Novakon Torus PRO PDB Owner's Manual

Used with Sunfar C300 VFD

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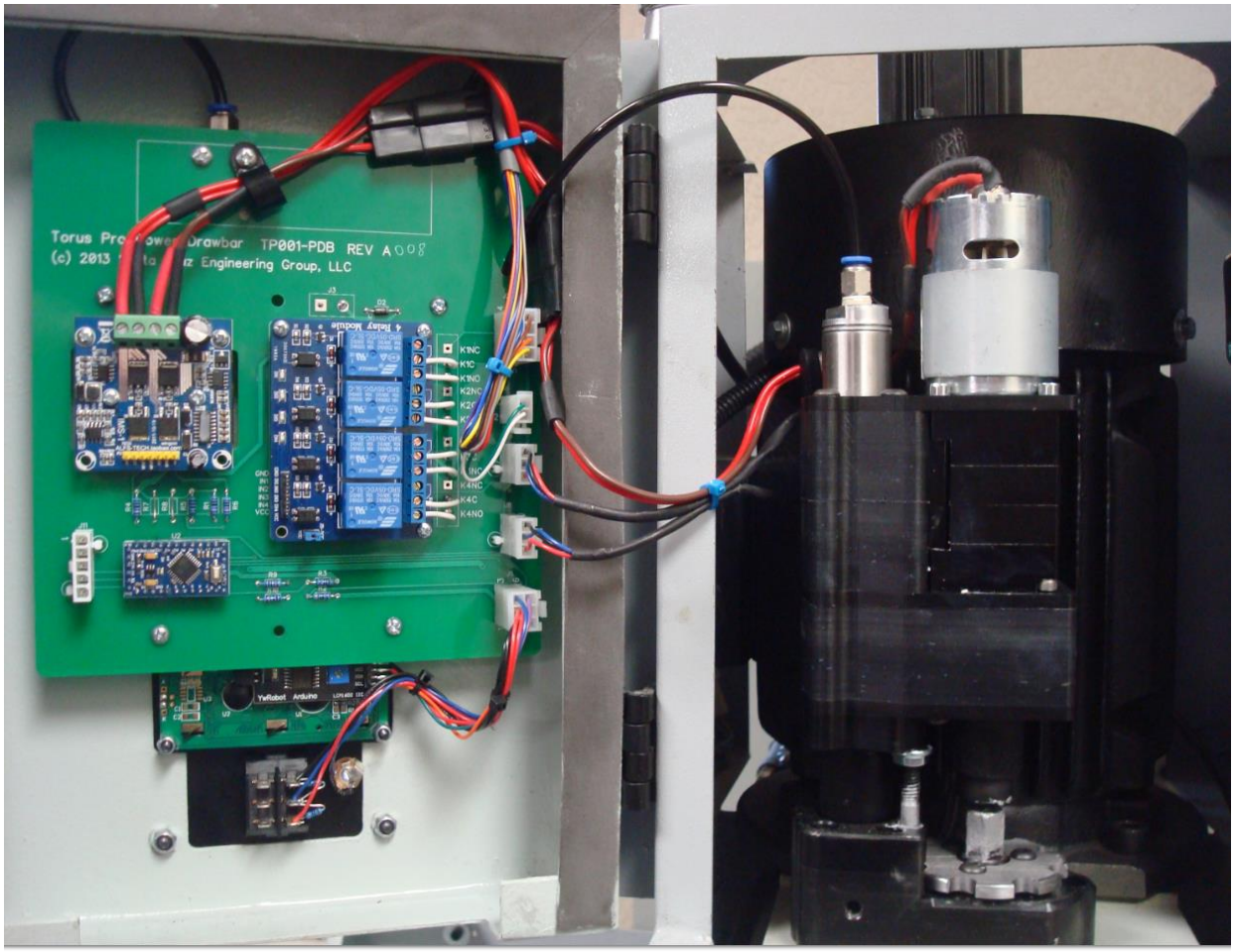
Used with Sunfar C300 VFD

THANK YOU FOR YOUR ORDER

Thank you for purchasing the Novakon Power Drawbar! With proper setup and maintenance, the PDB will deliver uncompromising performance, reliability, and many years of enjoyment. The Novakon PDB provides advanced features and performance not found on any other competing product:

- Fast operation, averaging under two seconds to grab or release any quick change tool.
- The ability to change R8 tools easily.
- Higher tool retention force than other competing products eliminates quick change “pull-out”.
- Integrated true spindle speed readout.
- Integrate spindle load meter.
- Intelligent MCU-based controller, with extensive diagnostics and error reporting.

The Novakon Torus Pro is used to manufacture the Novakon Power Drawbar.



IMPORTANT

This manual covers general instructions regarding the Novakon Torus PRO PDB set-up, operation, maintenance and troubleshooting.

Carefully read this instruction manual and any accompanying instruction manuals before installing the PDB and operating your Novakon Torus PRO CNC Mill. Instruction manuals should be kept in a safe place where they are always easily accessible for reference while operating the Torus PRO CNC Mill.

While this manual has been compiled to give detailed description and usage of the Novakon Torus PRO PDB, changes are possible due to continuous design and development efforts.

Remember safety comes above all else. Carefully read, follow and understand the safety information outline in chapter 2 of this manual and always let common sense be your guide.

SUGGESTIONS / COMMENTS

We are interested in any suggestions and comments you might have to improve our products, Operator's Manual and services. Feel free to contact Novakon International Corporation with your suggestions and comments by e-mail to sales@novakon.net.

Check the www.novakon.net website periodically for the latest updates and revisions to this manual.

While every precaution has been taken in the preparation of this manual, neither Novakon, Inc., Novakon International Corporation, nor Santa Cruz Engineering Group, LLC shall have any liability to any person or entity with respect to any loss or damage caused or alleged to be caused directly or indirectly by the instructions contained in this manual or by the computer software and hardware products described in it. The information provided is on an "as is" basis.

If any trademarks are used in this manual but not acknowledged, please notify Novakon International Corporation so this can be remedied.

TABLE OF CONTENTS

1 CUSTOMER INFORMATION

Please record the information below about your Novakon Torus PRO PDB kit. Having this information readily available will save time if you need to contact Novakon for questions, service, accessories or replacement parts.

_____

Novakon Invoice Number:

_____

PDB Purchase Date:

_____

PDB Delivery Date:

We look forward to a long working relationship with you, and thank you again for putting your trust in Novakon International Corporation.

2 SAFETY GUIDELINES

OVERVIEW

1) This is a preliminary draft manual, and is likely to contain minor errors or omissions. In addition, the design details of the Torus PRO CNC Mill itself have changed over time, and the design of the PDB itself is also likely to change over time. The photos in this manual are intended to provide general guidance on the installation of the PDB, but your particular machine may vary from what is depicted in the photographs.

2) This manual describes general operational techniques and safety procedures. The Torus PRO includes various safety devices to protect the operator and the machine. However, these cannot cover all aspects of safety. Therefore, the operator must thoroughly read and understand the content of this manual before operating the PDB. The operator should also take into consideration these and other aspects of safety related to his/her particular environmental conditions, materials and tools.

3) Operating the PDB in accordance with the manufacturer's instructions, will provide you with reliable service. However, with equipment of this nature, serious accidents may occur due to improper or careless operation. It is mandatory that you read this manual and other documentation to become thoroughly familiar with CNC machines prior to operating the PDB. PDB operations which are not documented in this manual, should be considered potentially dangerous. Do not perform undocumented PDB operations before consulting Novakon for advice.

4) Novakon emphasizes that it is the operator's sole responsibility to perform all operations using the Novakon PDB in a safe manner.

5) This manual tries to give you guidance on safety precautions/techniques in using the PDB. We accept no responsibility for the performance of this PDB or any damage or injury caused by its use. In other words, it is your responsibility to ensure that you understand the implications of using the Novakon PDB, and to comply with any legislation and codes of practice applicable to your country or state.

GENERAL GUIDELINES FOR SAFE OPERATION

1) The Novakon Torus PRO CNC Mill and PDB have various mechanical and electrical safety devices to protect the operator and the machine. The safety devices include interlock devices and emergency stop switches. However, all machine tools are potentially dangerous, and computer controlled machines are potentially more dangerous since CNC machines start, stop and move automatically. Therefore, it is extremely important that you are aware of the machine's moving parts, chips projectiles and fluid while operating the machine.

2) Neither the manufacturer nor its representative or dealers can assume responsibility for any mishaps, damage or personal injury, which may occur because of improper operation or from failure to observe the safety precautions mentioned in this manual.

3) Do not under any circumstances attempt to operate this PDB prior to reading and understanding this manual. Neglecting these instructions and warnings can cause serious injury to you and/or damage to the machine.

4) Familiarize yourself with the position of the EMERGENCY STOP BUTTON on the machine so that you can press it immediately from any position in case of an emergency.

5) Use extreme care when engaging fellow workers in conversations and running the machine at the same time. Do not proceed to the next step without informing the other personnel that you are about to do so.

SAFETY CHECK PRIOR TO APPLYING POWER TO THE MILL

1) Learn the control functions of the Novakon PDB before operating it.

2) Make sure that all safety covers are fitted and electrical boxes are closed and secured before the power is switched to ON.

3) Check to make sure that the cutting tool will clear the table, fixture, vise and clamps.

4) Make sure to anchor all items placed on the machine's table before starting the machine.

5) Learn to use the correct spindle speed, feed and depth of cut suitable for the work piece and material. Do not operate the spindle above the rated speed of the accessories mounted in it. Replace worn tools prior to a milling operation. Make sure that the tool length to diameter ratio is proper to prevent chatter. Make sure that the tool holders are tightened properly before actual cutting operations.

ELECTRICAL SAFETY

1) There are high voltage terminals in the electrical control panel, motors, junction boxes and other equipment. When the power supply is on, take extreme care to avoid contact with these components. After the power has been switched off, high voltage remains in various electrical components. Prior to touching any component, carefully check for voltage with a multi-meter or equivalent instrument to make sure that any residual voltage has dissipated.

2) Check all electrical cables for damage prior to applying electrical power to the machine.

3) Shut down Mach3 and turn off the computer prior to switching off the power to the Novakon Torus PRO CNC Mill.

BASIC POINTS OF SAFETY

1) To prevent incorrect operation of the PDB, carefully check the position of switches before operation. If in doubt, consult this manual or a Novakon technician for advice.

2) Do not use compressed air to blow chips away from the spindle, parts, the machine or the floor around the machine.

3) All work platforms used around the machine should be sturdy, safe and include anti-slip surfaces.

4) Always be mentally alert, well rested, sober, and never under the influence of drugs that can affect the safe operation of the machine. Do not operate the machine if you suffer from dizziness.

5) Avoid unnecessary touching of the operator controls while the machine is running.

6) Keep the area around the machine free of oil/coolant, chips, debris and other obstructions.

