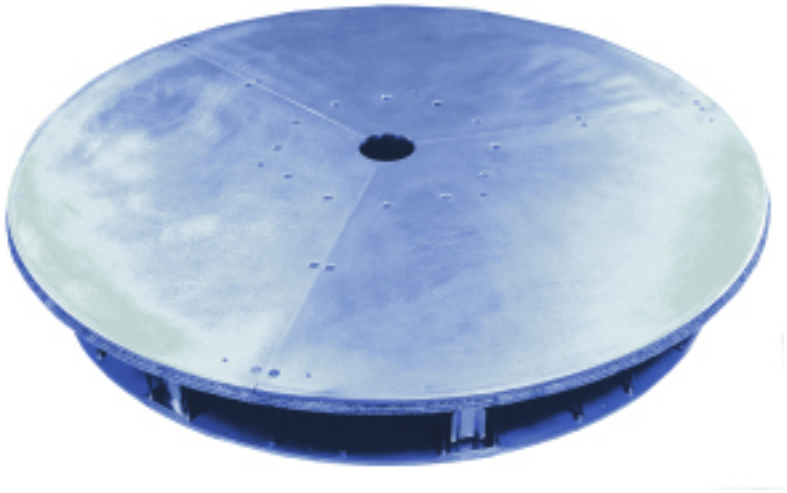
Model 2087

Electric Powered Turntable

2 & 3 Meter Models
MANUAL



ETS·LINDGREN™
An ESCO Technologies Company

 REV C – PN 399233

EMC Test Systems, L.P. reserves the right to make changes to any products herein to improve functioning, design, or for any other reason. Nothing contained herein shall constitute EMC Test Systems, L.P. assuming any liability whatsoever arising out of the application or use of any product or circuit described herein. EMC Test Systems, L.P. does not convey any license under its patent rights or the rights of others.

E-MAIL & INTERNET
Support@ets-lindgren.com
http://www.ets-lindgren.com

USA
1301 Arrow Point Dr., Cedar Park, TX 78613
P.O. Box 80589, Austin, TX 78708-0589
Tel 512.531.6400 Fax 512.531.6500

FINLAND
Euroshield OY
Mekaanikontie 1
27510, Eura, Finland
Tel 358.2.838.3300
Fax 358.2.865.1233

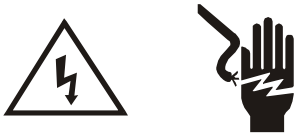
SINGAPORE
Lindgren RF Enclosures Asia-Pacific
87 Beach Road
#06-02 Chye Sing Building
Singapore 189695
Tel 65.536.7078 Fax 65.536.7093

Table of Contents

NOTICE: This product and related documentation must be reviewed for familiarization with safety markings and instructions before operation.

SAFETY SYMBOL DEFINITIONS

REFER TO MANUAL When product is marked with this symbol refer to instruction manual for additional information.



HIGH VOLTAGE Indicates presence of hazardous voltage. Unsafe practice could result in severe personal injury or death.

PROTECTIVE EARTH GROUND (SAFETY GROUND)
Indicates protective earth terminal. You should provide uninterruptible safety earth ground from the main power source to the product input wiring terminals, power cord, or supplied power cord set.

CAUTION

CAUTION Denotes a hazard. Failure to follow instructions could result in minor personal injury and/or property damage. Included text gives proper procedures.

WARNING

WARNING Denotes a hazard. Failure to follow instructions could result in SEVERE personal injury and/or property damage. Included text gives proper procedures.

GENERAL SAFETY CONSIDERATIONS

BEFORE POWER IS APPLIED TO THIS INSTRUMENT,
GROUND IT PROPERLY through the protective conductor of the AC power cable to a power source provided with protective earth contact. Any interruption of the protective (grounding) conductor, inside or outside the instrument, or disconnection of the protective earth terminal could result in personal injury.

