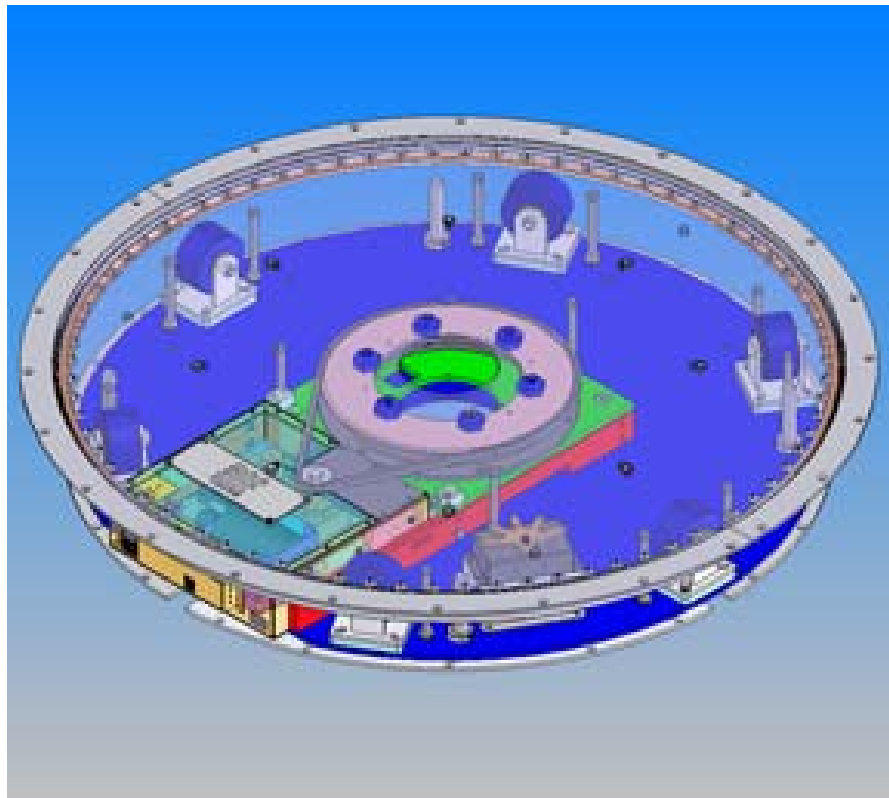


Turntable
Model 2188
1.2m, 1.5m and 2.0m
Users Manual



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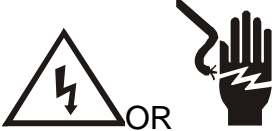




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Revision	Description	Date
A	Initial Release	November, 2005
B	Added two meter turntable information, updated illustrations and drawings	January, 2006

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SAFETY SYMBOL DEFINITIONS	
NOTICE: This product and related documentation must be reviewed for familiarization with safety markings and instructions prior to operation of the product.	
	REFER TO MANUAL —When the product is marked with this symbol refer to the instruction manual for additional information. If the instruction manual has been misplaced, go to www.ets-lindgren.com for downloadable files or contact ETS-Lindgren customer service.
	HIGH VOLTAGE —Indicates the presence of hazardous voltage. Unsafe practice could result in several personal injury or death.
	PROTECTIVE EARTH GROUND (SAFETY GROUND) —Indicates protective earth terminal. Uninterruptible safety earth ground from the main power source to the product input wiring terminals, power cord or supplied power cord set shall be provided.
<div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;">CAUTION</div>	CAUTION —Denotes a hazard. Failure to follow instructions could result in minor personal injury and/or property damage. Text that follows the symbol will provide proper procedures.
<div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;">WARNING</div>	WARNING —Denotes a hazard. Failure to follow instruction could result in SEVERE personal injury and/or property damage. Text that follows the symbol will provide proper procedures.
GENERAL SAFETY CONSIDERATIONS/PRECAUTIONS	
	Read this manual completely before beginning the installation of the turntable. Refer to drawings at the rear of the manual and the “Tools Required” list included prior to beginning 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.
	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 of the instrument, or disconnection of the protective earth terminal could result in personal injury.

GENERAL SAFETY CONSIDERATIONS/PRECAUTIONS (continued)	
	<p>BEFORE SERVICING: CONTACT ETS-LINDGREN (+1.512.531.6400)—servicing or modifying the unit without ETS-Lindgren authorization may void your warranty. If an attempt to service the unit must be made, disconnect all electrical power prior to beginning. Voltages exist at many points within the instrument that could, if contacted, cause personal injury. Only trained service personnel should perform adjustments and/or service procedures upon this instrument. <i>Capacitors inside this instrument may still be CHARGED even when the instrument is disconnected from the power source.</i></p>
	<p>Do not make any modifications to this unit without consulting the factory directly.</p>
	<p>ONLY QUALIFIED PERSONNEL should operate or service this equipment.</p>
	<p>STAY CLEAR of moving components during operation of equipment. Do not operate the turntable while someone is physically on the turntable top.</p>
	<p>Do not, at any time, place hands or feet in the vicinity of the drive pinion on the turntable.</p>
	<p>Regularly inspect all equipment and conduct scheduled maintenance in accordance with the factory recommendations provided.</p>
	<p>Only use replacement parts and fasteners ordered directly from the factory.</p>