7) Remove chips as often as necessary to prevent them from over accumulating in the machine.

8) Use an exhaust fan to control smoke and toxic fumes generated during machining operations. Always wear a protective mask when machining items that can create a toxic atmosphere.

9) Do not attempt to measure the work piece while the machine is running.

CLOTHING AND SAFETY

1) Always keep safety in mind. Wear eye protection at all times. Do not wear long sleeve shirts, loose or baggy clothes, neckties, wristwatches, rings, jewelry, etc., when operating this machine. Tie back long hair to prevent entangling with rotary tools.

2) Do not operate the PDB if any machine guards, interlocks and other safety devices have been removed or any of these safety items are not functioning correctly. Never run the machine with the electrical cabinet open.

3) Do not use gloves when typing on the computer keyboard.

4) Do not handle chips, cutters and coolant with bare hands.

SAFETY ASPECTS RELATED TO TOOLS, FIXTURES, ETC.

1) Take time to properly secure fixtures, work piece and tools.

2) Let the machine and spindle come to a complete stop before accessing the machine, parts, tools or spindle.

3) Use the legs not the back for lifting. Use a hoist or other lifting device to move heavy items.

4) Use proper tools for the job.

5) Always use gloves when loading or unloading work pieces. Use the proper tools when removing chips from the work area to protect your hands from sharp chips and burns generated during machining operations.

6) Do not remove chips when the machine is in operation. Lockout the machine by initiating the E-Stop switch before removing chips, fixtures, parts and cutting tools. Stop all machine operations before cleaning the machine or any of the peripheral equipment.

7) Always use proper cutting tools and work holding clamps suitable for the work and within the specifications of the machine. Do not exceed the machine table rating of 870 pounds. The maximum weight rating includes all items placed on the table, including fixtures, vises, clamps, parts, etc.

SAFETY ASPECTS RELATED TO TOOLING

1) Tools and miscellaneous equipment should be kept away from the moving parts of the machine.

2) Exercise caution when using fixtures, vises and parts that extend beyond the work table. These items could interfere with other machine parts or the machine enclosure.

SAFETY ASPECTS RELATED TO MAINTENANCE

1) If any components or safety covers are to be removed, first switch off or disconnect the main plug.

2) Only qualified personnel should use and/or perform maintenance on the Novakon PDB. The operator and programmer should be thoroughly familiar with the PDB.

3) Keep the PDB well lubricated and clean as detailed in Chapter 8, PERIODIC MAINTENANCE.

4) Do not modify the PDB in any way that will affect safety.

5) In case the PDB crashes, do not operate it again until the cause and any damage have been evaluated and corrected.

3 INSTALLATION AND SETUP

RECOMMENDED TOOLS FOR ASSEMBLY

Flat Head Screw Driver

Philips Head Screw Driver

Allen Wrenches (Metric and SAE)

Wrenches (Metric and SAE)

Ratchet Set (Metric and SAE)

Flashlight

Voltmeter

Anti-seize paste (available from most hardware and auto parts stores)

Safety Goggles

Safety Gloves

Extra Helper

PDB KIT CONTENTS

1) Unpack the PDB kit and familiarize yourself with its contents shown in Figure 3-1 PDB Kit Contents.

<table>
<tr>
<td> 
PDB Power Head</td>
<td> 
PDB Battery Charger</td>
<td> 
PDB Spindle Hub and Brake Disc</td>
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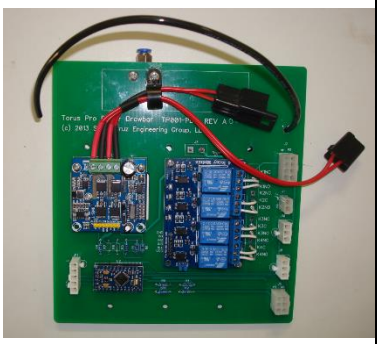
<td> 
PDB Electronics</td>
<td> 
PDB Battery</td>
<td> 
PDB Control Panel</td>
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<td> 
Misc. Small Parts Bag</td>
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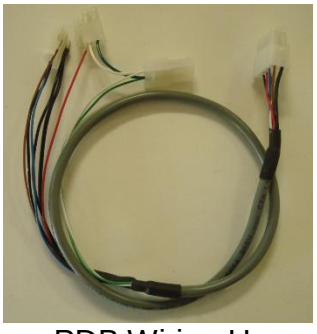
PDB Drawbar</td>
<td> 
Long PDB Wiring Harness</td>
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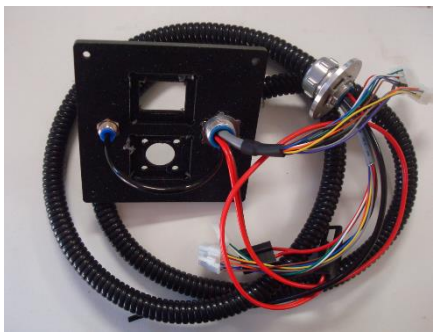
Two Short PDB Wiring Harnesses</td>
<td> 
PDB Air/Wiring Harness</td>
<td> 
PDB Air Hose</td>
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</table>

Figure 3-1 PDB Kit Contents

IS THE MOTOR ENCLOSURE READY TO INSTALL THE PDB?

1) If your Novakon Torus PRO CNC Mill did not come with the front motor access door panel precut and drilled for installation of the PDB kit, refer to Chapter 12 “MODIFICATIONS TO THE MOTOR ENCLOSURE ACCESS DOOR” for further instructions.

Figure 3-2 Precut and Drilled for PDB

Figure 3-3 Not Precut and Drilled for PDB

ELECTRICAL BOX WIRING

1) Turn off the NM-200 CNC machine and disconnect the 220 volt power cable from the electrical control panel cabinet.

There are high voltage terminals in the electrical control panel cabinet, motors, junction boxes and other equipment. Extreme care should be taken when working around the aforementioned items.

Figure 3-4 AC 220 Volt Plug

2) Remove the middle fan grill located above the power switches on the side of the electrical control panel cabinet. The grill is a two-piece assembly snapped together. Using a thin screwdriver, gently pry one corner of the exposed part of the grill away from the electrical control panel cabinet to expose four mounting bolts. Remove the bolts, and the inner half of the grill. Save the bolts and nuts, as they will be used to attach the new panel assembly. The two-piece grill is no longer required.

Figure 3-5

Figure 3-6

Figure 3-7

3) Remove the plastic cover from the VFD box.

Figure 3-8

4) Disconnect all wires from the VFD's green screw terminal strip. Do NOT disconnect any of the AC power or motor wires from the VFD's lower terminal strip. Unplug the other end of the previously disconnected wiring harness from the BOB and remove it from the electrical control panel cabinet. This is the 6-pin white connector identified by the red arrow in Figure 3-9. This wiring harness will no longer be required for the PDB, but would be required should the PDB be removed and the manual drawbar reinstalled. The position and orientation of the BOB and VFD has varied during the Torus PRO production run. On some machines, this 6- pin connector will be along the bottom edge of the BOB, while on others it will be along the top edge. It should be the only 6-pin connector on the board.

Figure 3-9 BOB and VFD

5) Locate the PDB main air/wiring harness, and mount the PDB pass-thru panel to the side of the electrical control panel cabinet where the middle fan grill was removed. Mount the new panel to the electrical control panel cabinet with the flex conduit near the top edge, and the flex conduit pointing up, and towards the front of the machine.

Secure the panel in place using the four nuts and bolts that had previously been fastening the removed vent grill to the cabinet.

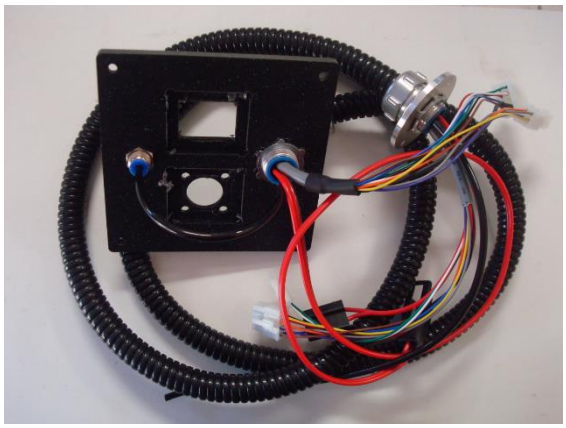


Figure 3-10 PDB Main Air/Wiring Harness

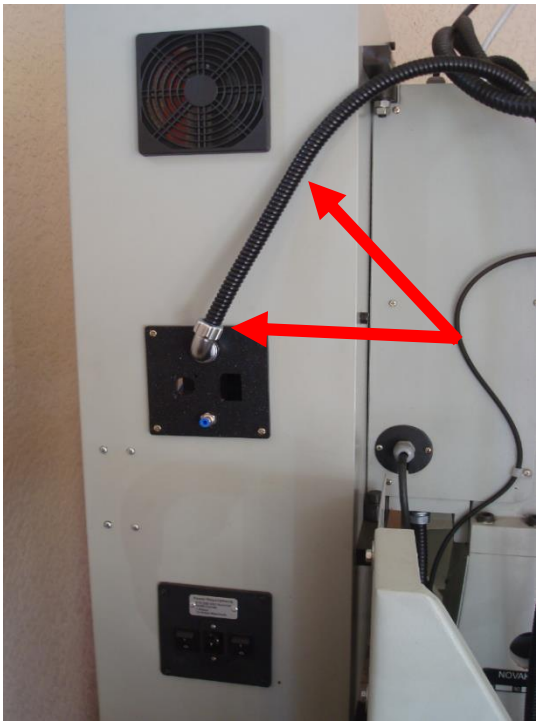


Figure 3-11

Connect the air hose to your air supply plumbing. There is a 5-foot length of 4mm hose, and a 4mm-1/8”NPT fitting provided for making this connection. The air pressure provided to the PDB must be between 80 and 100 PSI. If your supply is over 100PSI, use a pressure regulator to reduce the pressure provided to the PDB.

Do not turn on the air to the PDB until instructed to do so later in this manual.

6) There are three wiring harnesses included in the PDB kit. Locate the wiring harness (Figure 3-12) that has a 4-pin connector on one end, and four wires with stripped ends on the other end. Connect the 4-pin connector to the mating connector on the end of the PDB main air/wiring harness assembly where it enters the electrical control panel cabinet.