BEFORE SERVICING: CONTACT ETS-LINDGREN - servicing (or modifying) the unit by yourself may void your warranty. If you attempt to service the unit by yourself, disconnect all electrical power before starting. There are voltages at many points in the instrument which could, if contacted, cause personal injury. Only trained service personnel should perform adjustments and/or service procedures upon this instrument. *Capacitors inside this instrument may still be CHARGED even when instrument is disconnected from its power source.*

ONLY QUALIFIED PERSONNEL should operate (or service) this equipment.

STAY CLEAR of moving components during operation of equipment.

INTRODUCTION

The ETS-Lindgren Model 2087 is an electric powered turntable platform system designed to be used with the Model 2090 Positioning Controller for EMI compliance testing. The Model 2087 is available in 2.03 and 3.03 meter sizes, both designed for indoor or outdoor use.

The sectional turntable top surface is made of aluminum. The conductive metal top is fitted with a ground brush to electrically couple the turntable to the ground plane. The brush provides continuous contact with the floor flange supplied. To extend the life of the ground brush, a one-piece stainless steel liner is attached to the inside edge of the stationary floor flange.

Both models utilize a pinion and gear drive with a gear reducer and electric motor located beneath the platform. The bearing on which the turntable rotates has the drive teeth cut directly on the outside and will easily support most Equipment Under Test (EUT). Support for the turntable includes casters that aid in the support of cantilevered loads on the outside of the turntable.

The turntable top is sectional to provide easy access if service is required. On standard models, a 15 cm hole is provided in the center of the turntable to accommodate customer supplied cabling to and from the EUT. This hole also provides access to the limit switch adjustment knobs and the primary circuit breaker.

To prevent over-travel of the turntable in either direction of movement, mechanical limits can be adjusted. The limit switch adjustments are on the encoder/limit assembly which is located below the turntable top. For continuous rotation without limits, adjustments can be made in the encoder/limit assembly. Soft limits can be set within the mechanical limits, using the Model 2090 positioning controller. Signal I/O between the turntable and positioning controller is provided by fiber-optic control lines.

STANDARD CONFIGURATION

- Turntable assembly
- Ground ring assembly with ground brush and floor flange
- 230 VAC Electric Motor Unit
- Rotational limit adjust switches
- Continuous or Non-continuous operation
- Ten-meter fiber-optic control cables
- Overall height 280 mm (11”)
- SCAN and SEEK Capability

OPTIONS

Model 2090 Positioning Controller: This controller provides control for two separate devices (ETS-Lindgren towers and turntables) in any combination, plus the control of four auxiliary devices. The unit includes a GPIB bus and is compatible with most popular software.

Hand Control Unit (HCU): This sturdy, hand-held controller will allow the user to manually operate the table remotely and independently from the Model 2090 Positioning Controller. This controller attaches conveniently to the electrical enclosure located on the base of the turntable. Functions include clockwise (CW) and counter-clockwise (CCW) control.

Slip Ring: This optional allows continuous rotation of the turntable through the use of the latest technology in mercury slip rings. The slip ring option is typically supplied with Schuko or NEMA connectors. Specify part #103441 for NEMA connectors, and part #103351 for Schuko connectors. The current rating for the standard electrical assembly is 20 amperes. Consult the factory for all custom requirements on slip rings.

Shield Room Feed-Through: This option allows the customer to take the fiber-optic control cable from the control room to the shield room and still maintain satisfactory shielding attenuation. The unit is made of brass for conductivity and provides attenuation of greater than 100 dB at 10 GHz. A single 22.25 mm (.875”) hole is required to mount this option.

Variable Speed Drive: An optional variable speed drive package is available with the Model 2087 Turntable. Speed adjustment is electronically controlled by the Model 2090 Controller via the front panel or through the GPIB interface.

EUT Power Outlets: Receptacles are usually mounted on the base of the turntable at its center axis point. These receptacles can be custom mounted, flush with the tabletop on some turntables. Consult the factory for more details.

Mounted LISNs: LISNs can be mounted to the underside of some turntables. This option is only practical on larger turntables with sufficient clearance.

Additional Fiber Optic Cable: Additional lengths of fiber optic cable may be ordered.

PRECAUTIONS

Read this manual completely before starting installation. This equipment should be installed and operated only by qualified personnel.