Model 2188 Turntable

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1. Introduction

The ETS-Lindgren Model 2188 is an electric-powered, variable-speed turntable platform system designed for use with an EMCO Model 2090 series positioning controller to perform EMI compliance testing. The Model 2188 is available in 1.2-meter, 1.5-meter and 2.0-meter diameters. The turntable is ideal for installations in new or existing test locations where pit excavation is not an option or must be shallow.

The top of the turntable is conductive with a continuous ground brush to electrically couple it to the ground plane. The ground brushes are attached directly to the chamber floor via the floor flange and are in continuous contact with the turntable top. The brushes point downward from the floor flange. .

The drive motor and gearing are located beneath the platform. The Model 2188 turntable is powered by an electric motor through a worm gear box with a chain and sprocket final drive. The top of the turntable is removable to provide easy access in the event that service is required. The electronics are located in a shielded enclosure. Signal I/O is via fiber-optic cable.

To prevent over-travel of the turntable in either direction of movement, “hard” limits are provided in the form of pins that actuate switches located below the tabletop. These pins allow limits to be set and allow as much as two full rotations. Rotation speed can be varied from the front panel of the controller or through the IEEE-488 interface bus.

1.1. Standard Configuration

- Turntable Assembly
- Single-phase electric drive (208-230 VAC 50/60 Hz)
- Variable speed drive
- Conductive top
- Continuous rotation
- One (1) ten meter fiber-optic control cable
- Fiber optic shield penetration kit
- Two (2) fiber optic feed-thrus
- One (1) three meter fiber optic control cable

1.2. Model 2188 Options

1.2.1. Model 2090 Series Positioning Controller

The Model 2090 Series Multi-Device Positioning Controller is designed for use with ETS-Lindgren positioning devices such as antenna towers, turntables, reverberation paddles, multi-axis positioners, etc. to accomplish a variety of tests for EMC compliance, antenna pattern measurements, and more.

The Controller allows the user to synchronize the simultaneous, yet independent movement of two primary devices such as towers or turntables in either manual or remote GPIB modes while controlling the on/off operation of up to four auxiliary devices. The unit includes a GPIB bus and is compatible with most popular software. Firmware revision 3.11 or higher required.

Each primary device is interfaced to the controller through a bi-directional fiber optic interface using a proprietary command protocol. Auxiliary devices use a single fiber optic signal to control simple on/off operation. The fiber optic control lines that attach devices to the unit eliminate extraneous RF interference signals that can normally be conducted through wire signal cables.

The front panel of the Model 2090 provides the interface for two separate and complete device controllers, each with identical displays and function keys. The function keys let the user configure device specific parameters, adjust limit and position settings and control device motion. Numeric displays and status indicators are provided for each device interface to show positioning and operational information as well as device parameter settings. In addition to the two primary device interfaces, an auxiliary control interface for four auxiliary devices is present. This interface provides keys and indicators to allow the user to manually toggle the auxiliary devices on or off.

Control of all devices may be accomplished either in the manual or remote modes through the use of the GPIB (IEEE 488 standard interface bus) port located on the rear panel. Each primary device is identified by a unique GPIB address that the controller recognizes, allowing each positioning device to function as a separate device on the GPIB bus.

1.2.2. Additional Fiber Optic Cable

Various lengths of fiber optic cable may be ordered. Specify additional cable lengths at the time of order placement. Cables are terminated with type ST connectors.

Model 2188 Turntable

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2. Getting Started

2.1. Unpacking and Acceptance

Step 1. Upon delivery of your order, inspect the shipping container(s) for evidence of damage. Record any damage on the delivery receipt before signing. In case of concealed damage or loss, retain the packing materials for inspection by the carrier.

Step 2. Once all of the materials are removed from the container by a qualified installer, check all materials against the packing list to verify that the equipment received matches what was ordered. If you find any discrepancies, note them and call ETS-Lindgren Customer Service (+1.512.531.6400) for further instructions.

Ensure that you are satisfied with the contents of your order and the condition of your equipment prior to 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.