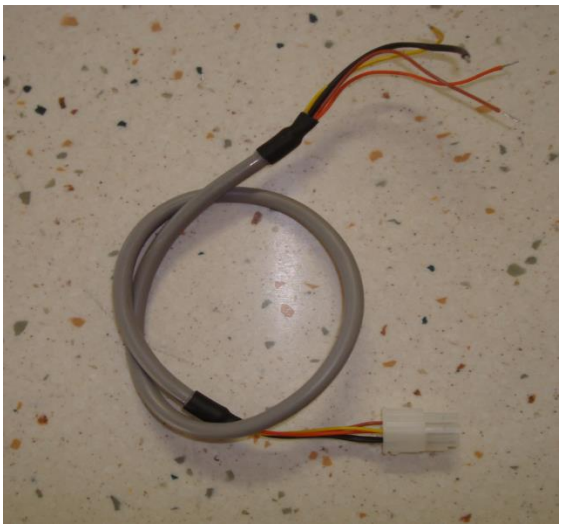


Figure 3-12

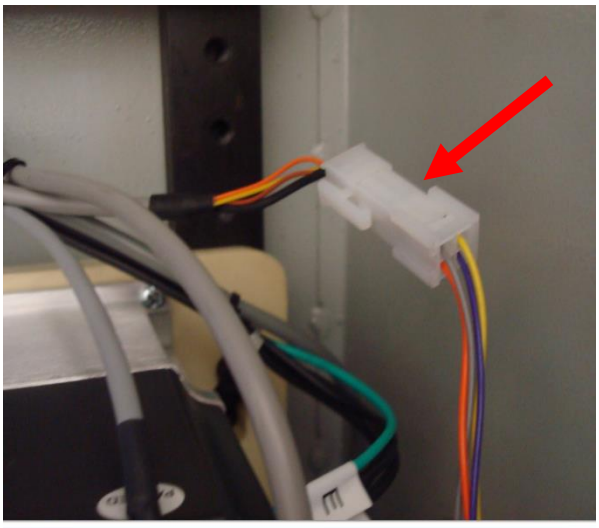


Figure 3-13

7) Connect the stripped ends of the wires from this cable to the green VFD terminal block as follows:

- Brown wire to the AVO terminal
- Yellow wire to the FWD terminal
- Orange wire to the X1 terminal
- Black wire to the GND terminal

Figure 3-14

8) Now find the harness with a 6-pin connector on one end, and three wires with stripped ends on the other end. Connect the stripped ends of the wires from this cable to the VFD screw terminals as follows:

- Black wire to GND (This is the second wire attached to the GND terminal)
- Red wire to VC
- White wire to REV

Figure 3-15

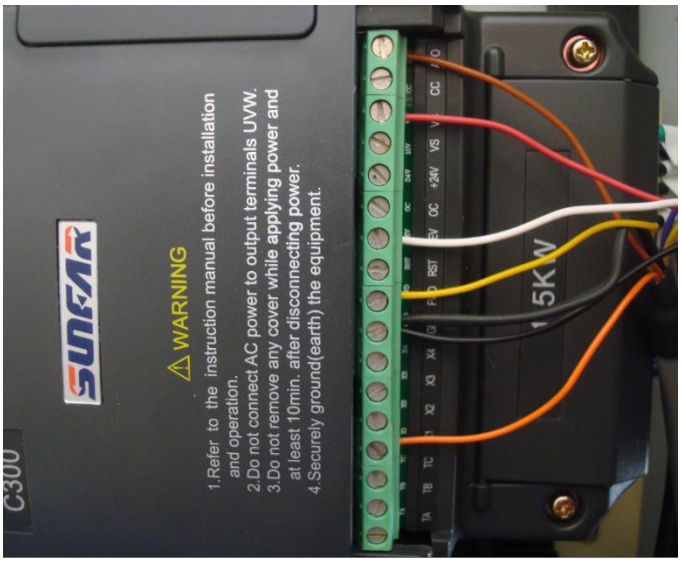


Figure 3-16

9) Route the wiring harnesses so all connections can be made to the terminal strip without the harness putting tension on the individual wires. One or more small Zip Ties can be used to position the harness to ensure there is no tension on the wires. Replace the plastic cover over the green terminal strip.

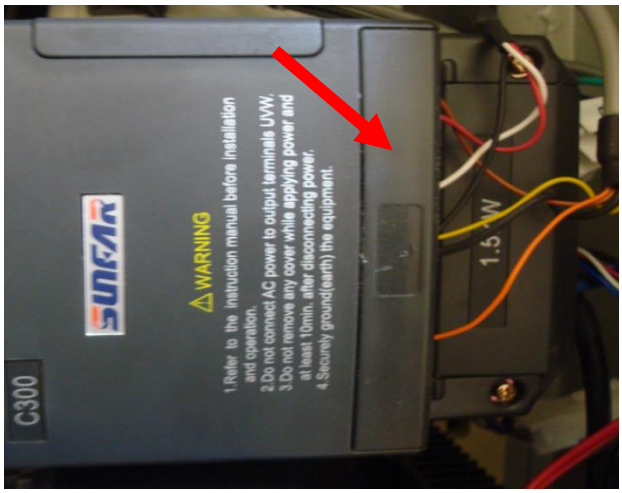


Figure 3-17

10) Locate the 6-pin connector near the free end of the wiring harness previously connected to the VFD. Plug this 6-pin male connector into the 6-pin VFD female connector located on the BOB. This is the only 6-pin connector on the BOB and will be located along one edge of the board.

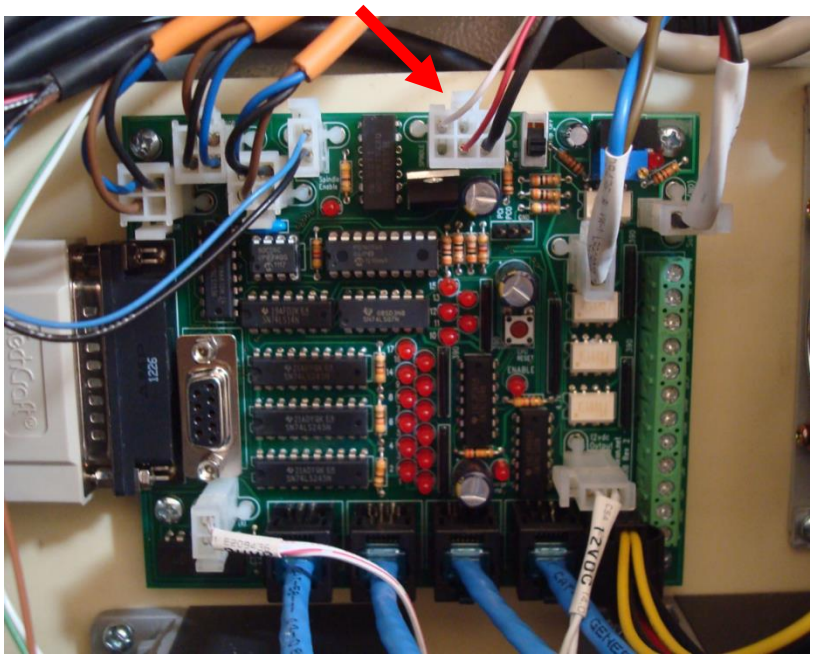


Figure 3-18 BOB 6-Pin Connector

11) The remaining wiring harness has an 8-pin connector on one end, and a variety of connections on the other end. Connect the 8-pin connector to the mating connector on the end of the PDB main air/wiring harness assembly where it enters the electrical control panel cabinet.

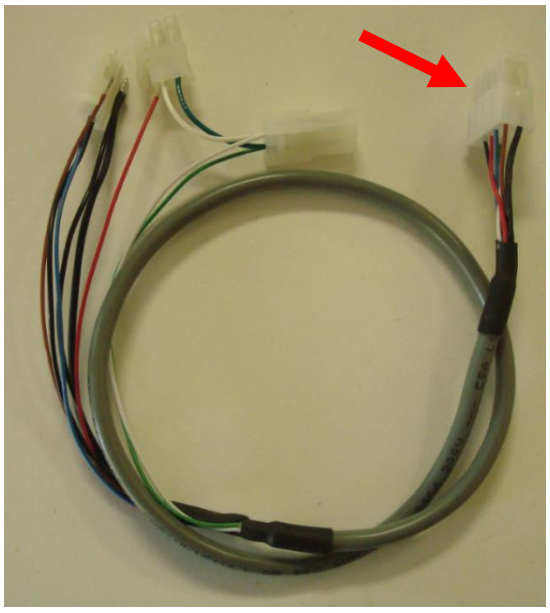


Figure 3-19

Figure 3-20

12) This wiring harness also has a 2-pin connector with Blue and Black wires located at the other end of the wiring harness. Connect the 2-pin male connector to the “Spindle Enable” female connector located on the BOB. This connector should be located close to the 6-pin VFD connector, and you should see “Spindle Enable” or something similar silk-screened in white on the board near the connector.

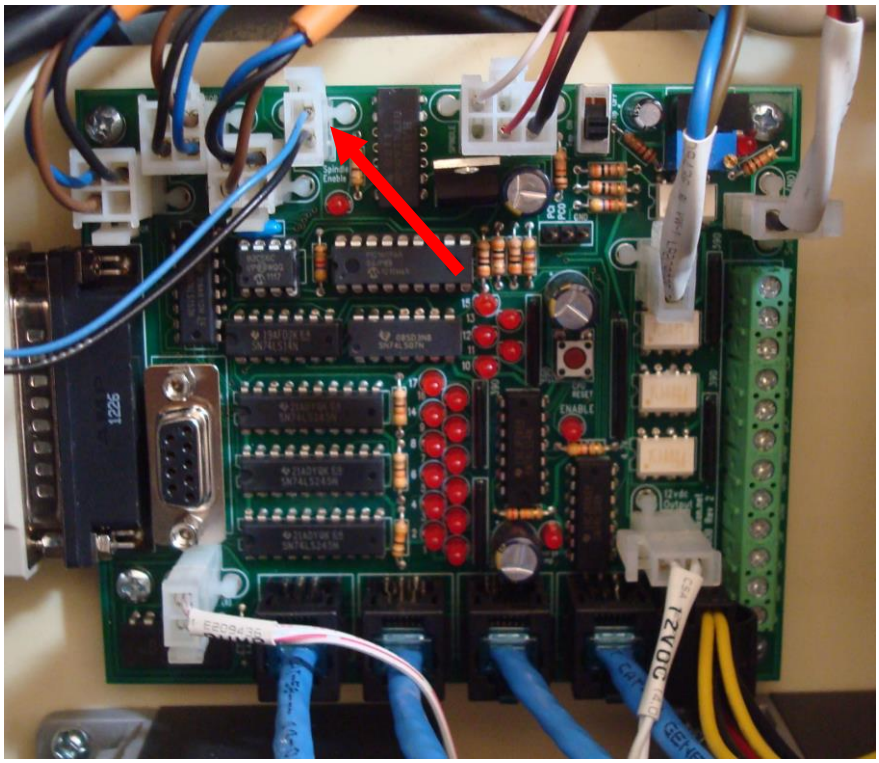


Figure 3-21

13) Now locate the wiring harness end with a pair of 2-pin connectors with Green and White wires. Note that one connector is male and the other is female.

