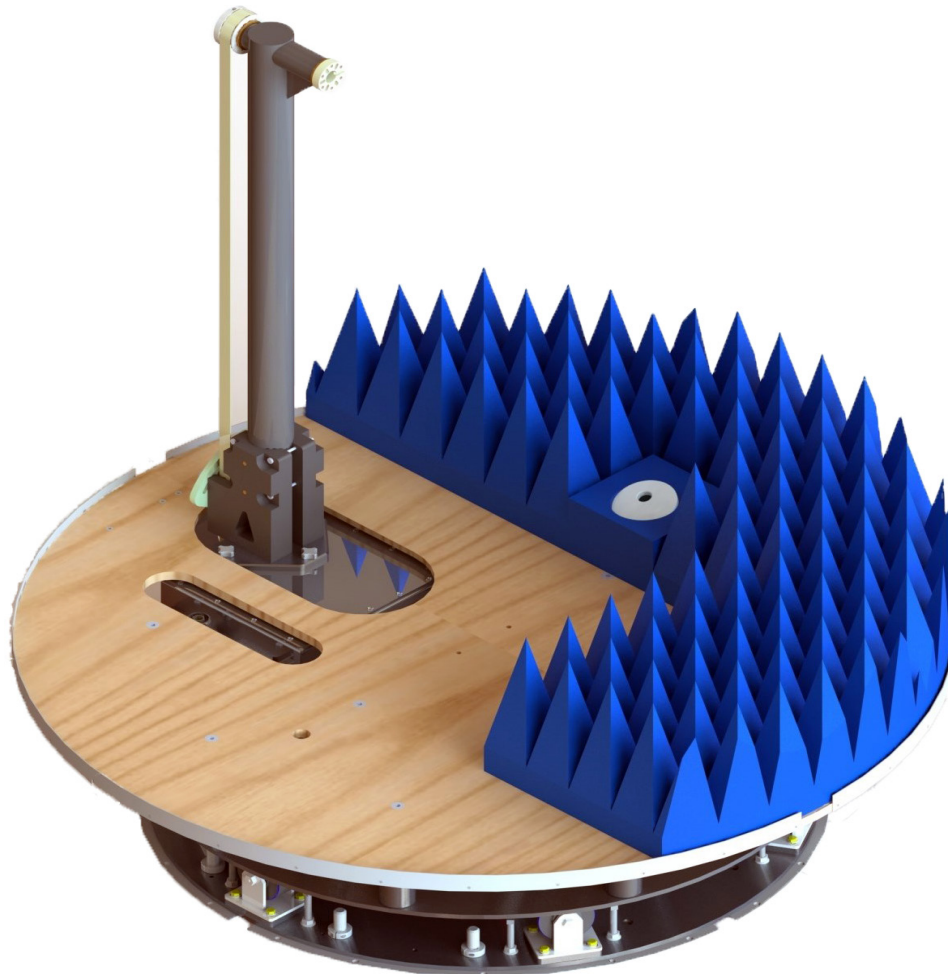


Multi-Axis Positioning System (MAPS™)

User Manual



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NOTES, CAUTIONS AND WARNINGS



Note: Denotes helpful information intended to provide tips for better use of the product.

CAUTION

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

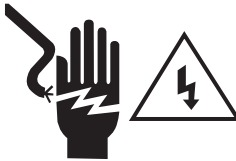
WARNING

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

SAFETY INFORMATION



Refer to Manual: When product is marked with this symbol, see the instruction manual for additional information. If the instruction manual has been misplaced, download it from ets-lindgren.com, or contact ETS-Lindgren Customer Service.



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.



See the ETS-Lindgren *Product Information Bulletin* for safety, regulatory, and other product marking information.

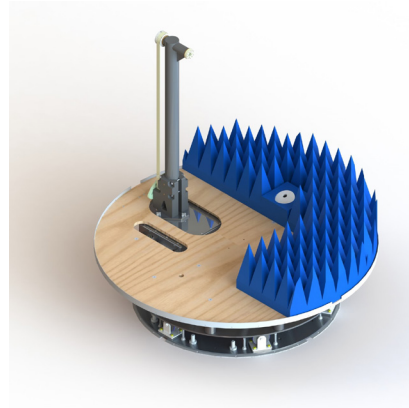
INTRODUCTION

The ETS-Lindgren Multi Axis Positioning System (MAPS™) is available in three types for light, medium, and heavy duty:

DD=Direct Drive	
2112-NNNN	Light duty DD MAPS
2117-NNNN	Medium duty DD MAPS
2122-NNNN	Heavy duty DD MAPS

The base model number are 2112, 2117 and 2122. A suffix is added to indicate the height above the floor for the phi axis in inches.

For example, Model 2117-6000 is a medium duty MAPS with a phi axis rotation height of 60.00 inches.



Model 2112
Medium Duty MAPS
(partial assembly shown)

The MAPS is designed to perform measurements of spherical antenna patterns as well as total and effective isotropic radiated power of wireless devices.

The MAPS provides independent rotation in both horizontal and vertical axes. In addition, the MAPS rotates continuously around the vertical axis.

The MAPS is built according to the customer specified height; the height of this axis must be specified when placing the order. A motor drive at the base of the vertical support column controls the movement of the MAPS, in conjunction with a positioning controller (sold separately), such as the EMCenter™ Modular RF Platform.

To minimize potential radio frequency (RF) obstruction or distortions of RF signals from low directive wireless transmit antennas, the following features were implemented into the design of the MAPS:

- The use of minimum composite tube materials to fabricate the rotating shaft and mounts for Equipment Under Test (EUT).
- RF cable connection to the EUT is made through a hole provided in the center of the roll axis shaft.



Standard Configuration



Note: The direct drive MAPS mast supplied with the 2112, 2117, and 2122 MAPS models are not compatible with previous MAPS models. Retrofit kits are available. Please consult Technical Support at ETS-Lindgren for upgrade options. Additional changes to the positioning controller (2090 or EMCenter) may be required to complete the upgrade.



Note: For part numbers, see *Replacement Parts* and *Optional Parts*, pages 14-15.