2.2. Electrical Specifications

Nominal AC Voltage	230 VAC
Input Frequency	50/60 Hz
Phase	Single Phase
AMP	2.0
RPM	0.5/2.0 variable

Table 1: Electrical Specifications

2.2.1. Mechanical

Diameter	1.2 meter	1.5 meter	2.0 meter
Height (Minimum)	16.51 cm (6.12 in.)	16.51 cm (6.12 in.)	16.51 cm (6.12 in.)
Distributed Load Rating*	500 kg (1,100 lb)	1,000 kg (2,200 lb)	1,000 kg (2,200 lb)

*Distributed Load Rating is based on an evenly distributed load to each section. Point loads under 0.37 sq. m (4 sq. ft) should not exceed 500 kg (1,100 lb.). Nothing over 400 kg (882 lb.) may be applied to a 45-degree segment outboard of the casters.

Table 2: Mechanical Parameters

2.3. Turntable Installation Considerations

2.3.1. Conduit

Power and signal line paths must be planned in advance. Power and signal lines must never run through the same conduit. Conduit must be in place before pouring concrete or installing the ground plane. Consider the size of the cable bundle when selecting conduit diameter.

2.3.2. Electrical Considerations

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

2.3.3. Access

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

3. Installation

The turntable installation will vary based on the host location. Several installation options may be presented in the steps that follow. Please select the option that applies to your location.

The installation of turntables must 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.

CAUTION: Ensure power is off and secured before proceeding further.

3.1. Tools Required

- | | |
|--|---|
| • 3/16" Allen wrench | • Measuring tape |
| • 1/4" Allen wrench | • Pry bar |
| • 3/8" Allen wrenches, qty 3 | • Level |
| • 6 mm Allen wrench | • Square |
| • 3/8" ratchet wrench | • Hacksaw |
| • 12" crescent wrench | • Black marker |
| • 15 mm, 12 point socket for 1/2" square head screws | • File |
| • 7/16" open/box end wrench | • WD 40 |
| • 1/2" open/box end wrench | • 3/4" pipe clamp ends |
| • 3/4" open/box end wrench | • 3/4" pipe (length depends on table size 6 ft. will cover most tables) |
| • 0.120 drill bit for 6-32 self tapping screws | • 1 – 1/2" C-clamps, qty 8 |
| • #7 Drill bit for 1/4"-20 tap | • Cutting Oil |
| • 3/8" hand drill | • Syringe for applying conductive grease |
| • 9/32 drill bit | • Grease Gun |
| • #2 Phillips screw bit | • Vacuum |
| • #3 Phillips screw bit | • 1/2" Hammer Drill |

CAUTION: Only qualified personnel must perform lifting of the turntable assembly using a forklift or other lifting machinery. Damage to the turntable or serious injury to the personnel may occur.

3.2. Unpacking

A qualified installer will perform the following steps in preparation for installation of the turntable. Please pull the drawings from the back pocket of this manual to assist in the installation directions that follow.

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 or parts until the turntable is fully assembled.

2. Verify that that fiber optic cable is long enough to reach from the turntable to the control room. When working around the table, avoid stepping on the fiber optic connectors located on the motor base.
3. If the turntable is to be installed in a pit, check pit depth and inside diameter and compare measurements with the drawings for your turntable size at the back of this manual. The inner diameter of the receptacle pit should be as follows:
 - 1.2 meter turntable = 49.00" (+/-0.25")
 - 1.5 meter turntable = 60.00" (+/-0.25")
 - 2.0 meter turntable = 79.75" (+/-0.25")
4. Remove the bolts that attach the top onto the turntable drive assembly. These are the six flathead bolts closest to center of the tabletop. Remove top and place in position as not to damage any components on the top. Refer to the assembly drawing 2188-1.2, 2188-1.5 or 2188-2.0 included at the rear of this manual for more details.

3.3. Positioning the Turntable

5. Using a forklift or other appropriate lifting device, place the turntable bottom into position. The motorbase with the fiber optic connectors should point in the direction that the fiber optic cable will be installed. This position will reduce the chance of the cable being kinked or twisted.