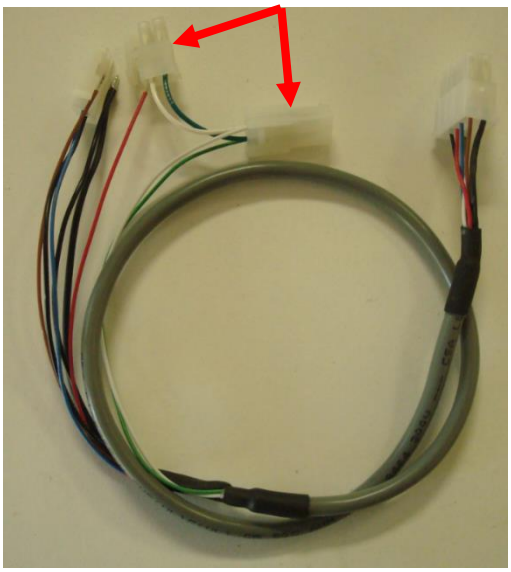


Figure 3-22

14) Locate the 2-pin E-Stop connector located on the BOB near one end of the screw terminal strip. This connector is labelled “Soft E-Stop (NO)”. This connection is used to enable the BOB to E-Stop the machine in the event of a PDB malfunction that might create a safety hazard.

If your machine already has a cable plugged into this Soft E-Stop connector, unplug it and plug that cable into the female connector on the PDB harness (Highlighted with green arrows in Figure 3-23 and Figure 3-24).

Plug the 2-pin male connector on the PDB harness into the Soft E-Stop connector on the BOB (Highlighted with the blue arrow in Figure 3-24).

Plug the 2-pin male connector with black and blue wires into the Spindle Enable connector (Highlighted with the red arrow in Figure 3-23).

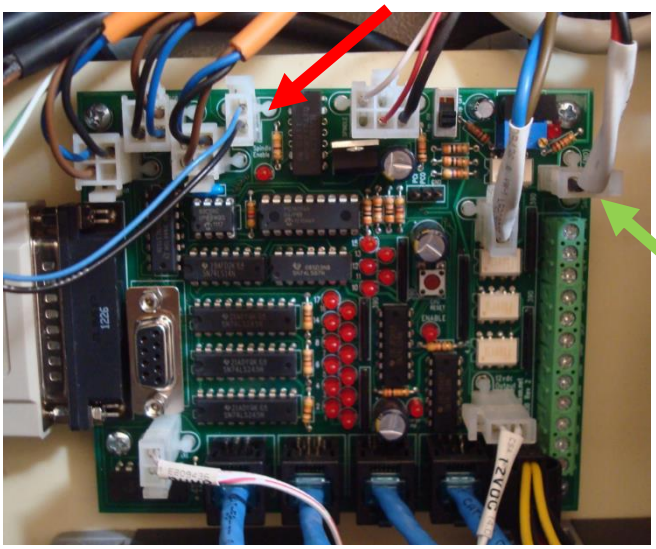


Figure 3-23

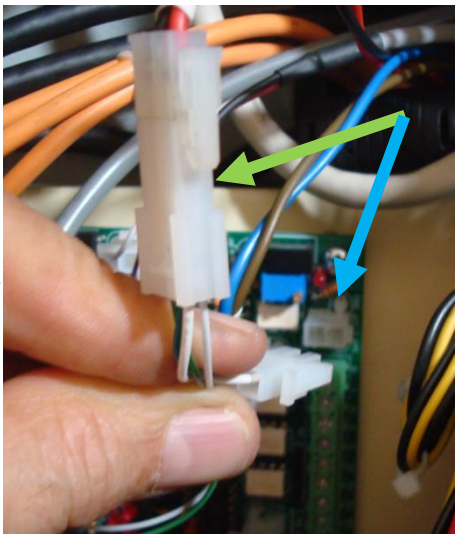


Figure 3-24

15) You should now have only Black, Red and Brown wires with stripped ends, remaining unconnected on this PDB wiring harness. The Red and Black wires provide logic power to the PDB electronics, and the Brown wire is the signal wire from the Probe connector on the PDB control panel. Connect these wires to the green terminal block along one side of the BOB as follows:

- Black Wire to any “GND” screw terminal
- Red Wire to any “5V” screw terminal
- Brown Wire to the “15” screw terminal, putting the Probe input on parallel port input Pin 15

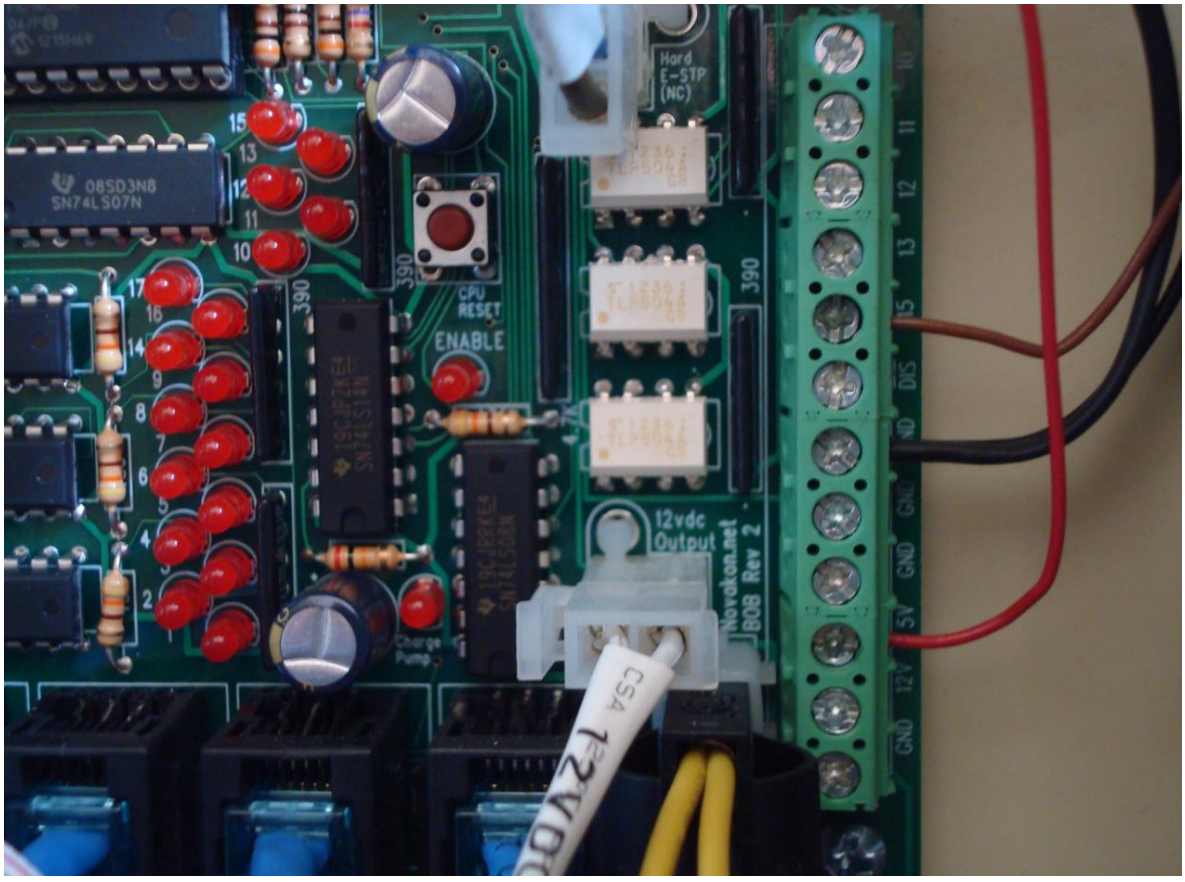


Figure 3-25

16) Locate the PDB Battery Charger. Note that each of the AC leads on the charger is terminated with a dual male/female spade terminal.

Figure 3-26 Battery Charger

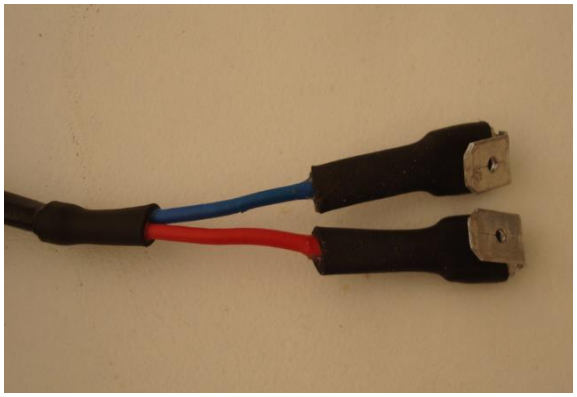


Figure 3-27 AC End of Battery Charger

17) Now locate the AC black and white wires connected to the power switch panel located on the inside of the electrical control panel cabinet. Unplug the white wire from the terminal, and plug the red wire female spade terminal from the PDB Battery Charger onto the terminal where the white wire female terminal was connected. Unplug the black wire from the terminal, and plug the blue wire female spade terminal from the PDB Battery Charger onto the terminal where the black wire female was connected.

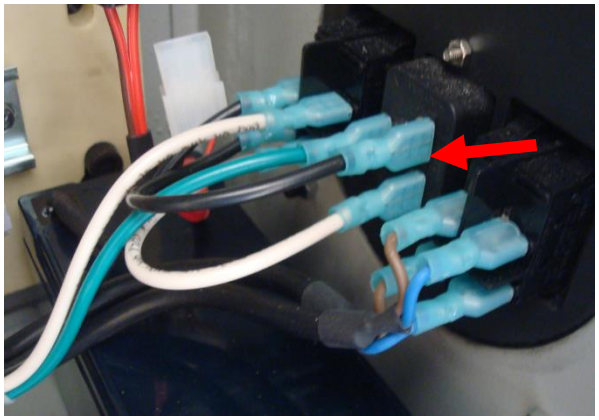


Figure 3-28

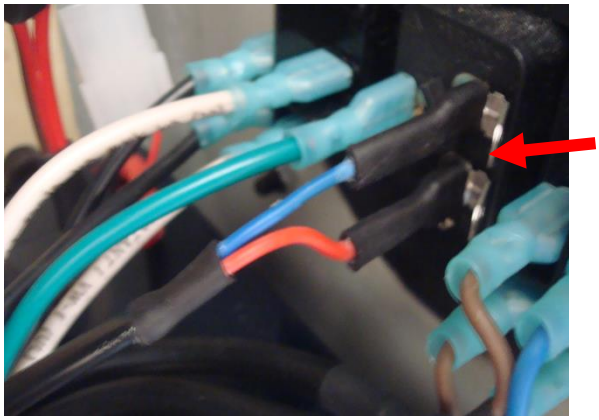


Figure 3-29

18) Now plug the white wire, previously removed from the power switch, onto the red wire terminal and the black wire previously removed onto the blue terminal.

