Diamond Engineering

Automated Measurement Systems

Installation and Configuration Guide

D6050 Multi Axis Positioner

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Diamond Engineering
Automated Measurement Systems

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D6050 - System Introduction and Package Contents

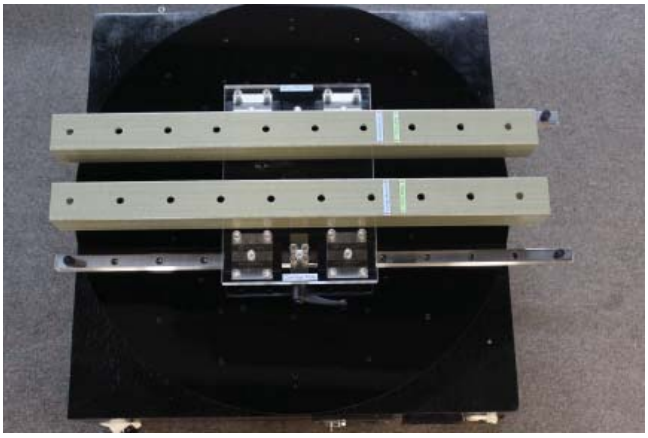
Overview

The Diamond Engineering D6050 multi-axis positioner is a 2-axis positioner (EL/AZ) / (Theta/Phi) with up to two additional linear axis options (Z and X) for automated phase measurements. The positioner can interface directly with the DAMS Antenna Measurement Studio software, or can be controlled via custom software over an RS-232 communications bus.

Package Contents

- D6050 Turntable Base with RF Components
- D6050 Mast Assembly
- Mast Attachment Base
- Two 24" fiberglass rail extensions
- One 8' Phi / Roll Axis RF Cable
- Two 10' RF Cables
- Right Angle RF Adapter* and other RF Connectors
- Roll Axis Control Cable
- 24V Power Supply and Line Cord
- 10' DB9 serial cable (with USB to serial converter)
- Assembly Hardware
- Laser and Digital Level
- AUT Mounting Hardware
- Tools

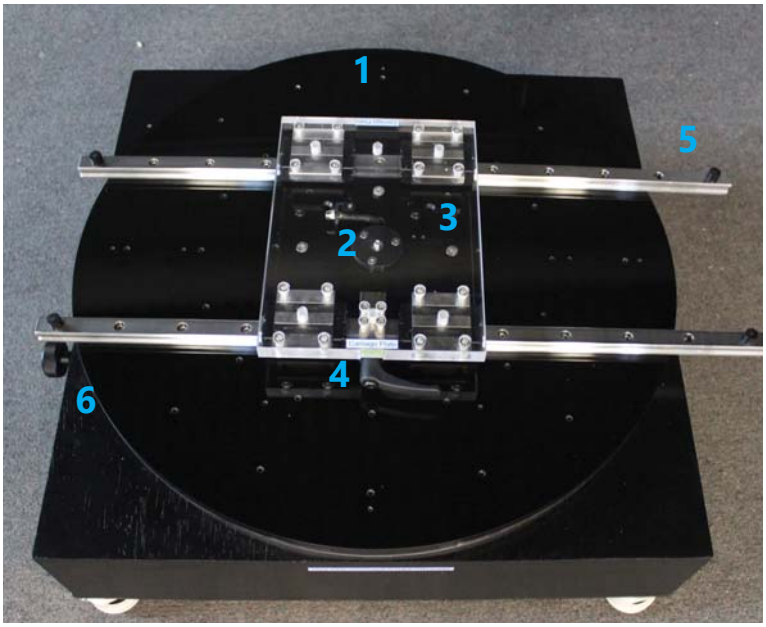
** unless included on roll cable (not applicable to 67 GHz option)*



Positioner Components Overview

D6050 Turntable

1. 24″ Turntable Plate
2. Rotary Joint
3. Main Carriage Plate
4. Linear Guide Brake (to lock rails after centering antenna)
5. Linear Guide stops
6. Manual rotation knob (for pre-positioning or to manually position turntable)



Connector Panel and Fan

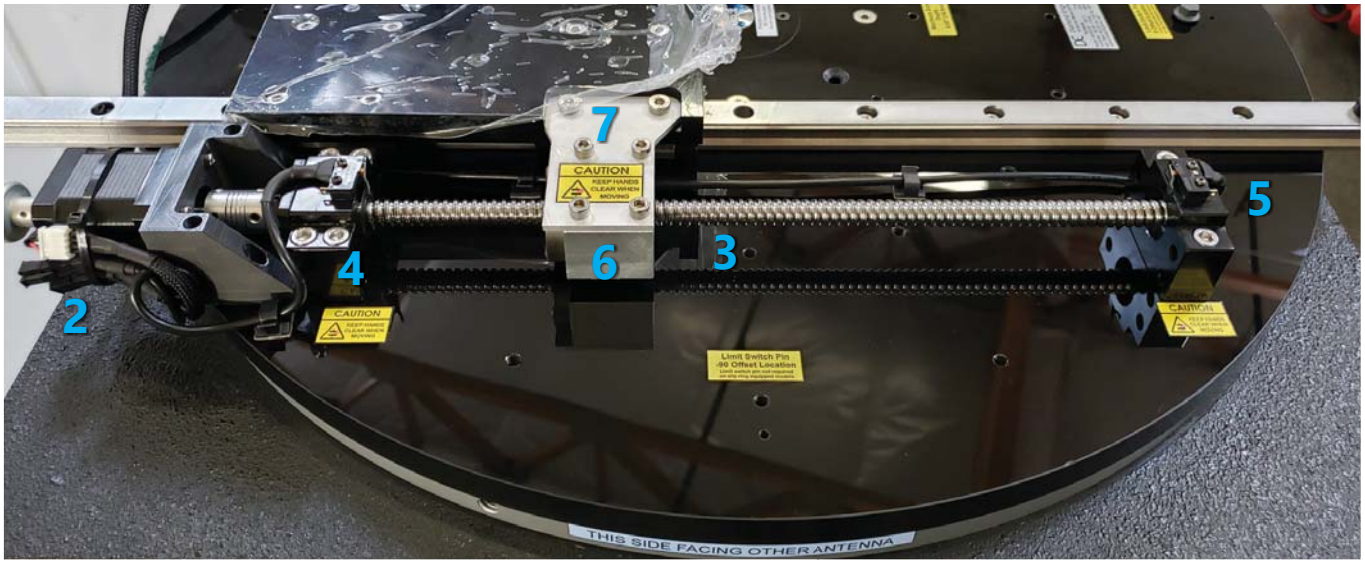
1. Power Switch w/ Indicator LED
2. 24V 5A DC Power Jack (2.5mm barrel)
3. RF Connector
4. Aux (Z) Axis (optional)
5. 9 Pin (DB9) RS-232 Control Connector
6. Cooling Fan

Positioner Components Overview

Automated Z-Axis (mmW or add-on option)

The automated Z axis option connects a 0.02mm resolution precision ball screw actuator to the carriage plate providing precise position of the DUT over the turntable axis. Two limit switches enable stored home offset positions and prevent the collision of the ball nut into the end stops.

1. Manual Control Knob - To adjust position with controller on and holding current off
2. Drive Motor - NEMA 17 stepper motor
3. Ball Screw - 12mm diameter x 4mm pitch (4mm / turn)
4. Home Limit Switch - configured as normally open
5. Max Limit Switch - configured as normally open
6. Ball Nut / Block
7. Carriage Plate Bracket - connects ball nut block to carriage plate

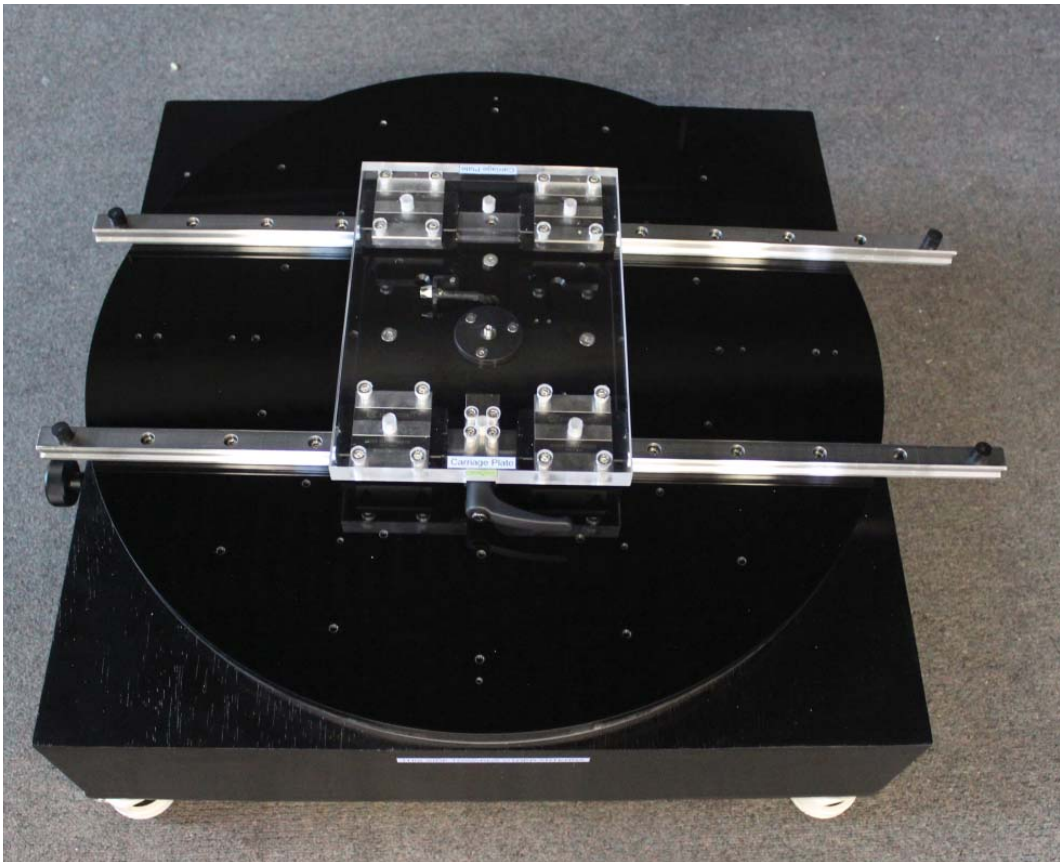


SAFETY NOTE: --- ALWAYS KEEP HANDS CLEAR WHEN MOVING!

Hardware Assembly (2-Axis Systems)

Unpacking The System

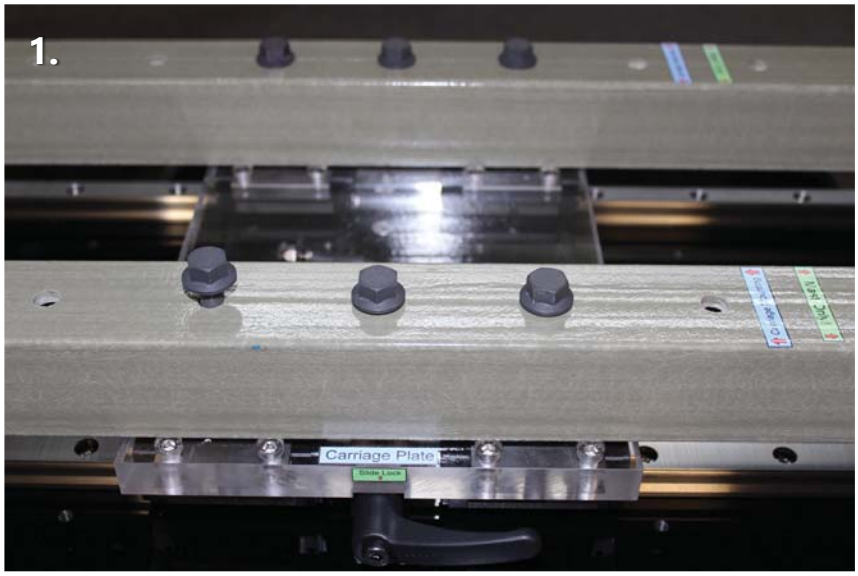
1. Unpack all components where turntable will be installed.
2. If possible, save shipping crates and packing materials in case you need to return system for maintenance or warranty repairs.
3. **IMPORTANT:** Position turntable so **connector panel faces away** from the reference antenna.



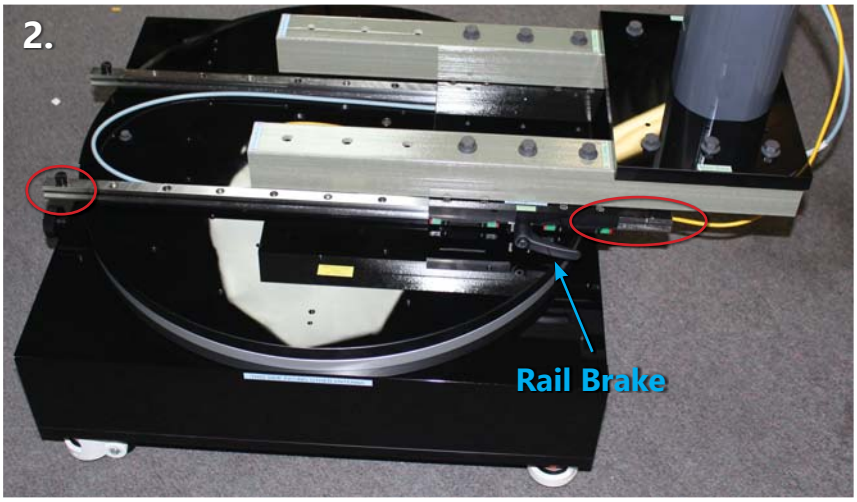
4. Rotate the orange dial on the wheels to lower the rubber feet, disabling wheel rotation.

Extension Rails & Mast Base Installation

1. Using supplied hardware, attach the two green fiberglass rail extensions to the main carriage plate, using the stickers on the rails for proper orientation. For initial installation we recommend using the set of holes shown in the picture #1 below.
2. Attach mast base assembly to the fiberglass rails using supplied hardware as shown in picture #2.



Do not tighten the bolts completely - leave slightly loose until the mast base has been attached, then tighten completely.



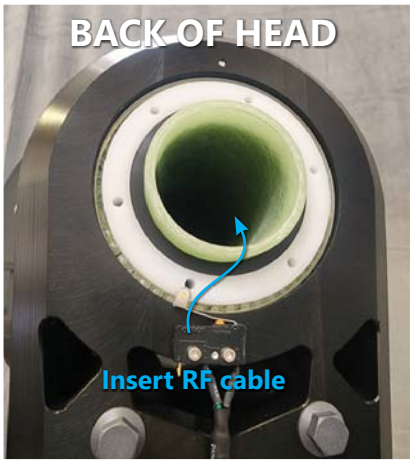
Position mast base on extension rails as shown above. Ensure mast base is to right of brake. Also please note the red circles, which are highlighting the length difference on the main steel rails. Mast should be affixed over the long end of rails.

