDE0082PTPK	Electrode tip with Pt Ring	1.5mm gap	PEEK shroud

RDE0070 Arbor for Rotating Disk and Ring-Disk is required

Disk Inserts for Interchangeable RDE and RRDE electrodes (5mm OD x 4mm thickness)

AFED050P040GC	Glassy Carbon
RDE0083PT	Platinum
RDE00831018	1018 Carbon Steel
RDE0083AG	Silver
RDE0083CU	Copper
RDEAFED050P040AU	Gold
RDEAFED050P040NI	Nickel
RDEAFED050P040T5	430 Stainless Steel

Disk Inserts with other common materials may also be available.

Tools and consumable accessories

RDEAFE6K050	ChangeDisk Toolkit
RDE0085	Replacement U-Cups

RDEAKPOLISH Polishing Solutions and Materials Kit

NOTE: For custom electrodes not listed above, please contact your representative for availability and quotation.

4.3 ADDITIONAL SUPPLIES FOR 636A (& 616)

RDE0018 Analytical Cell Kit. Includes:

- K0060 Cell Bottom (glass, 5-50 ml)
- K0066 Top Assembly (not used in rotating electrode applications)
- RDE0010 Top Assy (five holes). The center hole is 1.6 mm to accept the working electrode arbor. The other four are 1.4 mm standard taper ports to accept reference and counter electrodes, purge tube, etc.)
- RDE0019 Purge Tube
- RDE0020 Reference Electrode Tube Assembly
- RDE0021 Pt Counter Electrode Wire (6 in)
- RDE0022 AgCl-KCl Filling solution
- RDE0023 Counter Electrode Bridge Tube
- RDE0024 Reference Electrode Cap
- RDE0025 Counter Electrode Cap & Screw
- 1601-0077-09 Cell Collar
- 2811-0205-0 Counter Electrode Screw

These items can also be ordered separately.

- G0028 Purge Tube (Incorporates T14/20 standard taper joint to fit K0066 or RDE0010 Cell Top. Two-way Teflon stopcock directs inert gas stream through analyte solution for displacement of dissolved oxygen, or over solution to form inert gas blanket. Only flexible Teflon tubing contacts solution.)
- G0100 Vycor Frits, 4 mm (pkg of 5)
- K0015 Polishing Kit
- K0062 Low-Volume Cell Bottom (glass, 2-50 ml)
- K0064 Jacketed Cell Bottom (a water jacketed version of the K0060 Cell Bottom suitable for connection to constant-temperature circulators)
- RDE0026 Reference Bridge Tube

4.4 ELECTRODE CARE

Electrodes designed for use with the Model 636A are precision research tools. Each is tested and guaranteed to be leak free before shipment. The test was conducted at an ambient temperature of about 23^{o}C in a solution of 0.2M H_2SO_4.

1. Precautionary measures should be taken to avoid damage to the electrode. Leave the electrode wrapped when not in use.

2. Do not use Teflon shrouded electrodes above 30^{o}C because expansion at higher temperatures may cause the electrode to leak.

3. Keep the protective cover on the electrode when not in use.

4. Mount the electrode securely in the rotator. Do not apply excessive force to the Teflon shroud or the electrode because it can cause slipping off the shroud along the metal shaft. Mount the electrolysis cell so that the electrode enters the cell through the electrode port with the end of the electrode submerged approximately 5 mm below the surface of the solution. The electrode should be centered in the electrode port so that the shroud doesn't rub against the cell cover.

5. TRANSPORTATION AND STORAGE

5.1 TRANSPORTATION

It is suggested that the packing materials on which the unit was originally shipped be maintained for any future shipping requirements, either back to the factory for repair/modification, or to some other location. These packing materials were designed to provide both protection in shipment and minimum size and weight for efficient shipment. PAR normally employs carriers such as UPS, DHL or FedEx for shipment of these units.

5.2 STORAGE

In the event that the rotator system is not going to be used for a long period of time, it is suggested that it be stored in the original packaging material to prevent damage. In any case the unit should be stored at temperatures between 0°F and 100°F, and at humidity levels less than 95% non-condensing.

NOTES:

NOTES:

www.ameteksi.com

Telephone: 865-482-4411

Please see the website for a complete list of the global offices and authorized agents.