The electrical installation of this product should be accomplished by an individual who is authorized to so do by the appropriate local authority. The installation should be in compliance with local electrical safety codes.

Do not attempt to service unless qualified to do so. As with any electrical equipment, ensure unit electrical power has been disconnected and secured when performing scheduled maintenance or adjustments.

Do not make any modifications to this unit without consulting the factory directly.

Stay clear of all moving components on this equipment.

Do not operate turntable while someone is physically on the turntable top.

Do not, at any time, place hands or feet in the vicinity of the drive pinion on the turntable.

Regularly inspect all equipment and conduct scheduled maintenance in accordance with the factory recommendations provided.

Only use replacement parts and fasteners ordered directly from the factory.

TURNTABLE INSTALLATION CONSIDERATIONS

Pre-planning is essential for a successful installation. Be sure to discuss your requirements will your sales representative and request dimensional drawings prior to construction of your site.

POWER AND SIGNAL LINES

Conduit

Power and signal line paths should be planned in advance. Conduit should be in place before pouring concrete or installing the ground plane. Be sure to consider the size of the cable bundle when selecting conduit diameter.

Electrical Considerations

A qualified and licensed electrical contractor should be used to install power lines, and the installation should comply with all applicable regulatory agencies. A dedicated circuit should be used, with the shortest distance possible between the power source and the turntable.

Access

An access area underneath the turntable is advisable for large diameter installations. A service switch should be installed to deactivate the turntable during service.

OUTDOOR INSTALLATIONS

Drainage

A centerline drain of at least 15cm (6in) must be installed to provide proper drainage during rain storms, etc.

Cold Climate Conditioning

Oil used in the gear assemblies will congeal at 2^{o} C (28^{o} F). Turntables operated in these temperatures should include a heat source and/or dehumidifier.

ASSEMBLY INSTRUCTIONS

The installation of turntables 2 meters and larger will be performed by a factory installation specialist or by individuals who have been authorized by ETS-Lindgren to do such work. Proper installation of the turntable directly affects performance. The following installation information is provided to familiarize the user of the turntable with the installation process.

1. Uncrate all parts. Check all parts for any shipping damage. Ensure a clear area is available to assemble the turntable unit safely. NOTE: Do not discard any packing material until unit is fully assembled.
2. Remove the bolts which attach the top onto the turntable drive assembly. Make note of the placement of each top section as it is removed. Refer to the assembly drawing in the rear of this manual for more details.

CAUTION Lifting the turntable assembly using a forklift or other lifting machinery should be performed by qualified personnel.

3. Using a forklift or other appropriate lifting device, place the turntable bottom or bearing support section into position. If the turntable is to be installed in a pit, center and level the assembly.

CAUTION Ensure power is off and secured before proceeding further.

4. The drawings at the back of this manual illustrate the placement of floor plates and leveling screws to anchor and level the turntable. Anchor the turntable through the attachment holes provided using the concrete expansion bolts provided. After installing the floor plates and leveling screws, level the entire turntable by adjusting all the leveling screws between and under the casters, and in the center section of the turntable.
5. Tighten all lock-nuts accompanying the leveling screws to lock the height of the turntable into place.

6. Connect the fiber-optic control cable and install the power connection per local electrical code. The standard power configuration is 230 VAC 50/60 Hz.

CAUTION Electrical connection should only be performed by a qualified electrician and subject to local electrical codes.

CAUTION Keep all body parts away from the drive pinion when the turntable is energized.

7. Install the ground ring flange using the instructions found in "Ground Ring Installation" in this manual.
8. Reinstall the top section removed in step #2 of these instructions.

GROUND RING INSTALLATION

The ground ring includes a floor flange assembly which interfaces with the brush ring located on the perimeter of the turntable. The floor flange provides constant electrical contact with the ground plane and is usually installed with the turntable.

Mounting methods vary according to user specifications. Clearance holes are provided along the outside perimeter of the ground ring as a means of attaching the ring to a customer supplied ground plane. These mounting holes are provided at evenly spaced intervals.

