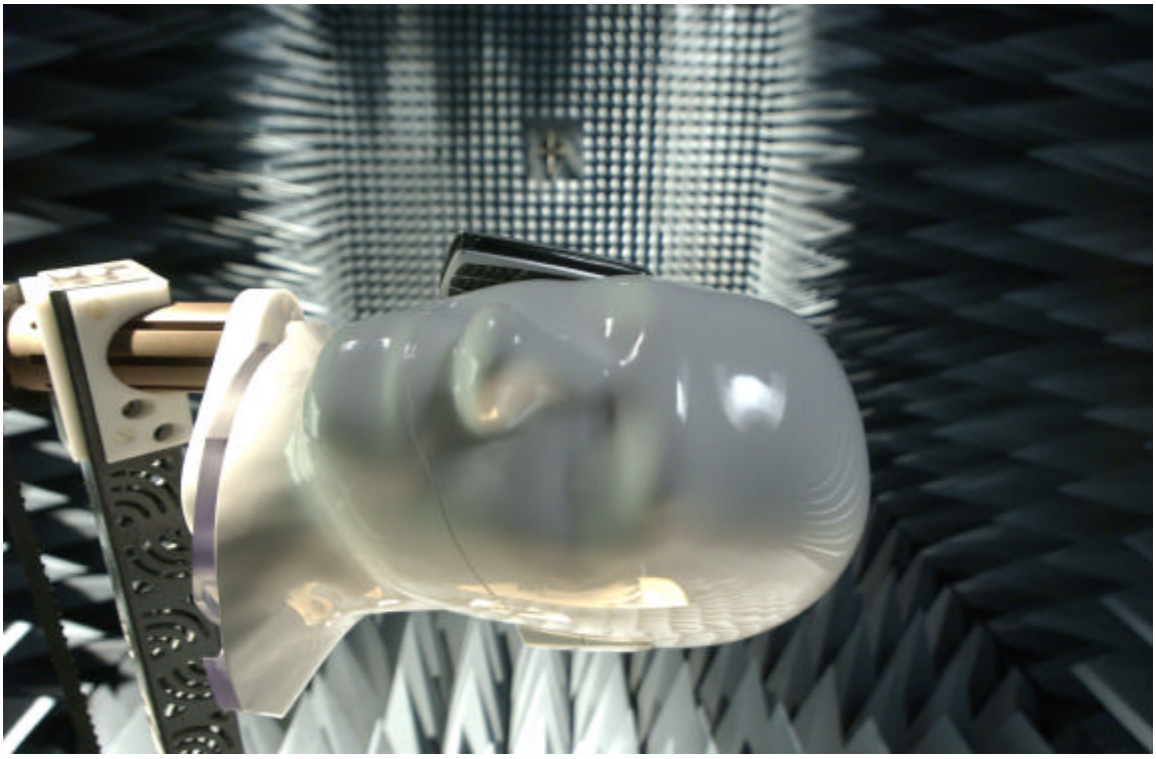
MAPS

Multi-Axis Positioning System

MANUAL



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ETS·LINDGREN™
An ESCO Technologies Company

 Rev. C – PN 399274

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
Phone 512.531.6400
Fax 512.531.6500

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

JAPAN
4-2-6, Kohinata
Bunkyo-ku
Tokyo 112-0006
JAPAN
Phone + 81 3 3813 7100
Fax + 81 3 3813 8068

CHINA
1917-1918 Xue Zhixuan Building
No 16 Xue Qing Road
Haidian District
Beijing Postcode: 100083
CHINA
Phone + 86 010 82755304
Fax + 86 010 82755307

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CE 05

European Community Declaration of Conformity

(in accordance with EN 45014:1998)

We, ETS-Lindgren, L.P., 1301 Arrow Point Drive, Cedar Park, TX, 78613, USA, declare that:

Model 20xx style Multi-Axis Positioning System (MAPS) with 2088 style motor base

to which this declaration relates, meets the requirements and conforms with the relevant EC Directives listed below using the relevant section of the following EC standards and other normative documents;

Directive(s):

EEC/73/23	The Low Voltage Directive (and its amending directives)
EEC/89/336	The Electromagnetic Compatibility Directive (and its amending directives)

Standard(s):