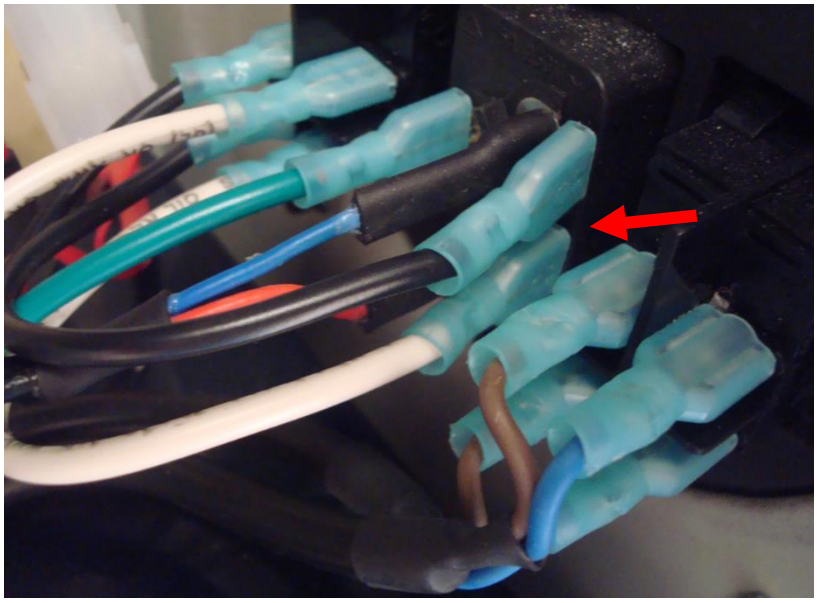


Figure 3-30

19) These connections provide AC power to the charger for the PDB battery.

The battery charger must be powered at all times, whether the machine is ON or OFF. So, make sure your machine always has AC power, and turn the machine off using its power switches, rather than an external switch or circuit breaker.

20) Locate the PDB battery, and place it in the lower corner of the electrical control panel cabinet, next to the fan, as shown in the photo. Place the battery charger next to the battery.

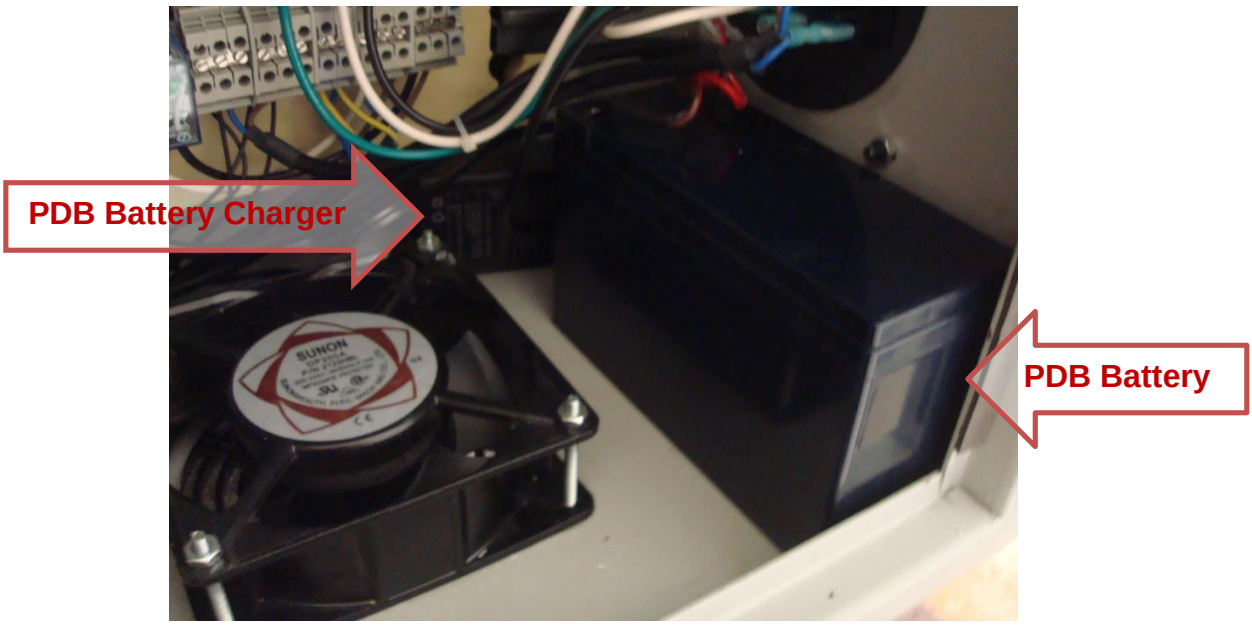


Figure 3-31 PDB Battery and Charger

21) Connect the white connector on the battery charger output cable to the mating connector on the battery. Tuck the charger wires and connector out of the way.

Do not connect the black connector from the main air/wiring harness to the black mating connector from the battery at this time. The large-gauge two-wire cable with red/brown wires and black connectors, when connected, will supply 12 volt DC power to the electronic boards to be installed in the motor enclosure door.

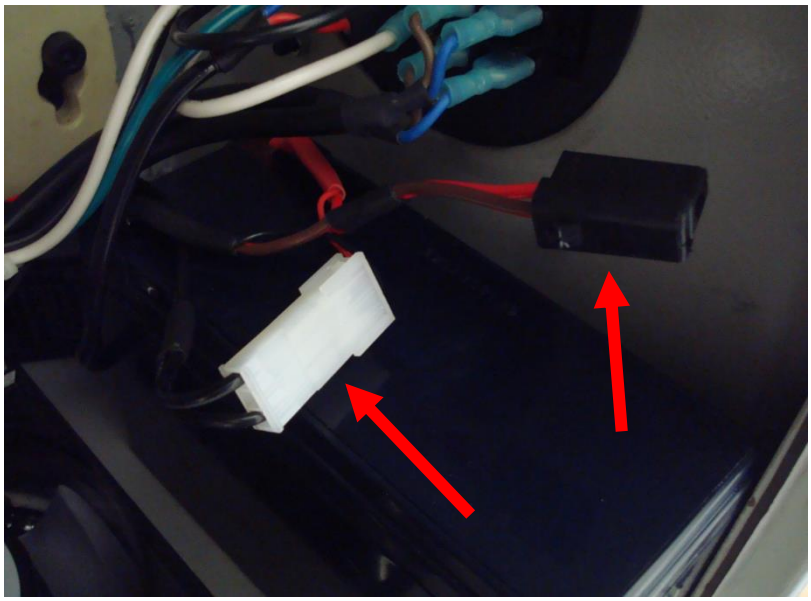


Figure 3-32

INSTALLING THE PDB HEAD

1) Remove the old drawbar from the Novakon Torus PRO Mill. Remember, the cap has left-handed threads, and the threaded end of the drawbar has right handed threads.

Figure 3-33

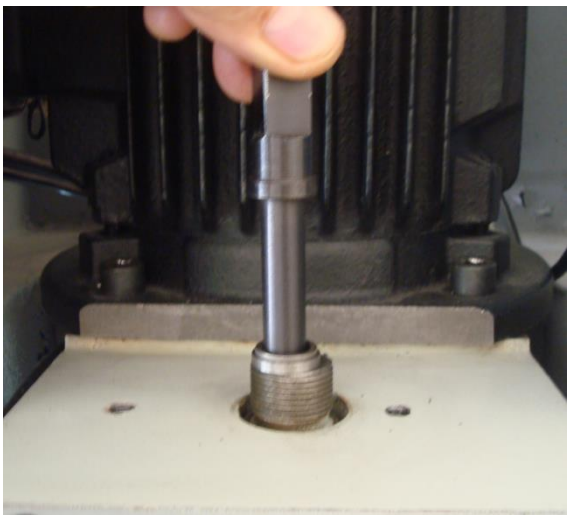


Figure 3-34

2) Locate the new hex-head drawbar that came with your kit. Coat the underside of the drawbar head, and both sides of the thrust washer, with a liberal coating of anti-seize. Coat the drawbar threads with a liberal coat of anti-seize. Place the drawbar, with its thrust washer, into the spindle. The old drawbar and "cap" will no longer be used.

Figure 3-35 Anti-seize

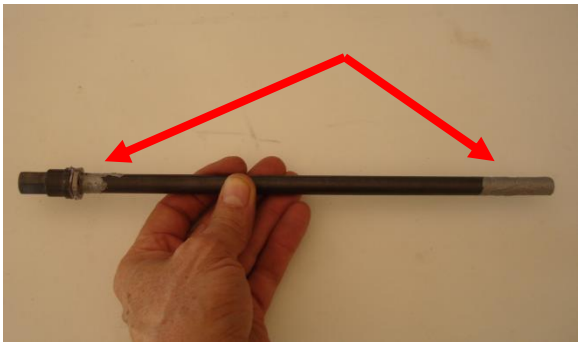


Figure 3-36 Drawbar

3) Thoroughly clean both the collet, and the inside of the spindle, especially the taper. Acetone is excellent for cleaning and de-greasing the collet, though any solvent that does not leave a residue can be used. It is critical that the inner bore of the collet and all tool shanks, are ALWAYS kept clean, dry and free of any lubricants

4) Install the new drawbar and washer into the head of the Novakon Torus PRO Mill.

5) ONLY put a VERY light coat of anti-seize on the collet taper and the cylindrical top-most section of the collet. Re-install the collet in the spindle finger-tight. Make sure you never get anti-seize on the inner bore of the collet, as that can cause tool holder pull-out and create slippage.

Figure 3-37

6) Locate the PDB power head. Near the bottom of the base plate is a set-screw. Loosen this screw a few turns, then carefully pull the entire "power head" assembly out of the base plate.

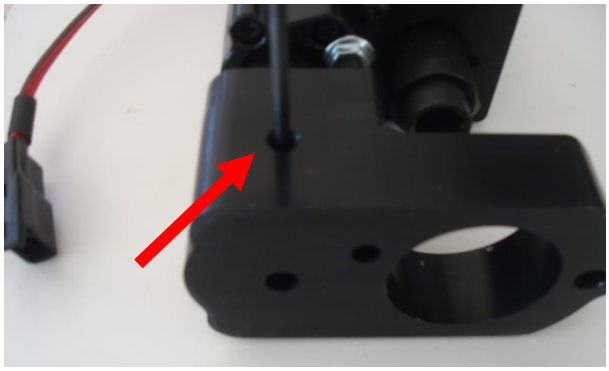


Figure 3-38

Figure 3-39

7) Remove the four screws on the top of the base plate, and lift the brake pin locating bracket off the base plate

Figure 3-40

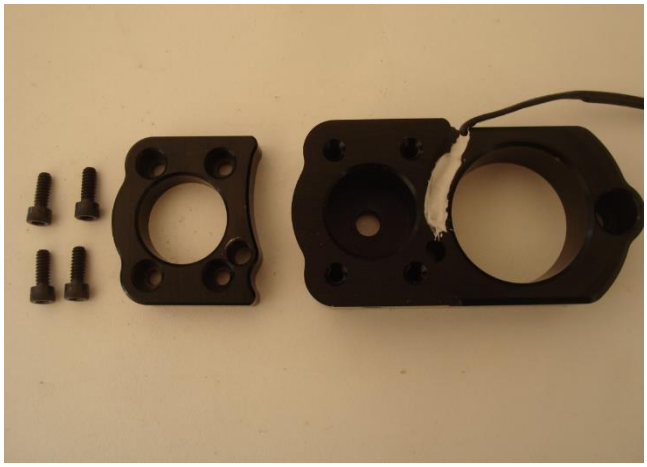


Figure 3-41

8) Locate two 6 mm x 1” Allen screws in the parts bag, and use them to mount the mounting bracket to the Torus PRO spindle head using the two drilled and tapped mounting holes. For now, leave the two bolts finger tight. The bolts should be tightened enough to hold the PDB in place, but still allow it to be moved with some effort.