1. When attaching the ground ring, first center and level the turntable assembly into the turntable pit.
2. Attach one end of a ground ring section to allow a gap of ¼ inch to 3/8 inch between the turntable top and the ground ring.
3. Attach adjacent mounting screws, working around the turntable's edge.
4. When attaching the final ground ring section, check the length of the ring. It may be necessary to trim the length of the ring for proper fit.

5. To maintain the proper spacing between the turntable and the ground ring, it may be necessary to shim or pull the ground ring into position before fastening.

ELECTRICAL INSTALLATION

CAUTION It is important that this electrical installation procedure be performed by a qualified electrician, in accordance with local and national electrical standards prior to energizing the unit.

The Model 2087 is configured to operate using 230 VAC, single phase, 50/60 Hz service. It is recommended to operate at this voltage level to reduce the surge currents necessary to operate an electric motor.

1. The branch circuit supplying power to the motorbase should be protected from excess current according to local electrical codes. An integral circuit breaker is mounted inside the main bearing on one of the bearing support blocks. The circuit breaker is specifically designed for the inductive load presented by the electric motor.
2. Check to ensure that the conductor size is adequate for the motor load and the distance from the mains source. Improperly sized conductors will lead to a high voltage drop in the power conductors and cause reduced starting torque and premature motor failure.
3. The motor base assembly is provided with an unterminated flexible conduit with input power leads exposed. The flexible conduit is to be terminated into a junction box fitted on or near the motor base. Terminate the power leads of the motor base assembly according to local electrical code requirements. The following conductor color code is observed:

   Brown: AC high
   Blue: AC neutral
   Green/Yellow: Protective Earth/Safety ground

Should it be desired to operate at 115 VAC, jumpers in the relay enclosure assembly can be reconfigured. Consult the factory for safe and proper modification of the jumper configuration.

Prior to changing these jumpers, insure that power has not been supplied or has been safely removed from the assembly. The jumpers provide a means for applying the proper voltage to both the internal power supply and to the electric motor. Three jumpers are used to adjust the motor voltage. One or two jumpers, depending on the voltage desired, are used to adjust the voltage applied to the power supply. Please consult the factory prior to making this modification.

CONNECTING THE MODEL 2090 POSITIONING CONTROLLER

Any combination of primary devices (towers, turntables, reverberation paddles, MAPS, etc.) can be connected to the two Device Interface ports located on the rear panel of the Model 2090 controller. For easy set up of an EMC facility, it is recommended that the turntable be connected to the Device 2 interface port. The controllers default settings are for a tower connected to the Device 1 interface port and a turntable connected to the Device 2 port.

Primary device connection is accomplished by way of a dual fiber cable included with the device. This cable terminates into two ST connectors that are identical at both ends. The cable is symmetrical; either end can be connected to the controller. A fiber optic cable that is connect to the IN port of a device should, at the other end, be connected to the primary OUT port of the motorbase. A fiber connected to the OUT port of the device should, at the other end, be connected to the primary IN port of the motorbase. Older motor base designs have only one fiber optic connector pair, while the newest motor base interface provides a secondary interface reserved for future expansion.

NOTE: Fiber optic cabling for each device should not be allowed to hang unsupported from the rear panel of the controller. The fibers and connectors are easily broken if twisted or bent. Keep the

fiber optic cables as straight as possible from the connector to the protective sheath.

Using the Model 2090 Position Controller (or hand controller), rotate the motor base shaft to verify proper operation. Run the motorbase down to the lower limit CCW and then back it off from the lower limit just a bit. The previous step will help when it is time to set the rotation limits for the turntable.

CAUTION The soft rotational limits in the Model 2090 controller must be set. Ensure the travel limit settings will not cause damage to user installed cables and equipment mounted on the table.

SETTING TRAVEL LIMITS

The mechanical limits of the turntable are located at the center of the turntable within the main bearing. The limit adjustment knobs are accessible through the center hole of the turntable's top. A label has been placed on the encoder/limit assembly to describe the limit adjustments.

CAUTION Keep all body parts away from the drive pinion when the turntable is energized.

1. To increase the amount of travel in either direction turn the knob in the direction indicated by the positive (+) sign.
2. To decrease the amount of travel in either direction you must turn the knob in the minus (-) direction as indicated.

