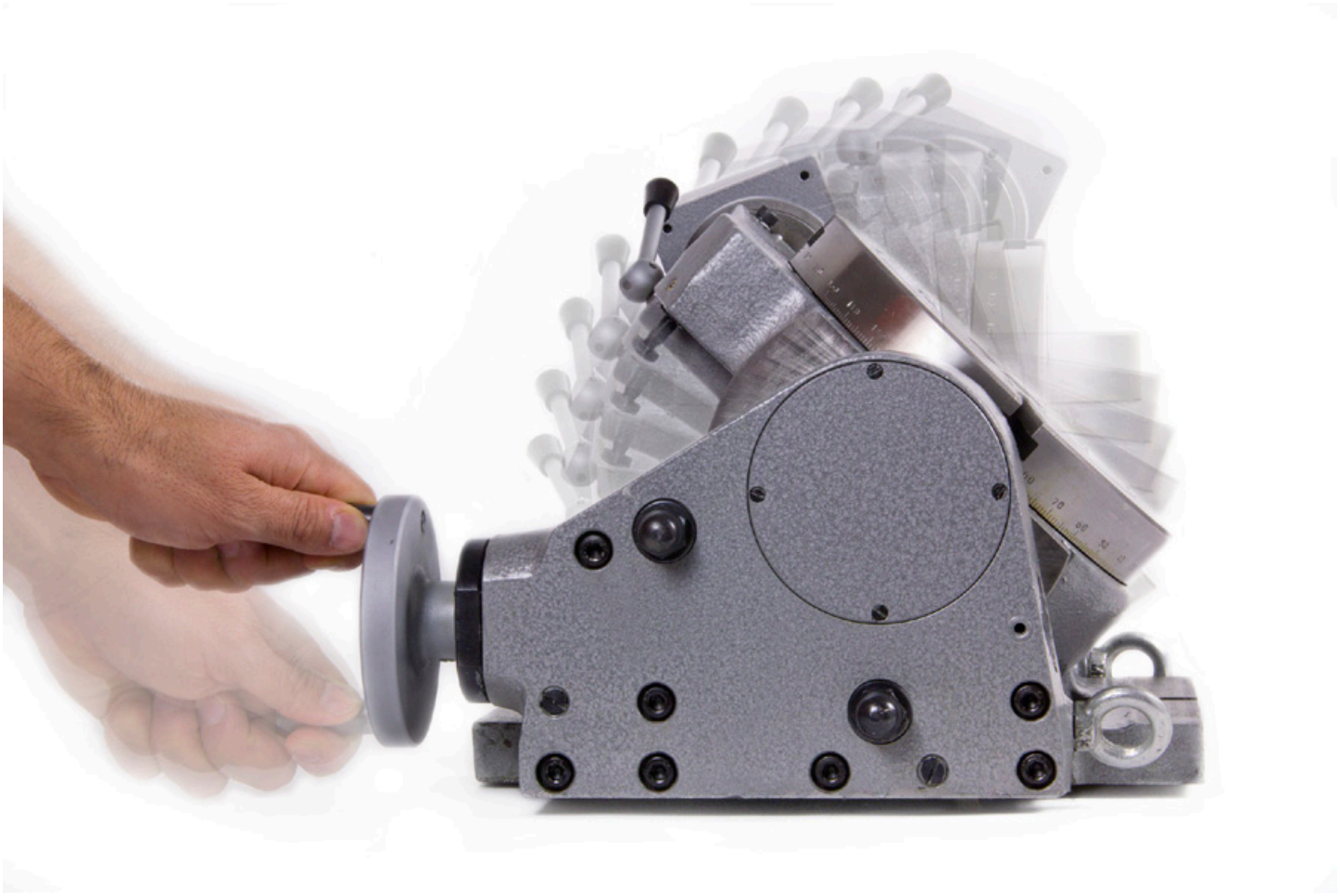
TORMACH 4TH AXIS AND ROTARY PRODUCTS

Operator's Manual



Questions or comments?
Please e-mail us at:
info@tormach.com

Tormach Rotary Products Manual:
UM10069_4th_Axis_And_Rotary_Products_0313A

TABLE OF CONTENTS

1. PREFACE

1.1 Safety

Read all warnings and cautions before using this product.

WARNING! FIRST USE LUBRICATION
This product is shipped without lubricating oil and must be filled before being put into service. Refer to the Lubrication section. Operation without lubrication voids all warranties. Refer to the *Maintenance* section for detailed instructions on how to lubricate both standard and tilting rotary tables.

WARNING! OPERATION
There are many ways to injure yourself using this motorized rotary table. This is especially true when the table is mounted on a drill press or milling machine with rotating spindles and sharp cutting tools. The warnings that follow cannot cover all possible conditions or situations that can occur. Use caution and common sense when using this product.

CAUTION: BEFORE USING THIS ROTARY TABLE

- Read and understand these warnings and instructions AND THOSE OF ANY MACHINERY it will be used with.
- MAINTAIN THIS ROTARY TABLE WITH CARE. Keep it clean and dry and when servicing use only identical replacement parts. Use only accessories intended for use with this rotary table.
- WEAR ANSI APPROVED EYE PROTECTION. Ordinary eyeglass only have impact resistant lenses and no side protection; they are not SAFETY GLASSES . A scratched cornea from a chip in the eye is very painful.
- WEAR APPROPRIATE APPAREL. Do not wear loose clothing, neckties, jewelry, gloves or anything that may get caught in moving parts. Contain long hair in a protective covering and wear nonskid safety footwear. Having a hand pulled into a cutting tool and mangled is not much fun.
- DO NOT OVER REACH. Keep proper footing and balance at all time to prevent tripping, falling, back injuries, etc.
- KEEP WORK AREA CLEAN. A cluttered work area invites injuries.
- USE A BRUSH TO REMOVE CHIPS. Using bare fingers can result in injury from slivers. Only remove chips after the cutter has stopped. Do not use a rag.
- NEVER USE YOUR HANDS TO HOLD A WORKPIECE IN PLACE. Always use a vise, clamps, or a fixture, and keep hands clear in case a part shifts unexpectedly.
- ALWAYS SECURELY CLAMP THIS ROTARY TABLE TO THE WORK TABLE IT WILL BE USED ON.
- DO NOT USE IF UNDER THE INFLUENCE OF ALCOHOL OR DRUGS OR WHEN TIRED OR DISTRACTED.
- KEEP CHILDREN AND VISITORS AWAY. To avoid distraction and injury keep all children and visitors a safe distance away, and make the workshop child proof with padlocks, master switches and safe storage of starter keys.
- DO NOT DROP. This rotary table is heavy and can cause serious damage or injury if dropped.
- DO NOT CUT OR PULL ON THE ELECTRICAL CABLE. Damage to the electrical cable could result in personal injury or damage to the electronics. Pay particular attention to the cable to insure it will never contact a cutting tool.
- INSURE THAT ALL POWER IS OFF BEFORE PLUGGING CABLE INTO CONTROL UNIT.
- ROTARY TABLE SHOULD ALWAYS BE BONDED TO EARTH GROUND.
- INDUSTRIAL APPLICATIONS MUST ADHERE TO OSHA REQUIREMENTS.
- WHEN NOT IN USE: Clean off chips, apply a light coat of oil and store in a dry location to inhibit rust and keep locked up out of the reach of children.

1.2 Warranty

Warranty and support for all Tormach products is limited to use consistent with the intended use of the product. See our online warranty statement at www.tormach.com for details.

1.3 Products

There are four products in the Tormach motorized rotary table product line. Each product can be purchased individually or as a 4th axis kit that contains all of the components required to operate your rotary table as a 4th axis on a Tormach mill.

6 Inch Tilting Rotary Table (31847)

8 Inch Tilting Rotary Table (31848)

6 Inch Rotary Table (30267)

8 Inch Rotary Table (30194)

1.4 Application and Use

Applications

The Tormach motorized rotary tables are intended to be used for general machining. The tables have been designed and built for precision operations that involve large forces, cutting fluids, and continuous operation. They can be used in either a horizontal or vertical position.

Our motorized rotary tables are also popular with machine builders, manufacturing engineers, and OEMs for custom integration as a 4-axis CNC capability for third party machinery or incorporation in a custom motion or manufacturing work cell.

Typical uses include:

- As a 4th-axis on a CNC milling machine to make barrel cams, twist tracks, machined springs, cylinder engravings, milled screws, variable pitch screws, turbine blades, etc.
- On a manual milling machine or drill press for rapid indexing for drilling and milling. Work can include flange drilling, gear cutting, slot cutting, radial hole patterns, etc.
- To automatically position work so that multiple sides of a part can be machined with only one manual handling of the part. Part handling and errors decrease and accuracy increases.
- The table is not limited to indexing between operations. Ample torque is available for machining operations at the full outer diameter of 6” or 8”, while also providing sufficient rotational speed needed for operations at smaller diameters.

Features Include:

- Horizontal and vertical operation
- High performance, direct drive motor
- Removable 5/8” locating key
- Dual anti-rotation locks
- Adjustable worm gear for backlash correction
- Quick release of worm gear for free rotation
- Pre-wired AMP CPC power connector

This manual periodically references the series configuration of the PCNC 770 and PCNC 1100 mills. To help determine which series applies to your mill, consider the following list:

1100 Series I: Serial Number 1-1325
1100 Series II: Serial Number 1326-1999
1100 Series 3: Serial Number 2000 and higher

770 Early Models: Serial Number 70000-70199
770 Series 3: Serial Number 70200 and higher

1.5 Design Details

The Tormach motorized rotary tables utilize a direct drive principle instead of a belt drive. This approach avoids the problems of side loading on the worm screw bearing. The motors are sealed against cutting fluids, chips, and dust.

In horizontal operation, the oversized coolant channels direct the coolant to your table channels. In vertical operation, the tables offer flat surfaces for rigid clamping both in front and behind. T bolts, nuts, and low profile clamp bars are all included. There is no need for unwieldy step blocks; the low profile clamps allow for extra work piece clearance.

Note: Allowing a direct stream or pool of coolant to contact the rotary joint between the table and base casting is not advised.

1.6 Performance Expectations

Machining is a mixture of science, skill, and art. The caveat in stating accuracy and repeatability is that these factors depend on the techniques used by the machinist. A skilled machinist can often deliver accuracy that exceeds the accuracy specified by the machine builder, while an inexperienced machinist may have difficulty delivering the expected accuracy. Nevertheless, the accuracy specified by a machine builder remains an important reference point. Tormach rotary tables are accurate to within 30 arc-secs of backlash.

The Tormach Motorized Rotary Tables can be used for a wide variety of machining operations. Whether drilling bolt patterns, milling angled slots, or making simple gears, the rotary tables offers quick and accurate indexing or consistent rotary feed. When integrated to your CNC machine they provide a cost effective way to turn a 3-axis machine into a 4-axis machine.

The motorized tables can also operate as stand-alone indexers when integrated to your existing CNC control system. Integration requires an industry standard bipolar stepper motor driver.

1.7 Accessories

The utility of the Tormach Motorized Rotary Tables can be further extended with our rotary table accessories:

4th Axis Kits: The 4th Axis kit includes a motorized rotary table, driver, and complete installation wiring harness to add a 4th axis to the PCNC 1100 or 770. The kit supports continuous coordinated motion between X, Y, Z and 4th axis.

4th Axis Kit (Standard: 6" = 30290, 8" = 30289) (Tilting: 6" = 31996, 8" = 31997)

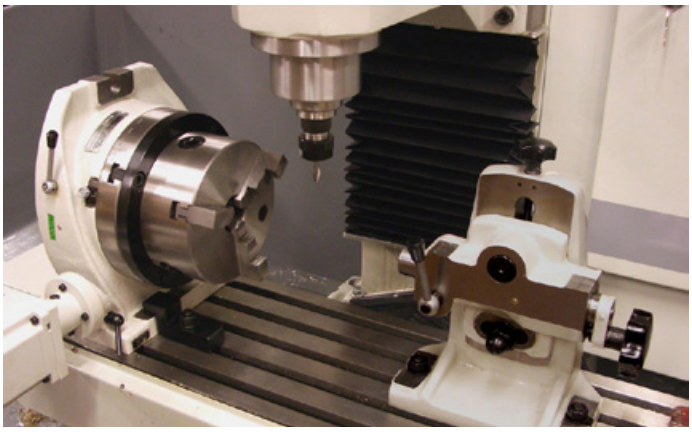
Chucks: 2, 3, and 4 jaw chucks with adapters for mounting the chuck to the rotary table.

2 Jaw Chuck (6" = 32627, 8" = 32622)

3 Jaw Chucks (8" = 30291, 6" = 30292) and 4 Jaw Chucks (8" = 30293, 6" = 31721)

Tailstocks: Support is needed for the end of the work piece when working on relatively long parts and the table is in the vertical position. Tormach offers height and angle adjustable tailstocks. A typical tailstock setup is shown in the figure below. Tailstocks are currently available in tall and medium sizes. Reference the Tormach website to determine which tailstock configuration is recommended for your rotary table.

The centering pin for the 8 inch tailstocks is included in the wooden shipping box. Make sure you find the center pin before discarding the box.

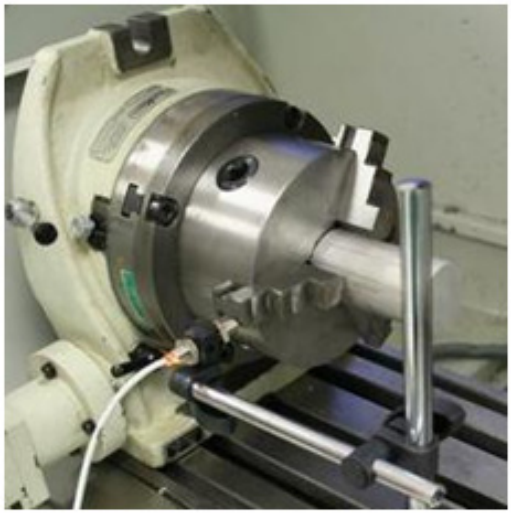


8" Rotary Table with 3 Jaw Chuck and Tailstock

5C Collet Fixture and Adaptor: These accessories will mount 5C (lathe type) collets on the rotary table. Supplied with closure key and precision centering adaptor and all required mounting hardware.