IMPORTANT: Do NOT over-tighten bolts! Never exceed more than 1/8 turn after bolt makes contact with surface.

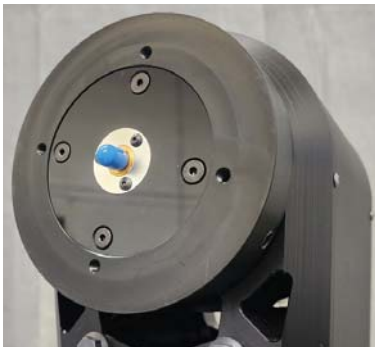
Belt-Driven Mast Head

Roll Plate, RF Cable and Rotary Joint Installation

1. Unpack the pre-mounted adapter plate, 10" roll plate, roll plate screws and the 96" RF cable. (In some cases, the rotary joint may arrive pre-installed on your rotary joint adapter plate.)
2. Run RF cable through back of 2" hollow axle so it accessible from the front of the head.
3. Attach RF cable to back side of rotary joint. (Rotating portion) We recommend using RF torque wrench to ensure 8 in./lb of torque. - a 10mm wrench can be used to hold the connector in place while torquing
4. Use 4 x 8-32 x 1/2" flat head screws to mount rotary joint adapter to head
5. Attach roll plate to head using the four included 10-32 x 1" screws.



Pre-assembled rotary joint assembly

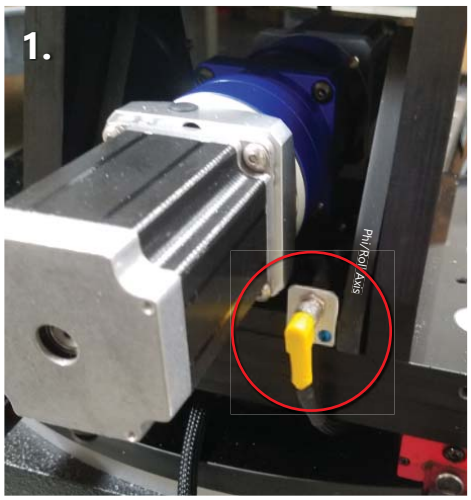


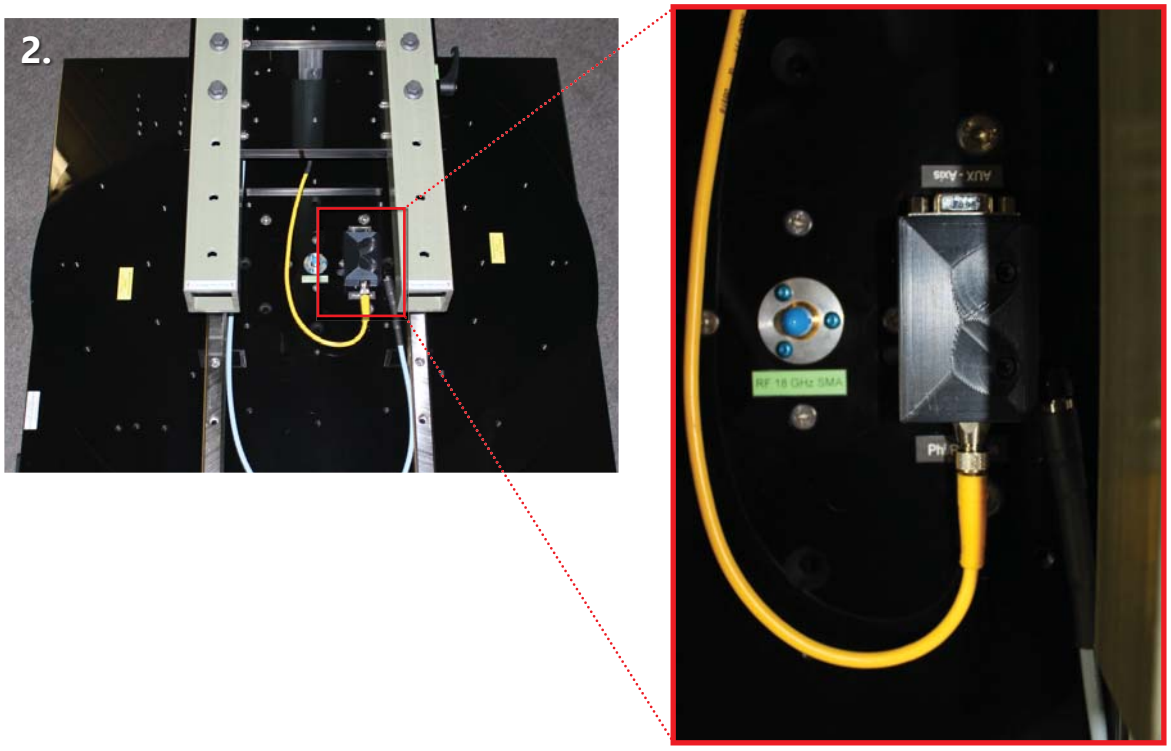
Rotary joint and adapter attached to RF cable and fastened to the front of head

Roll plate attached to front of the head after rotary assembly is attached

Roll Cable & Turntable RF Connections

1. First connect the right angle female connection to the motor on the bottom of the back of the mast. The connector is designated with a “Phi/Roll Axis” label.
2. Run the cable under the carriage plate and connect the male end to the connection box near the center of the turn table (to the side of the turntable rotary joint).
3. Utilizing the provided right-angle RF connector, attach it to the rotary joint at the center of the turntable. Use an RF torque wrench (or, if unavailable, torque to no more than 8 in. pounds). Also attach the RF cable using same technique.





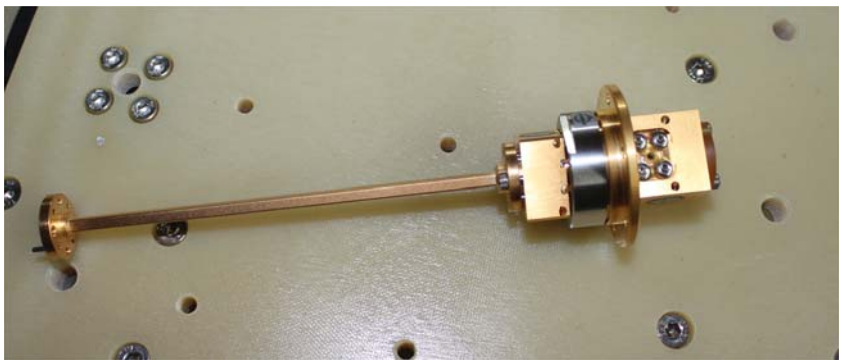
Hardware Assembly (mmW waveguide Only)

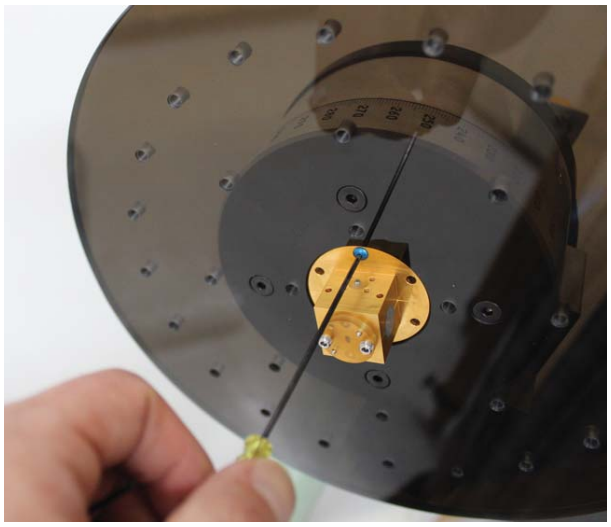
This ONLY covers installation of waveguide components on D6050-mmW systems.

IMPORTANT: **When assembling ensure all waveguide mating is flush across the entire flange!**

Rotary Joint Installation

1. Unpack waveguide parts and attach 5.25" waveguide section to the rotating section of the rotary joint
2. Insert rotary joint with attached waveguide into the roll plate
3. Fasten rotary joint using included 4-40 thread screws

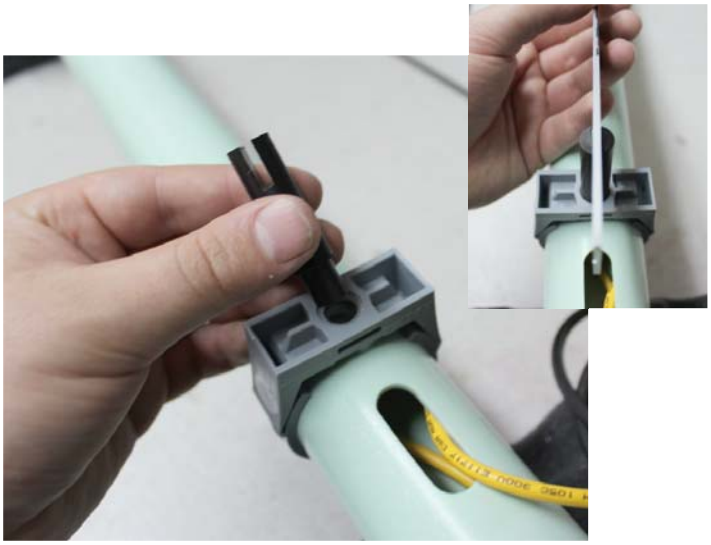


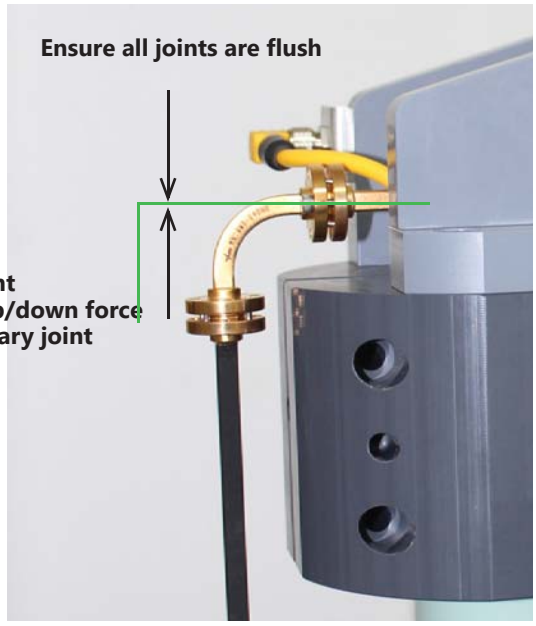


Waveguide and Support Installation

1. Locate waveguide support pieces and insert into grey clamps, keep slot parallel with the vertical mast tube.
2. For Copper Mountain and Anritsu installations connect the "H" plane 90 degree elbow the rotary joint assembly.
3. Carefully Insert long waveguide section into the waveguide supports
4. Fasten long waveguide section to upper 90 degree elbow.

IMPORTANT: Ensure waveguide does not push or pull against the upper waveguide flange, this ensures that no rotational force is being placed onto the rotary joint.



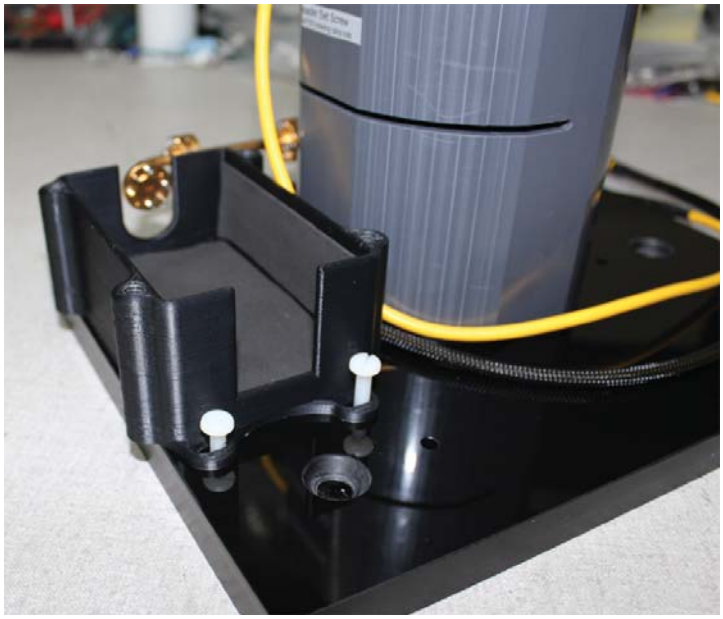


Lower Waveguide Components

1. For Anritsu and Copper Mountain extenders attach the “E” Plane 90 degree bend to the bottom of the long waveguide section.
2. Attach other waveguide sections as required.

Installing Anritsu Shockline mmW Head Mount

1. Attach the included shockline head mount onto the mast baseplate using the four 10-32 screws. The curved slot should face the waveguide components
2. Verify the proper height of the waveguide components as minor mast height adjustments may be necessary to reach the desired height.

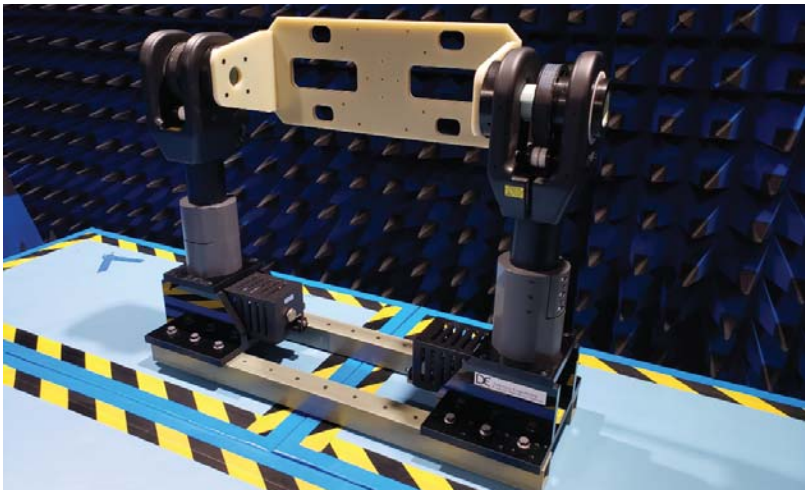


To adjust mast height:
Loosen LOWER mast clamp and raise/lower entire assembly until proper waveguide height is achieved.