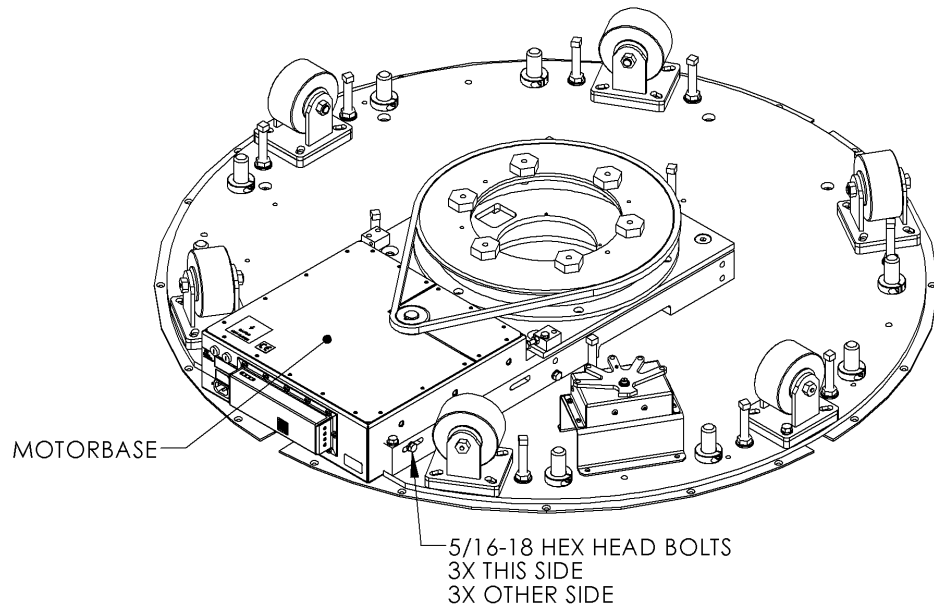


Figure 1: Turntable Interior Design

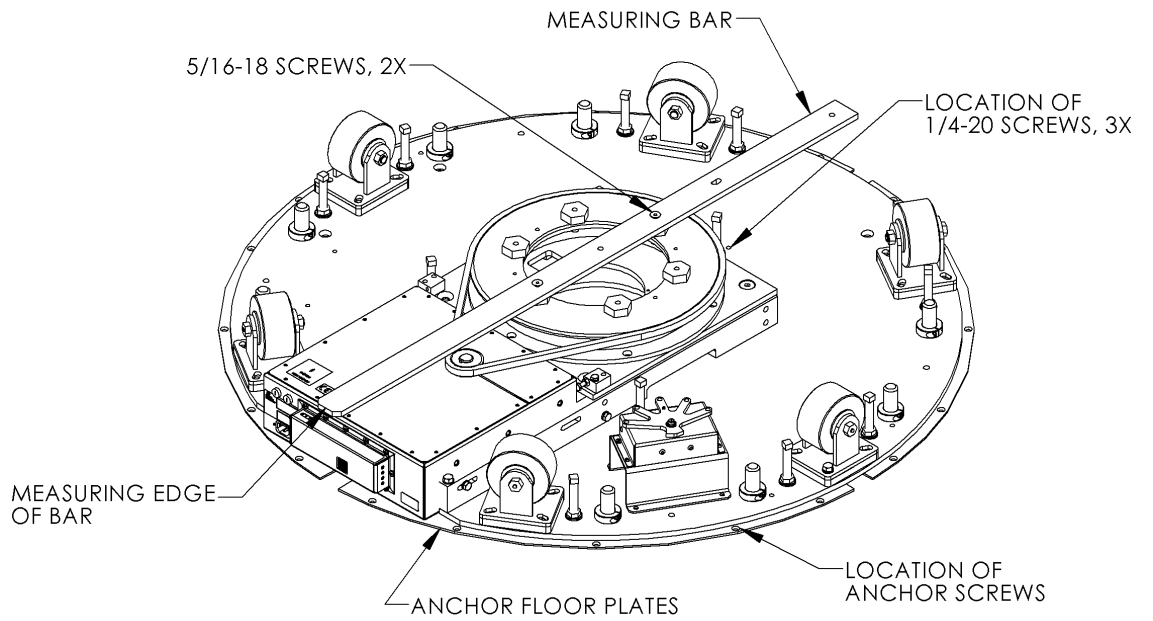


Figure 2: Turntable Pit Locator Detail

6. Position the table as close as possible to the center. Attach the measuring bar provided to the brass spacers mounted onto the bearing. Note the appropriate hole-mount locations in reference to the size of the turntable to be installed. Rotate the bearing and ensure approximately $7/8$ " to 1" spacing exists between the edge of the outer measuring bar and the diameter of hole cut into the pit. Adjust if necessary.
7. Once the center is located, using a marker, mark around the perimeter of the table base or outer floor plates. These marks may be used for reference if the assembly moves during placement of the floor shims or anchor plates.

NOTE: When installing the turntable on modular shielding, attempt to make as many anchor holes miss the floor joint strips as possible when positioning the table. Use the shim plates provided for this application.

8. The Model 2188 turntable includes curved floor anchor plates that are under the base unit. The 1.5m and 2.0m model includes an outer ring of floor plates to support additional casters. Place between the base unit and outer plates, the four connector strips included to ensure proper spacing. Please refer to drawing number 2188-1.2, 2188-1.5 or 2188-2.0 included at the back of this manual and figure two for the placement and securing of floor plates. If the turntable is to be installed in a welded chamber with a steel pit and steel raised floor, please refer to step 12.

3.4. Installing Anchor Plates

9. The anchor plates are held in place by $1/4$ -20 screws and set collars. Screw the anchor plates to the floor using #14x1" #3 square socket flat head screws. Drill $1/8$ " pilot holes for these screws and vacuum up shavings so that you have good contact with the floor. Continue mounting the rest of the plates.
10. Once all anchor plates are securely mounted, remove the $1/4$ -20 screws that hold the anchor plates to the base and discard.
11. Proceed to level the table to the raised floor.