WARNING Ensure the current travel limit settings will not cause damage to existing cables and equipment located underneath or on top of the turntable.

3. To allow for continuous rotation, the encoder/limit assembly must be configured to disengage the limit mechanism. To access the limit mechanism, remove the adjustment knobs.
4. Each knob has two Allen-type set screws. Remove the four screws at the base of the cover and lift the cover off.

5. Disengaged the limit mechanism by loosening the inline coupler and sliding the coupler at least ¼ inch back from its mate to disengage the drive teeth.
6. Retighten the shaft set screws on the coupler.
7. Reinstall the cover and the adjustment knobs.

Once limits have been set or disengaged using the above procedure, return the turntable to its original position by replacing the top section.

OPERATION

Please refer to the Model 2090 Positioning Controller manual if you are unfamiliar with the operation of the unit. A 2090 manual is included with each 2090 shipment and is also available for download from our website: www.ets-lindgren.com.

With the assembly complete the Model 2090 controller will need to be connected to the unit and power applied to both the motor base and controller in order to continue. Refer to the electrical installation section if you have questions about how to connect the fiber optic cables.

Using the Model 2090 Positioning Controller check the CW and CCW rotation in both directions by a few degrees. The position in degrees increases (+) in the CW direction and decreases (-) in CCW direction.

The turntable is calibrated at the factory to read out 360 degrees (+ or - 1 degree) for one complete revolution. If the table is not within this accuracy, the unit can be re-calibrated per the instructions in the “Turntable Encoder Calibration” section.

RECOMMENDED PARAMETERS FOR THE MODEL 2090 POSITIONING CONTROLLER

DEVICE 2		
Parameter	**Value**	**Description**
P1	0	Turntable
P2	0	Standard Turntable
P3	000	Infinite Scan Count
P5	1	Non-continuous rotation
P8	2.5	2.5 Second reverse delay
P9	9	Primary GPIB address 9
b1	000	User options disabled
c	3600	3600 encoder counts per meter
S0	-1	Step speed = run speed
Oc	On	Overshoot compensation enabled

EDITING MODEL 2090 POSITIONING CONTROLLER CONFIGURATION PARAMETERS

To edit a configuration parameter, press the PARAM key to display the current parameter. Pressing the PARAM key repeatedly will scroll down through the parameter list, showing each parameter in turn. While viewing a parameter, the STEP keys (INC/DEC) may be used to scroll up or down the parameter list. This reduces the effort necessary to scan through a long parameter list using the PARAM key. Pressing any of the LIMIT/POSITION selection keys will return the display to that selection. Pressing any of the remaining motion keys will return the display to the current position and execute that motion. Pressing the PARAM key again will return to the last displayed parameter in the list, allowing easy transition between parameter adjustment and device operation.

Once the desired limit, position or parameter is visible in the display window, pressing INCRM, DECRM, or ENTER will

toggle into edit mode. The lowest adjustable digit will flash on and off. Pressing the LOCAL key for that device will switch the flashing digit to the next higher digit. In this way, it is possible to rapidly adjust any digit of a multi-digit parameter or limit.

TURNTABLE ENCODER CALIBRATION

C Refers to the encoder calibration parameter. This setting is used to convert the encoder count values returned from a motor base into the corresponding centimeter or degree position reading. For turntables, this represents the number of encoder counts per revolution. Using this parameter, a variety of standard, retrofit, and custom devices can be used. The setting for the Model 2087 Turntable Series is: 3600

If the given value does not appear to work correctly, the encoder calibration value can be determined using the following procedure:

1. Set the encoder calibration value to 3600.
2. Insure that the turntable is positioned to allow more than a full revolution of travel in the clockwise direction and use the STEP keys to run the turntable clockwise a few degrees to remove any play in the table.
3. Mark the current location of the turntable against the ground ring (masking tape works well), and set the current position reading to 000.0.
4. Using the STEP keys, rotate the turntable clockwise until it is again aligned with the mark on the ground ring. For best results, the last motion should always be in the clockwise direction to insure that any play in the gearing between the motor and encoder is accounted for.
5. Record the reading of the display, ignoring the decimal point (i.e. 360.0 would be 3600). This is the encoder calibration value.