5C Collet Adaptor (Top) and Fixture (Bottom) (8" Adaptor = 30294, 6" Fixture = 31414, 8" Fixture= 31415)

4th Axis Homing Kit: The Tormach 4th Axis Homing Kit is an accessory to the PCNC 1100 and 770 mills that can be used to reference a fourth axis to a repeatable home position. This eliminates the need to re-indicate work after a power cycle, eliminates "rewinding" of the axis after operations that jog the axis in one direction only, and reduces set-up time for fourth axis work. The kit includes 1 inductive proximity sensor, with 6' lead and DIN plug to interface to a Tormach mill accessory plug as shown.



4th Axis Homing Kit (31921)

Collet Set: Several different collet sets are available for purchase on the Tormach website. The collet sets are available in both Metric and Imperial units, in pre-sprung and/or standard configurations.

Choices are:

- 15 Piece 5C round collet set - 1/8" to 1" sizes by 1/16" increments as shown in the figure below. (30252)
- 15 Piece 5C Collet Set - pre-sprung for easy workholding and automatic collet closer applications. Set covers 1/8-1" nominal diameters. (32275)
- 13 Piece 5C Metric Collet Set - pre-sprung for easy workholding and automatic collet closer applications. Covers 13-25mm nominal diameters. (32307)
- 9 Piece 5C Metric Collet Set - pre-sprung for easy workholding and automatic collet closer applications. Covers 4-12mm nominal diameters. (32308)

5C Collet Set

Tooling Adaptor: On the 8" tables only use the 3MT x 3/4" collet and drawbolt to mount quick change TTS (Tormach Tooling System) and 3/4" shank tooling.

MT3 Collet and Drawbolt (30233)

Bulkhead Mount Electrical Connector: For cabinet mounted connection to stepper driver, AMP 211398-1 with solder sockets.

Note: These pieces are included with the 4th Axis kit shown.

Bulkhead Mount

Oil Can: 8 oz. Oil Can with trigger activation. Suitable for applying oil to Zerk fittings on Tormach 4th Axis as shown in the figure below.

8oz. Oil Can (32398)

2. PREPARATION

2.1 Uncrating and Inspection

When you receive your Rotary Table, inspect the shipping container and all parts for damage. If any parts have been damaged in shipment please notify Tormach and report the damages. Keep an eye out for any small parts or hardware that may have come loose during shipping.

Note: The centering pin for the 8" Rotary Table is included in the wooden shipping box that the adaptor plate comes in. Make sure you find the center pin before discarding the box.

The pin is a light press fit and can be done by lining up the pin with the hole in the adaptor plate and then slowly closing the vice to set the pin. You can also leave the pin out if you need to use the through hole on the rotary table.

Inside the shipping crate, you will find:

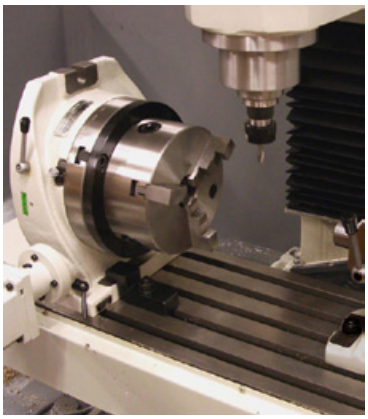
- Motorized Table
- Toe Clamps and T-nuts

2.2 First Lubrication and Backlash Adjustment

Tormach Rotary Tables are shipped without lubricating oil and must be filled before being put into service. Refer to Lubrication in the Maintenance section. Operation without lubrication voids all warranties. Adjusting backlash is recommended for new tables to ensure accuracy, see the *Maintenance* section.

2.3 Mounting Vertically (Typical A-axis)

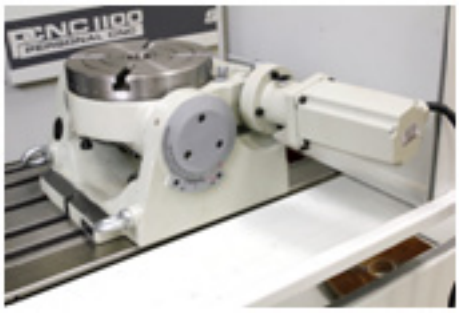
Typically, this is done with a rotary table with the 4th Axis positioned on the left-hand side of the table, as shown. Use the Toe Clamps provided to secure the 4th Axis to the table. With the Tilting Rotary Table the 4th Axis is typically positioned on the right hand side of the table, to avoid interference with the spindle head and cutting tool.



A-Axis Mounting

2.4 Mounting Horizontally (Typical C-axis)

Typically, this is done with a rotary table positioned in the center of the table as shown. Use the Toe Clamps provided to secure the Rotary Table to the table of the mill.



C-Axis Mounting

3. ELECTRICAL INSTALLATION

3.1 Product Identification

These procedures apply to PCNC 1100 Milling Machine Serial Numbers 1000 to 9999 and all PCNC 770's.

CAUTION! IF YOU HAVE AN EARLIER MACHINE, SERIAL NUMBER 001 TO 999, DO NOT USE THESE INSTRUCTIONS. INSTEAD REFER TO SERVICE BULLETIN 14, WHICH IS INCLUDED IN YOUR 4TH AXIS KIT.

3.2 Background

The fourth axis can be used as a rotary table (i.e., with its axis of rotation parallel to the Z-axis) or more commonly as a dividing/indexing head with its axis of rotation parallel to the X-axis.

Note: Most pictures relate to the PCNC 1100 but are applicable to the PCNC 770.

3.3 Tools Needed

The 4th Axis is supplied as a kit of parts that interface your rotary table with your Tormach mill (see the *Accessories* section). It does not require any special knowledge to install. You will need a Phillips (#2) screwdriver, a small screwdriver, a set of wire cutters, a set of simple crimping pliers and, ideally, a hot air gun.

4th Axis Kit

WARNING! BEFORE CONTINUING, UNPLUG THE PCNC AND THE COMPUTER/ COOLANT CIRCUITS FROM THEIR WALL OUTLETS AND WAIT UNTIL ALL POWER LIGHTS IN THE CONTROL CABINET GO OUT.

3.4 Mounting the Interface Connector

Remove the blanking plate below the main switch on the right hand side of the control cabinet. Retain its screws.

Note: Some machines will have this hole already pre drilled. Use the larger of the 2 holes for the 4th axis.

Drill out the four holes in the flange of the rotary table interface connector with a 5/32" (4 mm) twist drill.

Note: This step may not be required on newer machines or PCNC 770's.

Thread the wires of the interface connector through the cabinet side. Using the original screws, fix the connector flange. The dust cap should be fixed with the bottom right screw.

Connector and Dust Cap

Remove the covers from the cable troughs and put temporary labels on the ends of wires 320 thru 323. Lightly twist 320/321 as one pair and 322/323 as another pair. Lay them into the cable trough so that they emerge upwards in the top right hand corner of the cabinet where the 4th axis driver will be mounted (at D in the figure on the next page).

Cable Runs in Cabinet

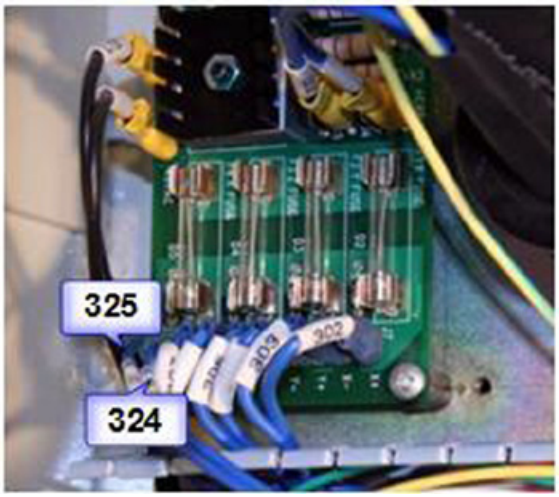
Shorten the ground wire (Green/Yellow) so it neatly reaches a spare screw on the ground bar. Crimp the ring terminal onto this wire and screw it onto the ground bar.

Ground Connection

3.5 Power Wiring (PCNC1100)

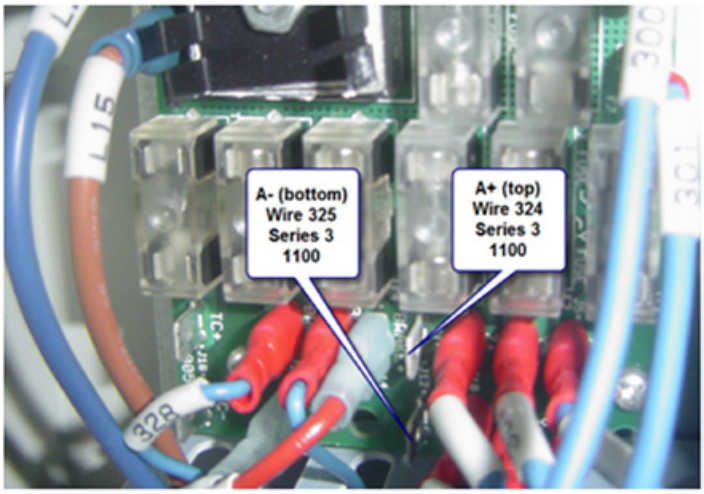
Take the power cable with the two ¼" "Faston" connectors (has wire labels "324" and "325") and cut it into two halves. Plug the "Faston" connectors onto the unused spades on the DC Bus Board (at P in the figure of the cable runs in the cabinet above).

Series I and Series II: Wire 325 goes on the left hand connector (marked –A) and wire 324 goes on the right hand one (marked +A).



PCNC 1100 Series I and Series II Connection to the DC Bus Board

Series 3: Wire 325 goes on the bottom connector (marked –A) and wire 324 goes on the top one (marked +A).

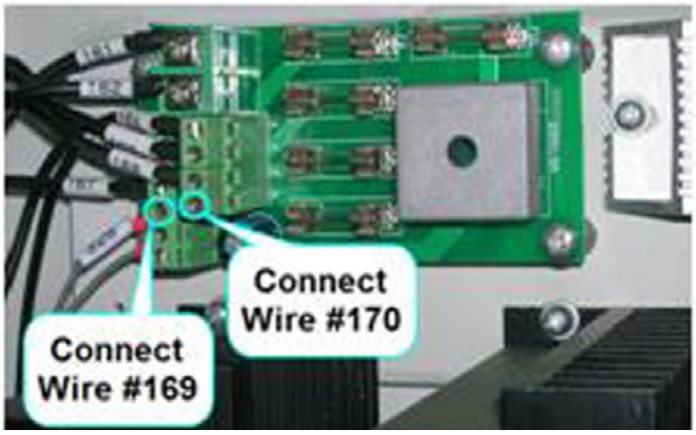


PCNC 1100 Series 3 Connection to the DC Bus Board

3.6 Power Wiring (PCNC770)

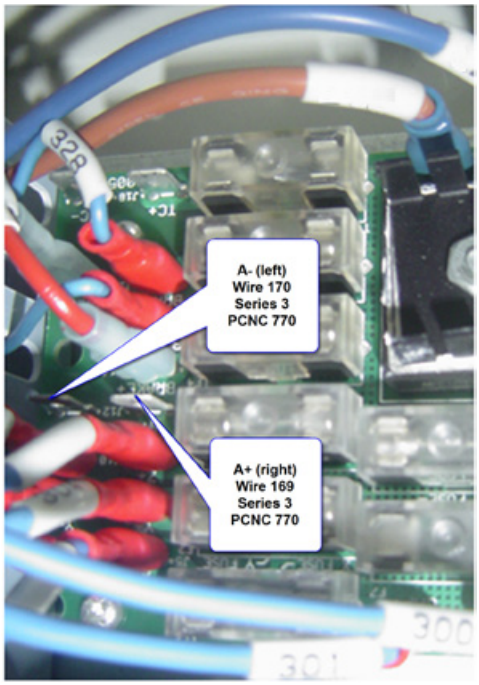
Take the power cable with wire labels “169” and “170” and cut it in 2 halves.

Series I: Connect the end with the label to the AC distribution board (upper left corner of cabinet) as shown in .



PCNC 770 Series I Connection to the AC/DC Distribution Board

Series 3: Connect wires 169 and 170 to the DC Bus Board. Wire 170 goes on the left connector (marked –A) and wire 169 goes on the right connector (marked +A).



PCNC 770 Series 3 Connection to the DC Bus Board

3.7 Fitting the Driver Module

Carefully remove the screw connector block from the pins of the 4th axis driver module.

Driver Module with Connector(s)

Note: Older machines will have 2 blocks.

The 4th axis driver module is secured in the cabinet with 2 M4 screws (8mm or 10mm long).Loosely insert the bottom screw into the tapped hole (at D in the figure). Rest the driver module on this screw and insert the top screw. Finally tighten the bottom screw.