12. When mounting to a steel pit and steel raised floor, a #7 drill bit for tapping or a 9/32 drill bit to create “through holes” is required when mounting anchor plates to the steel raised floor. Locate and mark holes in each group of anchor plates. Drill and tap or drill through each hole and then screw in ¼-20 hardware so that the table does not move as you go around each location. Proceed with leveling instructions.

CAUTION: Before leveling make sure all ½-13 flange nuts and clamp collars are backed off all the way to avoid pulling plates off the floor. Refer to drawings at the back of this manual.

13. Raise the table by turning the ½-13 square head screws clockwise until the measuring bar top is 3/16” above the raised floor; this is just a rough finish height. Check height with a leveling instrument (torpedo laser level or some other device).

Once the table is leveled, tighten flange nuts on the square head screws and secure set collars on the torque pins down onto the base top surface and outer plate if applicable. Remove the measuring bar. Refer to figure three and drawing 2188-1.2 at the rear of the manual for more details.

3.5. Raised Panel Floor Flange Installation

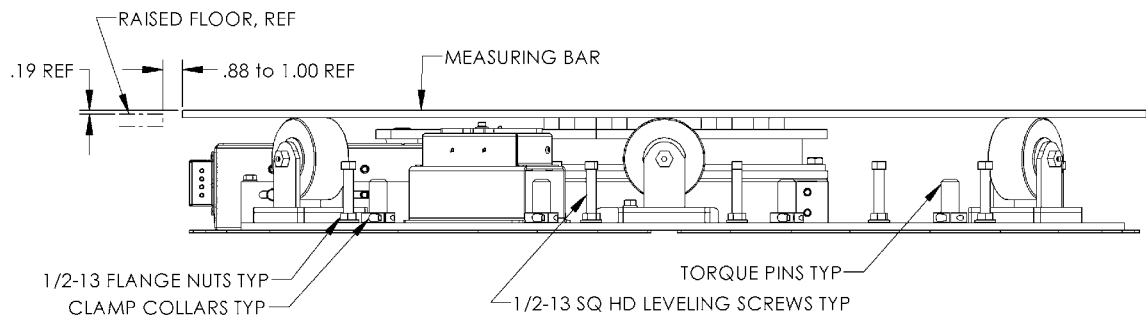


Figure 3: Turntable Elevation View

The ground ring assembly includes a floor flange with a mounted brush ring that interfaces with the contact ring mounted underneath the turntable top. The floor flange provides constant electrical contact with the ground plane.

Mounting methods vary according to user specifications. Clearance holes are provided, at evenly spaced intervals, along the outside perimeter of the ground ring as a means of attaching the ring to a customer supplied ground plane. These instructions cover installation for a paneled floor; please see the section on “Floor Flange Mounting in Concrete Pit” for further instructions regarding mounting in a concrete pit.

For this step you will need three ¼” spacers i.e. bolts, drill bits, etc. A hand drill, 5/32” drill bit, #3 Phillips drive bit, a small square, #14 x 1 wood/metal screws are also required at this time.

The turntables described in this manual each have two floor flange pieces. All of the flanges are pre-cut at the factory for drop in fit. Lay the floor flange into the opening of the raised floor and push outward to the diameter of the opening. Attach the turntable top onto the brass spacers with the hardware provided.

14. Using a pipe clamp and ¼” Allen wrenches or ¼” pin, place a spacer between the turntable and flange starting in three places in the center or on the flange. Once tension exists on all three wrenches, drill a 5/32” hole through the counter-sunk holes in the floor flange. Drill completely through the panel and place screws into the holes. Continue working around the flange completing two or three holes at a time. Refer to the 2188 1.2 drawing included for details

NOTE: It is very important that a ¼” gap between turntable top and ground brush flange mounted on floor flange be held as close as possible so that the grounding brushes seat properly. Also, it is important to ensure the flange ends are flush with each other.

15. Continue mounting as stated above until all screws have been installed. Some screws may fall between the floor panel joints. Try to position the flanges, ensuring as few screws hit these points as possible, and making certain that the first or last hole in the flange is not too close to one of these joints. Also, the top floor joint strips will need to be trimmed to fit up against the flange.

3.6. Floor Flange Mounting in a Concrete Pit

Mounting to concrete is the same with the exception of the mounting hardware. Instead of the #14 x 1” square socket flat head screws, you will use ¼ x 1 ¾” Phillips flat head TAPCON screws.