Figure 3-42

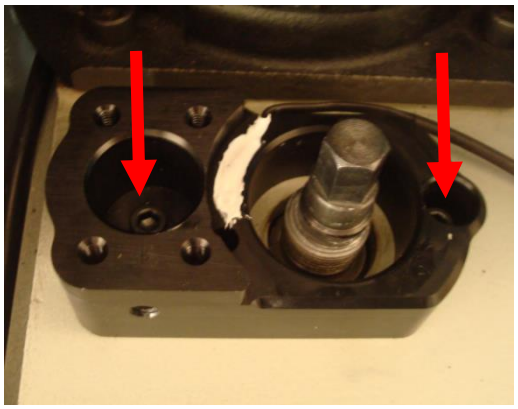


Figure 3-43

9) Place the spindle cap and brake disc assembly over the top of the drawbar and screw it on the spindle. Remember, this is a left-handed thread.

Figure 3-44

Figure 3-45

10) Re-install the brake pin locating bracket and tighten the four screws.

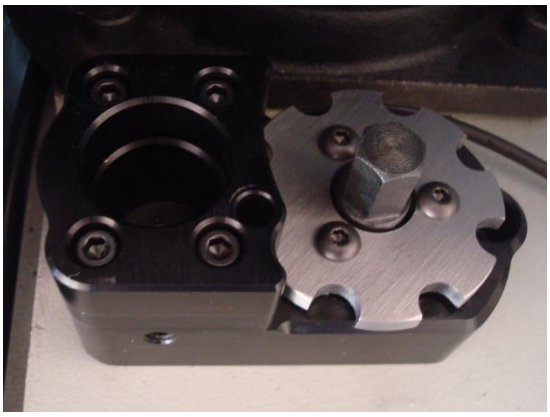


Figure 3-46

11) Securely tighten the spindle cap onto the spindle. This is most easily accomplished by putting a short piece of ¼" rod through the brake locating bracket pin hole and one of the brake disc slots. Then use the large spindle wrench that came with the Novakon Torus PRO Mill to tighten the cap.

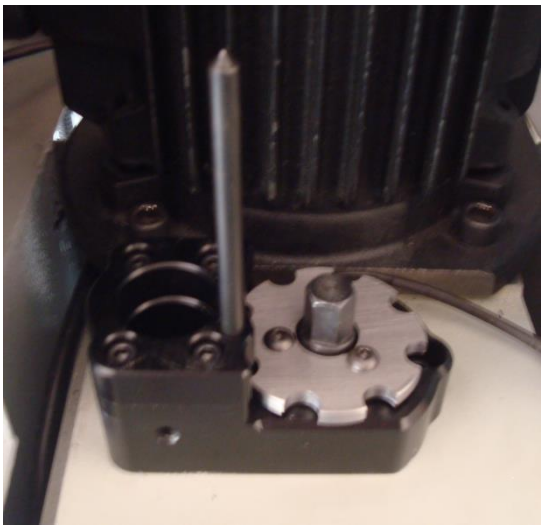


Figure 3-47

12) Ensure the spindle turns freely and does not make contact with the PDB mounting bracket. Visually inspect the position of the mounting bracket relative to the brake disc. The brake disc should be centered between the brake pin locating bracket and the PDB mounting plate.

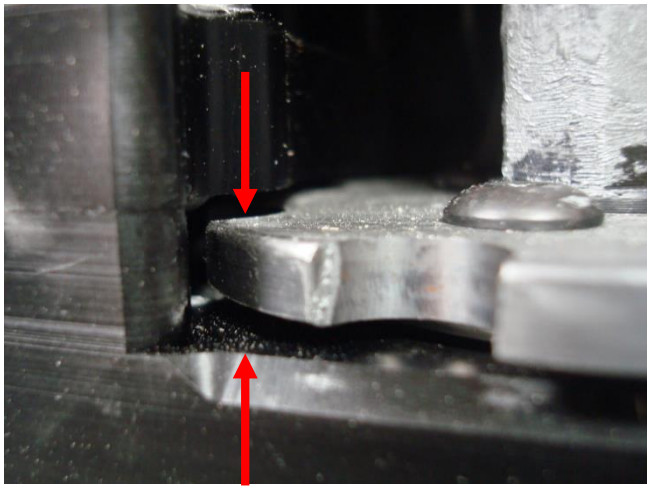


Figure 3-48

13) If the brake disc needs to be raised or lowered, remove the three socket-head screws from the top of the brake disc. Install or remove spacers as required to center the brake disc between the brake pin locating bracket and the PDB mounting plate. Use “Loc-tite” when reinstalling the three socket-head screws.

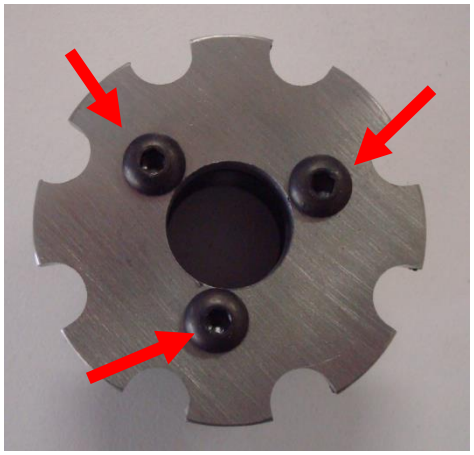


Figure 3-49

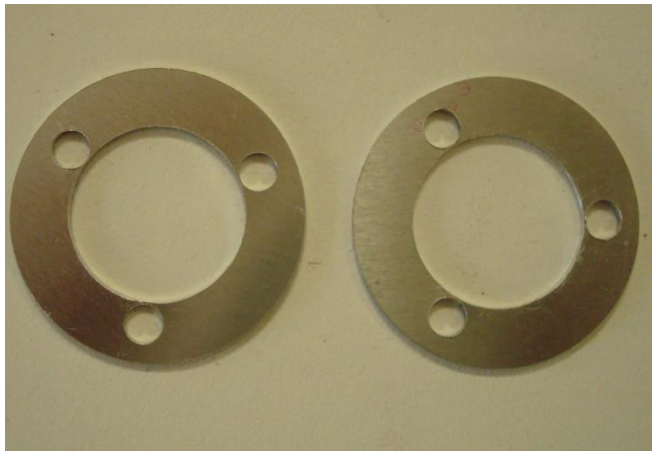


Figure 3-50

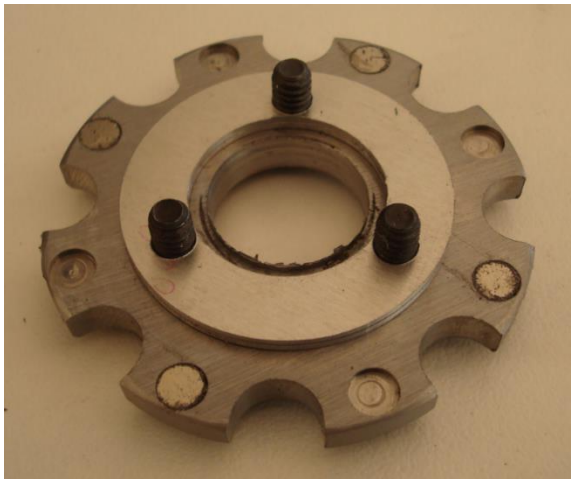


Figure 3-51

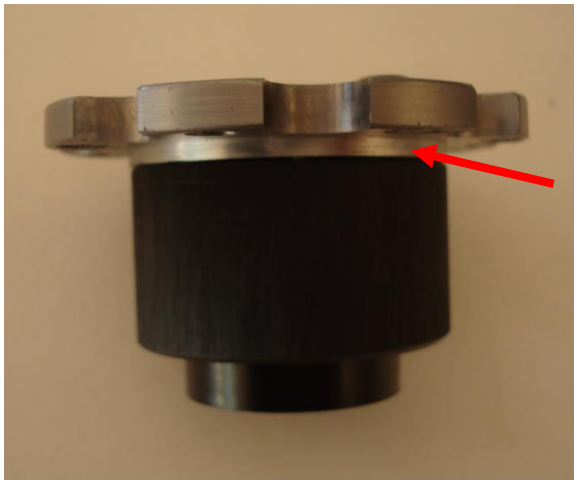


Figure 3-52

14) Coat the inside of the PDB socket with anti-seize and re-install the rest of the power head into the PDB mounting bracket and tighten the set screw just enough to hold it in place.

Do not over tighten the set screw.

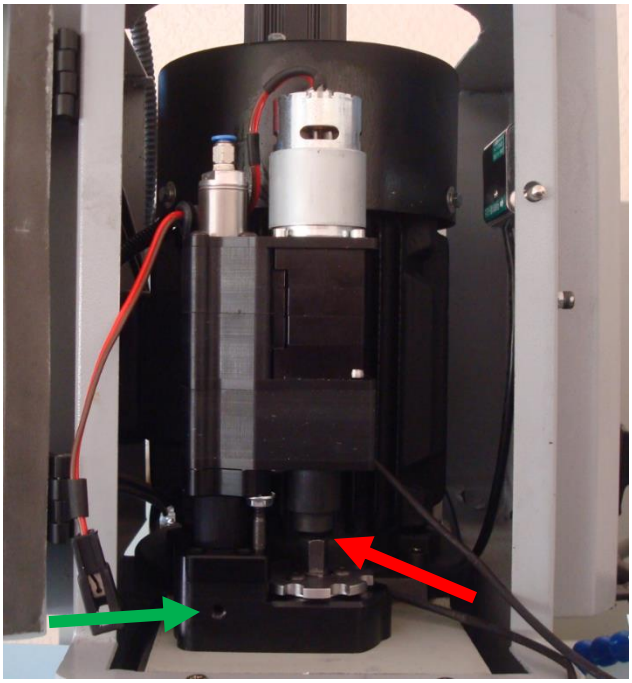


Figure 3-53

The PDB socket must be carefully aligned to the drawbar itself. This is accomplished by altering the position of the PDB mounting bracket on the head. Getting this alignment correct is an iterative process and will require removing and re-installing the upper part of the PDB power head several, perhaps numerous times, to gain access to the mounting bolts. But, once the PDB assembly is aligned, other than the mounting bracket, it can quickly and easily be removed and replaced.