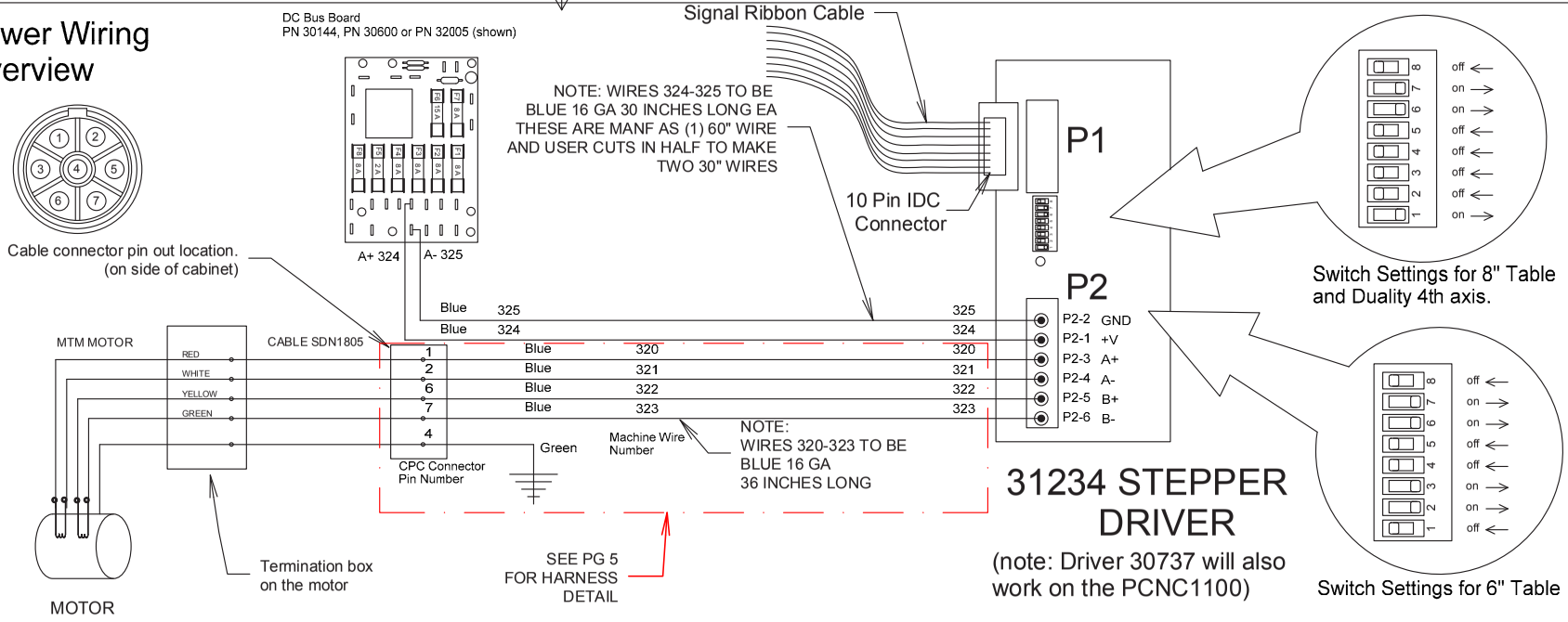
Cable Runs in Cabinet

3.8 Cutting and Labeling the Power Wires

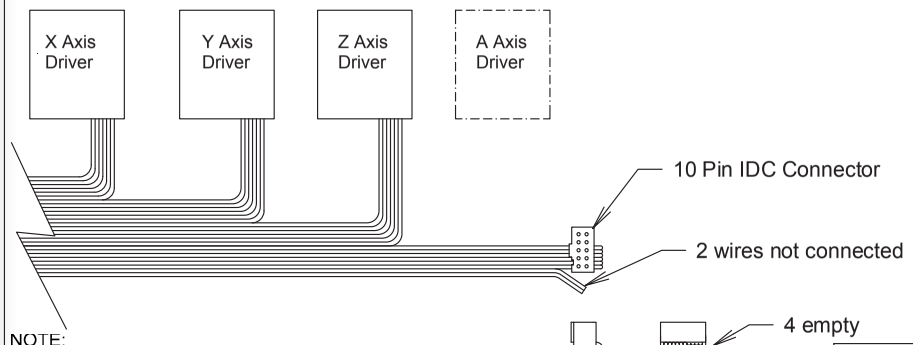
One by one, cut the wires 320 thru 325 to length so that they will neatly connect to the 4th axis drive module. This procedure is described in the *Connecting to Terminal Blocks* section in the *Electrical Installation* chapter. Strip about 1/8” of insulation from the end of the wire.

Wrap the appropriate wire number tag around the wire and protect it with a length of clear heat-shrink sleeve. It is very important that the wires are correctly identified. See the wiring schematics shown on the following two pages.

Power Wiring Overview



Signal Wiring Overview



NOTE:
IDC (ribbon cable connector) is used in conjunction with PN 30589. This is a small circuit board which adapts the 10 pin IDC to the drive signal inputs.

NOTE:
Only 6 wires of the cable are used. 4 should be empty. The last 2 wires of the 26 pin connector are not used. Of the 26 wire cable, 6 go to each of X, Y, Z, and A drivers, 2 wires are not connected.

Notes:
Installation of the 4th axis wiring kit is further detailed in the Rotary Products instruction manual (UM10069), chapter 3.

Wiring is identical for 6" and 8", tilting and standard tables as well as the Duality Lathe 4th axis. This applies to all PCNC 1100's up to and including Series 3.

Related Part Numbers
PN: 30488 4th axis integration kit for all rotary tables and Duality Lathe 4th axis Kits including the following:30289, 30290, 31702, 31996 and 31997.

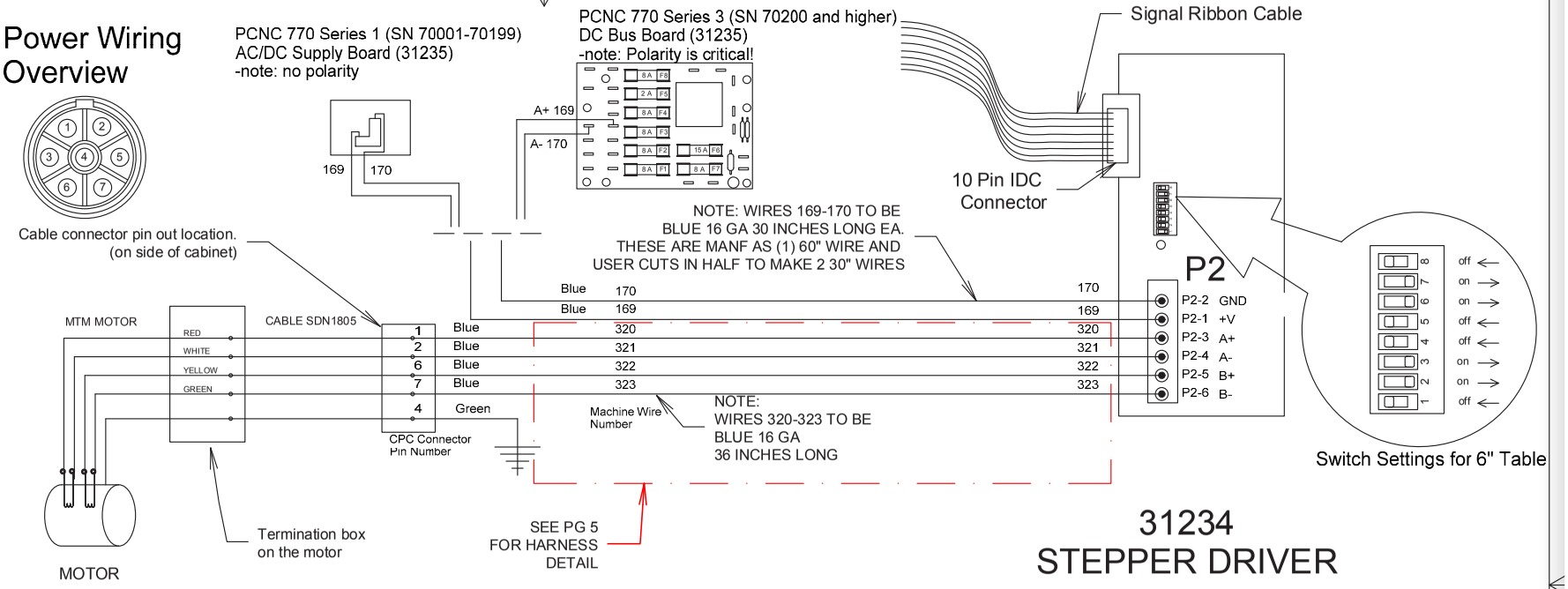
PCNC 1100's, serial number 001-999 require an additional mounting bracket (32011), not included with this kit.

NOTE:
This drawing is used in the rotary table manual "UM10069" which must be updated when this drawing is revised.

TORMACH
Tormach
204 Moravian Valley Rd., Suite N
Waunakee, WI 53597
Phone: 608.849.8381
www.tormach.com

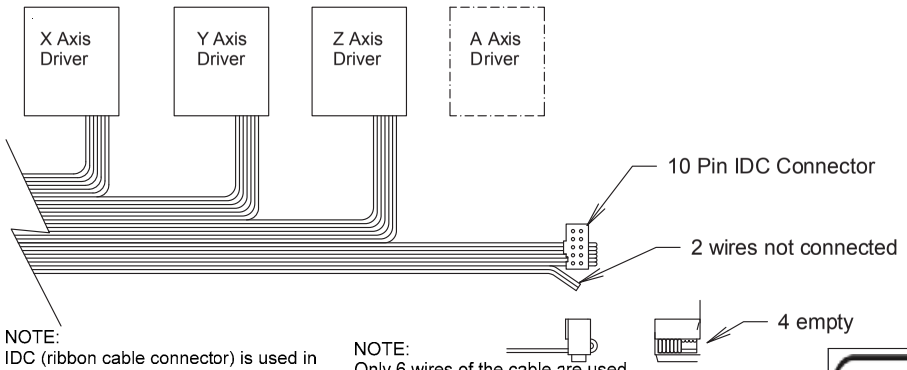
TITLE	Wiring Detail for 4th Axis Driver & Motor. Applies to all PCNC 1100's			
SIZE A	CAGE CODE	DWG NO D40130		REV J
SCALE			SHEET 3 of 5	

Power Wiring Overview



31234 STEPPER DRIVER

Signal Wiring Overview



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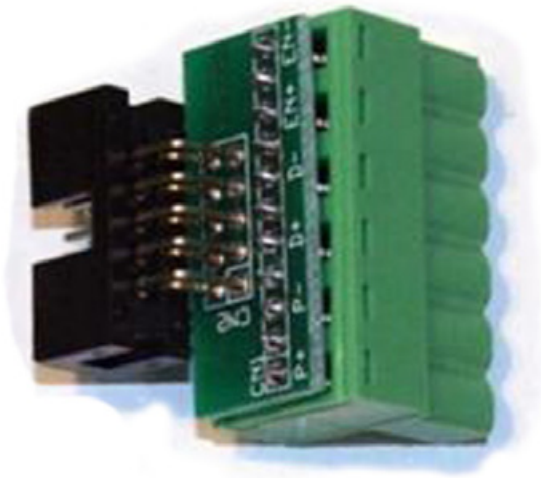
TITLE	Wiring Detail for 4th Axis Driver & Motor. Applies to PCNC 770 machines		
SIZE A	CAGE CODE	DWG NO D40130	REV J
SCALE		SHEET 4 of 5	

3.9 Mounting the Signal Adaptor

NOTE: Newer 4th axis kits do not require this adapter as it is built in to the drive.

Locate the ribbon cable in the cable trough. It should have a 10 pin IDC (insulation displacement connector) attached.

The drive connector normally uses discrete wire connections. Tormach provides a signal adaptor that will allow you to plug in the signal cable instead of installing discrete wires. The pins of the adaptor are installed in the terminal block.

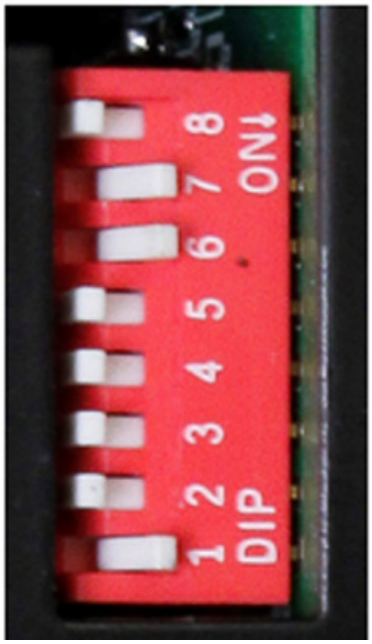


Adapter Mounted on Connector

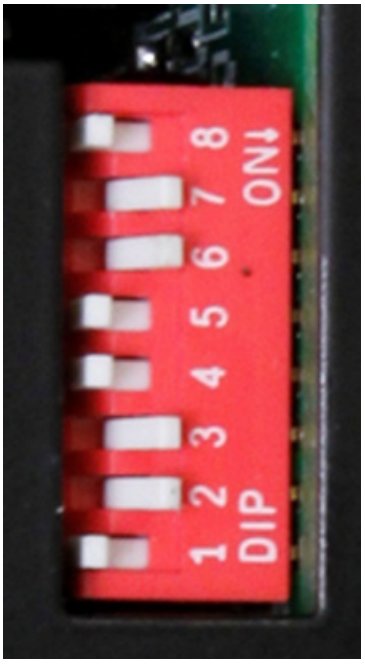
The adaptor will appear to be firmly mounted if you tighten only two screws, but make absolutely certain that you tighten all 6 of the terminal screws. You are likely to suffer intermittent electrical problems (the worst kind) in the future if you do not tighten each of the terminals against their corresponding pins.

3.10 Setting the DIP Switch

Before the final wire connections are made, you need to set the DIP switch according to your table size. The following figures show the DIP switch settings for both the 6” and 8” table.