Hardware Assembly (Gimbal / OPT. DSM)

This section covers the assembly and connection of the Dual Mast / Gimbal option. Please note, photos likely show a much shorter mast height than your machine.

IMPORTANT: **Be sure to follow advanced positioner settings for OPT. DSM within the DAMS Software. Failure to do so will result in underpowered gimbal rotation.**



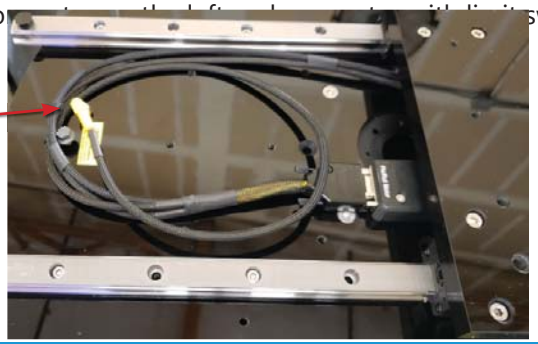
Included Items:

1. (Qty: 2) Belt Drive Masts
2. (Qty: 2) Extended Rails
3. (Qty: 18) 3/8-16 Hex head Fiberglass bolts
4. Dual mast roll cable with limit switch connectors
5. FR4 Gimbal Tray w/ 8 x 10-32 x 1" Flat Hex Screws (overall size can vary)
6. (Qty: 2) Gimbal installation tools

Step 1. Connect Dual Roll Cable *(if applicable)*

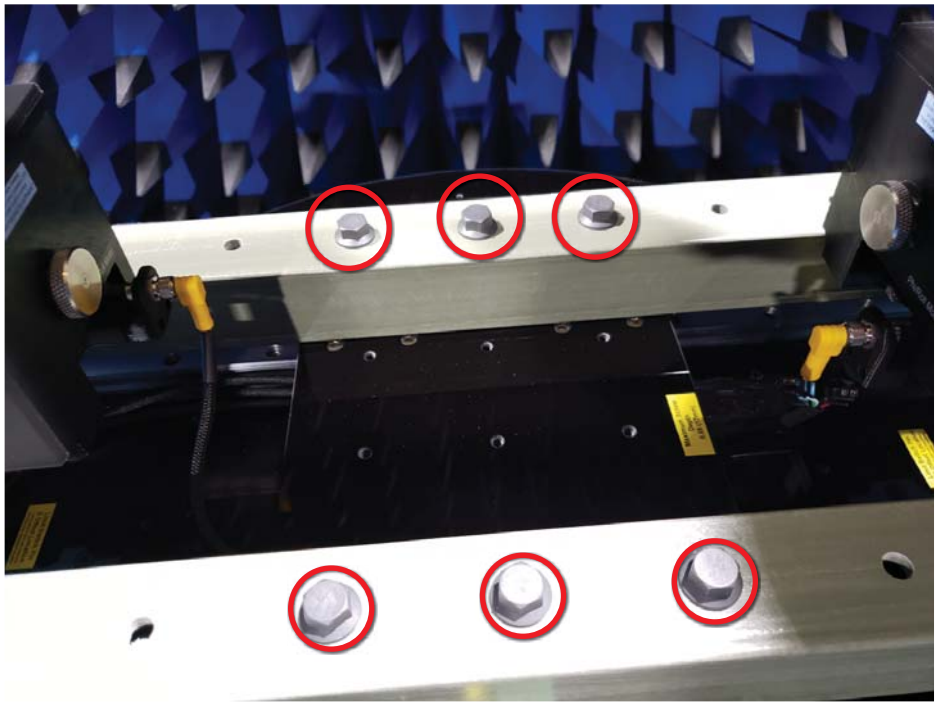
Attach the roll cable to the Phi/Roll port on the top of the D6050 Positioner. If standing from point of reference antenna, have the single co[illegible]switch on the right side of the carriage plate.

Single connector on left side of carriage plate (yellow)



Step 2. Attach extended rails to D6050 Carriage Plate

Using 3/8-16 x 2.6" (qty: 6) fiberglass hex bolts, attach the green fiberglass rails to the D6050 carriage plate Default configuration is to mount the rails centered on the carriage plate.

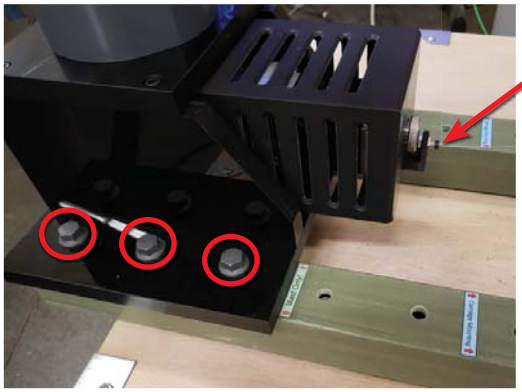


Step 3. Attach Masts to Green Rails

Using 3/8-16 x 2.6" (quantity of 12) fiberglass hex bolts, attach the left and right masts to the green rails, Motor connectors must face the center of the turntable.

Note: Connectors should be oriented inward facing center of turntable

Do NOT fully tighten bolts yet



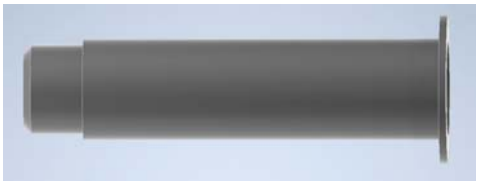
Do NOT fully tighten bolts yet

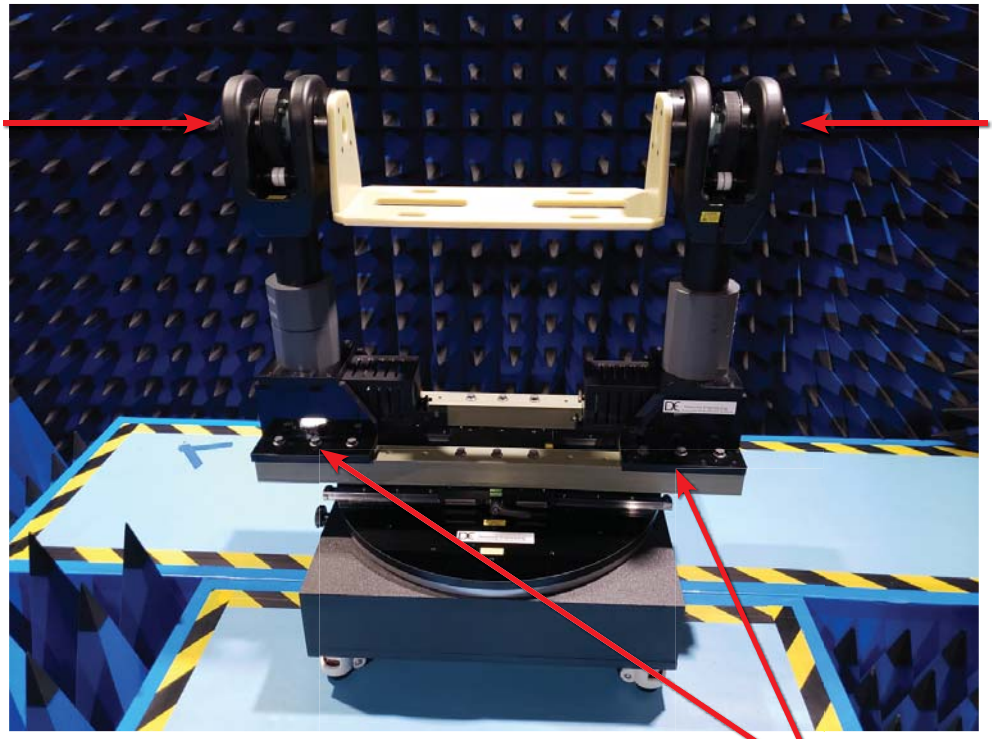
Step 3. Attach Gimbal to Masts

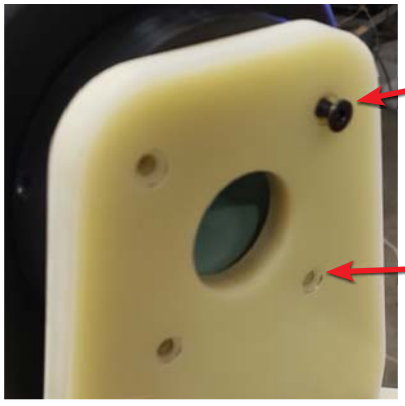
Two alignment tools (shown below) are provided to enable easy alignment of the side plates of the gimbal tray to each mounting plate on both heads.

1. Hold the gimbal assembly between the two masts and slide alignment tools through the back of the heads until it is inserted into the gimbal tray. Do this for both sides.
2. Line up the gimbal side plate holes with the 4 mounting holes in the head and fasten using the provided (qty: 4) 10-32 x 1" flathead hex screws. Do this for both sides.
3. Tighten the (qty: 12) 3/8-16 hex head bolts located at the base of each mast.

Gimbal Installation Tool

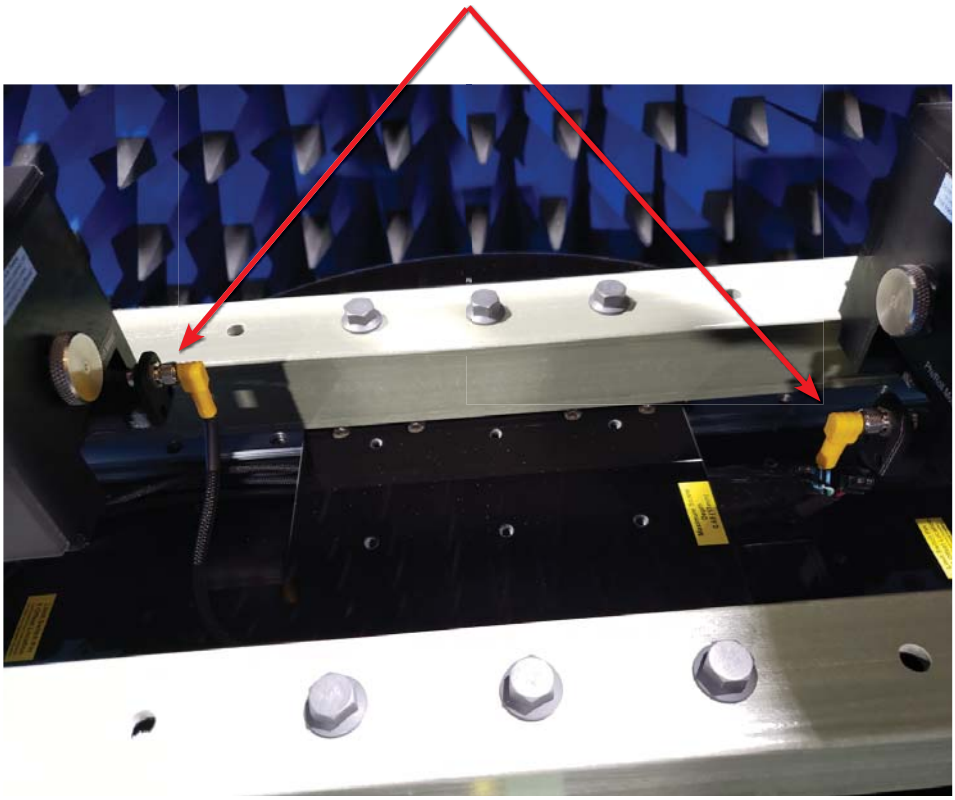






Step 4. Connect Motor Cables

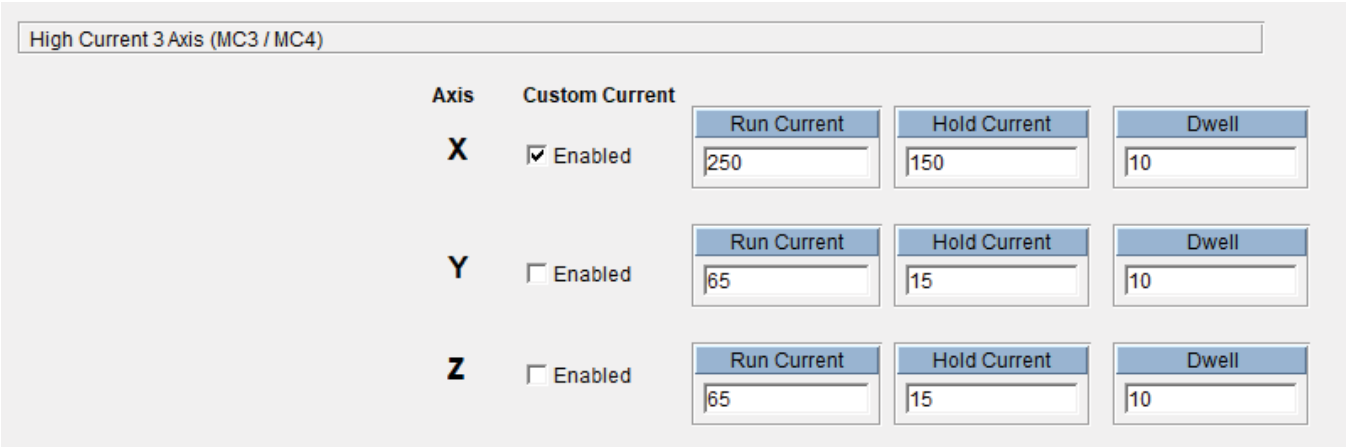
Connect each cable end to their respective motors. This may vary depending on your model configuration.



Step 5. Set Custom Current Settings - ONLY FOR GIMBAL SYSTEMS!!!