   NOTE: If the value is below 3600, the resolution of the encoder is low and thus the 2090 will not provide 0.1 degree resolution, even though the display shows that digit. If the value has gone past 9999, the encoder has too many counts per

meter and the 2090 can not correct for it. In this case, contact ETS-Lindgren for assistance.

6. Enter this value for the encoder calibration value and reset the limits and position information.

7. Test the turntable by moving it a complete revolution and comparing the alignment marks. It may be necessary to adjust the encoder calibration value up or down slightly depending on the result.

   NOTE: When scanning between limits, it is not uncommon to have a small discrepancy between the absolute position of the table and the display on the 2090. This is because reversing the direction of rotation reverses any gear play between the encoder and the table top, allowing that play to be visible in the positioning accuracy.

TT CALIBRATION EXAMPLE

The table is set at the 0 degree position. A piece of tape is placed on the edge of the TT to line up with the edge of the gearbox cover. The table is stopped when the tape travels exactly 360 degrees around. The display on the 2090 now reads 356.3 degrees which is recorded.

The table is rotated CCW back to 0. The parameter button is set on the “C” setting. The “C” digits display 3430. A new “C” setting is now calculated:

New “C” = (356.3 divided into 360) times 3430 = 3395 (rounded off)

The decrement the C parameter to 3395 and “ENTER” is pressed. Then the “current position” button is pressed to get back to operation mode.

The table is rotated from 0 to 360 and the mark is now within one degree of being one full TT revolution. Calibration is complete.

SETTING CURRENT POSITION ON 2090

The total travel between the mechanical limits is typically set between 370 and 400 degrees at the factory. Set the 0 degree position on the 2090 so that the 2090 moves the table between the mechanical limits without engaging them in normal operation.

EXAMPLE (CW - clockwise, CCW - counterclockwise)
The table is rotated CCW until it stops at the mechanical limit. The table current position is then set at 0. Then it is rotated CW till it stops at the CW mechanical limit switch. The controller now reads 385 degrees which is the full travel between mechanical limits. The current position on the 2090 is then reset to 360 about 10-15 degrees from the CW mechanical limit. This will keep it from hitting both mechanical limits when rotating from 0 to 360 during operation by the 2090.

CAUTION: ON RESETTING CURRENT POSITION ON 2090

The 0 degree position of the 2090 controller is fixed with respect to the mechanical limits described in the “Setting Current Position on 2090” section if they are not disabled per the instructions in the “Setting Mechanical Limits” section.

Should it become necessary to reset the current position readout of the Model 2090 Controller. The platform can be rotated periodically back to a desired position and the 2090 current position can be reset to 0 only if the mechanical limits are disabled. The CW and CCW limits on the 2090 will continue to function with the mechanical limits disabled. If the mechanical limits remain in operation, the 360 travel on the 2090 will no longer be between mechanical limits and normal operation will be interrupted if they are not disabled per the instructions in the “Setting Mechanical Limits” section.

HAND CONTROL UNIT

To connect the Hand Control Unit (HCU), remove the connector cap on the motor base. Plug the cable receptacle from the hand control unit into the electrical enclosure and screw connectors completely together. The HCU is now ready to operate. Be sure to coordinate use of the unit with the operator of the Model 2090 Positioning Controller.

CAUTION Do not plug the Hand Control Unit into the motor base while that device is in operation. Coordinate with the operator of the Model 2090 Positioning Controller before plugging in, using, or unplugging.

To allow the HCU to operate, push the control switch from MAIN to HAND. When the HCU is selected, the Model 2090 Positioning Controller is overridden until control is returned from the HCU. If the Model 2090 Positioning Controller is left on while the HCU is used, the Model 2090 Device Controller records all changes in position.

CAUTION Do not push the CW and CCW buttons at the same time. Be sure that the motor is completely stopped before reversing direction with the hand control unit.

When you are ready to change to automated testing, toggle the control switch from HAND to MAIN.