DIP Switch Configured for 8” Table



DIP Switch Configured for 6” Table

3.11 Connecting to Terminal Blocks

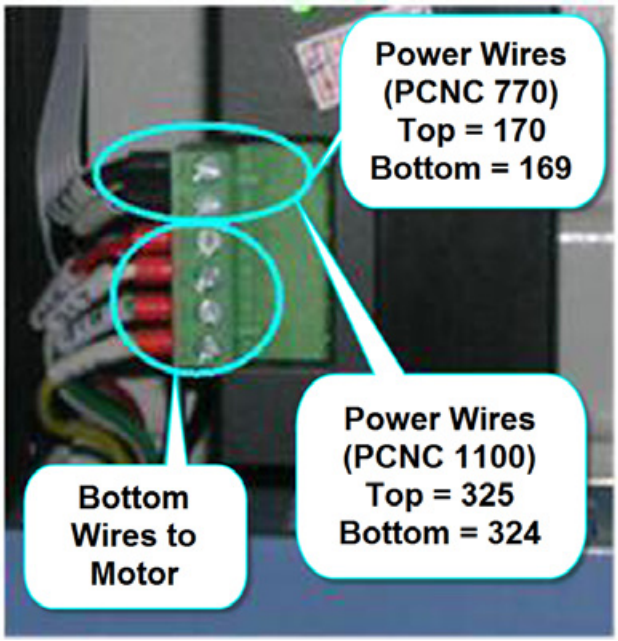
The six terminals on the bottom are for power. The six terminals (or IDC connector) on the top are for control signals. The control signal ribbon cable is plugged into the adaptor/IDC connector. This ribbon cable is already in your machine cabinet. Remove the wire trough cover and locate the ribbon cable going to the other drivers, attached to this will be a 4th connector to be used for this procedure.

Plug the ribbon cable into the top of the drive, as shown.

Connecting the Ribbon Cable

The power wires should be installed with the wire numbers visible. Use the electrical diagrams following the C*utting and Labeling the Power Wires* section for reference. We recommend you attach the included wire labels.

CAUTION! FOLLOW THE ELECTRICAL DIAGRAM TO ENSURE THE CORRECT WIRES ARE LABELED WITH THEIR CORRESPONDING LABELS.



Completed Power Connections

3.12 Final Check Before Power Up

After everything is assembled, review the wiring in detail:

1. Check closely to see that there are no individual strands of copper wire loose, a magnifying glass can help.
2. Confirm each of the wire numbers for the power wires.
3. Confirm the wire clamps are clamping on the copper wire and not clamping on the plastic insulation.

Note: The positions of wires 324/325 (PCNC1100) and 169/170 (PCNC770) are vital.

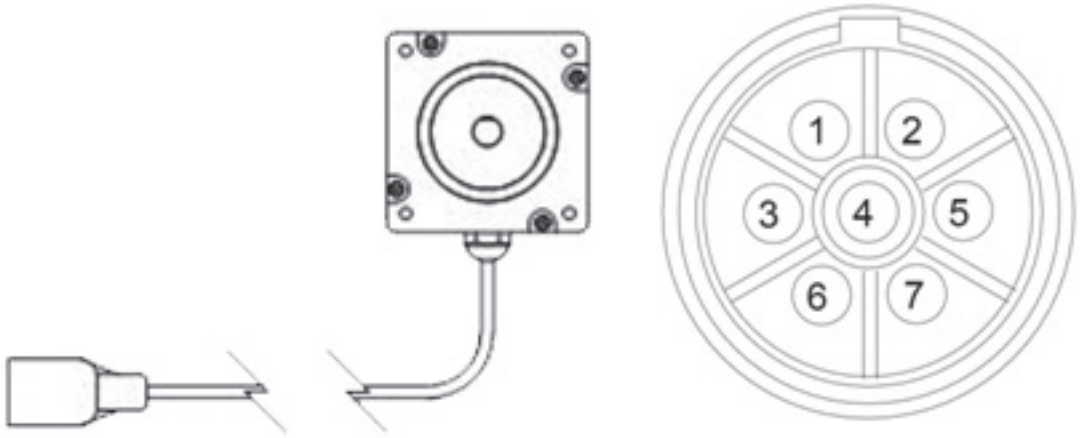
4. If these are reversed then the driver module will be destroyed within 0.030 seconds when you switch on the PCNC. If you have an ohm-meter or reasonable digital multi-meter then you can check the other power wiring with it. Plug the rotary table into its connector on the side of the cabinet but remove the plug from the driver (shown in the figure for the completed power connections). This will allow you to measure the motor resistance, confirming the correct wire connections. Measure the resistance between wires 320 and 321 at the driver module. It should be between 1 and 5 ohms. The exact value depends on the model of rotary table. The resistance between wires 322 and 323 should be the same ±10%. There should be no connection between 320 and 322.

Finally replace the covers of the cable troughs, plug in the rotary table, reconnect the mains power and switch on the PCNC. The power LED on the newly installed driver module should light. Run the control program. You should be able to jog the rotary table using the + and - keys on the numeric pad.

3.13 Integrating with a Custom System

The motor, cable and, plug are shown in the following figure and the motor wiring chart is shown in the corresponding Motor Wiring Chart.

- The Cable Plug is: AMP CPC series 211400-1
- The Mating Receptacle is: AMP CPC series 211398-1



Motor, Cable, and Plug

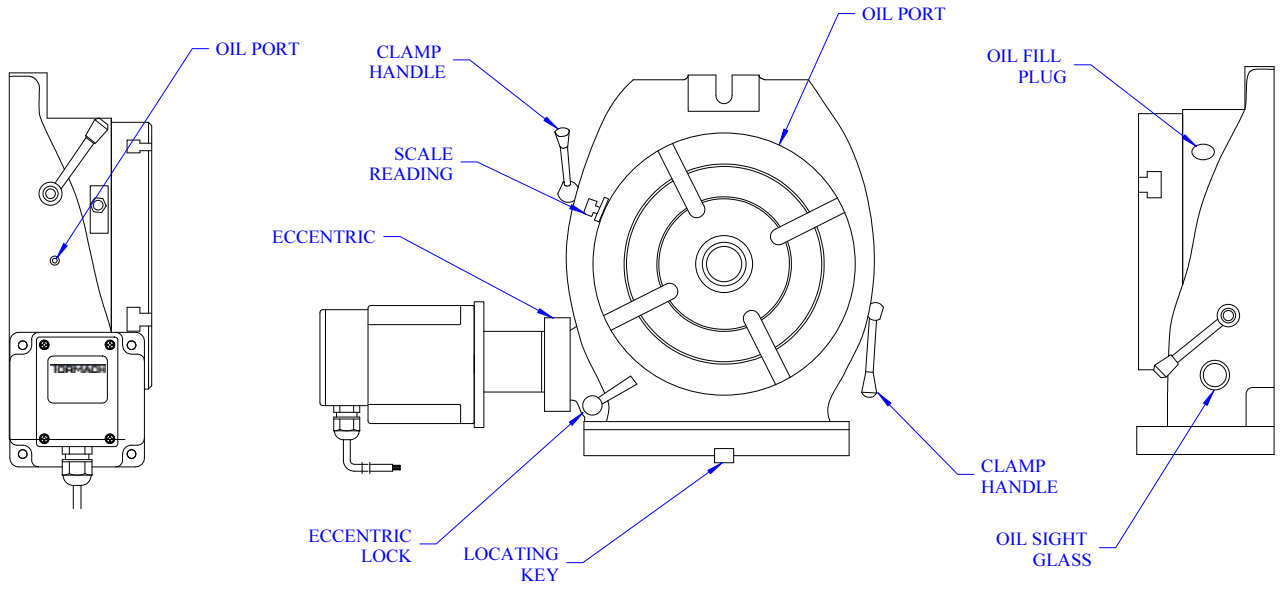
Plug Pin	Cable	Motor Connection	Motor Function
1	White 1	Red	Phase A+
2	Black 1	White	Phase A-
3	NC		NC
4	Shield	Case	Case ground
5	NC		NC
6	White 2	Yellow	Phase B+
7	Black 2	Green	Phase B-

Motor Wiring Chart

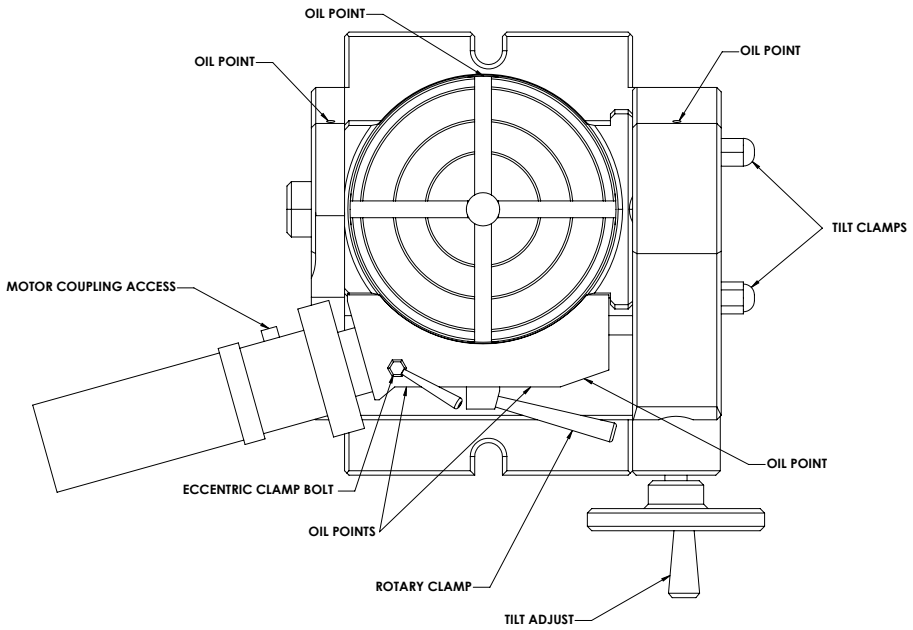
4. BASIC OPERATION

4.1 Overview and General Operation

Components of the Rotary Table and Tilting Rotary Table are as follows:



Rotary Table Components



Tilting Rotary Table Components

PRIOR TO FIRST USE THE ROTARY TABLE MUST BE OILED AND BACKLASH SHOULD BE ADJUSTED.

CAUTION! THE ROTARY PRODUCTS ARE SHIPPED WITHOUT LUBRICATING OIL. THEY MUST BE OILED PRIOR TO FIRST USE AS DESCRIBED IN THE MAINTENANCE IN CHAPTER 6. OPERATION WITHOUT LUBRICATION VOIDS ALL WARRANTIES.

Adjust Backlash: Prior to first use, adjust the backlash of the rotary products table as described in Chapter 6 prior to first use.

Rotary Clamps: To keep the table from rotating during heavy milling operations, tighten the clamps with the clamp handles. The clamps should be loosened during motorized rotation to allow free rotation. If the clamps are left locked during a move, correct position will likely be lost.

Tilt Clamps: The tilting rotary table also has two nuts that are tightened to lock the tilt position. These must be tightened prior to machining.

Engaging and Disengaging the Worm Drive:
On the standard rotary tables, to disengage the worm wheel so the table can be turned by hand, loosen the eccentric lock/eccentric clamp bolt (part 25), rotate the eccentric by turning the motor mount (part 39) as far as it will rotate clockwise, and tighten the eccentric lock. To reengage the worm loosen the eccentric lock/eccentric clamp bolt, rotate the motor mount as far as it will rotate counter clockwise, and tighten the eccentric lock/eccentric clamp bolt.

The table may need to be rotated by hand slightly so the worm can engage the worm wheel. If the worm is not completely engaged the table will exhibit excessive backlash. If you disengage the worm from the worm gear frequently scribe or paint a line on the motor mount as a position indicator to remind you when the worm is disengaged.

Scale Pointer: Used to read angles directly off the table, the clamp holding it in place can be loosened to allow the pointer to be moved to an exact degree mark.

Vertical Setup: Chucks or fixtures to be used with the table in the vertical position are often easier to setup if the table is first horizontal and then moved to the vertical position.

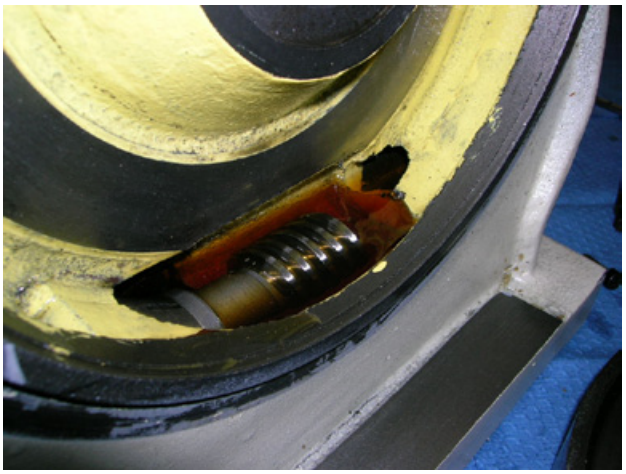
Work Holding: The center hole is ground to an MT3 taper (8 inch tables) or an MT2 taper (6 inch tables) to fit work holders, and concentric with the taper there is a hole which is used to locate a three or four jaw chuck or other tooling. See the *Workholding* section for more information.

Coolant: The electric motor is sealed against cutting fluids. However, submersion or setups where the motor or motor cable are under constant flow or exposed to high pressure coolant jets should be avoided. Keep the motor body painted, particularly the magnetic laminations in the center. To prevent rust from trapped water based coolants on the table base (and the surface it is bolted to), wipe a thin film of oil on those surfaces before setting the table up.

Wear: Try to distribute wear over the whole of the worm gear. When doing long runs of constant back and forth movement, occasionally reposition the table top and work holding fixture. Or if moves are close to 180 degrees, continue rotating in the same direction to the start point rather than returning in the opposite direction. Or if the part permits, program the start point to change a few degrees each time.

4.2 Locking the Eccentric

Power is transmitted from the stepper motor to the rotary table by a worm gear at the end of the drive shaft as shown. Use the lever (standard table) or clamping bolt (tilting table) to lock the eccentric sleeve from rotating. This must be done before the worm drive is engaged to prevent the drive from disengaging during use.