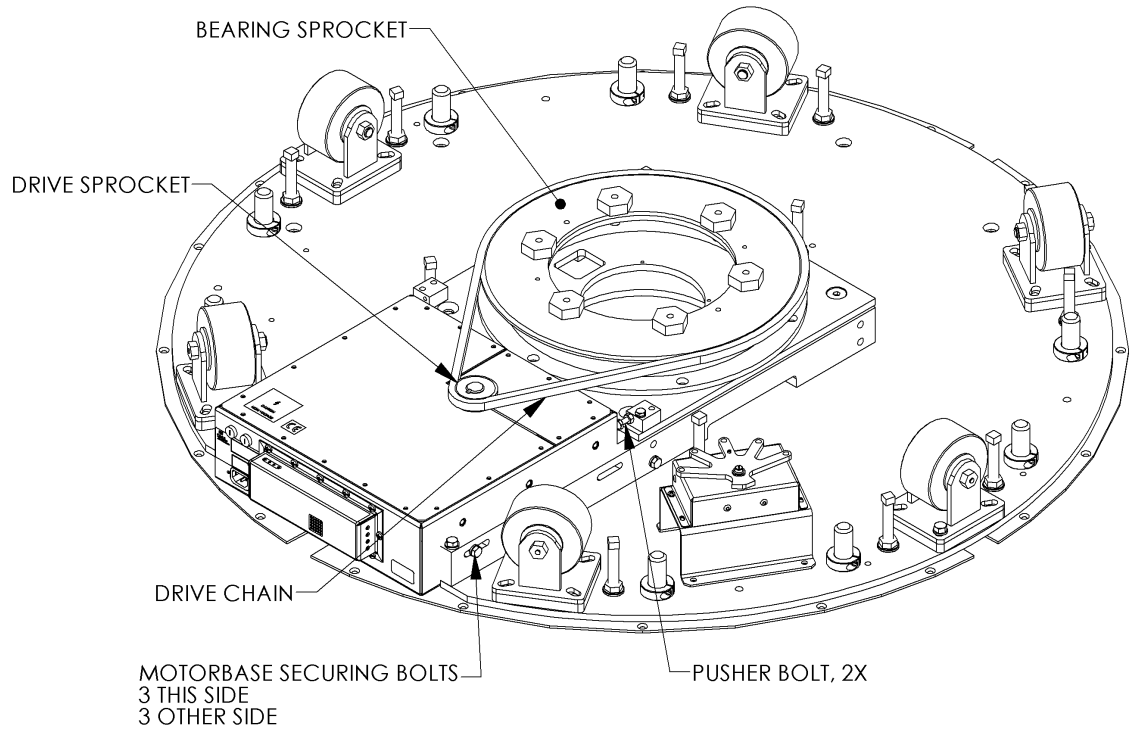


Figure 4: Turntable Motorbase

A ½” hammer drill, 3/16 x 3 ½” min. hammer drill bit, and a vacuum to clean in holes drilled for maximum thread engagement will be required for this stage of the installation.

NOTE: When drilling holes, watch out for buried conduit and pit drainpipes. Drill 3/16” holes 2” min. depth.

3.7. Motorbase Attachment

Locate the box that contains the motorbase. The box also includes the hardware needed to attach the motorbase to the turntable. Refer to figure four above to locate the drive chain and bolts to secure the motorbase. Slide the motorbase between the two rails provided.

Attach three bolts, flat and lock washers provided on each side of the motorbase, do not tighten them completely at this time.

Attach the chain around the bearing sprocket and the drive sprocket. Adjust the mortorbase using the two pusher bolts provided. Allow only ¼ inch maximum side-to-side motion for proper chain tension on the motor. Finally, tighten the six securing bolts.

3.8. Final Leveling of the Table

Once the table is in place with the floor flange and wear strip mounted, check that the table is level. Ensure that it is level and all screws, nuts, and collars have been tightened.

3.9. Application of Conductive Grease

Before placing the turntable into operation, apply conductive grease to the ground brush. Apply the contents of one tube of GC Electronics conductive grease to the brush. Apply one tube per meter size of the diameter of the table.

4. Electrical Installation

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

The Model 2188 is designed to operate using 208-230 VAC single-phase 50 or 60Hz 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 turntable 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 series positioning controller manual for instructions 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.

In order to feed the fiber optic connectors through the waveguide in a chamber it may be necessary to remove part of the protective sheath. The removal of a portion of the sheath will allow the connectors to fit through the hole without bending or kinking the fiber optic cable excessively. Find the spot in which you will need to remove the sheath and mark. A very sharp knife is needed to make the splice. Being very careful, cut around the outside of the sheath at each end of the area needing to be cut, cut very lightly so as to not cut into the fiber cables. You should then be able to bend the sheath back and forth until you can see the fiber cables.

Next, you will need to make a cut down the length of sheath area, being careful not to cut into fiber cable. You will see two pieces of white string inside the sheath. Find the string and use it to split the sheath open. Now insert the cable into the waveguide.

Model 2188 Turntable

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5. Operation

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

With the assembly of the turntable complete the Model 2090 series controller must 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 series positioning controller check the CW (clockwise) and CCW (counter clockwise) 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 in 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 below.