EN 55011	Group1, Class B
EN 61000-4-2:1995	Level 2/3 (4/8kV)
EN 61000-4-3:1997	Level 2 (3V/m)
EN 61000-4-4	Level 2 (1/0.5kV)
ENV 50204:1996	Level 2 (3V/m)
EN 61000-4-5:1995	Level 3 (2/1kV)
EN 61000-4-11:1994	2 kV
EN 61010-1	Safety requirements for electrical equipment for measurement, control, and laboratory use

I hereby declare that the equipment named above has been designed to comply with the relevant sections of the above referenced specifications. The unit complies with all essential requirements of the Directives. The CE marking has been affixed on the device according to article 10 of the EC directive 89/336/EEC

Authorized Signatory

Bryan Sayler
General Manager, ETS-Lindgren, L.P..

01 May 2005
Date of Declaration:

The authorizing signature on the EC Declaration of Conformity document authorizes ETS-Lindgren, L.P. to affix the CE mark to the indicated product. CE marks placed on these products will be distinct and visible. Other marks or inscriptions liable to be confused with the CE mark will not be affixed to these products.

ETS-Lindgren, L.P. has ensured that appropriate documentation shall remain available on premises for inspection and validation purposes for a period of no less than ten (10) years

ETS-Lindgren L.P. · 1301 Arrow Point Drive · Cedar Park, Texas 78613 · Phone 512.531.6400 · Fax 512.531.6500
info@ets-lindgren.com · www.ets-lindgren.com

Revision Record

MAPS Manual, Part Number 399274

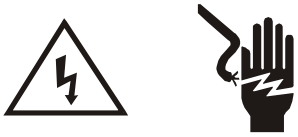
Revision	Description	Date
A	Initial Release	October, 2002
B	Manual updates (unreleased)	January, 2004
C	Addition of CE documentation and updates	July, 2005

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

ETS-Lindgren's Multi-Axis Positioning Systems (MAPS™) are designed to perform measurements of spherical antenna patterns plus total and effective isotropic radiated power of wireless hand-held devices. Two different positioner models are available with independent rotation in both azimuth and orthogonal axes.

The primary difference in the models is the vertical support column that supports the equipment under test (EUT). The Model 2010 Multi Axis Light Duty Position can accommodate EUTs up to 0.45 kg (1.0 lb), making it ideal for small devices. The Model 2015 Medium Duty Positioner is equipped with mounting plates to secure an EUT or phantom head up to 10 kg (22.0 lbs). The phantom head for testing wireless handsets is optional (not included).

The MAPS includes a horizontal roll axis, for mounting the EUT. The height of this axis must be specified when ordering the unit. Each MAPS is built according to the customer specified height by cutting the vertical support column to the appropriate length. A motor drive at the base of the vertical support column, in conjunction with the Model 2090 Positioning Controller, control the movement of the unit.

Each MAPS is furnished with a 63 inch diameter circular wood deck that is centered on a motorized turntable and bolts to the frame. The deck has an opening for the vertical support and access to the knobs that clamp the sliding carrier into a fixed position.

The MAPS is equipped with two motorbases, one to control each rotational axis. A 230 VAC 50 or 60 Hz single-phase receptacle is required to power each unit. Current draw is less than four Amps per motorbase.

The motor drives for the upper roll axis (x-axis or phi axis) and the rotation of the turntable (y-axis or theta axis) are controlled by the ETS-Lindgren Model 2090. The x-axis motor drive mounts onto a frame that is attached to the turntable. The frame is positioned on the turntable so that the roll axis centerline (x-axis) projects through the center of the turntable. This frame has a sliding carrier which moves the vertical

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support assembly in or out, in a six inch range, from the center of the turntable. The sliding carrier enables the movement of the EUT in or out in the same range.

In order to minimize any potential RF obstruction or distortion of RF signals from low directive wireless transmit antennas, each model's rotating shaft assembly is constructed of low reflective dielectric materials. In addition, the positioning systems are provided with fiber optic control lines that enable the I/O signal between the motor base and the optional ETS-Lindgren Model 2090 Positioning Controller. The use of fiber optic lines eliminates a potential source of RF interference.

The Model 2015 medium-duty MAPS is a dual-axis angular positioner capable of rotation the EUT on the center of both rotation axes with 360 degree angular span while keeping the EUT on the center of both rotation axes. The angular accuracy is guaranteed within +/- 0.25 degrees for both axes. The two axes can be controlled independently through the controller or measurement software.