Mast

The MAPS mast supports the EUT and provides continuous 360° rotation on the horizontal axis while keeping the EUT on the center of both rotation axes. The angular accuracy is guaranteed within $\pm 0.25^\circ$ for both the 2122 Light Duty and 2117 Medium Duty Phi axes and $\pm 0.5^\circ$ for the 2122 Heavy Duty Phi axis. The two axes can be controlled independently through the controller or measurement software.

Horizontal Roll (Phi) Axis

The MAPS includes a horizontal roll axis for mounting EUT, and is equipped with mounting plates to secure the EUT or a Specific Anthropomorphic Mannequin (SAM) phantom head. Maximum EUT weight varies by MAPS model; see page 15 for weight specifications. The SAM phantom head for testing wireless handset is optional.

Turntable

The MAPS includes a 63 in (160 cm) diameter circular wood deck that is bolted onto a motorized turntable. The deck has an opening for the vertical support and access to the knobs that clamp the sliding carrier into a fixed position.

Motor Bases

The MAPS is equipped with two motor bases, one to control each rotational axis. The x axis motor drive mounts onto a rail system that is attached to the turntable. This system is positioned on the turntable so that the x axis centerline projects through the center of the turntable. The rail system has a sliding carrier that allows the vertical support assembly to be moved in or out, in a six inch (15.2 cm) range, from the center of the turntable. The sliding carrier enables the movement of the EUT in or out in the same range.

A 230 VAC 50 or 60 Hz single phase receptacle is required to power each motor base. Current draw is less than 4 amps per motor base. The drive power for both rotations is provided by the filtered 208–230 VAC, 50/60 Hz single phase power inside the chamber. Therefore, there is no need for power drive cables to penetrate the shielded enclosure.

Fiber Optic Cables

To minimize any potential RF obstruction or distortion of RF signals from low directive wireless transmit antennas, each MAPS is provided with fiber optic control lines that enable the I/O signal between the motor base and the positioning controller.

Tension Scale

To measure the tension on the belt, a tension scale is included with the DD MAPS. You must use this scale to make sure there is no excessive tension on the belt.

See *Using the Tension Scale to Measure and Set Belt Tension*, page 26, for the steps to measure and set the tension on the belt.



Positioning Controller

A positioning controller such as the ETS-Lindgren EMCenter™ Modular RF Platform (with EMControl™ Positioner Controller Plug In Card) is required for operation, and is sold separately. Contact ETS-Lindgren for ordering information. The EMCenter replaces the 2090 Controller, which has been discontinued. The basic controller configuration is an EMCenter with an EMControl card. This assembly is ETS-Lindgren part number 125241.

Check ets-lindgren.com or contact ETS-Lindgren to ensure that your EMCenter, the EMControl card, the backplane, and display all have the current firmware versions.

EMCenter: V5.21 (or later)

EMControl (7006-001) Card: V2.5.6 (or later)

Backplane: V2.3.0 (or later)

Display: V1.4.10 (or later)

The EMCenter is also expandable with a variety of additional options available. Please contact ETS-Lindgren with any questions.



Note: Existing ETS-Lindgren positioning controllers can be used with the Model 2112/2117/2122; contact ETS-Lindgren to confirm your controller is installed with the required firmware.

The 2090 requires firmware revision V 3.21 or higher. It is available for download at ets-lindgren.com and requires the program Flash Upgrade Wizard V 4.0 (also available at ets-lindgren.com).



EMCenter Modular RF Platform

The positioning controller directs the motor drives for the upper roll (*phi* axis) and the rotation of the turntable (*theta* axis).

ETS-Lindgren Product Information Bulletin

See the ETS-Lindgren *Product Information Bulletin* included with your shipment for the following:

- Warranty information
- Safety, regulatory, and other product marking information
- Steps to receive your shipment
- Steps to return a component for service
- ETS-Lindgren calibration service
- ETS-Lindgren contact information

MAINTENANCE

CAUTION

Caution: Before performing any maintenance, follow the safety information in the ETS-Lindgren *Product Information Bulletin* included with your shipment.

CAUTION

Caution: Do not perform maintenance while the MAPS is operating. During maintenance, disconnect power for safety.

WARNING

Warning: Only qualified individuals should conduct maintenance inspections or perform maintenance on the MAPS.



If you have any questions concerning maintenance, contact ETS-Lindgren Customer Service.

Belt Tension

Proper belt tension is required for the equipment to function correctly. See *Using the Tension Scale to Measure and Set Belt Tension*, page 26, for the steps to measure and set the tension on the belt.

Routine Maintenance

Perform the following maintenance prior to each use:

- Visually inspect the Multi Axis Positioning System (MAPS™) and surrounding absorber.
- Attempt to rotate each axis by hand. Excessive rotation may indicate a loose drive component.
- Check the belt tension and make any necessary adjustments.

During operation, listen for excessive or unusual noise.

Bi-Annual Maintenance

Perform bi-annual maintenance every six months after the MAPS is placed into operation. Prior to maintenance, remove sufficient amounts of absorber to provide access to the casters.

Grease the turntable casters every six months or after every 2000 hours of operation. Use a good quality bearing grease and a standard SAE grease gun to lubricate the casters.

Annual Maintenance

Perform the following maintenance every 12 months after the MAPS is placed into service:

- Use a good quality bearing grease to lubricate the turntable main bearing race. The grease fittings are located inside the race, 90° apart, under the top. Three discharges from the grease gun in each fitting are adequate.
- Use a good quality grease to lubricate the chain and sprocket of the chain drive.

Replacement Parts

Following are the part numbers for ordering replacement or optional parts for the MAPS.