15) You'll need to ensure that the brake disc is aligned so the brake pin can engage fully. You'll also need to ensure that the drawbar is aligned to the PDB socket, so that they engage correctly as well. Rotate the brake disc so that it blocks the brake pin. Press the powerhead down until the brake pin contacts the top of the brake disc. Ensure that there is 1/8"-1/4" gap between the end of the socket on the powerhead shaft and the top of the drawbar head. If the gap is not sufficient, loosen the locknut at the top of the brake pin and screw the pin up or down to adjust the gap to be within 1/8-3/16". Once properly aligned, tighten the locknut. It is important to ensure that the lift sensor triggers BEFORE the pin contacts the top of the brake disc. This is indicated by the top-most LED on the relay board going out. If the pin is adjusted too long, the function will not work, and a Lift Down error will result. The way to test the pin setting is to manually push the head down, until the pin contacts the brake disc. You can't tell just by watching the PDB operate - it's too quick. It is also still important that there be clearance between the bottom of the PDB socket and the top of the drawbar head (typically 1/8-1/4") at the point where the pin contacts the brake disc. **This check is not performed until item #7 on page 3-38.**

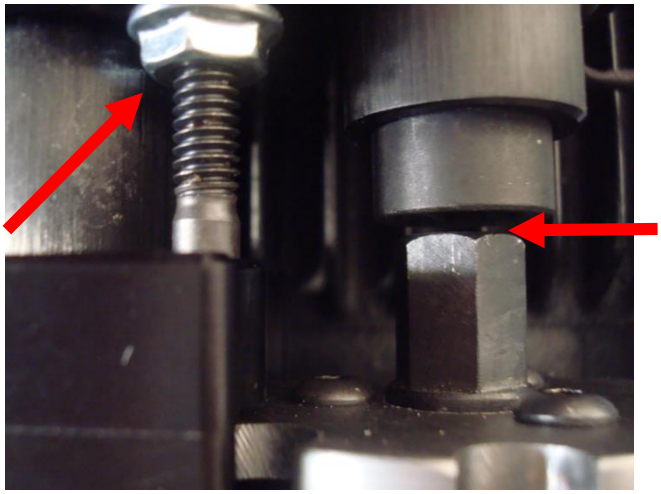


Figure 3-54

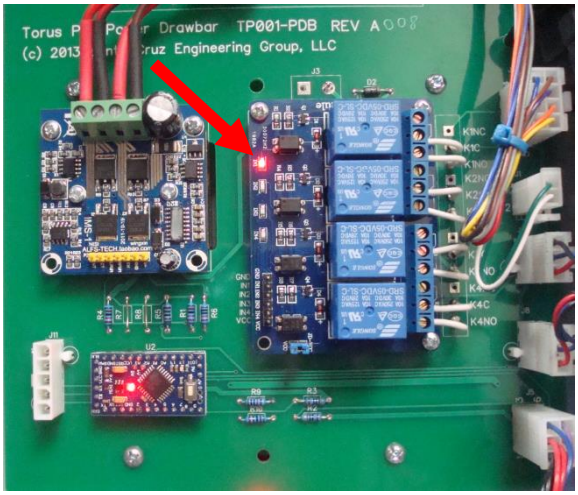


Figure 3-55 Sensor Trigger indicator LED

16) It will typically be necessary to manually turn the drawbar, to get it aligned to the PDB socket. Once aligned, it should be possible to push the PDB fully down. When released it should pop fully back up. Repeating this step several times will be a good indication of proper alignment.

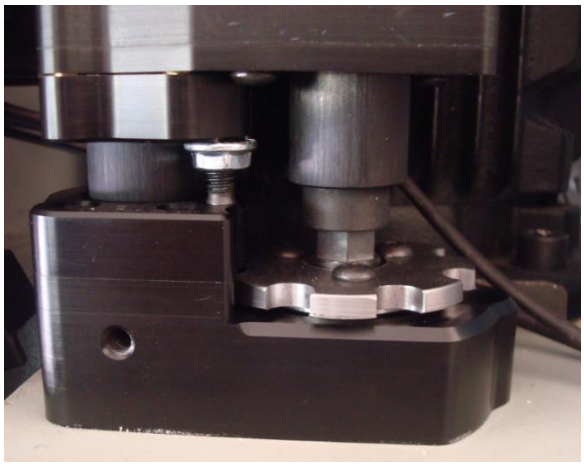


Figure 3-56

INSTALLATION OF DOOR MOUNTED PDB COMPONENTS

1. Remove the cover plate from the top of the motor enclosure access door. Pull the PDB harness through the exposed hole. Secure the PDB harness mounting plate to the top of motor enclosure access door using two ¼-20 x 1” Allen screws from the parts bag.

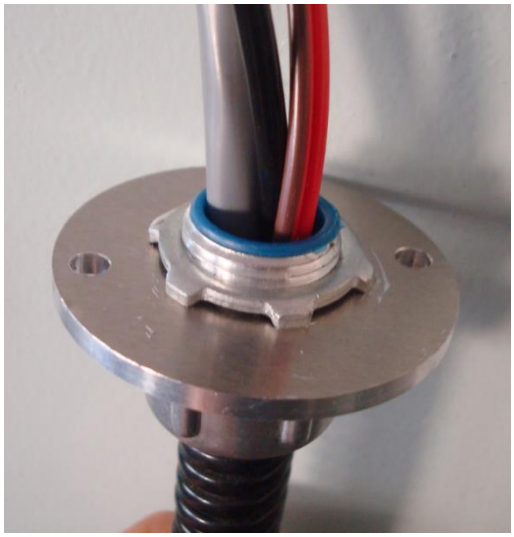


Figure 3-57

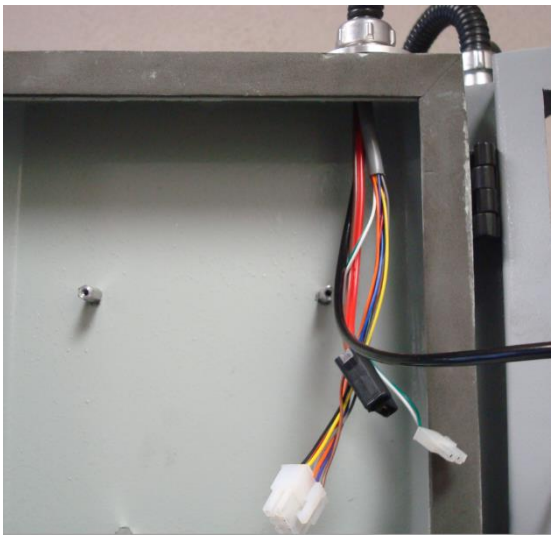


Figure 3-58

Figure 3-59

2. Install the PDB control panel into the front of the motor enclosure access door using four black #6-32 x ½" flat-head Allen screws. Use #6-32 Nylock nuts on the two lower screws. Use two #6-32 x 3/4" stand-offs on the two upper screws.

   Use two #6-32 x ½" Phillips pan-head screws to attach two #6-32 x 3/4" stand-offs to the two mounting holes near the top of the motor enclosure access door.

Figure 3-60

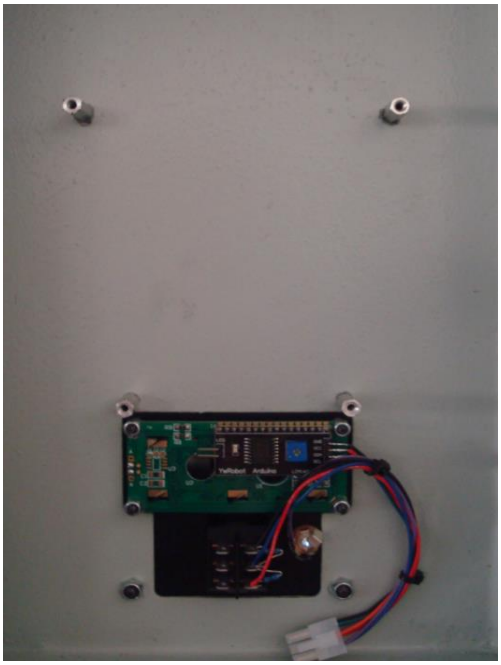


Figure 3-61

3. Locate the large PDB electronics panel, and the air hose coming from the main PDB wiring and air harness. Plug the air hose from the harness securely into the quick-release fitting on the top of the PDB air solenoid.

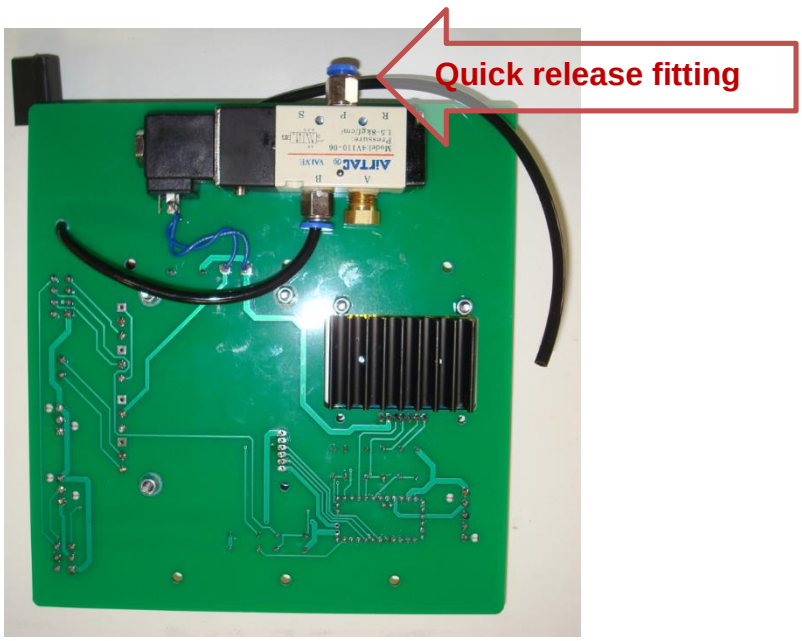


Figure 3-62 Large Electronics Panel

4. Use four #6-32 x ½" pan-head screws to mount the large electronics panel to the four stand-offs in the motor enclosure access door, so that the white connectors are along the hinge side of the door.