In order to minimize any potential RF obstruction or distortion of RF signals from low directive wireless transmit antennas, minimum composite tube materials are used to fabricate the rotating shaft and EUT. The resultant system test data shows virtually no RF interference from the light duty MAPS. In addition a half-inch hole is provided at the center of the roll axis shaft to allow the RF cable to go through so as to minimize the RF cable connecting to the equipment under test.

The drive-power for both rotations is provided by the filtered 230 VAC, 50 Hz single-phase power inside the chamber. Therefore, there is no need for power drive cables to penetrate the shielded enclosure. In many cases, the traditional power drive cables are responsible for breaking the shielding integrity of the test lab.

OPTIONS

Many options are available for the MAPS. Please ask your sales representative for details regarding these options.

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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.

Stay clear of gears and belt on vertical support.

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.

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INSTALLATION

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

Proper installation of the MAPS unit directly affects performance. For this reason we recommend that the installation be completed by a factory installation specialist or by individuals who have been authorized by ETS-Lindgren to do such work.

CAUTION Ensure power is off and secured before proceeding further.

TOOLS REQUIRED

Tools are supplied by the customer/installer.

- 3/16” Allen wrench
- 5/16” Allen wrench
- 3/8” Allen wrenches, qty 3
- 6 mm. Allen wrench
- 3/8” ratchet wrench
- 12” crescent wrench
- 15 mm. 12 point socket for ½” square head screws
- 7/16” open/box end wrench
- 1/2“ open/box end wrench
- 3/4“ open/box end wrench
- 0.120 drill bit (for 6-32 self tapping screws)
- “A” & “ B “ drill (for ¼-20 self tapping flat head screws)
- 27/64” drill bit (for 1 / 2”-13 Tap)
- 3/8” hand drill
- 1/2–13 Tap
- #2 Phillips screw bit
- #3 Phillips screw bit
- Measuring tape
- Pry bar
- Level (ie. Torpedo laser)
- Square
- Black sharpie marker
- WD 40 or similar
- Zip Ties
- Tie Down Connectors

TYPICAL INSTALLATION

Figure 1: Typical Light Duty MAPS Configuration

1. Uncrate all parts. Check all parts for any shipping damage. Ensure a clear area is available to assemble the MAPS unit safely.
   NOTE: Do not discard any packing material until the MAPS is fully assembled.

   The MAPS consists of a variable speed turntable with an additional motor base mounted to a slide rail system on top of the turntable, one or more support masts for the second rotational axis, and a wood cover for supporting RF absorber on the completed assembly. All cabling for the upper axis motor base is pre-wired at the factory, and all electrical, RF, and communication connections are made to panels at the base of the MAPS, below the metal top of the turntable. Additional user connections are made above the top of the turntable for RF signals and optional convenience outlet connections.

2. Determine a suitable installation location. The MAPS must be positioned such that the center of rotation of both the vertical (theta) and horizontal roll (phi) axes intersects the line through the bore sight of the measurement antenna. For installations with permanently fixed measurement antennas, i.e. tapered chambers or wall installations, location of the MAPS becomes critical, as the antenna cannot be adjusted to correct for misalignment. Depending on the installation, it is often helpful to install the mast for the rotational axis as an aid in properly aligning the installation position. The mast should be installed so that the horizontal axis of rotation intersects the vertical axis. It is recommended to use a five-beam laser level to verify the alignment and location.

3. Position the MAPS so that the connections on the turntable are easily accessible and located closest to available feed through panels and power supply connections. Verify that the supplied fiber optic cables, as well as any optional or customer supplied RF cables, are long enough to reach from the MAPS unit to the feed through panel before settling on an orientation. Note that there are two fiber optic connections; one directly to the turntable motor base and the other to the connector panel for the upper axis wiring harness. Make sure than any power supply feed or other conduits or connector panels installed on the floor near the MAPS are located outside the perimeter of the MAPS wooden top, are oriented in such a way that power cords or other cables will lay flat on the floor when installed. A number of protrusions that extend past the metal turntable top of the MAPS may catch loose cables when it rotates. When working around the table, DO NOT step on any cables or their connectors. The cables should not be installed until a later step.