DO NOT SET THESE SETTINGS UNLESS USING A DUAL MOTOR GIMBAL POSITIONER!!!
Open the DAMS Software and press “positioner Settings” - Press “ADVANCED CURRENT SETTINGS”

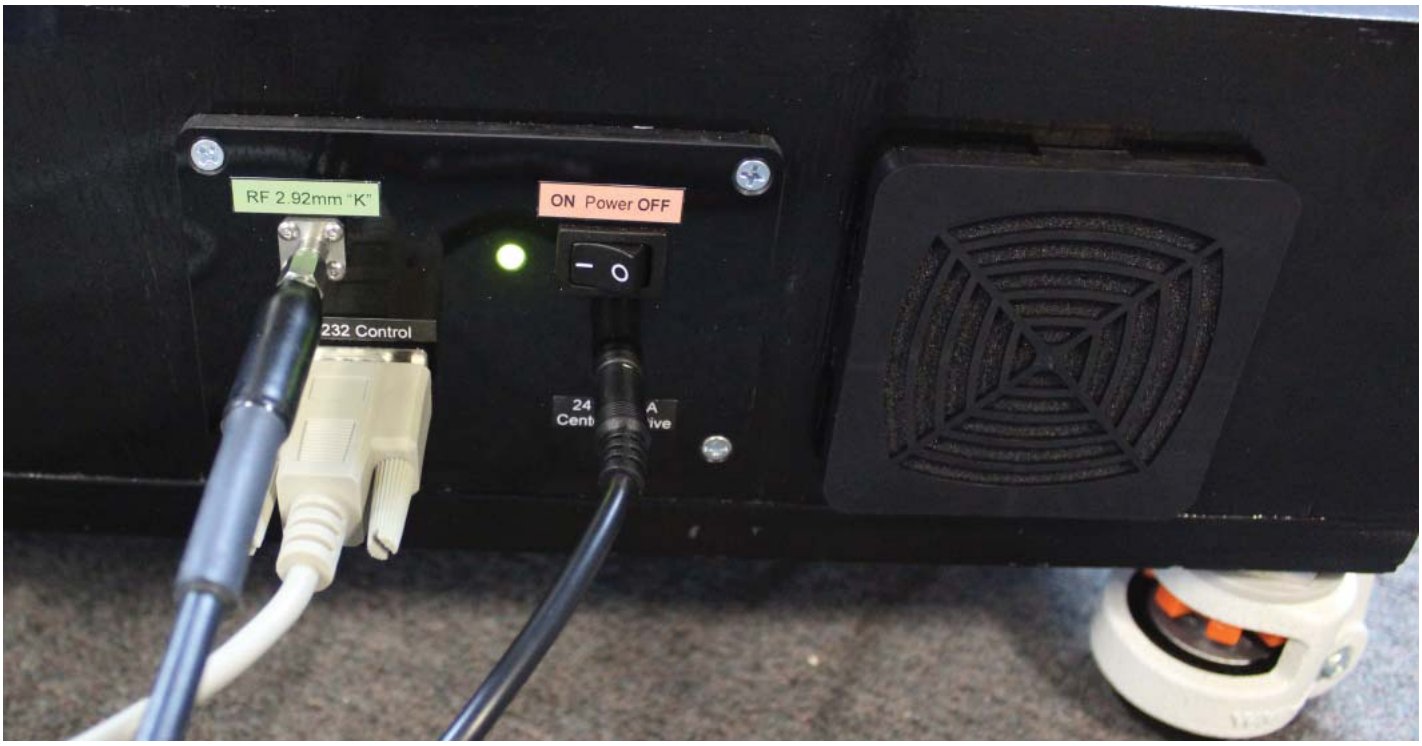
Enter the following settings under “MC3/MC4” Controllers - Press SAVE AND UPDATE , and SAVE to exit the positioner settings menu.



Cable Attachment

Cable Attachment

1. Attach the RS-232 control cable with USB-to-Serial adapter to the turntable.
2. Attach end of one RF cable to the turntable, attach the other end to port 1 or 2 of your network analyzer.
3. Plug in power supply and connect to DC power jack.



Software Installation

Software Installation

IMPORTANT: Administrator privileges are required to install software. .NET 3.5 is also required which can be installed from "turn windows features on/off"

1. Place CD in CD-ROM or Insert flash drive, Navigate to drive and launch setup.exe
2. Click Next/OK through all setup screens.
3. Agilent Runtime and I/O libraries Setup will launch.
   Windows 10/11 Users: you may receive an error that the operating system is not supported - ignore this error.
4. To verify installation is complete click Start Menu → Programs and ensure the folders below are present. If so, you may launch Antenna Measurement Studio.

   - Agilent Vee Pro Runtime 9.3
   - Agilent I/O Libraries
   - DAMS

NOTE: If any folders are missing or an installation error occurred. Manually install components by installing the runtime and/or IO Libraries from c:\dams\runtime93

Post Installation Instructions

A few extra steps are REQUIRED after the software has been installed

Microsoft Excel Open Excel, go to File → Options and set the default number of sheets to 3

Matlab 3D Plots Go to C:\Program Files (x86)\Agilent\Vee Pro Runtime 9.3 and right click on veerun.exe. Select the compatibility tab and select "Run as Administrator"

Entering Your License Key

1. In main screen of DAMS software, at the top of the screen, Under "DEMO LICENSE", press "system options" and select LICENSE INFO (***not*** simulator license)
2. Enter the license key located on the CD holder or on the front or back of your users manual Press "Verify and Save".
3. Key has been verified should appear. Click "QUIT" and restart the software to update the license.

Controller Installation

1. Ensure the Controller is Powered on.
2. Install the DAMS Measurement Software from the Included CD / USB Stick (Note: you must be administrator on the PC)
3. Connect the USB-Serial Adapter to the computer. Check device mananger to ensure it is on a COM port less than 9. if there is no COM port listed but an "unknown device" , right click and update driver from C:\DAMS\driver.
4. Open device manager (Control Panel → System → Hardware Tab → Device Manager). Click Ports and note the COM port of the USB/Serial Converter.

To configure your instruments refer to the DAMS Antenna Measurement Studio manual.

DAMS Software Configuration for positioner!

IMPORTANT: to prevent damage to positioner, follow configuration instructions listed on the next page!!!!

Support

If you need assistance with any of the steps above or have any questions about the system or software please contact us.

Email: Support@diamondeng.net
Phone: (530) 626-3857
Fax: (530) 626-0495

Diamond Engineering
P.O. Box 2037
Diamond Springs, CA 95619

DAMS Software Configuration for D6050

Configuration for D6050 MC3B 3 Axis Controller or systems manufactured after 4/2024

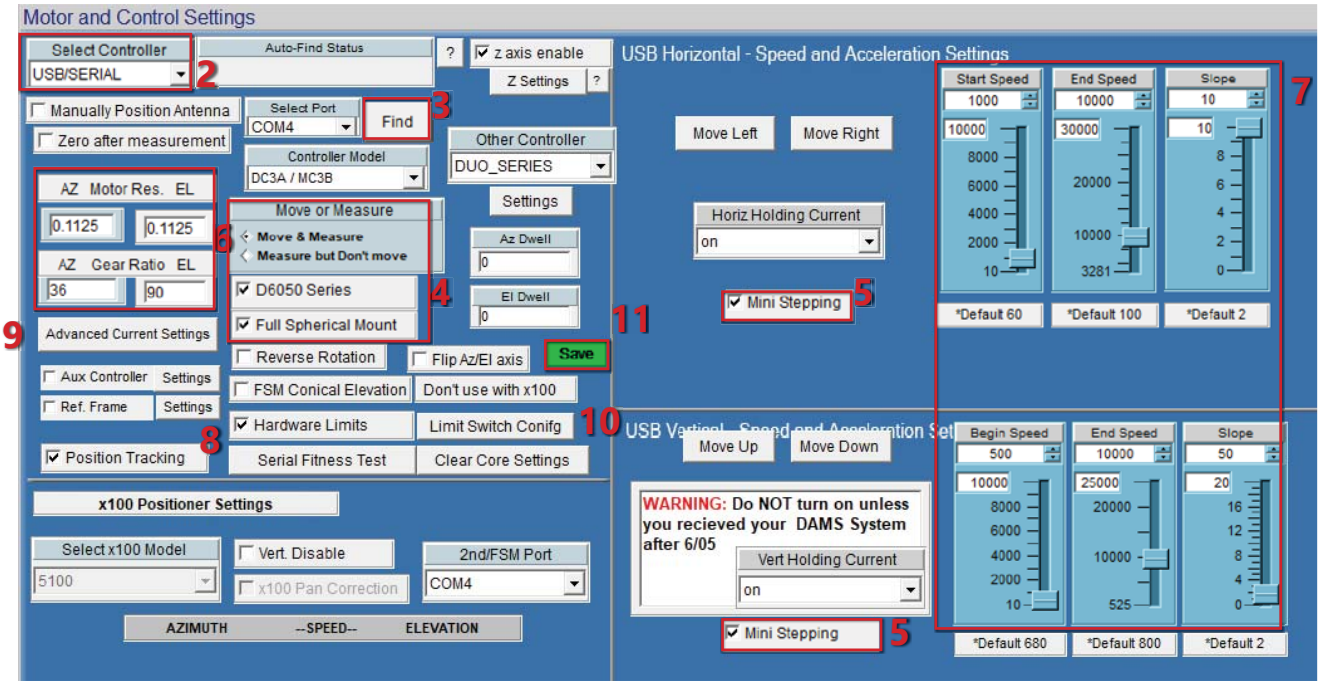
1. Open the DAMS Measurement software and select “positioner settings” from the upper right corner of the screen.
2. Select USB-SERIAL from “Select Controller”
3. Press “Find” to find the controller
4. Select “Move and Measure and place check mark in in D6050 and Full Spherical Mount
   NOTE: Selecting this box will auto-fill the boxes, but you still must change the settings as defined in steps 6/7
5. Enable Horizontal and Vertical Mini-Stepping (be sure to check both boxes)
6. Adjust motor resolution and gear ratio to the following values (as shown in graphic below):

AZ (Phi / roll)		EL (Theta / turntable)	
Motor Res.:	0.1125	Motor Res.:	0.1125
Gear Ratio:	36	Gear Ratio:	90

7. On the right hand side, adjust the Speed Settings on all six sliders to the following values:

Horizontal		Vertical	
Start:	500	Start:	200
Stop:	5,000	Stop:	5,000
Slope:	8	Slope:	5

8. Place check mark in “Position Tracking”
9. Press “advanced current settings” and enter settings shown on next page.
10. Place check mark un “Hardware Limits”, press “Limit Switch Config” and enter settings shown on next page.
11. Verify all settings still match then Press “SAVE”



IMPORTANT MC6x Series Settings (After 4/2024)

It is necessary to set custom current settings for D6050 series with MC6x series controllers or overheating of motors may occur! Please use settings below under “Advanced Current Settings’

SEE NEXT PAGE !!!!

IMPORTANT MC6x Series Settings (After 4/2024)

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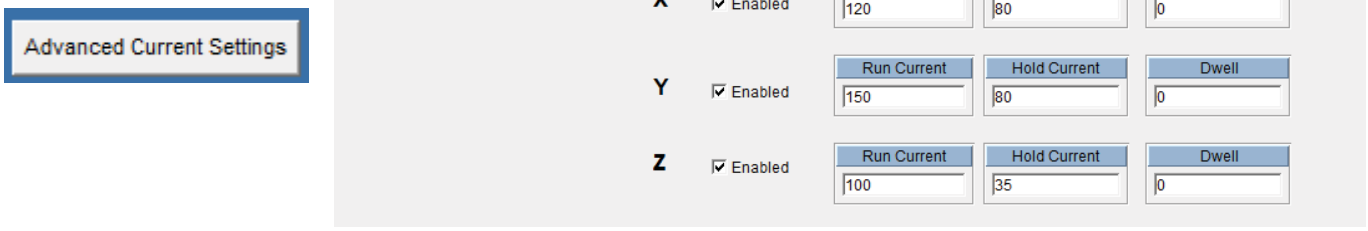
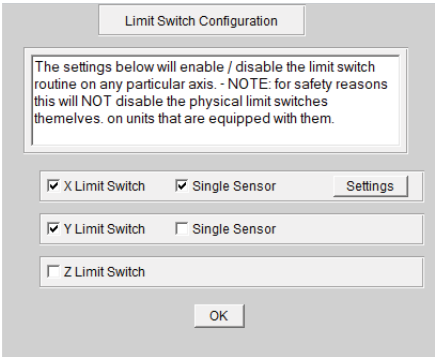


Limit Switch Settings

Configure the limit switch settings as shown to the right, if your roll axis has a roller switch on the back of the head please enable "single sensor" for the X axis, If your positioner is equipped with automated Z , please check this box



DAMS Software Configuration for D6050

DAMS Software Configuration for D6050 MC3B 3 Axis Controller or systems manufactured between 8/2017 and 4/2024

1. Open the DAMS Measurement software and select “positioner settings” from the upper right corner of the screen.
2. Select USB-SERIAL from “Select Controller”
3. Press “Find” to find the controller
4. Select “Move and Measure and place check mark in in D6050 and Full Spherical Mount

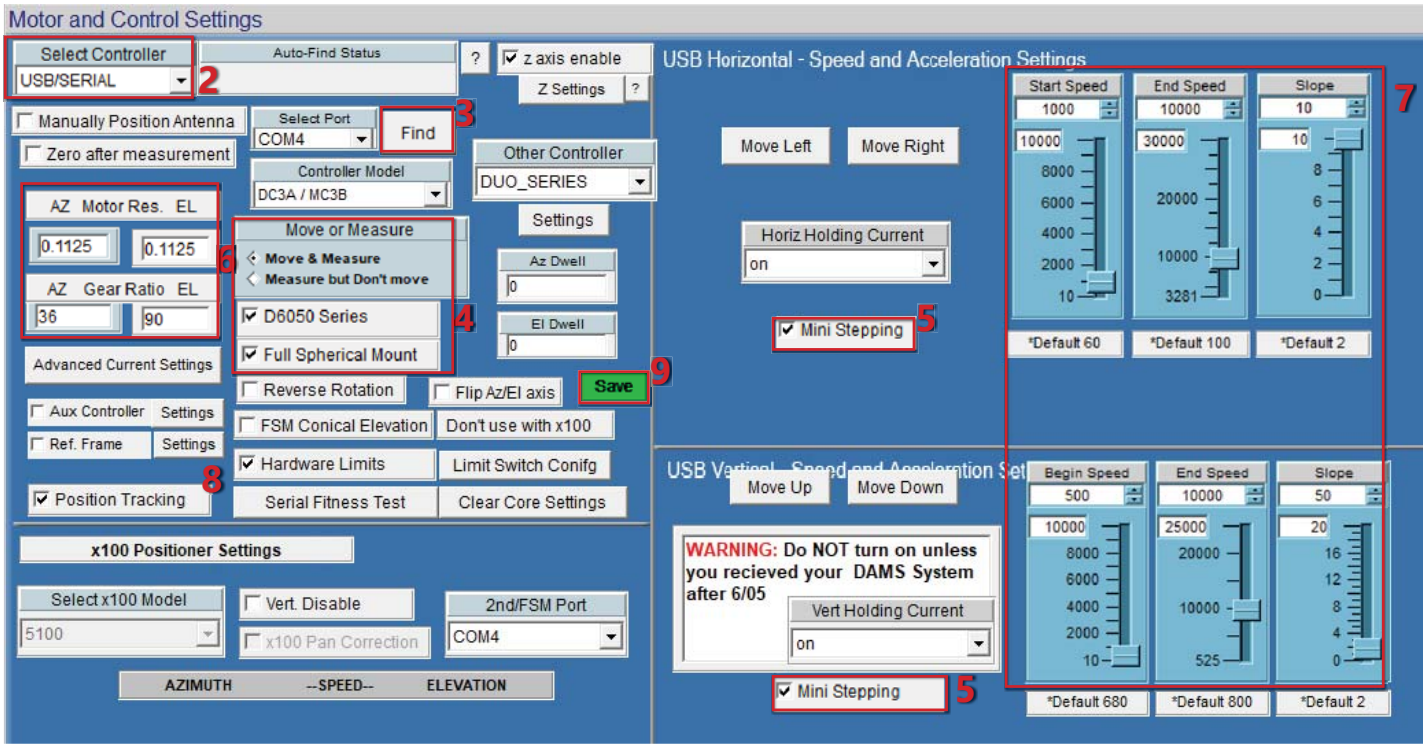
   NOTE: Selecting this box will auto-fill the boxes, but you still must change the settings as defined in steps 6/7
5. Enable Horizontal and Vertical Mini-Stepping (be sure to check both boxes)
6. Adjust motor resolution and gear ratio to the following values (as shown in graphic below):