Note: Specify height as *-NNNN*. For example:

- **72 inches is -7200**
- **59.5 inches is -5950**

Replacement Part Description	2112- <i>NNNN</i> Part Number	2117- <i>NNNN</i> Part Number	2122- <i>NNNN</i> Part Number
MAPS Turntable Assembly	111040		
Mast Assembly	114839- <i>NNNN</i>	114492- <i>NNNN</i>	117745- <i>NNNN</i>
Mount Plate (2122 only)	NA	NA	117830
Free Space Mount Kit (for light duty MAPS only)	107549	NA	NA
Fiber Optic Cables, 10 meters	705344 10		
Fiber Optic Bulkhead Feedthrough	708027		

Optional Parts (2117-NNNN Only)

Optional Part Description	Part Number
SAM Phantom Head	107182
Phantom Hand, Left	110209
Phantom Hand, Right	110208
SAM Phantom Head Center Rotation Kit Places center of the phantom head at the center of rotation of the upper axis	107550
SAM Phantom Ear Rotation Kit Places the left or right ear of the phantom head at the center of rotation of the upper axis	107551
Free Space Mount Kit <ul style="list-style-type: none"> • Medium duty free-space mount kit is not included with Model XXXX Medium Duty MAPS mast assembly • Not compatible with Model XXXX Light Duty MAPS mast assembly 	107559
Laptop Mount <ul style="list-style-type: none"> • To mount laptop or similar device • EUT rotation axis is at center of EUT 	108279

Optional Part Description	Part Number	
Mounting Adapters for Model 3160 Standard Gain Horn Antennas		
<ul style="list-style-type: none"> • Requires antenna mount; also requires an extension to be attached to the rotating axle of the upper mast assembly • If mounting two antennas that require the same extension, only one extension is required. 		
	Antenna Mount	Extension
– 3160-05 Standard Gain Horn Antenna	110758	110759
– 3160-06 Standard Gain Horn Antenna	108416	108793
– 3160-07 Standard Gain Horn Antenna	108417	108793
– 3160-08 Standard Gain Horn Antenna	108418	108793
Dipole Mount Base	107505	
CTIA Ripple Antenna Mount Kit <ul style="list-style-type: none"> • To mount loops and dipoles during the CTIA ripple test • Specify height as -NNNN For example, 72 inches is -7200 and 59.5 inches is -5950. 	107553-NNNN	

Service Procedures

Contacting ETS-Lindgren



Note: Please see ets-lindgren.com for a list of ETS-Lindgren offices, including phone and email contact information.

Sending a Component for Service

For the steps to return a system or system component to ETS-Lindgren for service, see the *Product Information Bulletin* included with your shipment.

Calibration Services and Annual Calibration

See the *Product Information Bulletin* included with your shipment for information on ETS-Lindgren calibration services.

SPECIFICATIONS

Electrical Specifications

Nominal AC Voltage:	208–230 VAC
Input Frequency:	50/60 Hz
Current Rating:	10 amp service
Phase:	Single

Physical Specifications

Unit Diameter:	160.02 cm (63 in)
Typical Turntable Platform Height:	36.96 cm (14.55 in)
Approximate Installed Unit Weight:	453.59 kg (1000 lb)

Mast Specifications

	2112	2117	2122
Height:	Customer-specified		
Maximum EUT Load (within the area of the provided mount):	0.45 kg (1 lb)	11.3 kg (25 lb)	34 kg (75 lb)



Note: Contact your ETS-Lindgren sales representative for shipping container dimensions and weight.

ELECTRICAL INSTALLATION

CAUTION

Caution: Before assembling, installing, or connecting any components, follow the safety information in the ETS-Lindgren *Product Information Bulletin* included with your shipment.



Electrical installation must be performed by a qualified electrician, and in accordance with local and national electrical standards.



Make sure the power is off and secured before proceeding.

The Multi Axis Positioning System (MAPS™) is designed to operate using 208–230 VAC single phase 50 or 60 Hz power.

1. The branch circuit supplying power to the motor bases must be protected from excess current according to local electrical codes. Integral circuit protection is provided in the motor base assembly.
2. Make sure 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. Each motor base assembly is provided with an IEC-320 power inlet for connecting to the mains.
4. Connect the fiber optic control cable and install the power connection according to local electrical code. See the controller manual for information on connecting the fiber optic cable. After the fiber optic cable is installed, secure it with a wire tie to one of the leveling screws.

INSTALLATION

CAUTION

Caution: Before assembling, installing, or connecting any components, follow the safety information in the ETS-Lindgren *Product Information Bulletin* included with your shipment.



Proper installation of the MAPS directly affects performance. The installation must be performed by factory installation specialists or individuals authorized by ETS-Lindgren to perform installation. This information provided in this manual is intended to be used only by those installation specialists.

See the assembly drawings located in the back pocket of the manual to assist with installation.



Note: The MAPS mast assembly is incompatible with the prior versions of the mast assembly due to a change in the gear ratio to facilitate the higher speed of the mast. To upgrade a mast, contact ETS-Lindgren.

The installation of the Multi Axis Positioning System (MAPS™) will take approximately eight hours and will require a minimum of two people.

If you have any questions concerning installation, contact ETS-Lindgren Customer Service.

Required Tools

The following tools are required to install the MAPS:

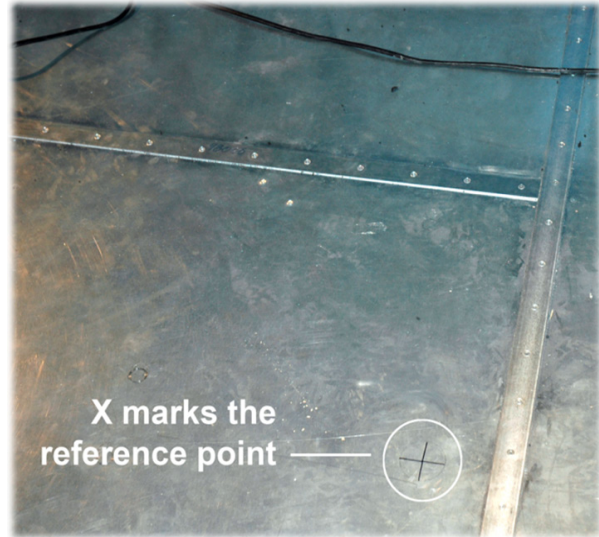
- Power hand drill, 3/8 in chuck
- Drill bit, 3/16 in diameter
- Drive bit, square (provided)
- Drive bit, #2 Phillips
- SAE hex key wrench set (maximum 1/2 in)
- Permanent marker
- Laser level, 5 beam, and stand
- Bubble level (36 in minimum)
- 10 in adjustable, open ended wrench

Reference Point



Note: If installing the MAPS in an existing chamber: Remove the absorber from the floor and lower wall areas prior to installation to avoid damage to the absorber.