4. The MAPS turntable must be anchored to the ground to ensure that it cannot move accidentally should it be bumped, get caught on a foreign object while in motion, etc. With the MAPS turntable in the desired position, use a marker to mark around the perimeter of the table base. These marks may be used for reference if the assembly moves during placement of the anchor plates.

5. The MAPS has four floor plates that will need to be placed under the base of the unit. Slide the floor plates into position under the turntable base. See the drawing at the back of this manual for floor plate positions. Use a marker to mark around the perimeter of the floor plates. These marks may be used for reference if the assembly moves during placement of the plates.

6. Insert ½-13 x 5" square head screws with ½-13 flange nuts to hold the plates in place. Screw the plates to the floor using #14x1" square socket flat head screws. Drill 1/8" (3mm) pilot holes for these screws before screwing them into the floor. Continue mounting the rest of the plates.

7. Once all plates have been secured to the floor it is time to level the table, with all flange nuts backed off. Using a leveling instrument (torpedo laser level or some other device), level the MAPS by turning the level mount pads on the turntable base plate. Make sure that the height of the horizontal axis of the MAPS is within 0.5 cm of the bore sight of the measurement antenna once leveled. A five-beam laser level should be able to point through the horizontal axis and to the center of the measurement antenna simultaneously. Adjust the leveling screws as needed to modify the height slightly. When you are satisfied that the turntable is level, tighten all lock nuts and flange nuts accompanying the leveling screws to lock the height of the MAPS into place.

INSTALLATION OF THE VERTICAL SUPPORT ASSEMBLY

Install the vertical support assembly onto the motor drive mount. The side with the timing belt drive and pulleys must be positioned opposite from the center of the turntable. Install the plastic spider onto the coupling half of the motor. Then, install the vertical support onto the motor mount plate being careful to engage the coupling at the base with the coupling on the motor. The jaws of each coupling half should mesh with the plastic spider and the plate at the bottom of the vertical support should now come down against the mount plate on the motor to be fully seated. Bolt down this bottom plate to the motor driving using six hex head bolts.

CHECKING AND TIGHTENING THE TIMING BELT

Be sure all slack is taken out of the timing belt along the vertical support column. The belt is not continuous so the roll axis limits should be set using the Model 2090, to allow no more than two revolutions total (depending on the height of the MAPS). The belt terminates at the black plastic tension clamp. Each end of the timing belt is anchored to one block of the tension clamp. Two nylon screws hold each end of the tension blocks together. Tightening the two screws will tighten the belt and remove any slack. If necessary, the belt can be shortened with the block removed and then reinstalled in the tension clamp.

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ROUTING THE CONTROL CABLES TO THE ROLL AXIS

The motor drive for the roll axis has fiber optic connectors and power cord connectors toward the inside of the turntable. The power required is single phase 230 VAC for the roll axis motor drive. The power cord and the fiber optic cable need to be “fished” up under the center bearing of the turntable and out through the center opening at the top. The cables need to turn horizontal and connect with the control panel on the roll axis motor drive. They should be adequately anchored at the panel with cable clamps or P clips. These cables should also be anchored to the top where they turn to go down through the center opening.

The cables need to be anchored at the base of the turntable and given enough slack for flexing and twisting when the turntable rotates. The turntable limits must be set to allow no more than one revolution.

All units have these cables installed at the factory. A connection panel exists at the base of the turntable for the fiber optic cable and power cord.

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INSTALLING THE LAPTOP MOUNT

LAPTOP MOUNT KIT (Medium Duty MAPS only)

The clear plastic shaft hub is installed opposite the timing belt drive on the upper roll axis shaft (1.25 inch diameter). This hub locks to the shaft with a ¼ inch diameter round shaft key (brown plastic), plus two 3/8 inch nylon setscrews that screw against the key and shaft. The EUT mount plate is one inch thick clear plastic with six ½ inch diameter fiberglass rods extending out for 15 inches. This plate should be slid onto the end of the shaft. Install nylon bolts through this plate into the hub.

Caution: Do not over tighten or the plastic screws will break.

The slider strap plates slip over the rods on one side, two straps are furnished to support the EUT. The plates have slots for slipping through the hold down straps. The EUT may be mounted against the sliding plates by wrapping the straps around the EUT and tightening them in place against the mount plates.