Worm Gear

5. WORKHOLDING

5.1 Direct Mount to the Table

The 6” tables have 3/8” T-slots and the 8 inch tables have 11 mm T-slots. These can be used in combination with T-nuts and a clamp set to hold work directly to the table. Similarly, you may also attach a vice or custom fixture plate to the table with bolts and T-nuts.

5.2 2 Jaw, 3 Jaw and 4 Jaw Chucks

2 Jaw chucks are a great solution for rapid prototyping workholding. The set includes a self-centering 2 jaw chuck with an adapter plate and mounting hardware, including jaw plates. The 8” kit includes a MT3 adapter ring.

3 Jaw and 4 jaw chucks are available for both the 6” and 8” table. Each chuck includes an adaptor plate and pin for mounting the chuck to the table and centering it to the rotational axis. Each chuck comes with both inside and outside interchangeable jaw sets.

5.3 5C Collet Holder

A 5C Collet holder is available for the 8” Table. It includes an adaptor plate for mounting and centering the holder.

5.4 5C Collet Adaptors

5C Collet Adaptors are available for both the 6” and 8” Table. These adaptors mount directly to the T-slots of the table

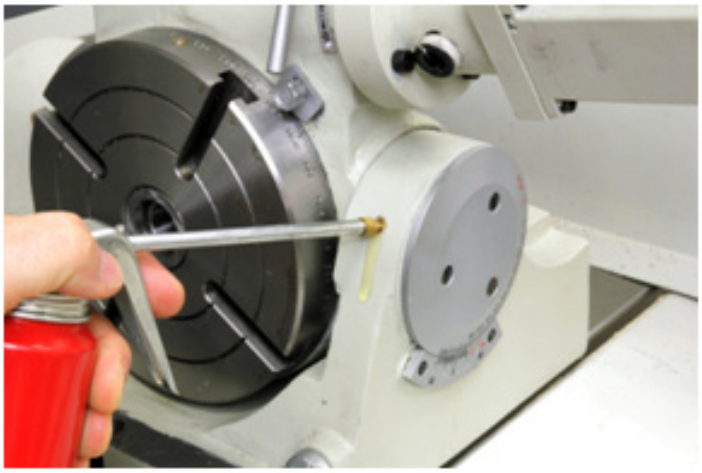
5.5 MT3 Collet and Drawbolt

The 8” table can accept an MT3 collet, held in with a drawbolt. This can be used in combination with a TTS (Tormach Tooling System™) tool holder as a low cost method for holding slender bar stock. The 6” table accepts an MT2 collet.

6.1 Lubrication

CAUTION! THE ROTARY PRODUCTS ARE SHIPPED WITHOUT LUBRICATING OIL. THEY MUST BE OILED PRIOR TO FIRST USE. OPERATION WITHOUT LUBRICATION VOIDS ALL WARRANTIES.

Filling the oil fittings will be easier with a trigger style piston pump oil can rather than diaphragm bottom (baby jar lid) type oil can. Depress the spring loaded ball with the tip of the oilier and pump until there is some back pressure. Tormach recommends an 8 oz. oil can with trigger activation. The oil can is suitable for applying oil to Zerk fittings on Tormach 4th Axis and can be purchased on the Tormach website (see the *Accessories* section in *Chapter 1*).



Filling a Spring Loaded Fitting

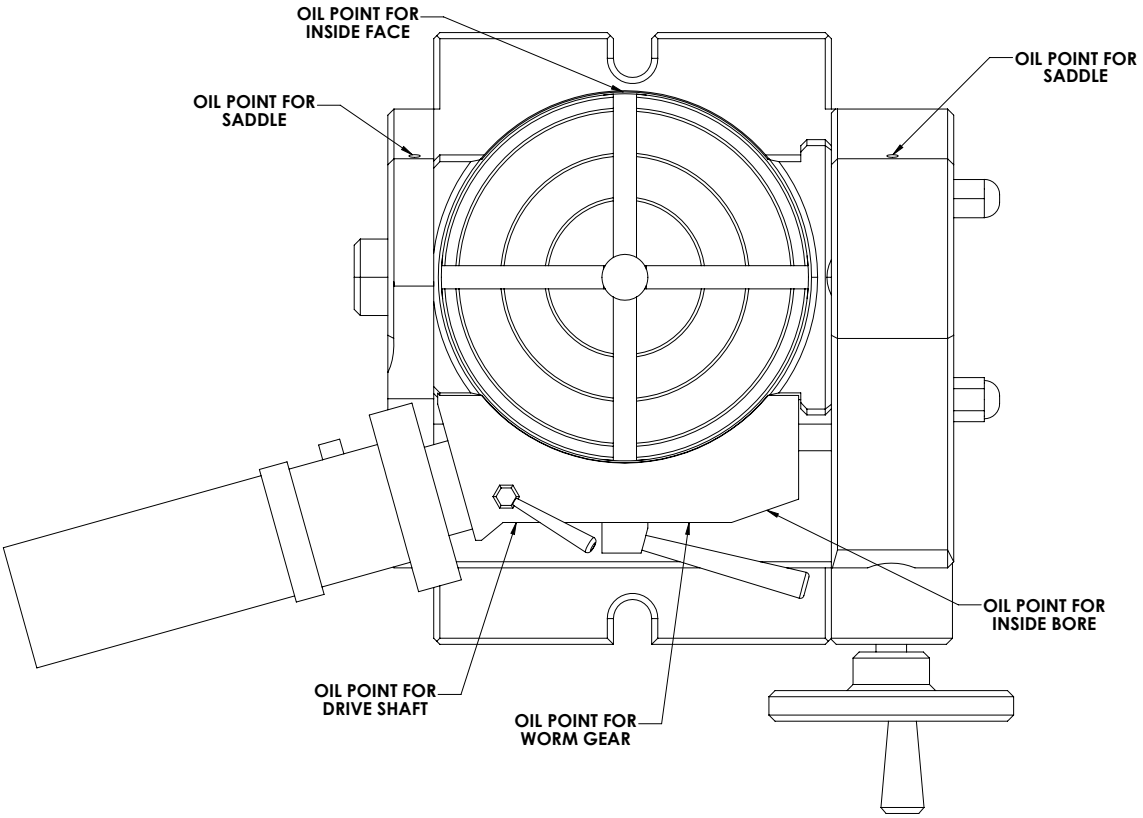
The standard rotary table has an oil reservoir and two spring loaded oil fittings sealing oil passages that must be filled with SAE 80 hypoid or ISO 68 or AGMA 2 gear oil or SAE 30 weight motor oil before first operation.

The oil reservoir on the standard rotary tables is filled through the oil plug (part 11). When possible the oil reservoir should be filled with the table in the orientation in which it will be used. With the table in the horizontal position and the oil plug removed, fill the reservoir until the sight glass shows oil to the middle of the window. With the table in the vertical position fill the reservoir until oil just begins to leak out at the bottom of the table. Overfilling the reservoir will result in a slow leakage of oil until it reaches the proper level. When the reservoir is filled to the proper level in the horizontal position and the table is moved to the vertical position oil will leak out. You can place the rotary table in a pan or on a stack of newspaper until the excess has drained out (this many take a day or two). There is no problem using the rotary table while the oil is leaking out.

Oil Reservoir Sight Glass on Standard Rotary Table

The tilting rotary tables have six spring loaded oil fittings connected to oil passages that must be filled prior to operation as shown in the figure on the following page.

NOTE: Tilting tables do not have an oil reservoir; frequent oiling is needed when using tilting tables.



Six Oil Points for Tilting Rotary Table

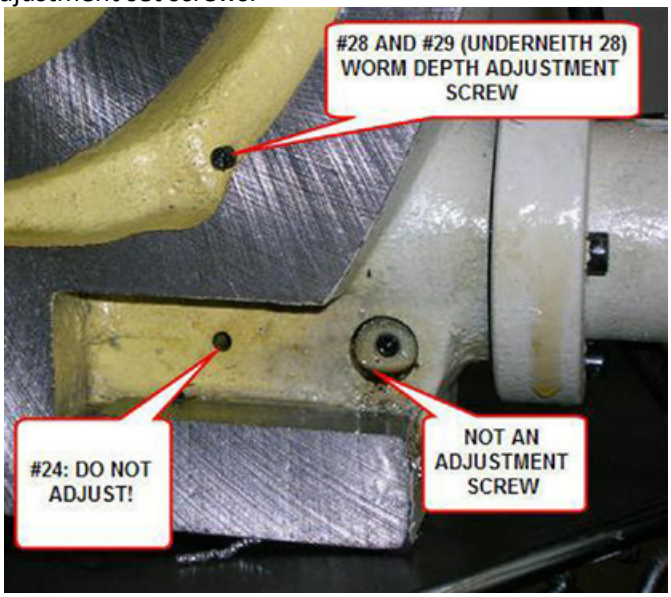
6.2 Adjusting Backlash

Backlash is an important element of overall accuracy. The rotary table has a number of internal sliding surfaces that depend on a hydrodynamic oil film for low friction and long life. Similar to the adjustments of the lead screw nut and gibs on a mill or lathe, adjustment of clearances between the internal moving parts will select a point of compromise between extreme precision and long life.

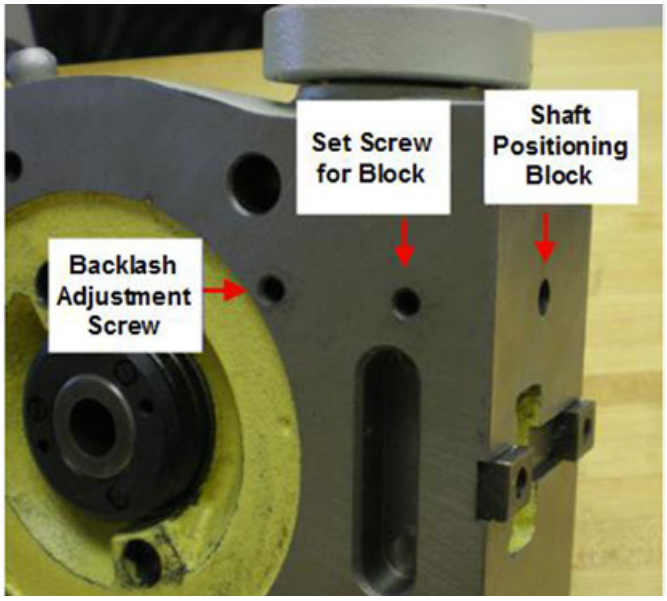
If you adjust to zero backlash the worm screw and other parts will be subject to excessive wear and friction. As the screw turns, the oil will shear off at the gear interface and there will be no film to protect against metal-to-metal wear. Correctly adjusted backlash provides both long life and a minimum of backlash.

1. Backlash is adjusted by positioning of the set screw (part 29 on the standard rotary table and part 17 on the on the tilting rotary table).
2. The backlash adjustment screw is accessed by completely removing the protective cover screw (part 28 on the standard rotary table and part 66 on the tilting rotary table) on top of it.

The following figures show the locations of the backlash adjustment set screws.



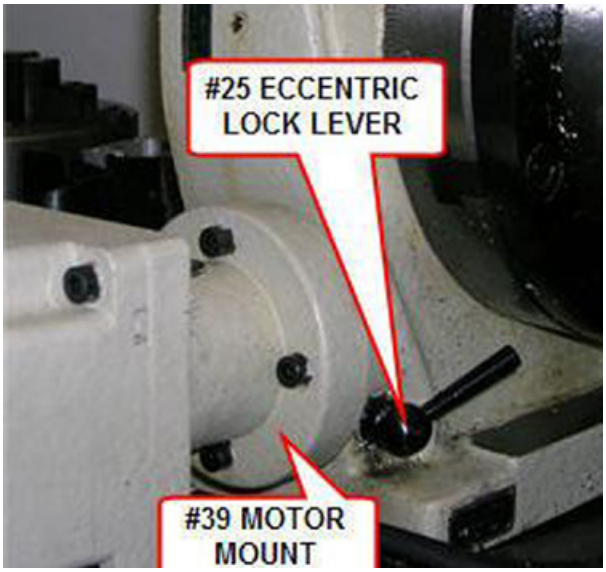
Backlash Adjustment Screw Location on Standard 8 Inch Table



Standard 6 Inch Rotary Table Backlash Adjustment

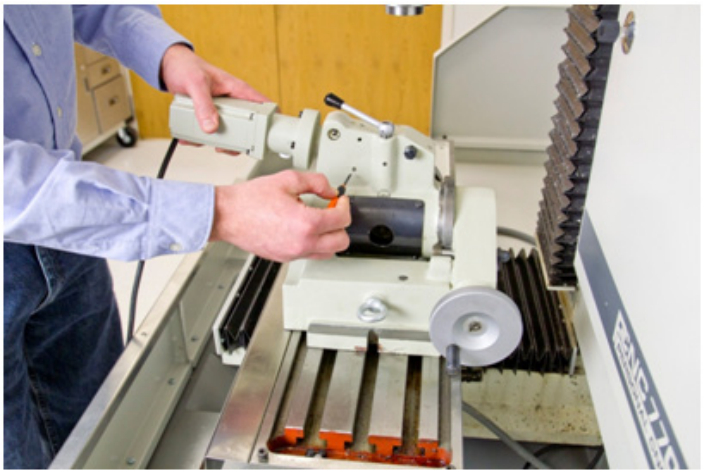
Removing the Cover and Set Screws on the Tilting Rotary Table

3. Disengage the eccentric lock lever (part 25 on the standard rotary table and part 65 on the on the tilting rotary table).



Disengage the Eccentric Lock Lever

4. Engage the motor by grasping it and rotating it fully Counter Clockwise (CCW).
5. Now, keeping CCW pressure on the motor with one hand, tighten the set screw 29/17 slowly until you feel resistance to the CCW pressure.