1. Locate the reference point. It is generally located along the bore axis of the range antenna. See *Bore Sight and Leveling* on page 29 for additional information regarding bore sight.
2. With permanent marker, place an **X** on the floor of the chamber at the reference point.
3. Draw a 31.5 in (.801 m) radius circle to represent the turntable perimeter.



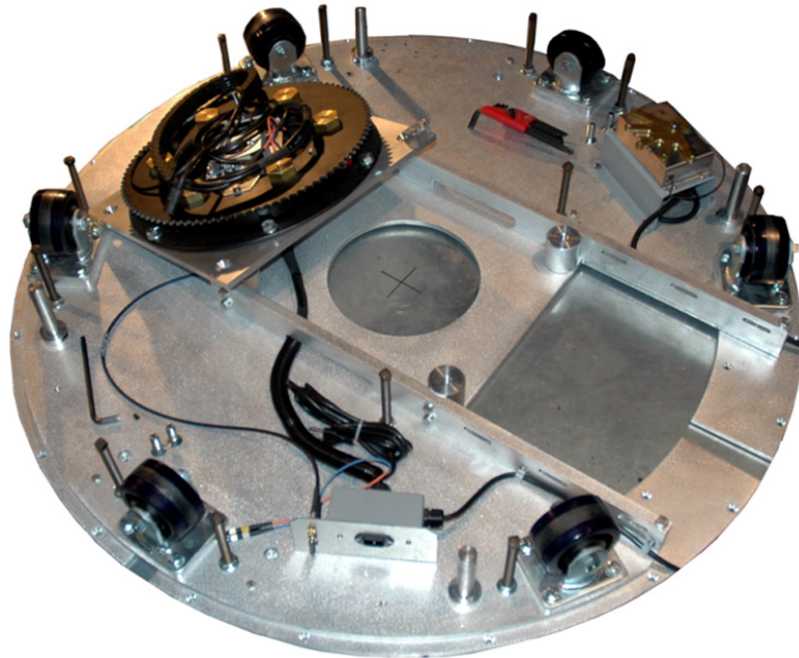
Note: The diameter is larger than the actual perimeter of the circular anchor plates for the turntable, and should only be used as a guide in centering the turntable portion of the MAPS.

System Installation

CAUTION

Caution: Fiber optic cables must be connected correctly for motor base function. Before removing fiber optic cables from the motor base, label the replacement locations for accurate reconnection.

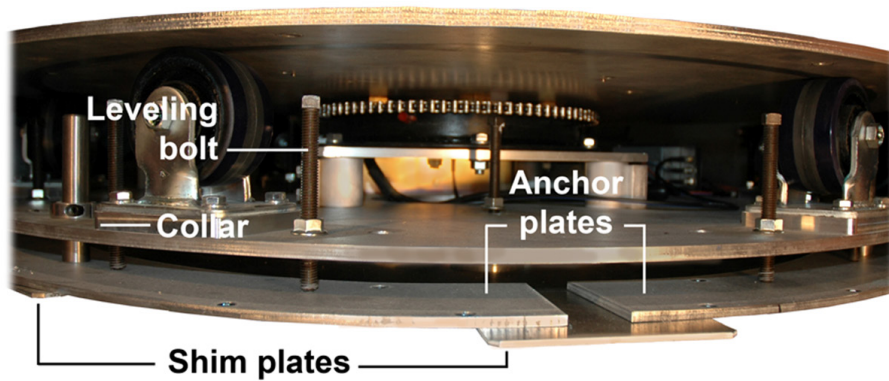
1. Remove the wood deck.
2. The drive units are designed to move from the shipping container to the chamber floor as a single unit. If you cannot move it as a single unit without causing damage, separate the upper drive unit. See *Upper Drive Unit Removal* on page 28.
3. Place on the chamber floor within the drawn circle.



Note: When installing the turntable on modular shielding, do not drill anchor holes through the floor joint strips. Use the shim plates provided.

4. Insert the shim plates to level the turntable over the vault seams.

Anchor Plate Installation



1. The anchor plates are held in place by 1/4–20 screws and set collars. Screw the anchor plates to the floor using 14x1 square socket flat head screws.
2. Drill pilot holes for these screws, and make sure to vacuum shavings to provide good contact with the floor. Continue mounting the remainder of the plates.
3. When all anchor plates are securely mounted, remove the 1/4–20 screws that hold the anchor plates to the base. Discard the screws.
4. Use a bubble level to verify the turntable unit is flat. This is a preliminary check only; final leveling of the turntable will be completed in a later step.
5. Use shim plates to level the table. The shim plates will remain in place after the installation.

Reconnecting Power and Fiber Optics

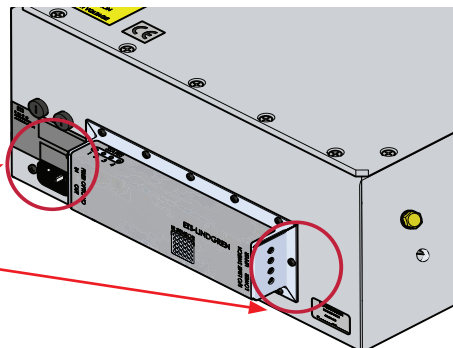


Electrical installation must be performed by a qualified electrician, and in accordance with local and national electrical standards. See Step 4 of *Electrical Installation*, page 19.

Make sure the power is off and secured before proceeding.