PHANTOM HEAD MOUNT KIT

A slotted mount plate attached to the hub with nylon hex bolts. A 1/6" dowel pin locks this plate to the shaft. The phantom head bolts to this plate with four fiberglass bolts.

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INSTALLING THE ABSORBER CIRCLE

Two semicircular wood pieces are supplied to support the absorber platform above the frame and motor drive. Install the half sections onto the wood 2 in. x 6 in support beams mounted to the frame. Line up the sections with the ¾ inch diameter dowel pins of the center beam. The section that has an extra slot cutout must be installed on the side of the frame with the stop block. The slot provides access to the knob screw that locks the sliding carrier in place on the frame. Next, use the ¼ x 1.5 inch long screws to bolt the wood deck to the threaded inserts in the beams.

Install the absorber as shown in the drawing at the back of this manual. An opening for the vertical support to pass through the absorber platform should be present.

With the absorber circle in place the absorbers can be placed on the wood deck.

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ELECTRICAL INSTALLATION

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

The MAPS is designed to operate using 230 VAC single phase 50 or 60 Hz power. The branch circuit supplying power to the motor base should be protected from excess current according to local electrical codes. ETS-Lindgren has provided integral circuit protection in the motor base assembly.

Check 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.

The motor base assembly is provided with an IEC-320 power inlet for connecting to the mains. Prior to servicing the MAPS or the turntable motor base, remove the power connection for safety.

Connect the fiber-optic control cable and install the power connection per local electrical code. Please refer to the Model 2090 Positioning Controller manual for instructions on connecting the fiber optic cable.

Two shield room kits are provided for fiber optic connection at the shield room wall panel. Each kit contains two fiber optic panel couplings and three meters of extra fiber optic cable.

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MECHANICAL CONNECTION AND OPERATION

The EUT cable is routed through the hollow shaft of the upper roll axis. The cable can then exit out the pulley end of the shaft and be turned downward along the vertical support to the frame. Finally, the cable can then be connected to the rotary joint (SMA) at the center of the MAPS.

The Model 2090, as a secondary device, controls the upper roll axis. Connect the fiber optic cable that is routed down through the turntable to the Model 2090 (some units have a connection panel at the turntable base). Connect the power cord to single phase 230VAC.

Be sure the EUT is firmly strapped in place.

Check to make sure all cables are firmly anchored where they change direction and that there is enough slack for turning and twisting through one turntable revolution.

Refer to the Model 2090 Positioning Controller Manual for additional information about how to control the MAPS unit using the Model 2090.

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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 Model 2090 manual if you have questions about how to connect the fiber optic cables.

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

Set the rotational limits; using the Model 2090, so that the upper roll axis does no more than one revolution. Refer to the section of this manual on “Setting Travel Limits” for more information.

Note: Be aware that using the “INC” and “DEC" keys of the Model 2090 may cause the MAPS to pass the set rotational limits.

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 of this manual.

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.

RECOMMENDED SETTINGS

Parameter	Device 1 – Turntable Theta Axis	Device 2 – Mast Upper Rotation Phi Axis
P1	0	0
P2	0	0
P3	000	000
P5	1 (0 will damage cables)	1 (0 will damage cables)
P8	0.1	0.1
P9	8	9
B1	000	000
C	4500	4500
SO	-1	-1
S1	31	31
S2	63	63
S3	95	95
S4	127	127
S5	159	159
S6	191	191
S7	223	223
S8	255	255
OC	OFF	OFF

SETTING TRAVEL LIMITS

The MAPS is not fitted with mechanically actuated or “hard” limit switches. The cabling harness for the upper (phi-axis) motor base is routed through the center of the MAPS turntable (theta-axis) around an RF rotary joint. The medium and light duty masts for the phi-axis use non-continuous belts with an adjustable clamping mechanism. It is essential that the user properly set the “soft” limits in the Model 2090 controller to avoid damage to the RF cabling, wiring harness, or belt and pulley system. Refer to the Model 2090 controller manual for information on setting the soft limits. Additional care should be taken when swapping mast sections or otherwise changing the configuration of the MAPS to avoid changing the current position. If the configuration is

changed and the current position is not adjusted accordingly, components may be damaged. The MAPS ships with the turntable configured to allow approximately +/- 1 rotation of travel. Once installed, the turntable should not be rotated over more than a fixed 360° range of rotation. The mast should be installed with the belt clamp near the middle of the range of motion, and the current position set to ensure that it does not reach either the upper or lower pulley and housing in the desired range of motion.