AZ (Phi / roll)		EL (Theta / turntable)	
Motor Res.:	0.1125	Motor Res.:	0.1125
Gear Ratio:	36	Gear Ratio:	90

7. On the right hand side, adjust the Speed Settings on all six sliders to the following values:

Horizontal		Vertical	
Start:	500	Start:	200
Stop:	5,000	Stop:	5,000
Slope:	8	Slope:	5

8. Place check mark in “Position Tracking”
9. Verify all settings still match then Press “SAVE” and on the subsequent pop-up, select “Restart with Default Extents”



DAMS Software Configuration for D6050 (LEGACY pre 2018)

DAMS Software Configuration for D6050 2-Axis Controller (Pre 2018)

1. Open the DAMS Measurement software and select "positioner settings" from the upper right corner of the screen.
2. Select USB-SERIAL from "Select Controller"
3. Select the COM Port that you noted earlier from Device Manager
4. Place a check mark in D6050 and Full Spherical Mount *NOTE: the settings control panel should fill in the rest of the settings below
5. Enable Horizontal and Vertical Mini-Stepping

6. Motor Resolution and Gear Ratio

AZ (phi / roll)

Motor Res: 1.8

Gear Ratio: 144

EL (theta / turntable

Motor Res: 1.8

Gear Ratio: 180

7. Speed Settings

HORIZONTAL

Start: 500

Stop: 3000

Slope: 8

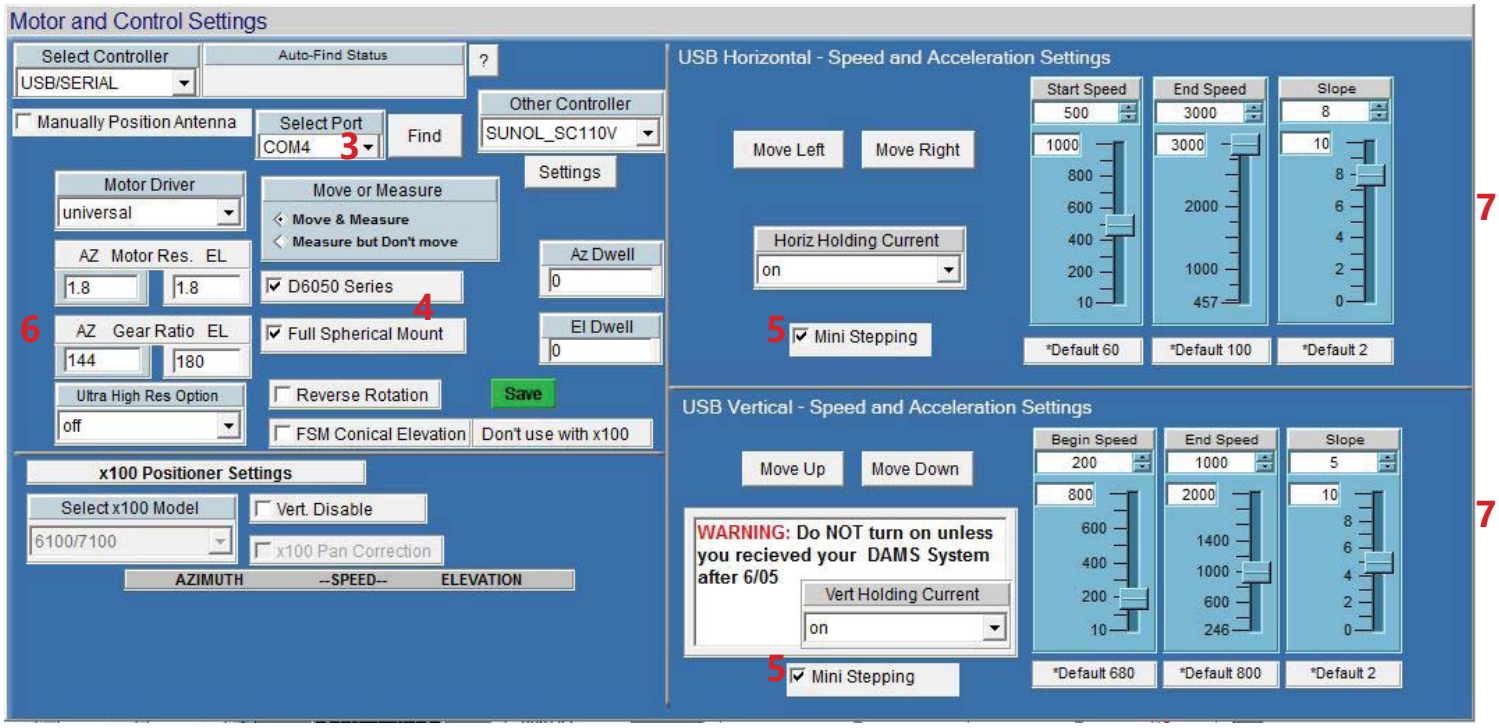
VERTICAL

Start: 200

Stop: 1000

Slope: 5

After you have configured the settings above, press "SAVE" then "Restart with Default Extents"



Basic Positioner Operation Overview

Overview --- See getting started on next page

At time of the writing of this manual, the positioner is configured for Az/El data collection. The Phi/Roll positioner is the azimuth and the turntable is Theta/Elevation. When configured for standard operation, the turntable has a range of +/- 90 degrees and the Phi/Roll positioner has a range of either 0 to 360 or +/- 180 degrees.

Position Tracking / Zeroing ** IMPORTANT **

The D6050 Positioner operates in an "open loop" positioning mode. This means the physical location of the turntable and roll positioner is not tracked using encoders but is tracked within the software. When the software is started, both Azimuth and Elevation are assumed to be 0 degrees. Before making any measurements or jogging the positioner it is critical to set the positioner to it's physical 0/Center locations.

Limit Switches

The D6050 Turntable is equipped with 2 limit switches, a "HOME" (full CW rotation) limit switch and a "MAX" (full CCW rotation) limit switch. These are located at roughly +/- 185 degrees respectively. These switches are critical in preventing the over-rotation of the turntable. If the turntable is over rotated, the Phi/Roll axis cable could become entangled with the centrally located RF Rotary joint causing damage to the cables and/or the positioner.

If the positioner has been properly zeroed before moving or making measurements the limit switches should never be tripped. In the event that either the home or max limit switch is triggered during a movement, it will instantly be stopped and any measurement will be cancelled. The software will then prompt you to move the turntable to either 180 degrees from the limit switch, or to a stored offset position. Once this has been done it is critical to use the Elevation Jog +/- buttons to physically center the turntable before pressing the "zero positioner" button.

The D6050 Phi/Roll Axis does not use limit switches and can be rotated unlimited times in CW or CCW direction.

Getting Started

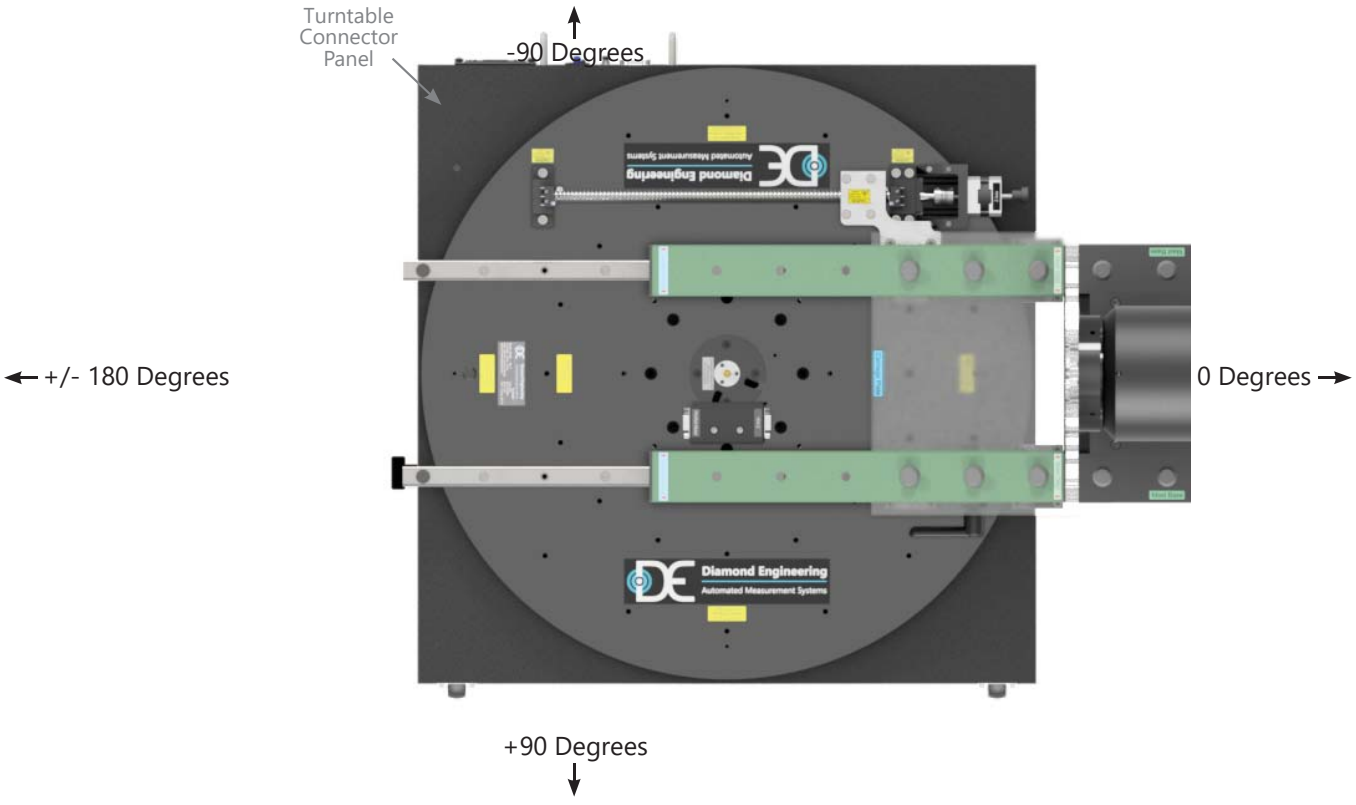
Start software and set positioner to physical zero

After starting the software—and *before* making a measurement—it is important that the positioner is set to 0,0—***especially*** the Turntable / Elevation axis. There are 3 main ways to set 0,0 listed below:

1. Basic Software Zero - without storing offsets

1. Start the software.
2. Using the elevation jog buttons, set the turntable so that it is oriented as shown in the graphic below. The roll positioner should be positioned so that the AUT bore sight is facing the stationary antenna.
3. Press the "Zero Positioner" button - select SET ZERO, this will set current turntable and roll position as zero.

Proper Orientation of Turntable / Elevation Axis



2. Software zero with storing offsets (Home or Max)

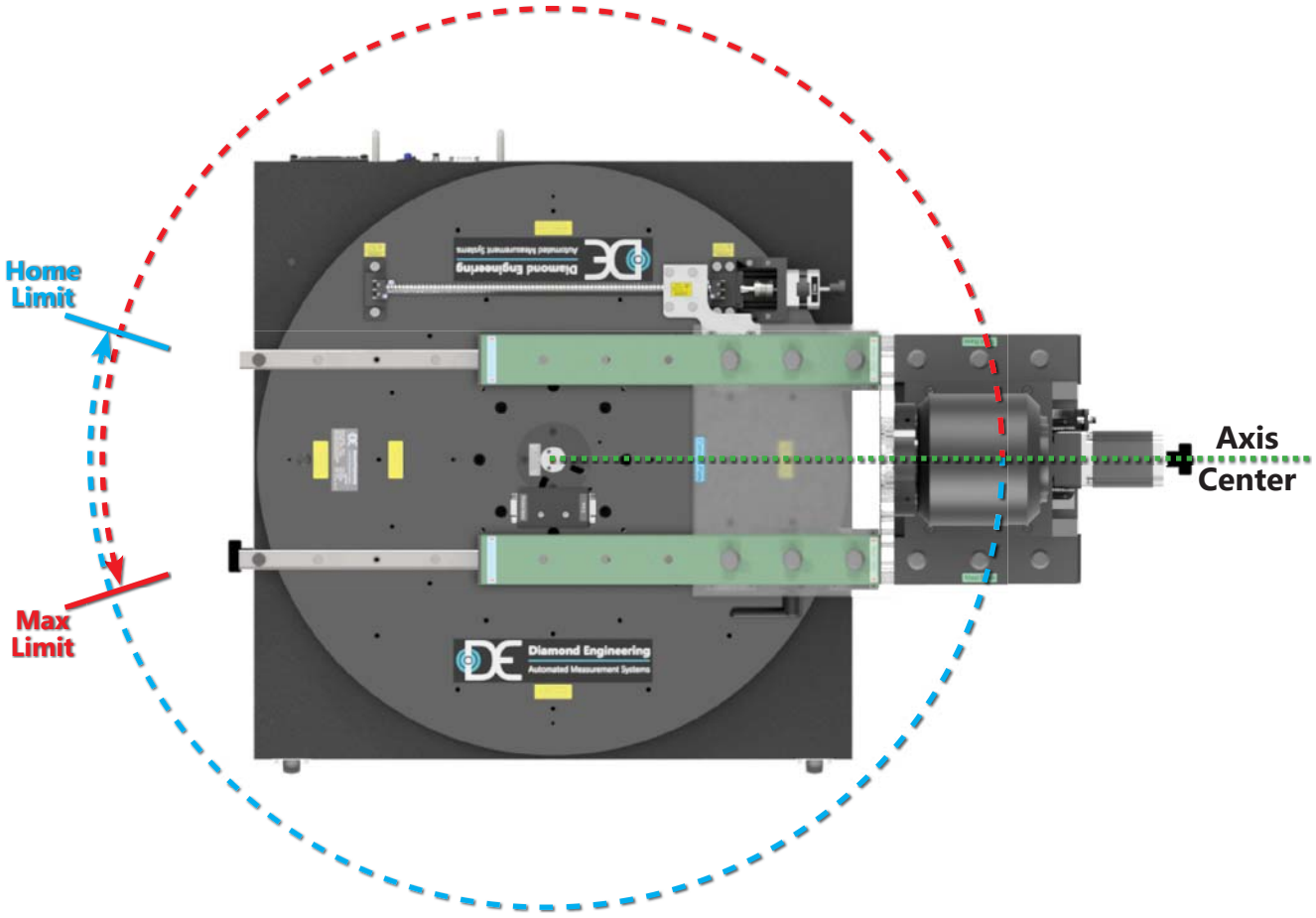
Home and Max limits can be used to re-position the turntable to 0 when a limit has been struck
** NOTE ** A home offset can be used to zero the positioner on startup.