1. Run fiber optic and power cables thru cable carrier track.
2. Plug in fiber optics and power cable.

Connections for power and fiber optics

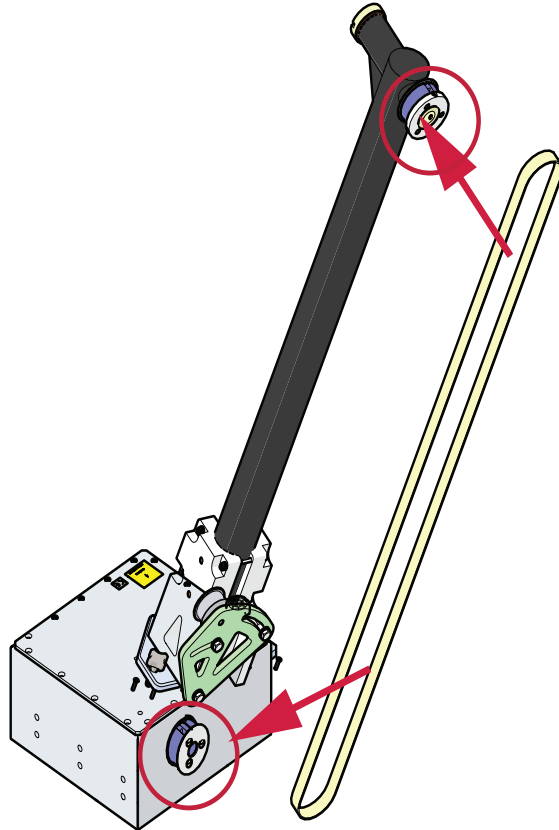


Sliding the Belt onto the Mast

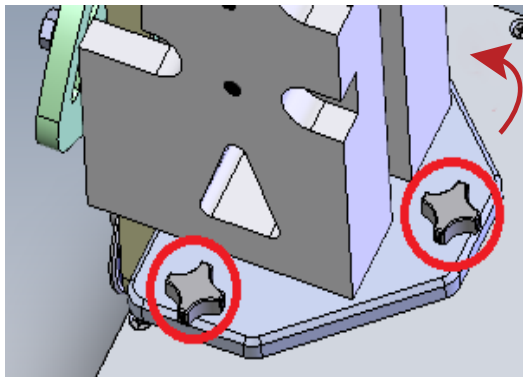
CAUTION

Caution: Do not over tighten the belt. See *Using the Tension Scale to Measure and Set Belt Tension*, below.

1. Slip belt onto motor box gear.



2. Clamp down mast using the three knobs.



Using the Tension Scale to Measure and Set Belt Tension

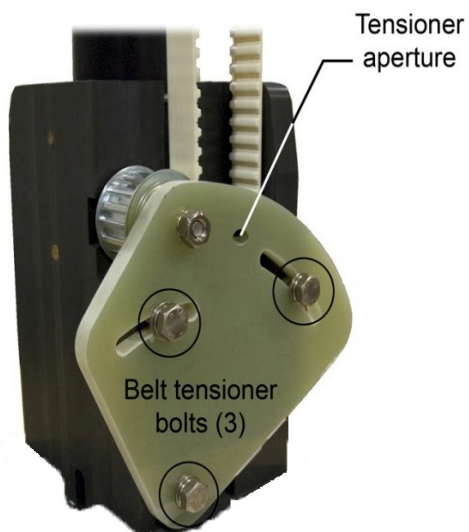
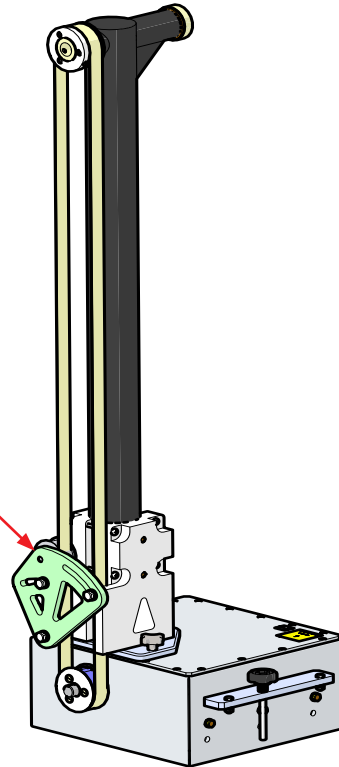
CAUTION

Caution: Do not over tighten the belt. Over tightening will reduce overall performance and cause component failure. The belt does not require a high degree of tension for normal operation.

CAUTION

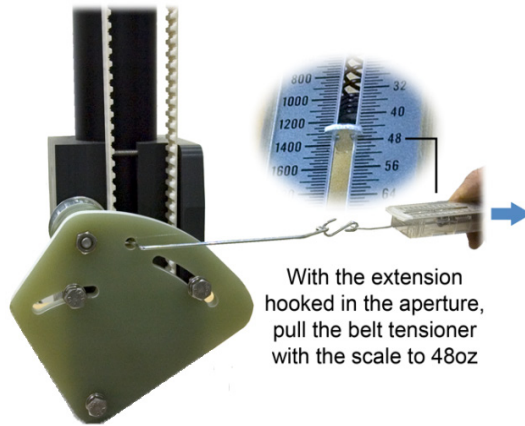
Caution: Using the included tension scale, follow the steps in this section to set the belt tension for the MAPS: 48 oz maximum.

Located on the back of the mast is the belt tensioner. Use this to reduce or increase the tension on the belt.



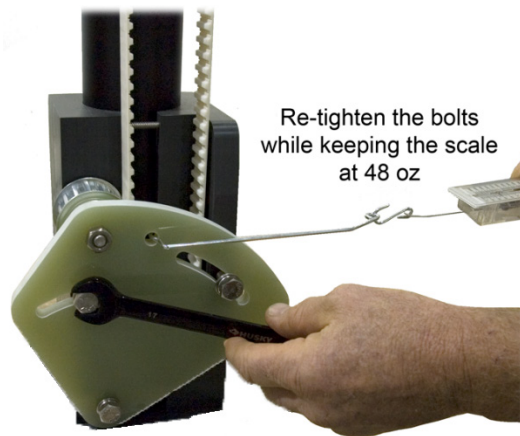
1. Loosen the three belt tensioner bolts to release all tension on the belt.

2. Attach the extension to the tension scale, and then insert the end of the extension into the tensioner aperture located on the belt tensioner.



3. Pull the belt tensioner to the right with the scale until the scale reads 48 oz. This is the maximum belt tension recommended.