6. At this point, the set screw is against the worm drive. Slowly back the screw off until you feel no resistance to the CCW pressure.
7. Finally, retighten the screw approximately ¼ turn after you first feel resistance. This step will create space for the oil film.

For those desiring to set backlash by the numbers we suggest adjusting for a minimum backlash of 30 arc-seconds. Measured at the outer circumference of an 8" diameter circle with a dial indicator, 30 arc-seconds will be 0.0006" of lost motion.

- Setting backlash to 60 arc-seconds will sustain a thicker oil film, yielding lower friction and longer life. This would be 0.0012" on the outside of an 8" circle.
- Setting backlash greater than 90 arc-seconds (1.5 arc-minutes) is not recommended; it will do nothing to improve the life of the mechanism and can result in chatter during machining operations.

8. Replace the cover screws.

6.3 Inspecting/Removing the Motor Coupling

A loose or cracked motor coupling will cause the table to slip relative to motor rotation and subsequently lose position. The probability of a loose or cracked motor coupling is rare. To inspect and remove the motor coupling on either the standard or the tilting table configuration, follow this procedure:

CAUTION: TO AVOID DAMAGE TO THE DRIVER, COMPLETELY POWER DOWN THE MACHINE BEFORE CONNECTING OR DISCONNECTING THE ROTARY TABLE.

1. Unplug the motor.
2. Remove the cap screw on the motor mount.

3. Once the cap screw has been removed, jog the motor until the first of two coupling screws can be accessed. Loosen the socket head cap screw; do not remove the set screw.

4. Jog the motor and loosen the second socket head cap screw; again, do not remove the set screw.

5. Detach the motor from the motor mount by removing the 4 mounting screws. You should now be able to remove the motor with the coupling still attached.

6. With the motor out, you can inspect the coupling and tighten the remaining coupling screws if needed.
7. If needed, it is now possible to remove the two socket head cap screws and the two set screws (four screws total) and detach the coupling from the motor.

6.4 Ensuring Water/Coolant Resistance

When servicing your table, there are several steps you can take to ensure that the table remains resistant to water/coolant. We recommend using PTFE tape to seal the cap screw on the motor housing. Position the motor so the cord, as coming out of the motor, points downward when the table is engaged. Depending on whether you plan to operate in horizontal or vertical position, this may require you to reposition the motor with respect to the motor coupling housing.

Use PFTE Tape on the Cap Screw

The motorized rotary table is designed to operate in the presence of coolant, but not submersed in coolant. If there is some dripping over the edge then there is rarely a problem. If there is a serious flow and the joint between the rotating table and the stationary body is submersed, then you are likely to have problems.

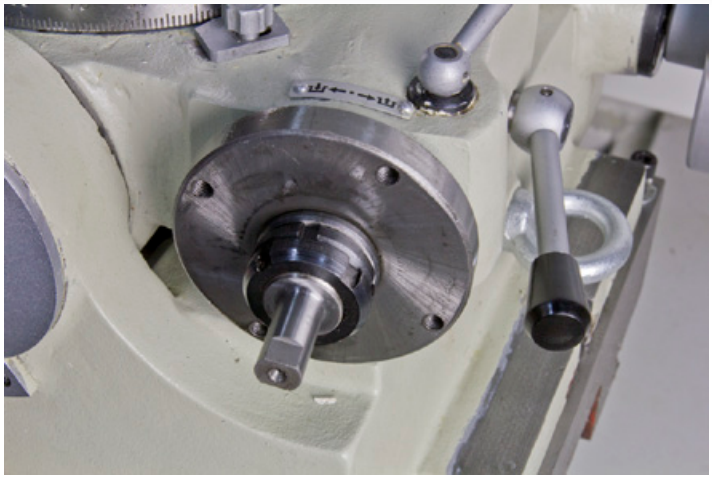
There is an oil distribution system internal to the table. As the table turns it carries oil over the worm gear. This distribution system does not cover the sliding joint between the rotating table and the body. That joint is similar to the slideways of a mill. It is a large flat surface supported by an oil film. The oil port on the edge of the rotary table and on the body itself provide oil to these sliding surfaces. Oiling at those ports on occasion is analogous to pulling the pump handle for oil distribution on the mill. It is important because this film of oil is essential to keep water/coolant away from the sliding joint. If you're running coolant then it becomes even more important to pump some oil in on occasion at the oil ports. A combination of heavy flood coolant and never oiling the sliding joints will certainly end up with coolant in the rotary table.

If you do end up with coolant in the rotary table, it is not essential to strip down the table. Simply drain it out and refill it with SAE 80 hypoid or ISO 68 or AGMA 2 gear oil or SAE 30 weight motor oil. Coolant contains anticorrosion agents which will protect the table surfaces. A small amount of coolant and oil will generally form an emulsion, with the oil view port showing a milky fluid inside. If the oil gets milky, or if you can see raw coolant inside, drain it and refill with new oil.

6.5 Worm Axial Adjustment

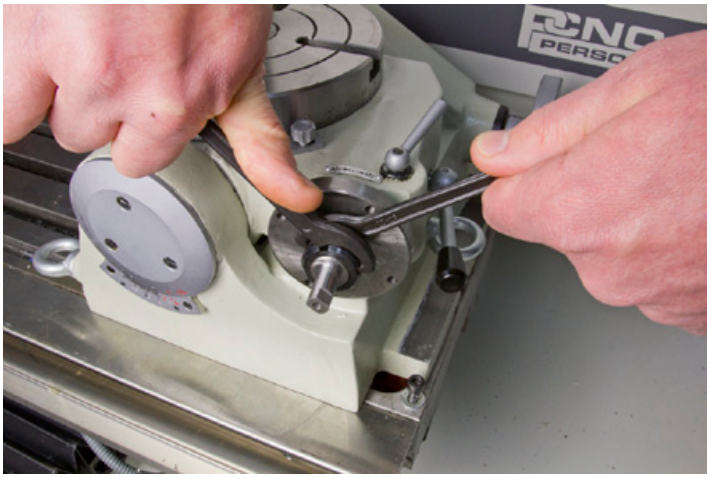
To adjust for wear in the worm shaft (part 31 on the standard table and part 59 on the tilting table), the lock nut must be adjusted.

1. Follow the steps in the *Inspecting/Removing the Motor Coupling* section to remove the motor coupling.



Remove the Motor Coupling

2. Apply a dab of grease to the back side of the spacer (part 34 on the standard table and part 52 on the tilting table).
3. Using two spanner wrenches, tighten (or loosen) the lock nut. Adjust the nuts so the spacer can be moved sideways with light taps from a punch and hammer or significant pressure from your fingertips, and the worm shaft rotates with noticeable drag in the disengaged position. Don't over tighten the locknut.



Tighten or Loosen the Lock Nut on the Worm Shaft

6.6 Eccentric Sleeve Adjustment

Not normally needing adjustment, axial play of the eccentric sleeve (part 37) on the standard rotary table can be adjusted when the eccentric lock (part 25) is loosened by removing oil plug (part 45), loosening set screw (part 24) two turns and while pushing on the block (part 30) with one screw driver retighten the set screw with another screw driver.

6.7 Table Adjustment

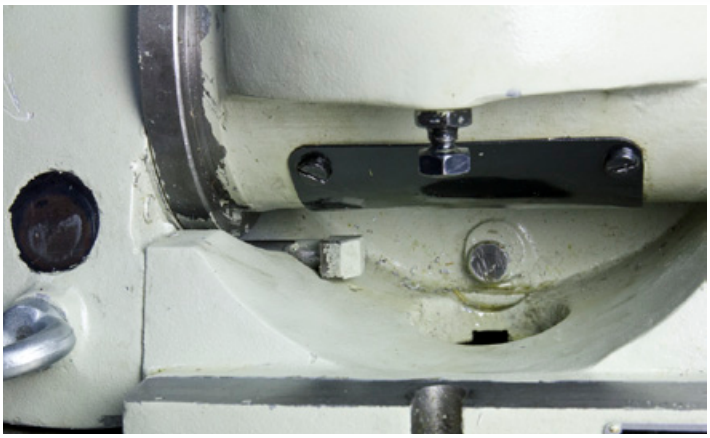
On the standard rotary table, test for correct axial adjustment by disengaging the worm and rotating the table (part 2) by hand. Slight drag should be felt. If not, loosen the three screws (part 21) two turns each by hand or with a spanner wrench (or, if necessary, a small hammer and punch applied to one of the two holes in retaining plate (part 20) rotate the plate clockwise to increase and counter clockwise to decrease drag.

6.8 Engaging Locking Lugs on the Tilting Table

The tilting rotary table has two locking lugs (part 15). When intentionally or inadvertently moved out of position, the table will not tilt within the full range of motion.

In particular, the more interior of the locking lugs is difficult to realign/fit with the recessed grove. To manually align this lug, manually crank the handle and move the table to a position allowing access to the displaced part :

Using your fingers or a small tool, move the locking lug back into place. In its correct orientation, only the cap of the lug will be visible.



Locking Lug out of Position

Locking Lug in Correct Position

7. TROUBLESHOOTING

4th axis will not move, but other axis operate properly			
Possible Cause	**Probability**	**Action to Identify Cause of Problem**	**Discussion**
No power to the table	High	Inspect cord	Make sure motor cord is plugged in to the 4th axis socket.
A bad electronic driver module	Low	Swap the ribbon cable connector for the control signals and the motor /AC supply connector between a known functioning drive.	Because there are at least three identical electronic driver modules in the axis drive sub-system, swapping control signals between modules is very helpful during troubleshooting. Remember to adjust the dip switch settings if you are working with a 6 inch rotary table.
Loose wires or ribbon cables	Medium	Remove and inspect power and ribbon cable connectors and wires entering and exiting the A axis stepper driver at both ends.	Tighten any loose wires.
Table lock(s) are engaged	High	Release the lock(s).	Standard table has two locks, tilting has one.
Motor coupling loose or cracked	Low	Inspect and tighten coupling bolts or replace coupling if necessary.	Refer to the *Inspecting/Removing the Motor Coupling* section in the *Maintenance* chapter.
Worm gear is not engaged	High	Engage the gear.	The gear operates on an eccentric pivot. To engage the gear manually, twist the motor and motor coupling housing CCW and lock into place with the lever (standard table) or locking bolt (tilting table).
Worm gear is out of adjustment	Medium	Inspect the worm gear adjustment screw and worm gear shaft locknut.	See the *Adjusting Backlash* and *Worm Axial Adjustment* sections in the *Maintenance* chapter.
A blown fuse on the AC/DC supply board	Low	Inspect fuse.	Note that a blown fuse usually is the result of a bad drive. If you replace a fuse and it immediately blows, suspect a bad drive or bad wiring to the drive.

<table>
<tr><th colspan="4">4th axis will not move, but other axis operate properly</th></tr>
<tr><th>Possible Cause</th><th>Probability</th><th>Action to Identify Cause of Problem</th><th>Discussion</th></tr>
<tr><td>A bad motor or motor connection</td><td>Low</td><td>Inspect motor and leads.</td><td>Remove the motor leads from the axis board. Measure the resistance of the windings of the motor and compare to the values in the table below. If the resistance is out of range, check the wiring carefully. If the wiring is good and the resistance readings are out of range, the motor is bad.

<table>
<tr><th colspan="2">A Axis</th><th rowspan="2">Resis-tance Ω</th></tr>
<tr><th>From (Black Probe)</th><th>To (Red Probe)</th></tr>
<tr><td>320</td><td>321
322
323</td><td>0.5-2.0 Ω
>1 M Ω
>1 M Ω</td></tr>
<tr><td>322</td><td>323
321</td><td>0.5-2.0 Ω
>1 M Ω</td></tr>
<tr><td>All Wires Above</td><td>Ground Bar</td><td>>1 M Ω</td></tr>
</table>
</td></tr>
<tr><th colspan="4">Table Losing Position</th></tr>
<tr><td>Backlash out of adjustment</td><td>Medium</td><td>Inspect backlash.</td><td>See the Adjusting Backlash section in the Maintenance chapter.</td></tr>
<tr><td>Coupling screws not tight</td><td>Medium</td><td>Inspect motor coupling.</td><td>Follow steps 1 - 6 in the Inspecting/ Removing the Motor Coupling section in the Maintenance chapter. Completely remove the motor coupling from the motor. The coupling must be removed from the motor in order to inspect all four set screws.</td></tr>
<tr><td>Coupling access plug in too far</td><td>Low</td><td>Inspect plug.</td><td>There is an access port used to tighten the worm-motor coupling. If the plug in the access hole is in too far, it binds on the coupling.</td></tr>
<tr><td>Exact stop mode used in program, Code G61</td><td>Low</td><td>Examine G code.</td><td>Use of Exact Stop Mode has been shown to cause a loss of steps on older versions of the machine. Avoid using this mode if at all possible. Try slowing down the rates of acceleration and deceleration by a factor of 10 to start and stop more smoothly.</td></tr>
<tr><th colspan="4">Table Spins the Wrong Way</th></tr>
<tr><td>Motor Wiring</td><td>Medium</td><td>Check motor wiring.</td><td>Set motor wiring per the instructions in the Electrical Installation chapter. Reversing the leads on either coil will change the motor direction.</td></tr>
</table>