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

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 MAPS is: 4500. 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. Ensure 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 CW until it is again aligned with the mark on the ground ring. For best results, the last motion should always be in the CW direction to ensure 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 cannot 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.

TURNTABLE CALIBRATION EXAMPLE

- The table is set at the zero degree position. A piece of tape is placed on the edge of the turntable 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 that is recorded.

- The table is rotated CCW back to zero. 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)

- Set “C” parameter to 3395 by decrement and press “ENTER”.

- 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.

CHANGING ROTATION SPEED

The MAPS is equipped with a variable speed drive. Firmware Revision 3.01 (or higher) must be installed in the Model 2090 controller for proper operation of the MAPS. The revision level is displayed on the front panel LED display during startup of the controller. If the controller does not have this or a later revision installed, consult the factory for an upgrade.

To select one of the eight speeds, use the **POLAR/SPEED** button to toggle through the speed options. It is necessary to set the Model 2090 parameters to configure the controller to properly control the motor base. Refer to the Model 2090 manual to the section that describes setting the parameters.

Specifically, parameter 2 must be set to the value 3, which is for variable speed control. Parameter C, which calibrates the encoder counts to the rotation of the turntable, should be set to the value 4500 (unless encoder calibration is needed, see Turntable Encoder Calibration section). This setting will ensure that the position display will properly report the full 360 degrees of travel.

VARIABLE SPEED SETTINGS

The Model 2090 parameters S1-S8 control the variable speed settings for the turntable. These parameters are the continuous variable speed settings for each of the eight speed selections described below. Each of these parameters can be set to any value from 1 to 255, with the resulting turntable speed being roughly an S/255 fraction of the maximum speed. Note that it is the nature of variable speed drives that a minimum speed exists at which the motor will operate. For the MAPS this minimum speed setting will be between 30-75 and should correspond to a value of 0.5 RPM or less. Below this setting, the motor will not be able to cause rotation, but will be active until a Motor Not Moving error (E002) occurs.

WARNING: Do not operate the MAPS in a stalled condition. Doing so can cause damage to the drive unit and will invalidate your warranty! Always insure that the minimum speed setting specified in the S1-S8 parameters is above the minimum value at which your table will turn under normal load.

SPEED SELECTION

For a standard turntable with variable speed capability, (previously selected as a Variable Speed Turntable by setting P2 = 3), the **SPEED** key also provides the ability to cycle between the eight preset speeds described above. For each press of the button, the turntable will change to the next speed setting. The **FAST** and **SLOW** polarization indicators will illuminate to represent the lower two bits of the speed selection in a binary fashion as shown below:

Speed 1 or 5: Both off
Speed 2 or 6: Top on, bottom off
Speed 3 or 7: Top off, bottom on
Speed 4 or 8: Both on

Each speed setting has its own individual overshoot compensation value to provide proper overshoot correction for each speed selection.

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TEST PROCEDURE

A utility that will make testing easier may be found on the ETS-Lindgren website at http://www.ets-lindgren.com/downloads/CTRLDEMO.zip. The utility will allow you to seek any target position you wish, as well as set position and limit settings from the PC.

First, double-check all of the encoder calibrations settings and range of motion by doing the following.

Run the turntable at a slow speed and have someone ready to stop the controller while the device motion is watched. For the turntable, start with the MAPS mast position the farthest away from the measurement antenna. Looking trough the hole in the light or medium duty mast from the outside edge of the turntable, one should be looking straight at the measurement antenna through the center of the turntable. That is, if a vertical line is drawn up through the center of the turntable and another horizontal line through the center of the horizontal axis to the measurement antenna, those two should intersect. The clamp ring on the upper axis of the MAPS may need to be loosened and rotated slightly to get it aligned through the center of the table. Once you're all lined up, set that position as zero on the turntable positioner. Then, make sure that if the turntable is rotated 360 degrees clockwise, the turntable will be back at the same position after only one turn. Watch the cables in the center and any cables and absorber around the MAPS to make sure they do not bind up or get caught on the turntable. As the absorber surrounding the MAPS is re-installed, it may be necessary to trim it to clear the rotation of the MAPS if this has not already been done.