4. Holding the scale steady at 48 oz, re-tighten the belt tensioner bolts.

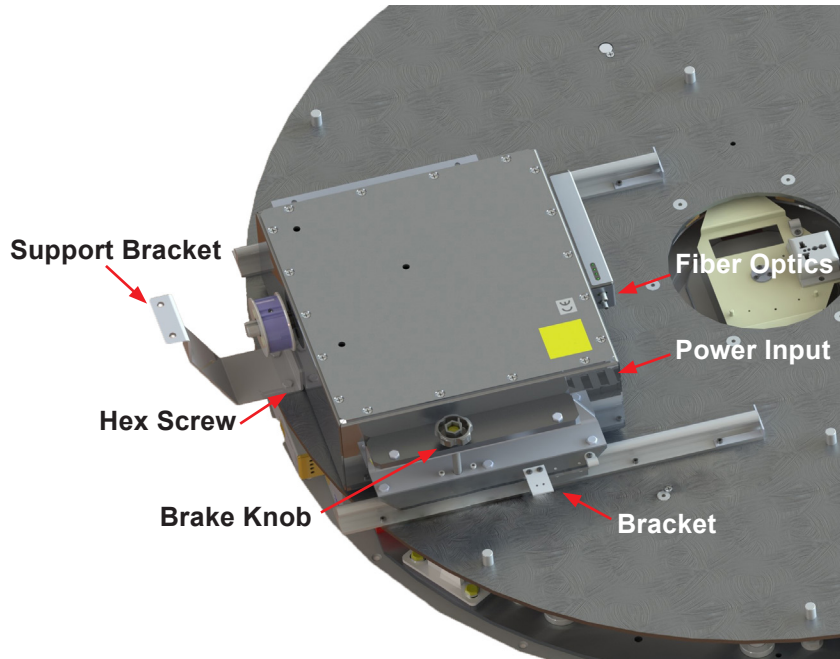


When all tensioner bolts are tightened, remove the extension from the aperture and place the scale in a safe, retrievable location.

Upper Drive Unit Removal

When installing the MAPS in an existing chamber, it may be necessary to remove the upper drive unit to avoid damage to the chamber or to the unit.

Following are the steps to separate the upper and lower drive units.



1. Prior to disconnecting the fiber optic cables from the upper drive unit, label and mark the locations for reconnection.
2. Verify the fiber optic cables to the upper motor base are not switched.
3. Remove the bracket mounted on the drive unit that is attached to cable carrier. Two #6 screws hold the bracket to the unit.
4. Remove the cable clip holding the power cable.
5. Remove the bracket on the opposite side of the unit that ties the drive unit to the turntable top. This temporary bracket holds the unit in place for shipping.
6. Turn the brake knob to release the drive unit and allow it to move toward center of table.



Note: When the turntable top is in place, use the brake knob to adjust the Equipment Under Test (EUT) to the center of rotation (middle of the quiet zone) by sliding the mast assembly back and forth.

7. Remove the two 1/4-20 hex head screws that hold the wood top support bracket, and then remove the bracket.
8. Slide the drive unit carrier out.
9. Reinstall in reverse order.



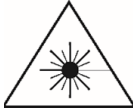
Note: The brake knob must be in the upper position to allow the drive unit to slide onto the rail system. Verify all hardware is secured.

Bore Sight and Leveling



Note: If the MAPS was ordered with multiple masts, you must bore sight each mast.

Bore Sight



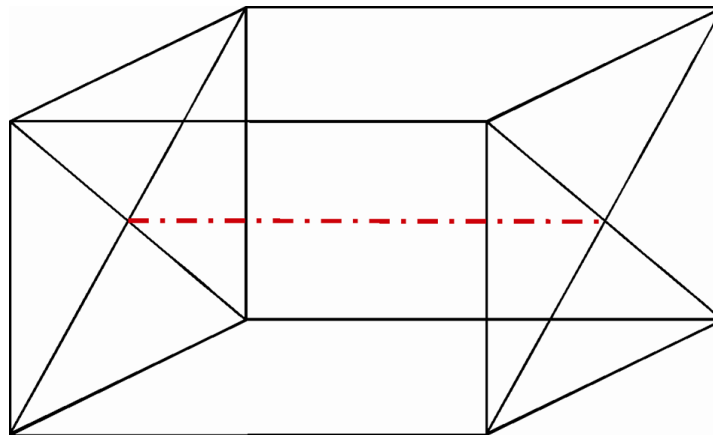
LASER WARNING: Denotes a laser is part of the operating system of the device.



Bore sight is critical to the accuracy of measurements, and is the most important step of the installation process. Take the time to verify all measurements are accurate.

To make sure the MAPS is level with the antennas in the chamber and is accurately centered in the chamber, install the mast. Bore sight requires a five-beam laser level.

Following are the typical installation steps used to achieve bore sight.



Locate center of chamber

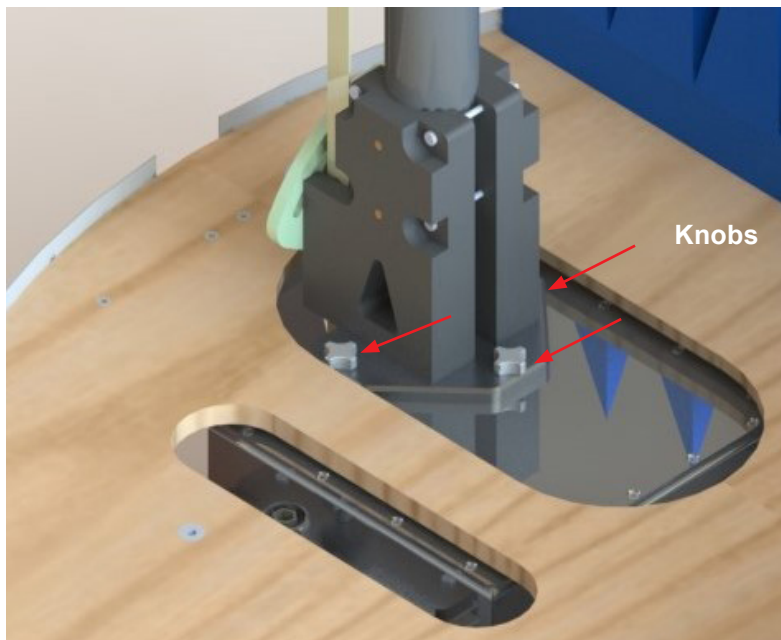
1. Locate and mark the center of the chamber wall opposite the range antenna mounted in the chamber end wall.