8. SPECIFICATIONS

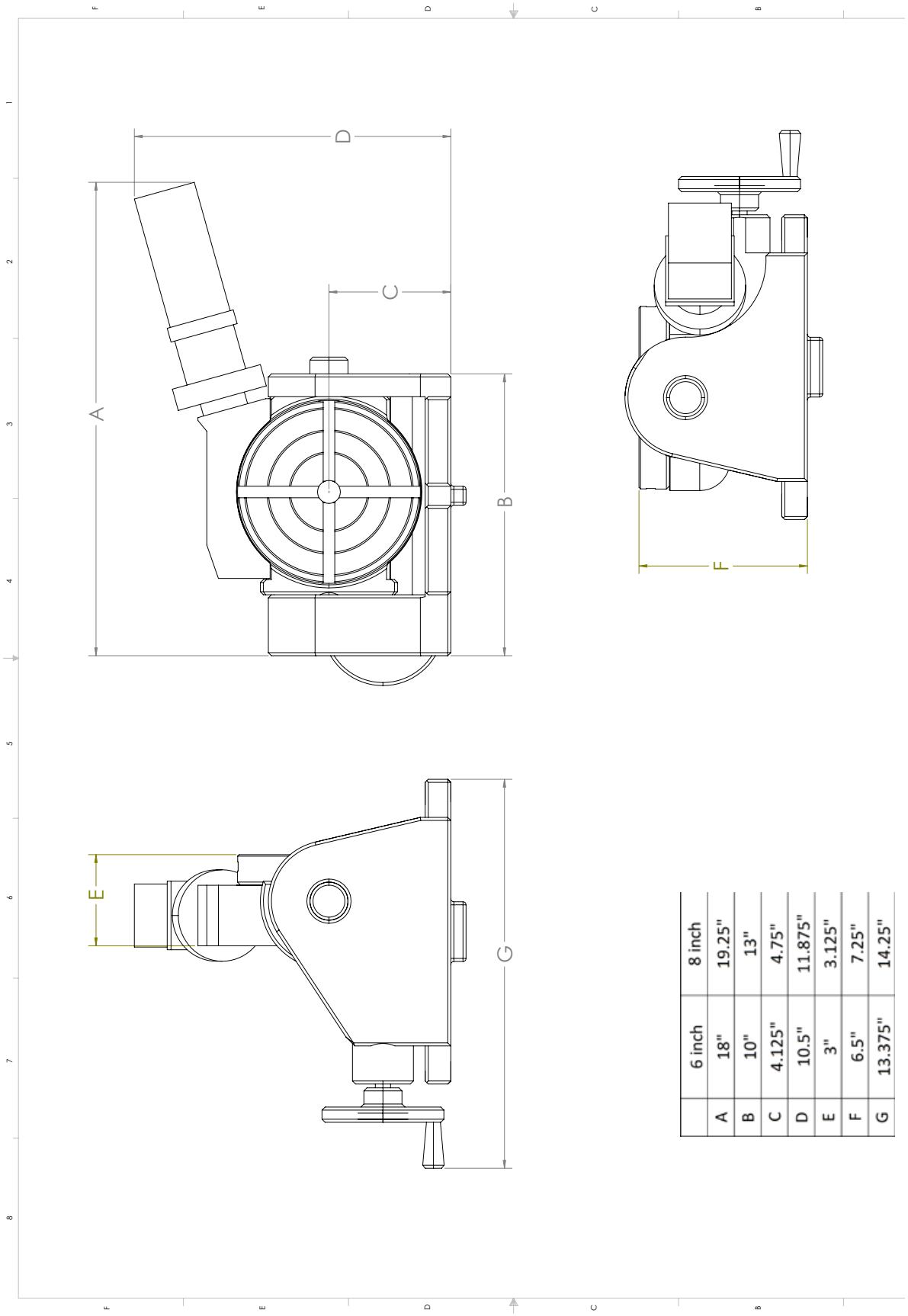
8.1 8 Inch and 6 Inch Rotary Table Specifications

Specifications are contained in the following table, which applies to standard and tilting rotary tables.

Description	8 Inch Table	6 Inch Table
Diameter of table	200 mm (7.9”)	160 mm (6.3”)
Taper of center hole	3MT (Morse taper)	2MT (Morse taper)
Width of T-slot	12 mm (0.47”)	10 mm (0.39”)
Adjacent angle of T-slot	90°	90°
Width of Locating Key	15.875 mm (5/8”)	15.875 mm (5/8”)
Worm ratio	1:90	1:90
Graduation of table	360° (1° per graduation)	360° (1° per graduation)
Rotating angle per full stepper motor step	0.02° (1.2’) Subdivide with microstepping	0.02° (1.2’) Subdivide with microstepping
Motor steps	200 steps/rev	200 steps/rev
Motor winding	2 phase, 4 wire	2 phase, 4 wire
Motor induction	3.5 mH	5.73 mH
Motor resistance	0.42 Ω	1.34 Ω
Motor phase current	5.5 A	2.8 A
Motor holding torque	4.6 Nm (640 oz”)	1.9 Nm (264 oz”)
Motor Mount	NEMA 34	NEMA 23
Motor Shaft	1/2”	1/4”
Cable	10ft - 18 AWG shielded, twisted pair. (Beldon 1063a)	10ft - 18 AWG shielded, twisted pair. (Beldon 1063a)
Shipping Weight	Standard Table: 43 kg (94 lbs) Tilting Table: 67kg (148 lbs) UPS shippable	Standard Table: 31 kg (67 lbs) Tilting Table: 44kg (97 lbs) UPS shippable

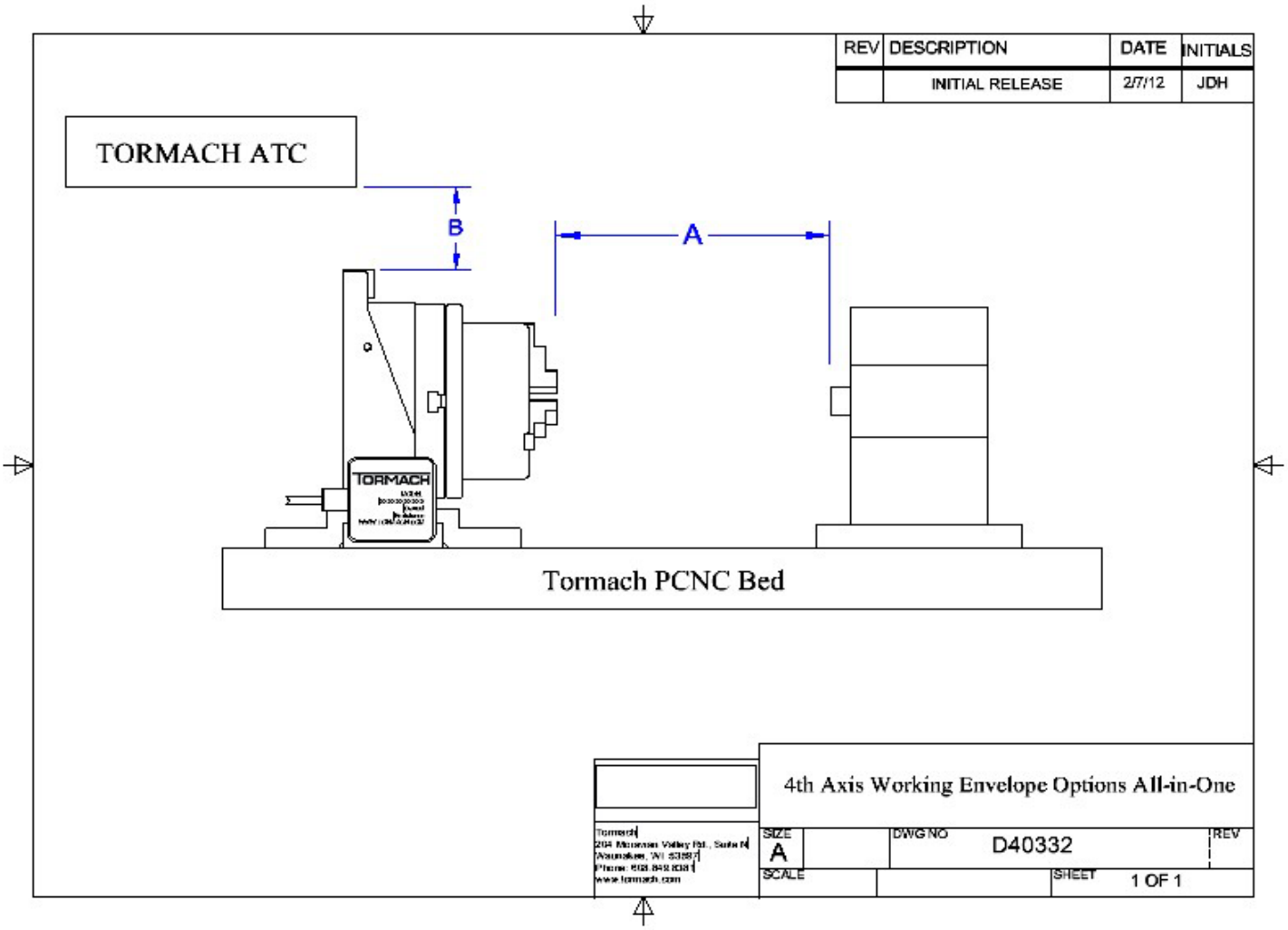
8.2 Rotary Table Dimensions

Dimensions for the 6 and 8 inch rotary table are shown in the figure below.



	6 inch	8 inch
A	18"	19.25"
B	10"	13"
C	4.125"	4.75"
D	10.5"	11.875"
E	3"	3.125"
F	6.5"	7.25"
G	13.375"	14.25"

Working envelope dimensions for both the 6 inch and 8 inch rotary tables are shown in the figure below and in the table on the following page:



PCNC 1100

	A					B
	2 Jaw Chuck (32622) With Tailstock	3 Jaw Chuck (30291) With Tailstock	4 Jaw Chuck (30293) With Tailstock	Without Chuck With Tailstock	5C Adaptor/ Fixture	With ATC Clearance In Z
8" Rotary Table (Tailstock: 30197)	9.0"	10.0"	10.0"	13.5"	Adaptor (30294): 9.8" Fixture (31415): 10.4"	3.0"
8" Tilting Rotary Table (Tailstock: 30272)	9.125"	9.375"	9.375"	13.625"	Adaptor (30294): 4.4" Fixture (31415): 5.0"	5.75" (See Note*)
6" Rotary Table (Tailstock: 30272)	11.5"	13.25"	13.25"	16.0"	Fixture (31414): 12.9"	5.0"
6" Tilting Rotary Table (Tailstock: 30272)	9.0"	10.0"	10.0"	13.0"	Fixture (31414): 9.5"	5.5" (See Note*)

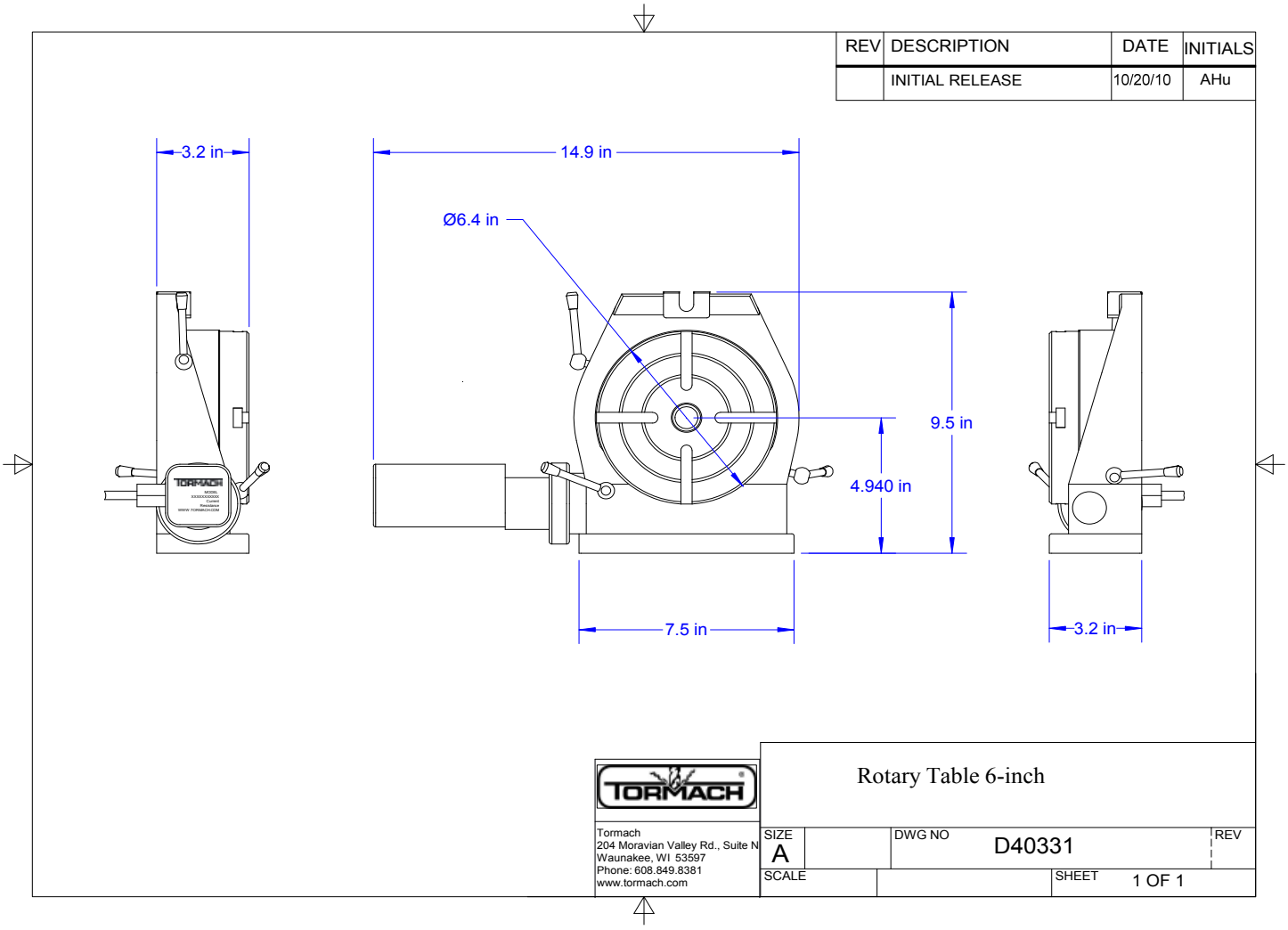
***Note: Tilting rotary tables mount on the right side of the mill. For tilting tables, "B" represents the clearance to the top of the tailstock.**