1. After a limit has been struck and the positioner moved off the limit, use the elevation jog buttons to position the turntable to the physical 0 position as shown in the diagram
2. Press the "Zero Positioner" button - select "SET ZERO, REC OFFSET", this will set current turntable and roll position as zero and store the offset degrees from the turntable's limit switch, the offset that is recorded is the one from the last switch that was struck.

3. Search for home, recall offset

When the software has just been started and you have previously set a HOME offset, the positioner can be moved to that exact position by first finding the home switch then moving the turntable the proper number of offset steps to reach the physical 0 position.

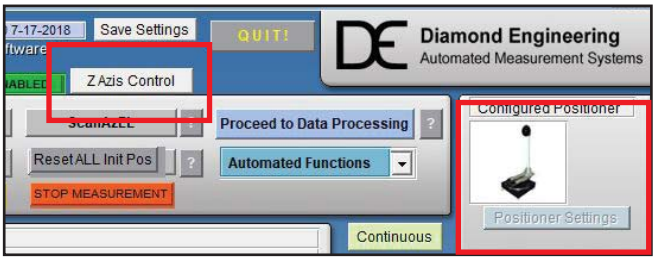
1. Have the DAMS Software running
2. Press "Zero Positioner"
3. Select "Search / move to zero"
4. The positioner will move up to 370 degrees Clockwise to find the limit switch, when the switch has been found use the "Stored position" option to have the software move the turntable to the physical 0 location.

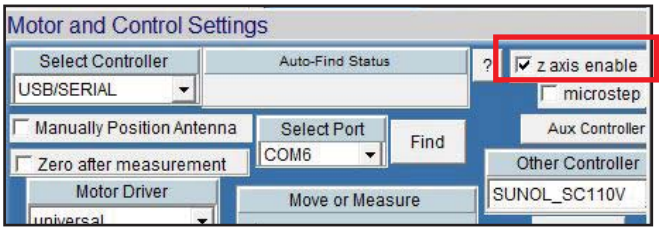


Using the Z-Axis

This section only applies models with the Z-Axis option.

Before you use the Z-Axis, you must be sure it has been enabled. This will show as an option for "Z-Axis Control" located above the measure buttons. To enable this option, open positioner settings and select Z-Axis in the upper section of the page.





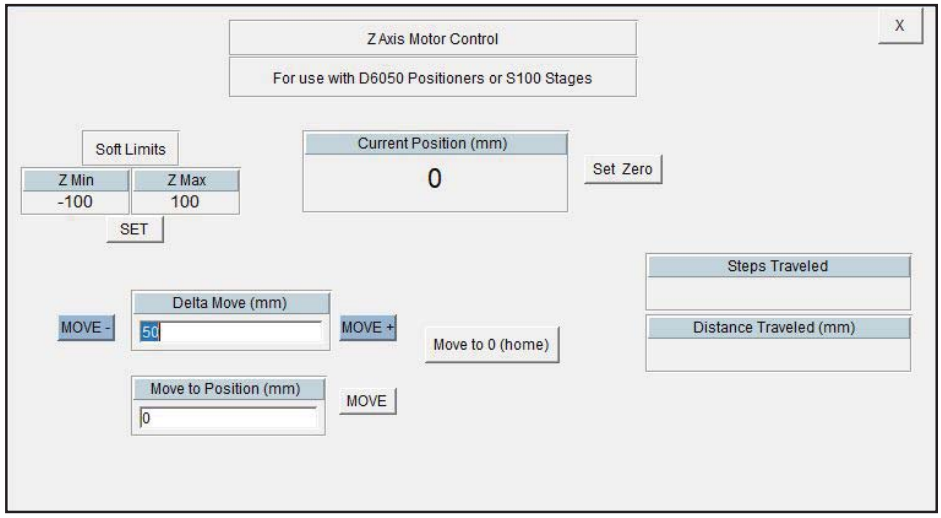
Z-Axis Motor Control

Move to 0 (Home)
Moves axis to last position established as "0"

Delta Move +
Distance to move away from turntable center

Delta Move -
Distance to move towards turntable center

Soft Limits (values in mm)
Typically this is accomplished by setting the positioner to 0 then measuring on each side of the ball nut



Current Position Displays the current position
Set Zero Offers options for zeroing the axis

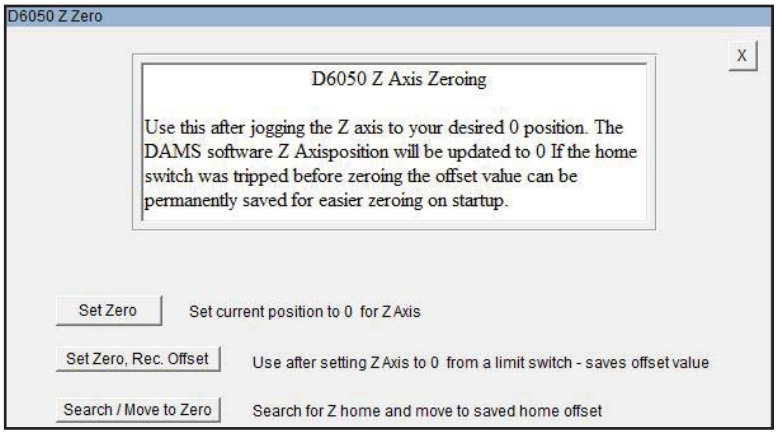
Steps Traveled Shows the real number of steps the axis was commanded to move
Distance Traveled- shows the distance the z-axis moved during last move

Z-Axis Motor Control

Set Zero Establishes current position as "0"

Set Zero, record offset- sets current position to 0, records step offset value (if available to use to re-zero the positioner

Search, Move to zero- Moves the axis until the home limit is struck, from here the positioner can be moved back to a stored zero position.



Z-Axis Homing and Limit Switches

Applies models and other models with Z-Axis option

The limit switches prevent over-travel of the axis and provide a known reference position for purposes of zeroing. Once the known position has been reached the internal controller count can be the monitored. The axis does not contain an encoder, so if the power to the controller is reset, or the software is restarted, or the axis is manually moved—the software cannot track it's position. In these cases it's necessary to either use a stored offset or create a new offset. The default stored offset is roughly at the center of the ball screw.

Creating a new zero offset

1. An offset can ONLY be stored once either the Home or Max limit switch has been struck once during the software session.
2. Open "Z Motor Control" and press "Set Zero"
3. If the home/limit switch has not yet been struck, press "search for home" which will cause the positioner to spin until finding the home limit switch.
4. Next, select "move to standard offset." This will move the Z-axis to the general center or zero position of the axis.
5. Using the Move+/- keys (or the "Move to" button), locate the position you want to set as zero.
6. Open the "set zero" option and press Set Zero/Record Offset, which will record the proper motor step count from the home switch location.
7. The software Z position is now set to zero and all movements will be relative.

Manual Jogging and Soft Limits

1. Press "Zero Positioner"
2. Select "Search / move to zero"
3. The positioner will move up to 370 degrees Clockwise to find the limit switch, when the switch has been found use the "Stored position" option to have the software move the turntable to the physical 0 location.

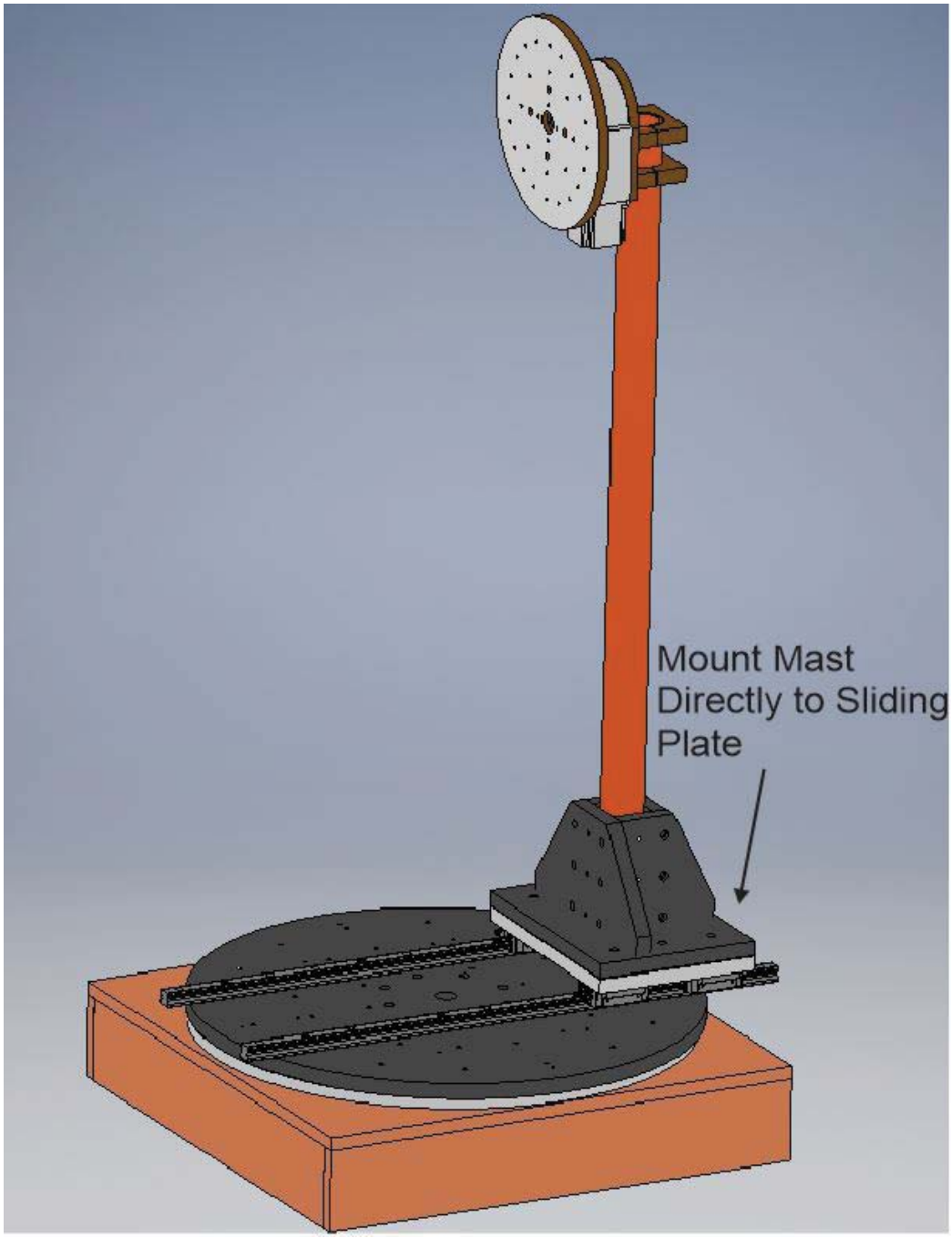
Using a stored offset

1. Open Z Motor Control and press "Set Zero"
2. Select "Search / Move to zero"
3. The positioner will move to the home switch and stop, when prompted select "move to stored offset" this will move the Z axis to the position last stored using the Z axis zeroing function. The software position is reset to zero and all movements are relative.