Marking may require the removal of absorber.

This applies for both rectangular and tapered chambers. In tapered chambers the antenna is mounted in the far end of the antenna apex. In both cases the typical installation of the antenna is parallel to the cross section of the opposite end wall.

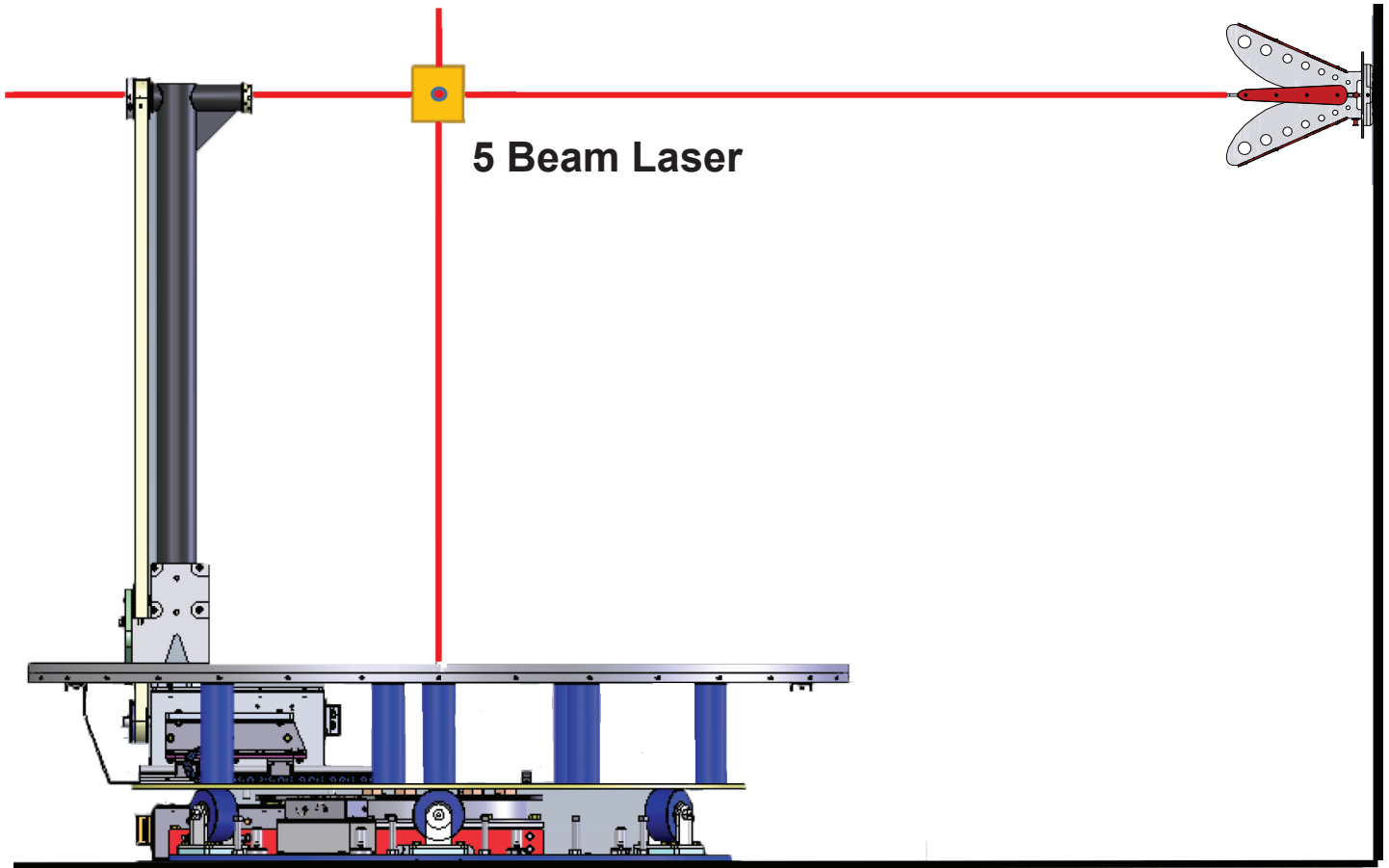
If the range antenna is mounted elsewhere in the chamber, then the bore sight line exists normal to the middle of the range antenna.

2. With the laser mounted on a tripod, mark the end of the bore sight line to the end wall for reference.



Slide the aluminum knobs over the collar of the mast.

3. Install the mast with provided threaded knobs (QTY: 3).
4. Align unit so that the center of the horizontal axis is aligned with the laser beam.
Small height corrections may be necessary. For information, see *Leveling and Height Adjustment* on page 32. After the system is leveled, additional height corrections may be required.
5. Mount the laser onto a tripod, and then place it on the turntable top.
6. Sight one horizontal laser in line with the antenna mounted in the end wall of the chamber.
Align the opposite side of the horizontal laser through the mounting gear to the center of the opposite end wall and to the reference point previously marked.
Align the vertical laser with the center of the dipole pole mount plate (optional) or the deck to the center axis of the bore sight line. The center of the deck is located between the two closest screws attaching the plywood deck to the bottom spacers.
7. Verify that the laser beam is visible through the horizontal axis while the mast is moved back and forth in the slider system.
8. Achieve bore sight for each mast to be used.