5.1. Editing 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.

5.2. Setting Travel Limits

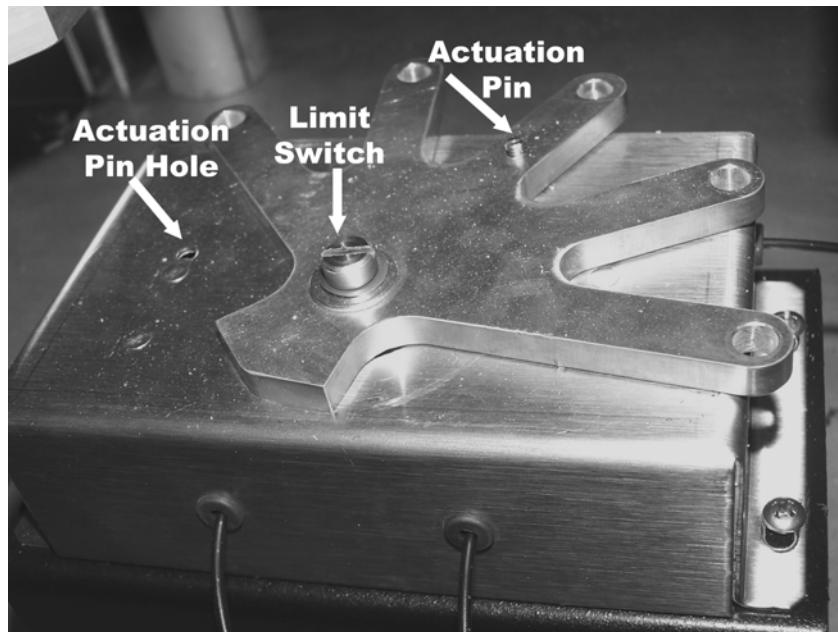


Figure 5: Turntable Limit Switch

The Model 2188 is fitted with mechanically actuated or “hard” limit switches. These switches are adjustable to allow for limited travel beyond zero and 360 degrees. Actuation pins are placed in the turntable top to engage the limit switch mechanism. The limit switch mechanism is designed so that the amount of travel is dictated by the pin position in the turntable top.

The default configuration allows for travel between -45 degrees and $+405$ degrees. Remove all pins and the access panel. Move the turntable so that the access hatch is directly above the limit switch mechanism (shown in Figure five above). Set the mechanism to the CCW armed position and insert actuations pins in the holes on either side of the mechanism 45 degrees away. Now, set the current position displayed by the controller to 000.0 degrees. Test the lower limit by holding down the DEC key, which allows the turntable to travel past the soft limit. The turntable should engage the lower hard limit between -35 and -55 degrees. You can also test the upper limit by holding down the INC key until the upper limit is engaged between 395 and 415 degrees.

It is also advised that the user properly set the “soft” limits in the controller should non-continuous operation be desired.

To set the counterclockwise rotational limit for the turntable, press the DOWN/CCW key under LIMIT. The indicator above this key will light. Set the limit by pressing the INCRM and DECRM keys under LIMIT until the desired limit is shown on the display. Then, press

the ENTER key. To set the clockwise rotational limit for the turntable, press the UP/CW key under LIMIT. The indicator light above this key will light. Set the limit by pressing the INCRM and DECRM keys under LIMIT until the desired limit is shown on the display. Press the ENTER key.

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

Should continuous operation be desired, the Model 2090 series controller permits easy configuration to this type of operation from the front panel or through the IEEE-488 interface bus. Refer to the positioning controller manual for more information. The limit pins should also be removed from the turntable top to allow for continuous operation.

5.3. Turntable Encoder Calibration

Parameter \bar{L} , which calibrates the encoder counts to the rotation of the turntable, must be set to the value 3600. Parameter \bar{L} 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. The setting for the Model 2188 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. 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 for marking), 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 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 consequently the controller 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 controller cannot correct for it. In this case, contact ETS-Lindgren for assistance.

6. Enter 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 controller. 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.

5.3.2. Turntable Calibration Example

- The table is set at the “0” 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 controller now reads 356.3 degrees, which 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).
- The decrement the C parameter to 3395 and “ENTER” is pressed. 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 turntable revolution. Calibration is complete.

5.4. Changing Rotation Speed

The Model 2188 turntable is equipped with a variable speed drive. Firmware Revision 3.11 (or higher) must be installed in the Model 2090 series controller for proper operation of the Model 2188. The revision level is displayed on the front panel LED display during startup of the Model 2090 series controller. If the controller does not have this or a later revision installed, consult the factory for an upgrade.

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

Specifically, parameter two must be set to the value three, 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 5440. This will insure that the position display will properly report the full 360 degrees of travel.