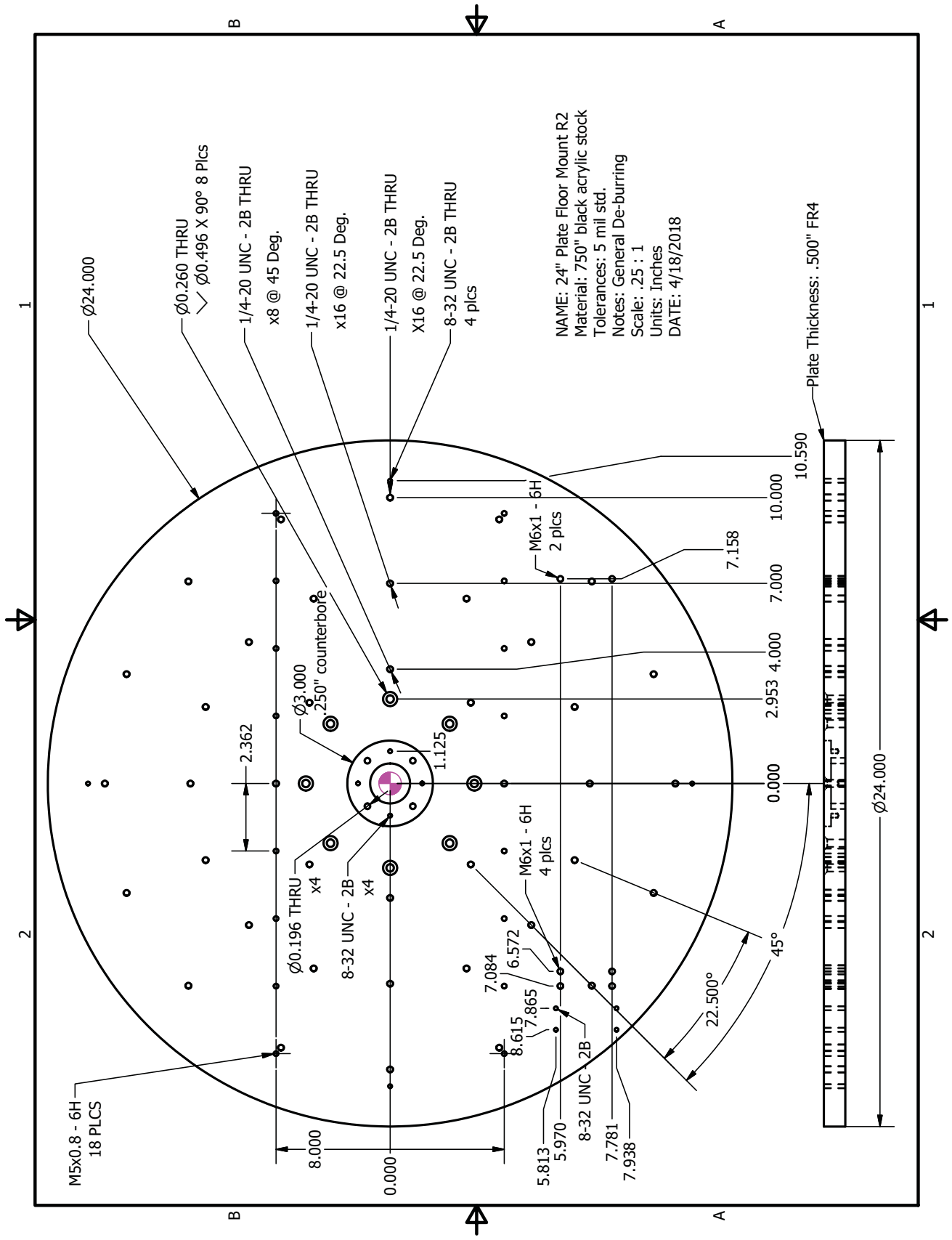
ALTERNATIVE MAST MOUNTING

Description

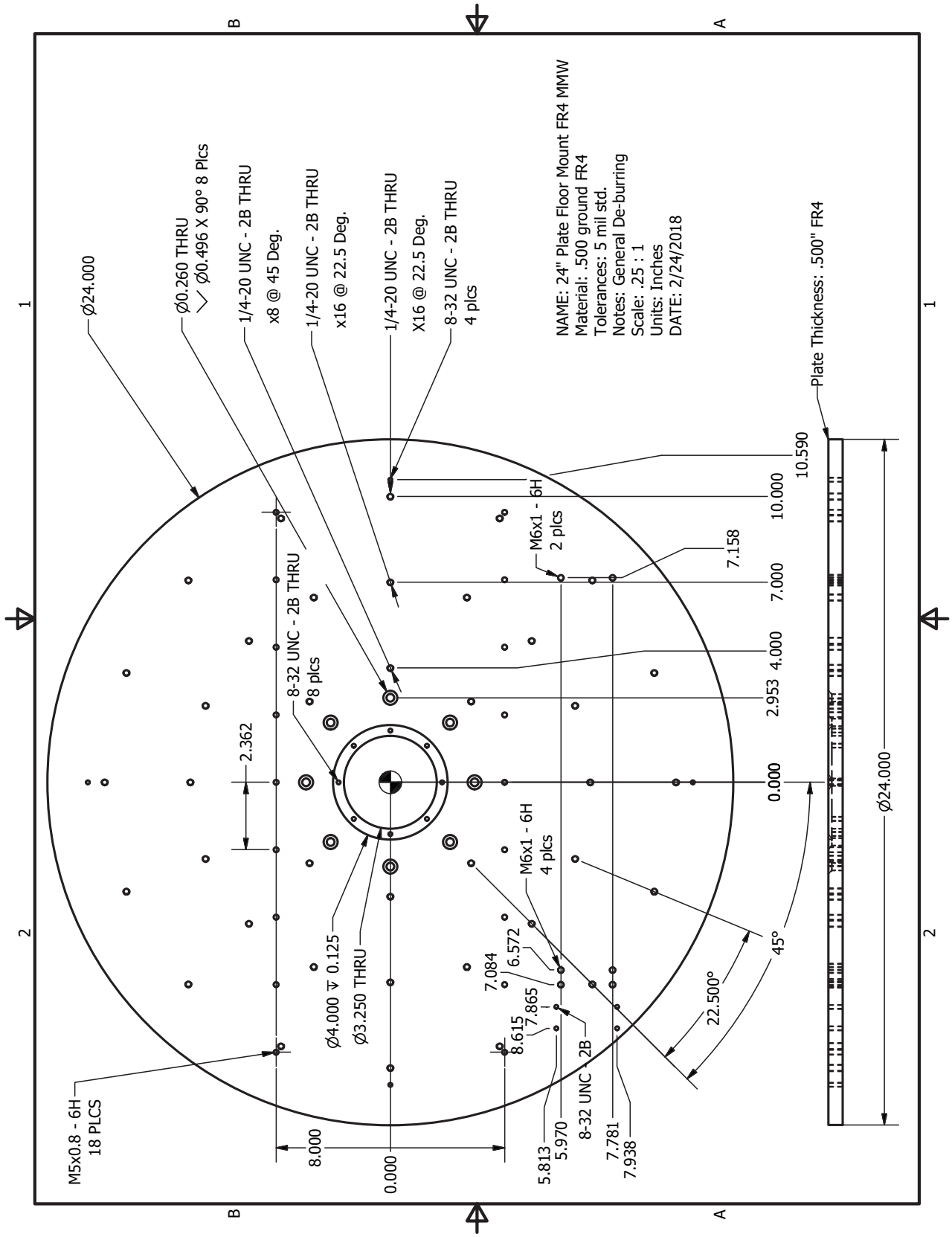
If you do not wish to use the fiberglass rail extensions, the mast base can be mounted directly to the carriage plate using the alternative mast base mounting bolts (3/8-16 x 1.25" Fiberglass flange bolts).



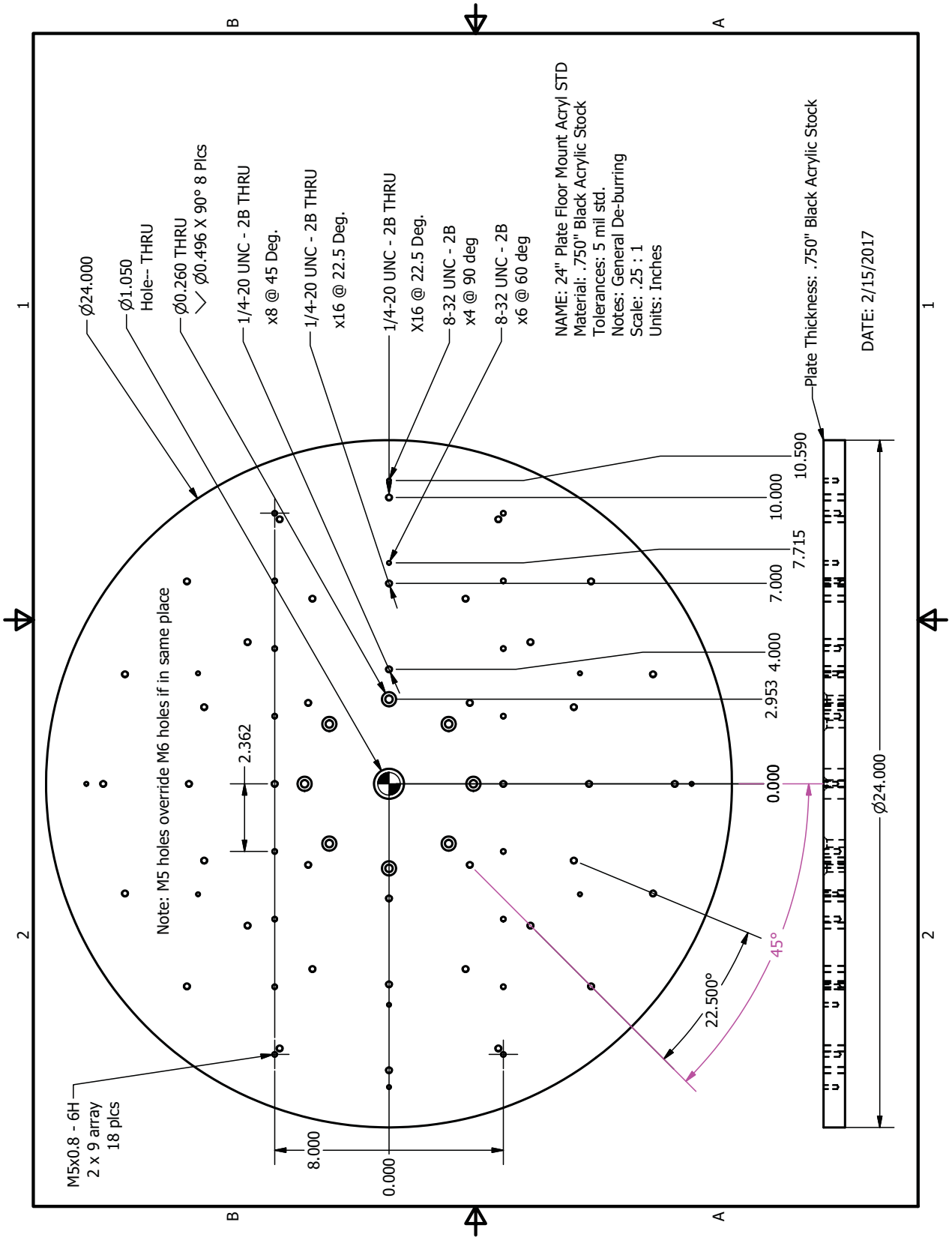
Appendix- Turntable Plate drawing R2- SAE - Inch Units



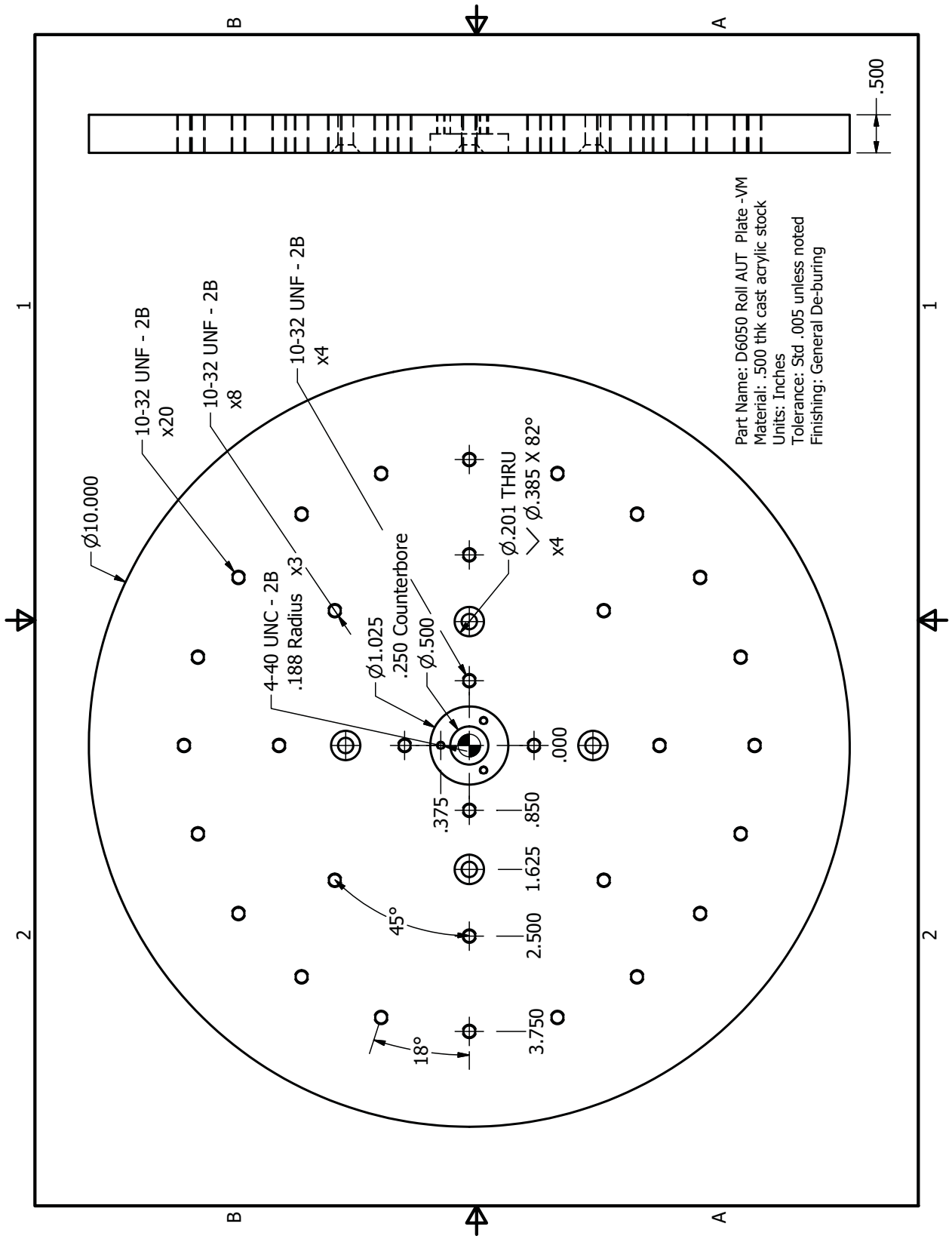
Appendix-Turntable Plate drawing FR4 mmW- SAE - Inch Units