Similarly for the horizontal axis, first make sure that the belt joint is in the middle of the range of motion and then choose any easy to remember position such as 180 degrees. This should ensure that the joint stays well away from either pulley. Rotate the positioner from zero to 360 degrees making sure that the horizontal axis only turns one full rotation and that the belt joint stays far enough away from the pulleys.

Once the range of motion is acceptable, run some other tests. Start by using the **SEEK** control in the CtrlDemo program or the EMQuest EMQ-100 program to rotate the devices through various ranges of angles at

various speeds. It is easier to start with the positioner at zero and change the upper limit to the desired setting then press **SCAN**. Repeat at several ranges or at least 10, 50 and 100 degrees. This exercise ensures targeting accuracy at different velocities, but ignore any inaccuracies if the speed is changed while the MAPS is moving (ETS-Lindgren does not guarantee accuracy if the user changes speed during movement). Both axes should be able to hit the target very precisely. An occasional 0.1 degree error is not a concern. Also, watch for error "E002" as the target is reached. This error indicates the motor has stalled due to a minimum speed setting that is too low.

Finally, run both axes for at least 30 minutes to provide a burn in test. By setting the axes to scan (they can run simultaneously). Provide monitoring of the system to ensure nothing fails.

RECOMMENDED MAINTENANCE

CAUTION: Do not perform maintenance while MAPS is operating. Disconnect the power connection for safety.

Regular maintenance will prolong the serviceability of your MAPS. Follow this recommended schedule.

EVERY SIX MONTHS

- Grease the casters. Use a good quality bearing grease to lubricate the casters.
- Check tension on drive belt – retighten if loose.
- Check cables for wear – be sure they are clear of potential damage from moving parts.

ANNUALLY

- Grease turntable bearings.

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WARRANTY STATEMENT

SCOPE AND DURATION OF WARRANTIES

Seller warrants to Buyer that the Standard EMCO Brand Products Excluding 5211 & 5220 be (1) free from defects in material, manufacturing workmanship, and title, and (2) conform to the Seller's applicable product descriptions and specifications, if any, contained in or attached to Seller's quotation. If no product descriptions or specifications are contained in or attached to the quotation, Seller's applicable product descriptions and specifications in effect on the date of shipment shall apply. The criteria for all testing shall be Seller's applicable product specifications utilizing factory-specified calibration and test procedures and instruments.

All product warranties, except the warranty of title, and all remedies for warranty failures are limited in time as shown in the table below.

Product Warranted	Duration of Warranty Period
Standard EMCO Brand Products Excluding 5211 & 5220	2 Years

Any product or part furnished to Buyer during the warranty period to correct a warranty failure shall be warranted to the extent of the unexpired term of the warranty applicable to the repaired or replaced product.

The warranty period shall commence on the date the product is delivered to Buyer; however, if Seller assembles the product, or provides technical direction of such assembly, the warranty period for such product shall commence on the date the assembly of the product is complete. Notwithstanding the foregoing, in the event that the assembly is delayed for a total of thirty (30) days or more from the date of delivery for any reason or reasons for which Seller is not responsible, the warranty period for such product may, at Seller's options, commence on the thirtieth (30th) day from the date such product is delivered to Buyer. Buyer shall promptly inspect all products upon delivery. No claims for shortages will be allowed unless shortages are reported to Seller in writing within ten (10) days after delivery. No other claims against Seller will be allowed unless asserted in writing within thirty (30) days after delivery (or assembly if the products are to be assembled by Seller) or, in the case of alleged breach of warranty, within the applicable warranty period.

WARRANTY EXCLUSIONS

Except as set forth in any applicable patent indemnity, the foregoing warranties are exclusive and in lieu of all other warranties, whether written, oral, express, implied, or statutory. EXCEPT AS EXPRESSLY STATED ABOVE, SELLER MAKES NO WARRANTY, EXPRESS OR IMPLIED, BY STATUTE OR OTHERWISE, WHETHER OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE OR USE OR OTHERWISE ON THE PRODUCTS, OR ON ANY PARTS OR LABOR FURNISHED DURING THE SALE, DELIVERY OR SERVICING OF THE PRODUCTS. THERE ARE NO WARRANTIES WHICH EXTEND BEYOND THE DESCRIPTION ON THE FACE HEREOF.