RECOMMENDED MAINTENANCE

Regular maintenance will prolong the effective operation and reliability of your turntable. Follow this recommended schedule.

CAUTION Do not perform maintenance while the turntable is operating.

EVERY SIX MONTHS

- Adjust the encoder chain. The chain should have no more than 20mm (1/8”) looseness when flexed to a point halfway between the two sprockets. Adjust the chain by loosening the two screws holding the encoder assembly. Move the encoder in or out to the desired tension.

- Lubricate the encoder chain. Use a good quality grease to lubricate the chain.

- Grease the casters. Use a good quality bearing grease to lubricate the casters.

- Check the gearbox for fluid leakage. A slight film that collects is normal. You should not have puddles of fluid. The gearbox is lubricated and sealed at the factory. Under normal conditions, it should not require servicing during its life.

EVERY 12 MONTHS

- Lubricate the main bearing race. Use a grease gun with a good quality bearing grease. The grease fittings are located inside the race, 90 degrees apart, underneath the top. Three discharges from the grease gun in each fitting are adequate.

- Grease the gear teeth. Apply a good quality grease to the gear teeth.

SPECIFICATIONS

ELECTRICAL

Drive Speeds	Single (Standard)	Variable (Optional)
Nominal AC Voltage	208-230 VAC	208-230 VAC
Input Frequency	50/60 Hz	50/60 Hz
Current Rating	20 amp service	20 amp service
AMP	4	8
RPM	1.9	.5/2.0
Phase	Single (1)	Single (1)

MECHANICAL

Diameter	2 meters	3 meters
Height	28 cm (11 in)	28 cm (11 in)
Distributed Load Rating *	907 kg (2000 lb)	1135 kg (2500 lb)

* Distributed Load Rating is based on load being evenly distributed to each section. No point loads under .37 sq. m (4 sq. ft) should exceed 500 kg (1100 lb); and not over 500 kg should be applied to a 45 degree segment outboard of the casters.

WARRANTY STATEMENT

EMC Test Systems, L.P., hereinafter referred to as the Seller, warrants that standard EMCO products are free from defect in materials and workmanship for a period of two (2) years from date of shipment. Standard EMCO Products include the following:

- Antennas, Loops, Horns
- GTEM cells, TEM cells, Helmholtz Coils
- LISNs, PLISNs, Rejection cavities & Networks
- Towers, Turntables, Tripods, & Controllers
- Field Probes, Current Probes, Injection Probes

If the Buyer notifies the Seller of a defect within the warranty period, the Seller will, at the Seller's option, either repair and/or replace those products that prove to be defective.

There will be no charge for warranty services performed at the location the Seller designates. The Buyer must, however, prepay inbound shipping costs and any duties or taxes. The Seller will pay outbound shipping cost for a carrier of the Seller's choice, exclusive of any duties or taxes. If the Seller determines that warranty service can only be performed at the Buyer's location, the Buyer will not be charged for the Seller's travel related costs.

This warranty does not apply to:

- Normal wear and tear of materials
- Consumable items such as fuses, batteries, etc.
- Products that have been improperly installed, maintained or used
- Products which have been operated outside the specifications
- Products which have been modified without authorization
- Calibration of products, unless necessitated by defects

THIS WARRANTY IS EXCLUSIVE. NO OTHER WARRANTY, WRITTEN OR ORAL, IS EXPRESSED OR IMPLIED, INCLUDING BUT NOT LMITED TO, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. THE REMEDIES PROVIDED BY THIS WARRANTY ARE THE BUYER'S SOLE AND EXCLUSIVE REMEDIES. IN NO EVENT IS THE SELLER LIABLE FOR ANY DAMAGES WHATSOEVER, INCLUDING BUT NOT LIMITED TO, DIRECT, INDIRECT, SPECIAL, INCIDENTAL, OR CONSEQUENTIAL DAMAGES, WHETHER BASED ON CONTRACT, TORT, OR ANY OTHER LEGAL THEORY.

Note: Please contact the Seller's sales department for a Return Materials Authorization (RMA) number before shipping equipment to us.

ILLUSTRATIONS