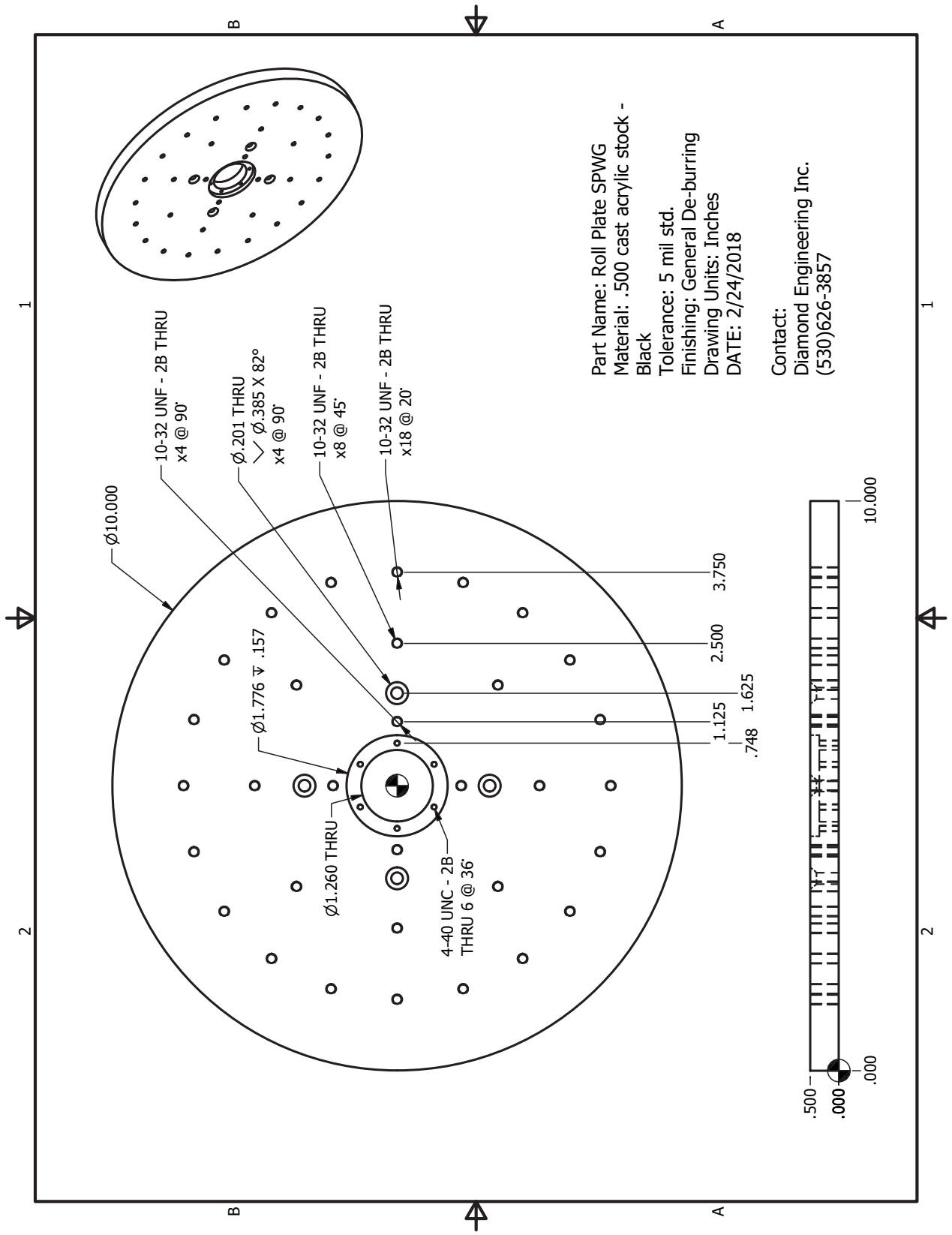
Appendix- Turntable Plate drawing V1 - SAE - Inch Units



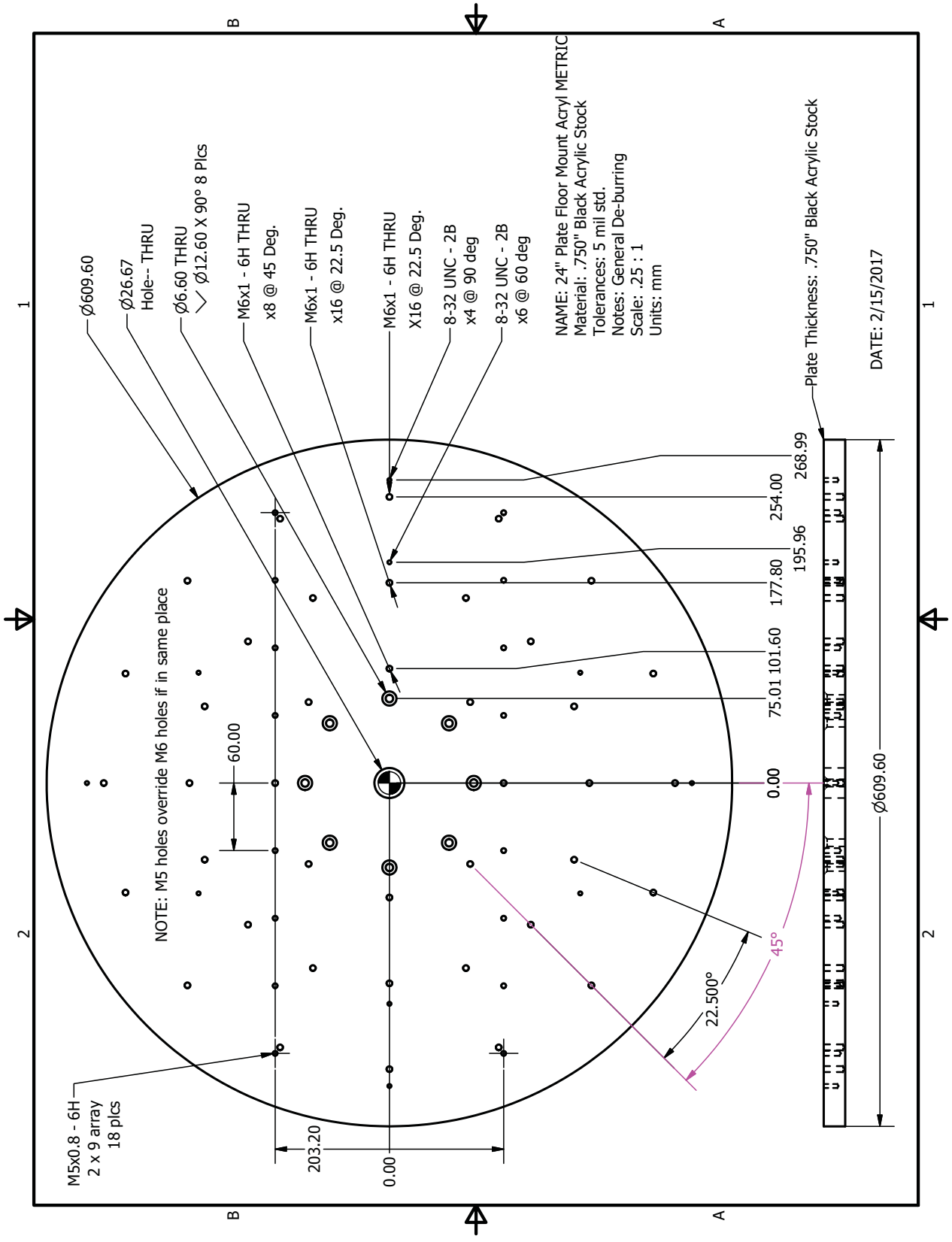
Appendix- Roll Plate drawing - SAE - Inch Units



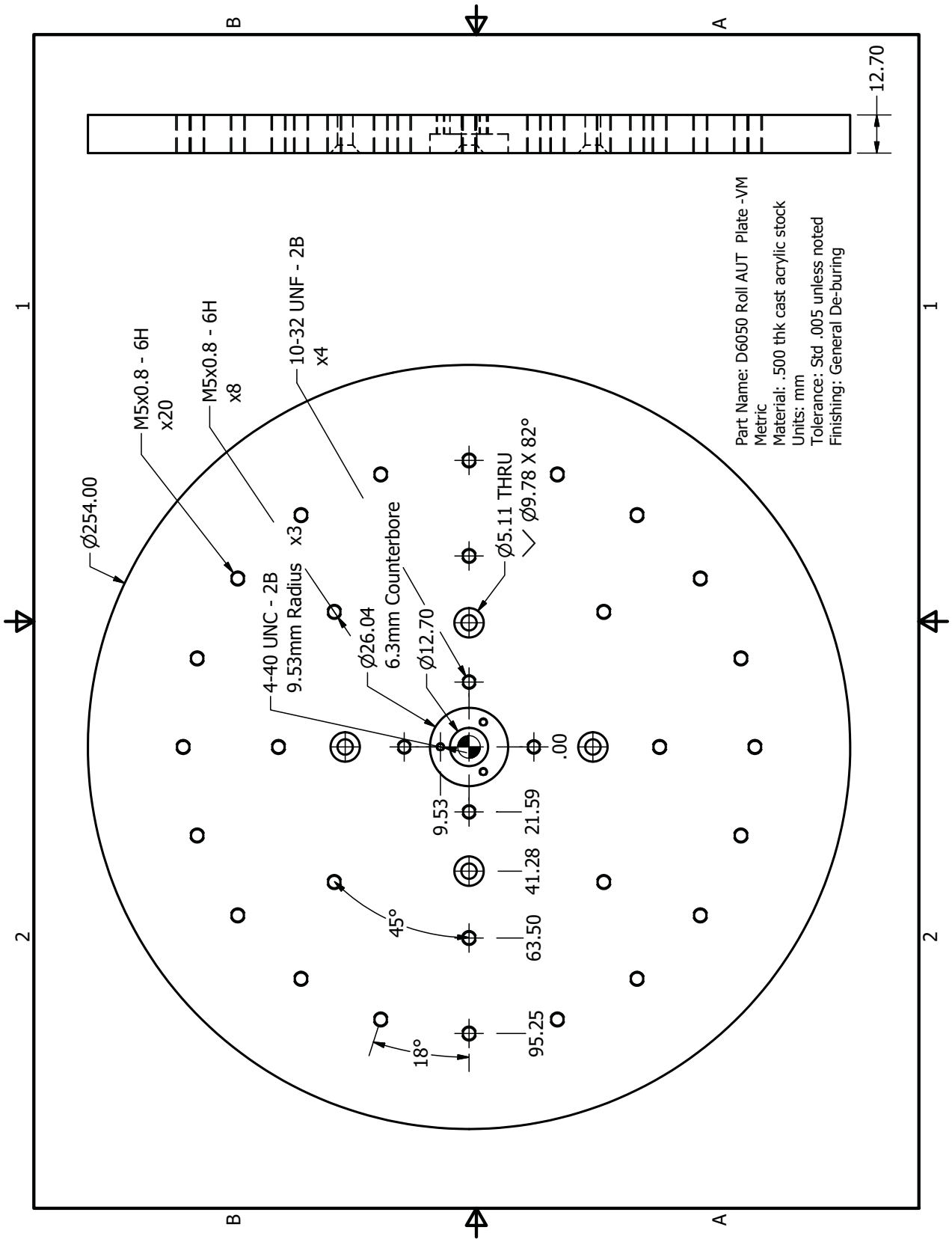
Appendix- Roll Plate drawing mmW-Spin - SAE - Inch Units



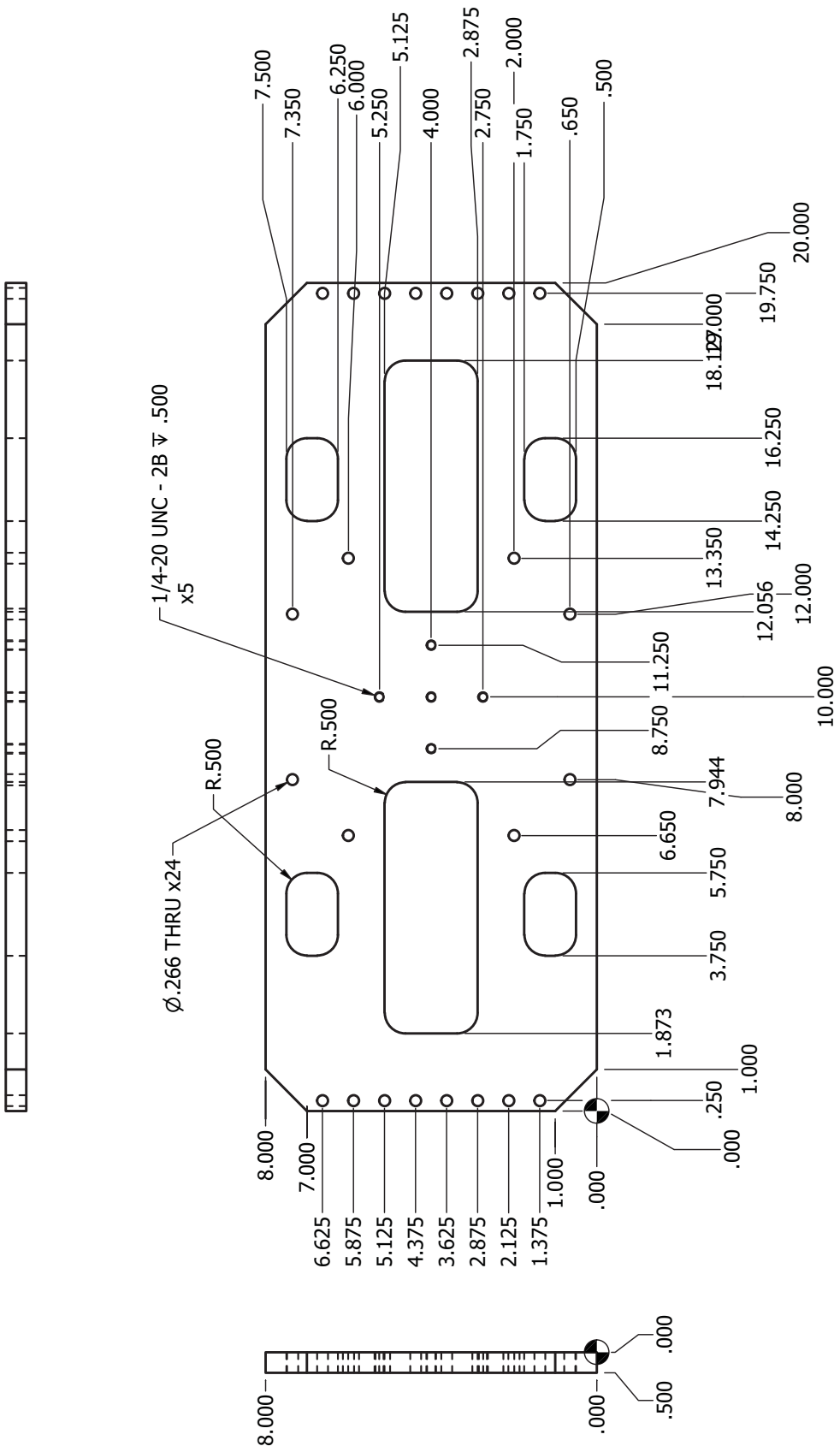
Appendix- Turntable Plate drawing - Metric - mm Units



Appendix- Roll Plate drawing - Metric - mm Units



Appendix- Gimbal Tray Drawing



Warranty, Replacement Parts & Contact Information

Warranty Information

Diamond Engineering's Antenna Measurement Systems are guaranteed from one to three years on parts and labor from the time it was received by you. If there is an issue with the product please send us a picture or write a very detailed description of the problem. If we determine that you have a faulty unit or a bad part, we will ship you a replacement part or unit along with a pre-paid self-addressed box to send the defective unit back.

Replacement Parts

If you ever need a replacement part for your unit, please call us or e-mail us for pricing information. Most repairs are covered under warranty except for damages resulting from obvious abuse or misuse of the product.

Contact Information

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