5.5. Variable Speed Settings

The Model 2090 series controller parameters $S1-S4$ control the variable speed settings for the turntable. These parameters are the continuous variable speed settings for each of the four 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 there is a minimum speed at which the motor will operate. For the Model 2188 this minimum speed setting will be somewhere 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 turntable in a stalled condition. Doing so may cause damage to the drive unit and will nullify your warranty. Always insure that the minimum speed setting specified in the S1-S4 parameters is above the minimum value at which your table will turn under normal load.

5.6. Speed Selection

For the Variable Speed Turntable, the Polarization/Flotation button 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 polarization LEDs will light to indicate the speed selection in a binary fashion as shown below:

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

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

5.7. GPIB Commands

The following GPIB commands have been added or modified:

- Sn: Select Speed, where n is 1 or 2 for a two-speed turntable and 1-4 for a variable speed turntable.
- S?: Query speed selection. Returns 1 or 2 for a two-speed turntable and 1-4 for a variable speed turntable.
- SSn: Set Speed Value, where “n” is 1-4. This command is valid only for a variable speed turntable. Valid speed values are from 1 to 255.
 - Command Usage: SSn <Speed>
 - Example: Output 708, "SS1 196;"
- Query Speed Value, where “n” is 1-4. This command is valid only for a variable speed turntable. Returns a speed value from 1 to 255.
 - Command Usage: SSn?
 - Example: Output 708, "SS2?;"

5.8. Controller Interface

Model 2188 Turntable

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6. Infrared Controller

The motor base features an infrared receiver that will respond to a universal remote control programmed to a specific protocol. Any remote that continuously transmits and contains the proper TV protocol can be used.

The basic functions supported are as follows:

Button	Command
Power	Emergency Stop
Channel Up	Up for linear positioner
Channel Down	Down for linear positioner
Volume Left	Counterclockwise for rotational positioner
Volume Right	Clockwise for rotational positioner
Mode	Polarization for linear positioners

Table 3: Controller Functions

State	1	2	3	4
Power	Any	Any	Any	Any
Init	Cycling			Amber
Up/CW	Green			
Down/CCW		Green		
Polar			Green	
Upper Limit	Red			
Lower Limit		Red		

Table 4: Motorbase Status Indicators

Model 2188 Turntable

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7. Recommended Maintenance

CAUTION: Do not perform maintenance while turntable is operating. Disconnect the power connection for safety. Only qualified individuals should conduct these maintenance inspections.

Regular maintenance will prolong the serviceable life of your turntable. Follow this recommended schedule. Use the inspection log that follows to maintain a record of maintenance described below.

7.1. Routine Maintenance

Routine maintenance should be conducted prior to each use of the turntable.

- Visually inspect the turntable prior to use. Look for foreign objects in the gap between the turntable top and the floor flange. If possible, remove the objects to eliminate damage to the turntable.
- Attempt to rotate the top by hand. Excessive rotation may indicate a loose drive component.
- Listen for excessive or unusual noise during turntable operation.

7.2. Bi-Annual Maintenance

These maintenance items should occur every six months once the turntable is put into operation. Prior to conducting any of the following items, remove the turntable top.

- Grease the casters. Use a good quality bearing grease to lubricate the casters. Using synthetic grease, grease all casters. Mobil 1 synthetic and a standard SAE grease gun is recommended; do not use lithium grease.
- Inspect the ground brush for contaminants. Vacuum the brush to remove unwanted debris. Add a small amount of conductive lubricant to the brush interface if required.
- Inspect the ground brush for wear. A well maintained ground brush should have a long serviceable life.
- Replace the ground brush.

7.3. Annual Maintenance

These maintenance items should occur every twelve months after the turntable is put into service.

- 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. Using synthetic grease, grease all casters. Mobil 1 synthetic is recommended; do not use lithium grease.
- Lubricate the chain and sprocket of the chain drive. Apply good quality grease to the chain and sprocket; do not use lithium grease.

EMCO Model 2188 Turntable Maintenance Log									
	Routine	Bi-Annual	Annual	Routine	Bi-Annual	Annual	Routine	Bi-Annual	Annual
Routine Check									
Remove foreign objects between turntable top and floor flange									
Check for excessive rotation by hand									
Listen for excessive noise									
Bi-Annual Check									
Grease the casters									
Inspect the ground brush for contaminates									
Inspect the ground brush for wear, replace if necessary									
Annual Check									
Lubricate the main bearing race									
Lubricate chain and sprocket of the chain drive									

Table 6: Turntable Maintenance Log

EMCO Model 2188 Turntable

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8. Warranty

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.

9. Addendum A: Drawings

Please locate the drawings placed in pocket of the back cover of this manual. Drawings include ETS-Lindgren drawing numbers:

- 2188-1.23B
- 2188-1.53 rev. 2
- 2188-2.03 rev. 1
- 108912C
- 110053B
- 110277 rev. 2
- 110406 rev. 2
- 398790