Warranty coverage does not include any defect or performance deficiency (including failure to conform to product descriptions or specifications) which results, in whole or in part, from (1) negligent storage or handling of the product by Buyer, its employees, agents, or contractors, (2) failure of Buyer to prepare the site or provide an operating environmental condition in compliance with any applicable instructions or recommendations of Seller, (3) absence of any product, component, or accessory recommended by Seller but omitted at Buyer's direction, (4) any design, specification, or instruction furnished by Buyer, its employees, agents or contractors, (5) any alteration of the product by persons other than Seller, (6) combining Seller's product with any product furnished by others, (7) combining incompatible products of Seller, (8) interference with the radio frequency fields due to conditions or causes outside the product as furnished by Seller, (9) improper or extraordinary use of the product, or failure to comply with any applicable instructions or recommendations of Seller, or (10) acts of God, acts of civil or military authority, fires, floods, strikes or other labor disturbances, war, riot, or any other causes beyond the reasonable control of Seller. This warranty does not cover (1) contact fingers or replacements unless loss is caused by a defect in material or manufacturing workmanship within the scope of this warranty (2) items designed to be consumable and (3) removal and reconstruction of walls, partitions, ceilings and other facility costs arising from repair or replacement of the product or parts thereof by Seller under the warranty. Seller does not warranty products of others which are not included in Seller's published price lists for shielding products and systems supplies and accessories.

BUYER'S REMEDIES

If Seller determines that any product fails to meet any warranty during the applicable warranty period, Seller shall correct any such failure by either, at its option, repairing, adjusting, or replacing without charge to Buyer any defective or nonconforming product, or part or parts of the product. Seller shall have the option to furnish either new or exchange replacement parts or assemblies.

Warranty service during the applicable warranty period will be performed without charge to Buyer within the contiguous 48 United States during Seller's normal business hours. After the warranty period, service will be performed at Seller's prevailing service rates. Subject to the availability of personnel, after-hours service is available upon request at an additional charge. For service outside the contiguous 48 United States, travel and per diem expenses, when required, shall be the responsibility of the Buyer, or End User, whichever is applicable.

The remedies set forth herein are conditioned upon Buyer promptly notifying Seller within the applicable warranty period of any defect or nonconformance and making the product available for correction.

The preceding paragraphs set forth Buyer's exclusive remedies and Seller's sole liability for claims based on failure of the products to meet any warranty, whether the claim is in contract, warranty, tort (including negligence and strict liability) or otherwise, and however instituted, and, upon the expiration of the applicable warranty period, all such liability shall terminate. IN NO EVENT SHALL SELLER BE LIABLE TO BUYER FOR ANY SPECIAL INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES OF ANY KIND ARISING OUT OF, OR AS A RESULT OF, THE SALE, DELIVERY, NON-DELIVERY, SERVICING, ASSEMBLING, USE OR LOSS OF USE OF THE PRODUCTS OR ANY PART THEREOF, OR FOR ANY CHARGES OR EXPENSES OF ANY NATURE INCURRED WITHOUT SELLER'S WRITTEN CONSENT DESPITE ANY NEGLIGENCE ON BEHALF OF THE SELLER. IN NO EVENT SHALL SELLER'S LIABILITIES UNDER

ANY CLAIM MADE BY BUYER EXCEED THE PURCHASE PRICE OF THE PRODUCT IN RESPECT OF WHICH DAMAGES ARE CLAIMED. This agreement shall be construed in accordance with laws of the State of Illinois. In the event that any provision hereof shall violate any applicable statute, ordinance, or rule of law, such provision shall be ineffective to the extent of such violation without invalidating any other provision hereof.
Any controversy or claim arising out of or relating to the sale, delivery, nondelivery, servicing, assembling, use or loss of use of the products or any part thereof or for any charges or expenses in connection therewith shall be settled in Austin, Texas by arbitration in accordance with the Rules of the American Arbitration Association, and judgment upon the award rendered by the Arbitrator may be entered in either the Federal District Court for the Western District of Texas or the State District Court in Austin, Texas, all of the parties hereto consenting to personal jurisdiction of the venue of such court and hereby waive the right to demand a jury trial under any of these actions.

ILLUSTRATIONS