PCNC 770

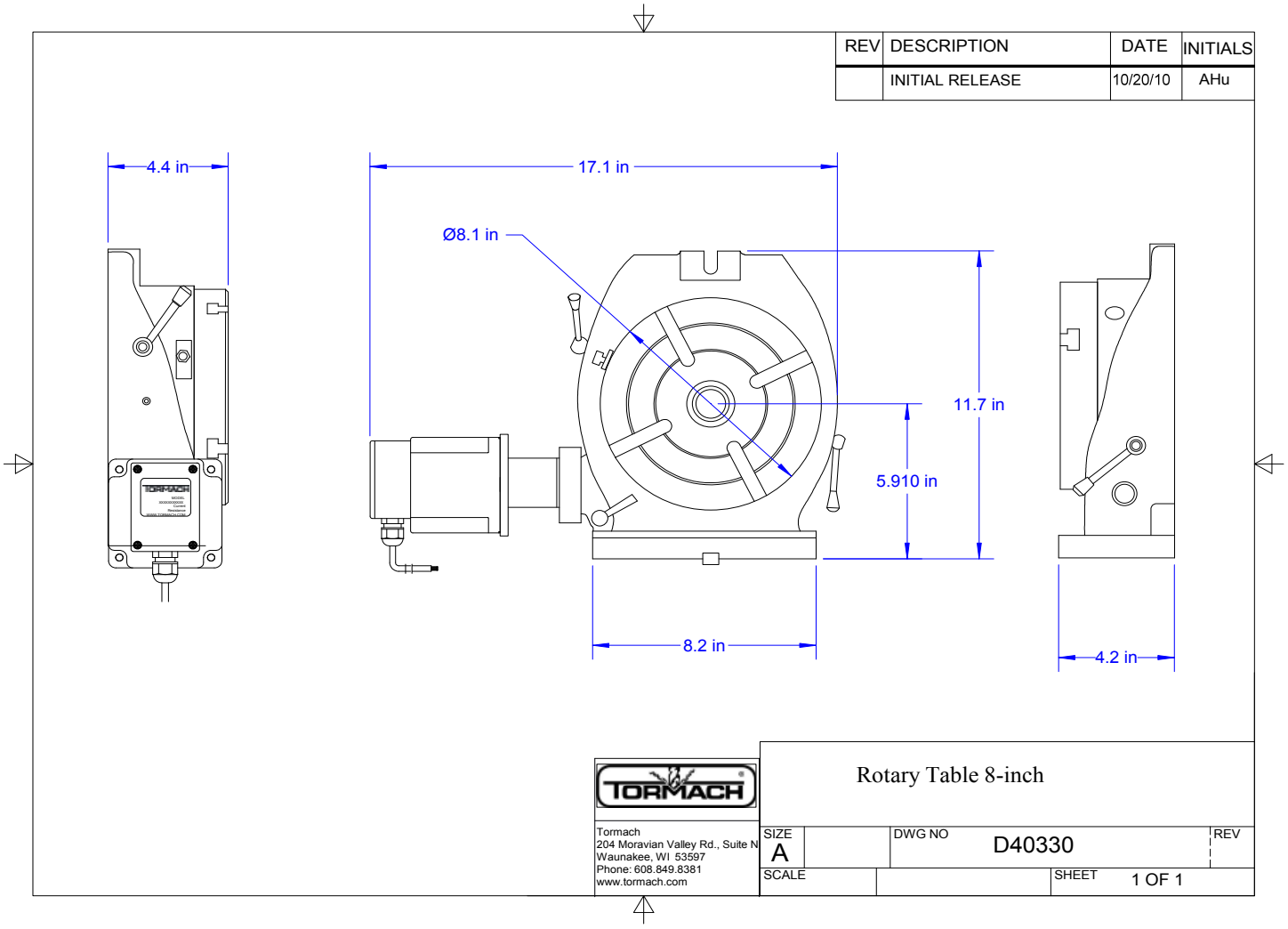
	A					B
	2 Jaw Chuck (32627) With Tailstock	3 Jaw Chuck (30292) With Tailstock	4 Jaw Chuck (31721) With Tailstock	Without Chuck With Tailstock	5C Fixture (31414)	With ATC Clearance In Z
6" Rotary Table	5.5"	7.0"	7.0"	10.0"	5.375"	2.0"
6" Tilting Rotary Table (Tailstock: 30272)	2.5"	4.0 "	4.0"	7.0"	2.75"	2.5" (See Note*)

*** Note: Tilting rotary tables mount on the right side of the mill. For tilting tables, "B" represents the clearance to the top of the tailstock.**

Dimensions for the 6 inch rotary table are shown in the drawing below:

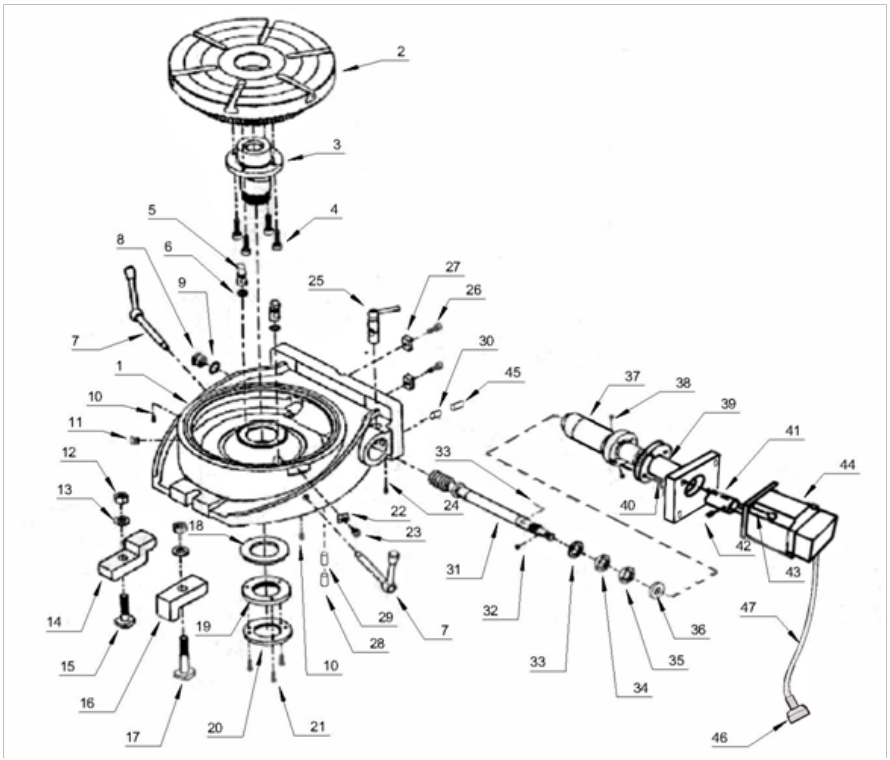


Dimensions for the 8 inch rotary table are shown in the drawing below:



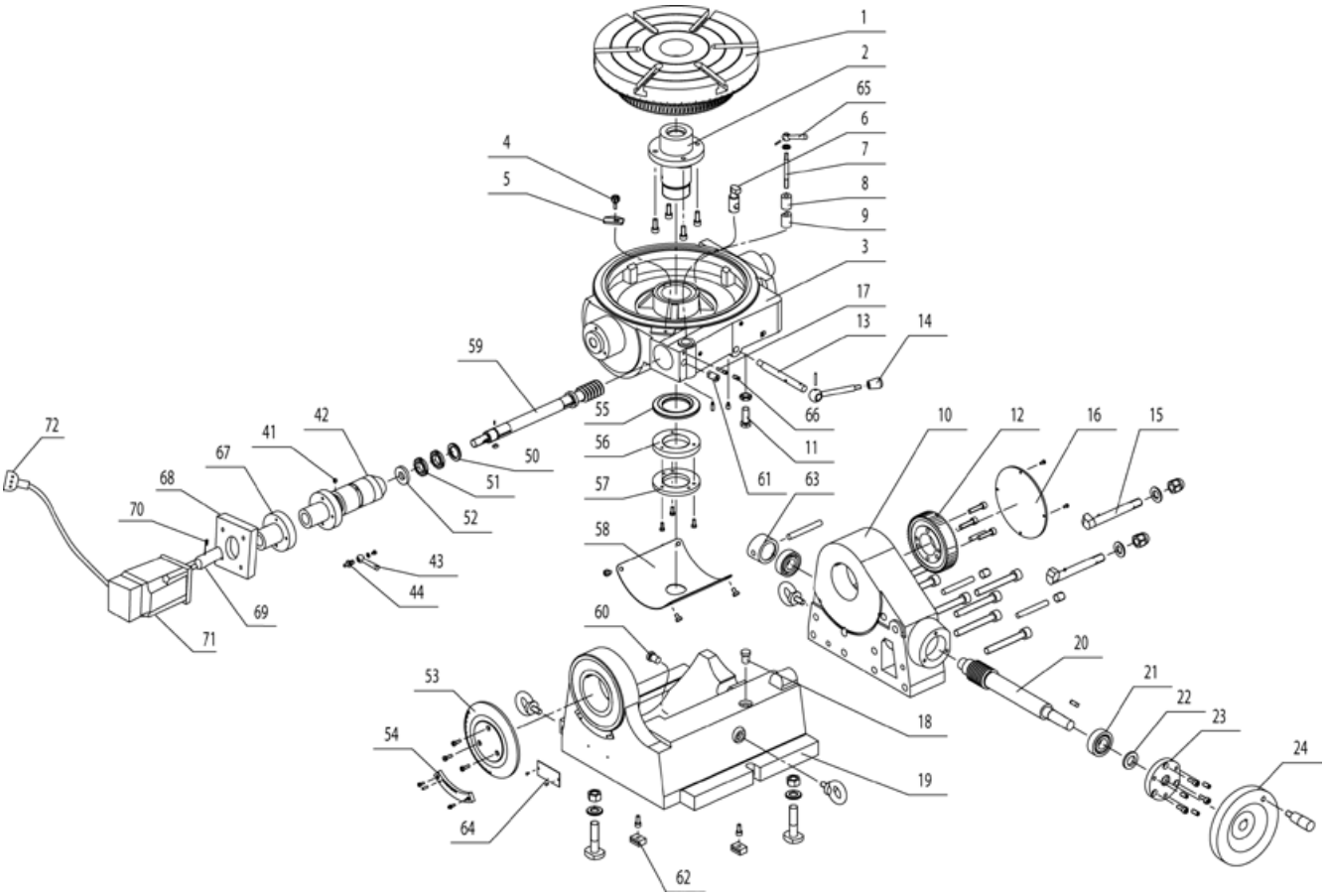
9. EXPLODED VIEW AND PARTS LIST

9.1 Standard Rotary Table Parts



Part	Description	Qty	Part	Description	Qty	Part	Description	Qty
1	Base	1	17	T-Bolt	1	33	Dowel pin	1
2	Table	1	18	Ring	1	34	Spacer	1
3	Taper sleeve	1	19	Table nut	1	35	Lock nut	2
4	Socket head bolt*	4	20	Retaining Plate	1	36	Spacer with keyway	1
5	Table clamp	2	21	Fillister head screw	3	37	Eccentric sleeve	1
6	O-Ring Dash 110*	2	22	Indicator	1	38	Fillister head screw	2
7	Handle assembly	2	23	Knob	1	39	Motor Mount	1
8	Sight glass	1	24	Set screw dog point	1	40	Socket head screw *	4
9	O-Ring	1	25	Eccentric lock	1	41	Coupling 6” PN 31840 8” PN 30715	1
10	Set screw dog point	2	26	Socket head bolt*	2	42	Set Screw *	1
11	Plug	1	27	Locating key	2	43	Socket head screw *	4
12	Hex nut*	4	28	Set Screw*	1	44	Motor Complete 6” PN 32677 8” PN 32379	1
13	Washer	2	29	Threaded pin	1	45	Oil Plug	1
14	Clamp	1	30	Block	1	46	Power Plug	1
15	T-Bolt	1	31	Worm shaft	1	47	Cable	1
16	L-Clamp	2	32	Key	1	*Standard hardware items		

9.2 Tilting Rotary Table Parts



Part	Description	Qty	Part	Description	Qty	Part	Description	Qty
1	Table	1	20	Screw Bar	1	60	Positioning Block	1
2	Taper Sleeve	1	21	Bearing	1	61	Pin	1
3	Base	1	22	Sealing	1	62	Locating Key	2
4	Knob	1	23	Cover	1	63	Block	1
5	Indicator	1	24	Handle Wheel	1	64	Nameplate	l
6	Table Clamp	1	41	Pin	1	65	Eccentric Lock	1
7	Bolt	1	42	Eccentric Sleeve	1	66	Bolt	1
8	Locking Pad	1	43	Handle	1	68	Socket Head Screw	1
9	Locking Pillar	1	44	Bolt	1	69	Motor Coupling 6” PN 31840 8” PN 30715	1
10	Supporter	1	50	Spacer	1			
11	Positioning Screw	1	51	Spanner Nut	2			
12	Helical Gear	1	52	Spacer	1	70	Set Screw	2
13	Eccentric Axle	1	53	Indicate Plate	1	71	Motor Complete 6” PN 32677 8” PN 32379	1
14	Table Clamp Handle	1	54	Vernier	1			
15	Locking Lug	2	55	Spacer	1			
16	Cover	1	56	Locating Nut	1	72	Power Plug	1
17	Screw	1	57	Locating Nut				
18	Positioning Block	1	58	Cover				
19	Base	1	59	Worm Shaft	1			

INDEX