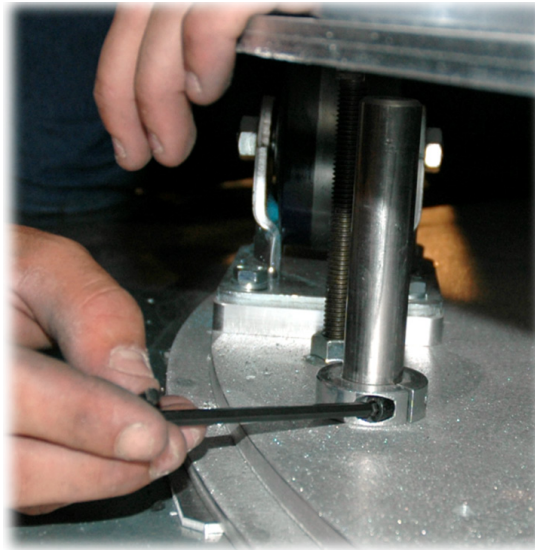


5 Beam Laser

Align laser through the mast mount to the center of the chamber

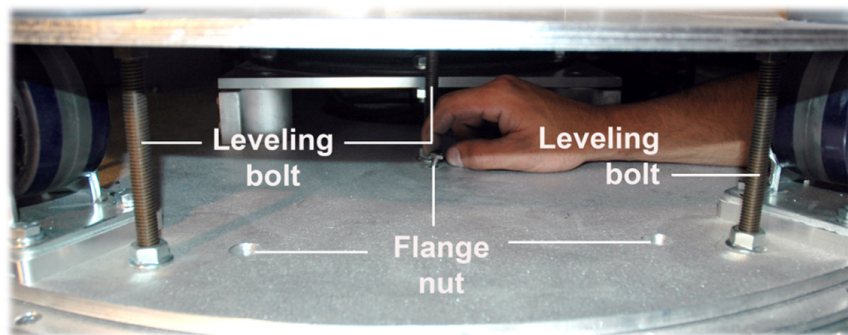
Leveling and Height Adjustment

If, during the bore sight process, it is determined that the unit must be leveled or the height adjusted, follow these steps.



Loosen collar on the anchor shafts

1. Use a 3/16 hex key wrench to loosen the collar on the anchor shafts.



Remove flange nuts, then raise or lower leveling bolts

2. Use an open-ended wrench to loosen the flange nuts on all leveling bolts.
3. Lower or raise the leveling bolts to set the turntable to the correct height. Begin leveling from two opposing sides.
4. When the level is accurate, move the remaining leveling bolts into the correct position.



Note: If installing the MAPS in a pit, mark the amount required to raise the unit up to level. Remove the top of the turntable and begin leveling.

5. Verify that the unit is level.

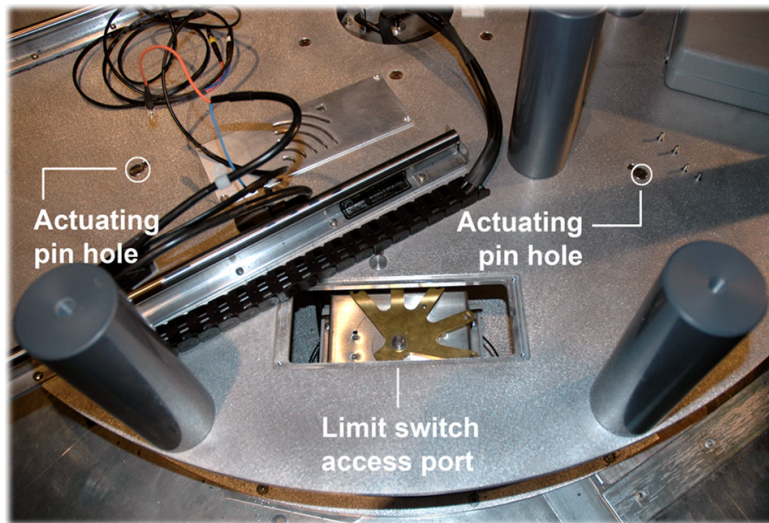


Attach the wooden turntable top

6. Position the wooden turntable top on the turntable base.

7. Use a 5/16 Allen wrench to tighten the bolts.

8. Secure the turntable top seams in place with a Phillips screwdriver.



Position the actuating pins on each side of the limit switch access port.

9. Verify the access port is located over the limit switch.

10. Position the actuating pins in the holes on each side of the access port.

Controller Interface

For information about connecting fiber optic cables from the MAPS to the positioning controller, see the controller manual.

Absorber Installation

After the leveling and bore sight is achieved, position the absorber that surrounds and covers the unit.

OPERATION

CAUTION

CAUTION: Before placing into operation, follow the safety information in the ETS-Lindgren *Product Information Bulletin* included with your shipment.



Note: The MAPS mast assembly is incompatible with the 2112/2117 mast assembly due to a change in the gear ratio to facilitate the higher speed of the mast. To upgrade a standard mast to a mast, contact ETS-Lindgren.

If you are unfamiliar with the operation of the EMCenter™ Modular RF Platform (with EMControl™ Positioner Controller Plug-In Card), see the manual, available for download from ets-lindgren.com.

With the installation of the Multi Axis Positioning System (MAPS™) complete, the controller must be connected to the unit and power applied to both the motor base and controller. See the controller manual for information on connecting the fiber optic cable.

Use the controller to 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.

EMCenter Parameter Settings

Encoder calibration for the positioners is 3600 and should be entered into the configuration page on the EMControl™.

For all other parameter settings, refer to the EMControl™ *Positioner Controller Plug-In Card User Manual*, available for download from ets-lindgren.com.



Note: If you are unfamiliar with the operation of the EMCenter, see the manual, available for download from ETS-Lindgren.com.

The EMCenter replaces the 2090 Controller, which has been discontinued.

The 2090 requires firmware revision V 3.21 or higher. It is available for download at ets-lindgren.com and requires the program Flash Upgrade Wizard V 4.0 (also available at ets-lindgren.com).

Appendix A: Warranty



Note: See the *Product Information Bulletin* included with your shipment for the complete ETS-Lindgren warranty for your MAPS.

Duration of Warranties

All product warranties, except the warranty of title, and all remedies for warranty failures are limited to two years.

Product Warranted	Duration of Warranty Period
2112 Multi-Axis Positioning System (MAPS™)	2 Years
2117 Multi-Axis Positioning System (MAPS™)	2 Years
2122 Multi-Axis Positioning System (MAPS™)	2 Years