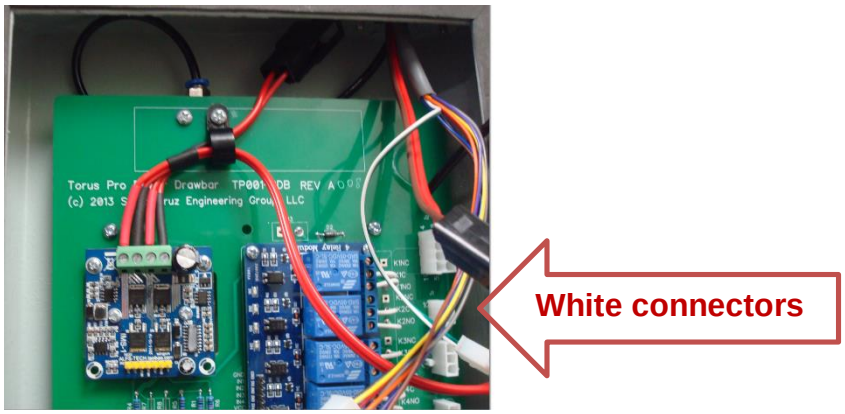


Figure 3-63

5. Plug the free end of the air hose coming from the large electronics panel into the fitting on top of the PDB power head.

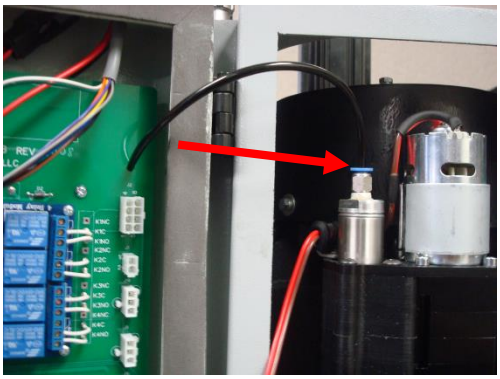


Figure 3-64

6. Note that all connectors used on the electronics panel are polarized and can only be inserted in the correct orientation. Each wiring harness connector has a small "latch" on one side.

To remove any connector, simply press the latch firmly and pull the connector out. Never pull directly on the wires, but rather pull only on the plastic connector shell.

7. Plug the 6-pin connector from the LCD control panel wiring harness into the bottom connector on the large electronics panel.

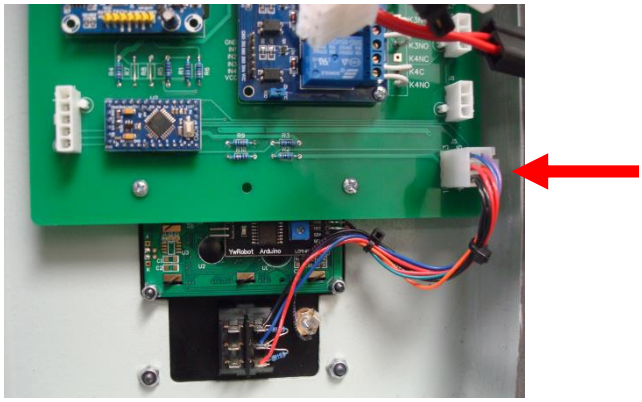


Figure 3-65

8. Plug the 3-pin connector from the PDB mounting base into the lower of the two 3-pin connectors on the large electronics panel.

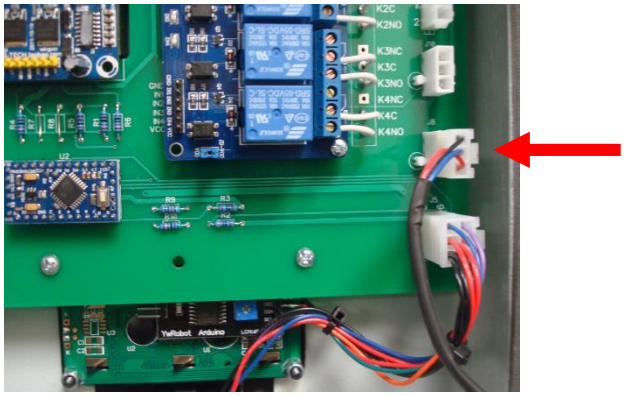


Figure 3-66

9. Plug the 3-pin connector from the PDB Head into the upper of the two 3-pin connectors on the large electronics panel.

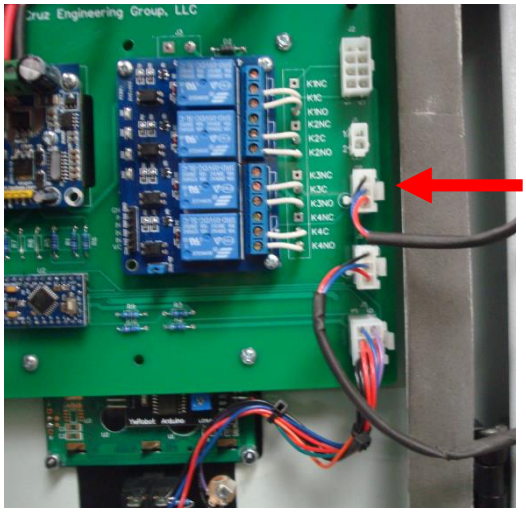


Figure 3-67

10. Plug the 2-pin connector from the PDB harness into the 2-pin connector on the large electronics panel.

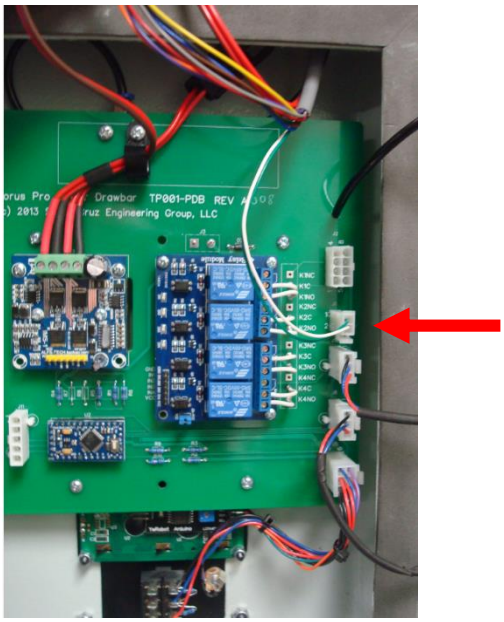


Figure 3-68

11. Plug the 8-pin connector from the PDB harness into the 8-pin connector at the top of the large electronics panel.

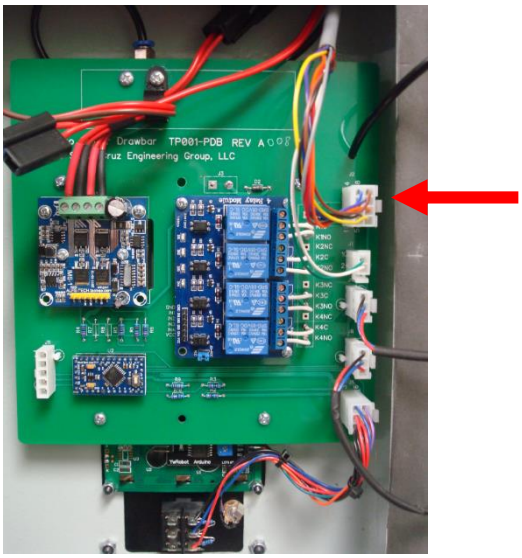


Figure 3-69

12. Connect the heavy red/brown two-wire cable with a black connector coming from the PDB air/wiring harness to one of the black connectors attached to the main electronics panel. The two black connectors attached to the electronics panel are polarized and can only be connected to a corresponding connector.

Your wiring harness may not have the black connectors. If so, the ends of the wires must be connected directly to the green terminal strip. If your wiring harness does not have the black connectors, insert the wire ends coming from the 12 volt battery, located in the main Torus PRO control panel, into the right side of the green terminal strip as indicated by the yellow arrow. Insert the wires coming from the PDB motor into the left side of the green terminal strip as indicated by the blue arrow.

NOTE: THE RED (Positive) WIRES ARE INSERTED TO THE LEFT OF THE RED/BROWN (Negative) WIRES. Reversing these wires will damage the PDB electronics which will not be covered under the PDB warranty.

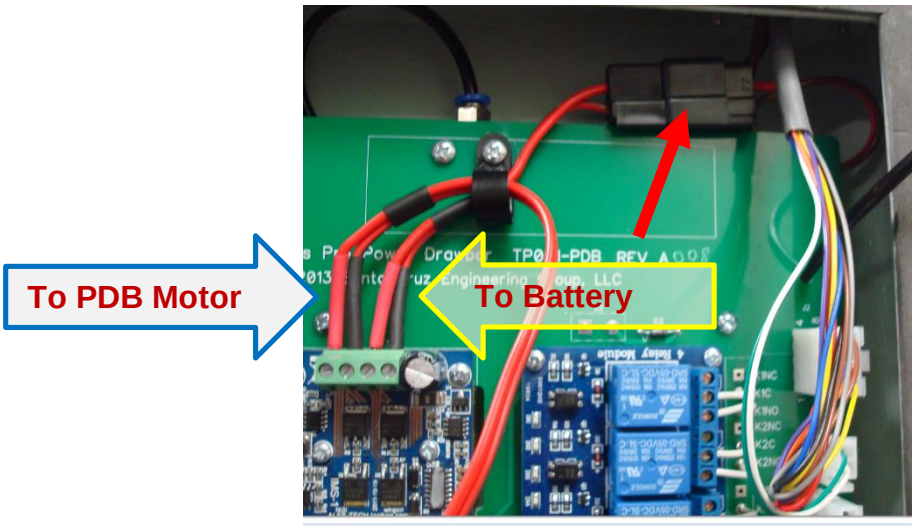


Figure 3-70

13. Connect the heavy red/brown two-wire cable with a black connector coming from the PDB motor to the other black connector attached to the large electronics panel. Neatly tuck both black connectors to the top and side of the large electronics panel.

.

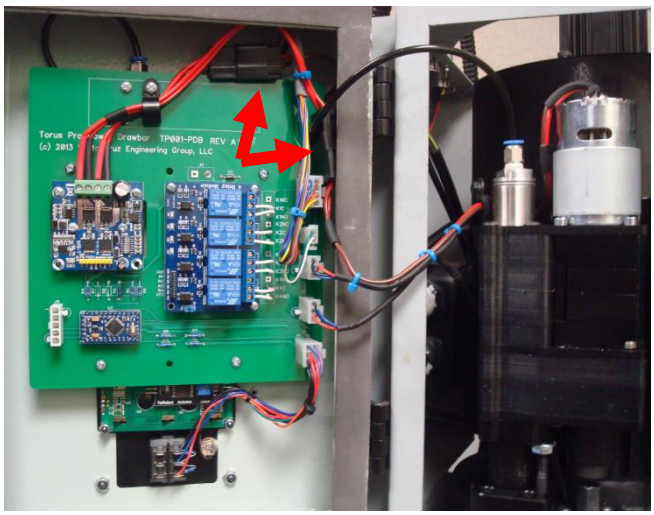
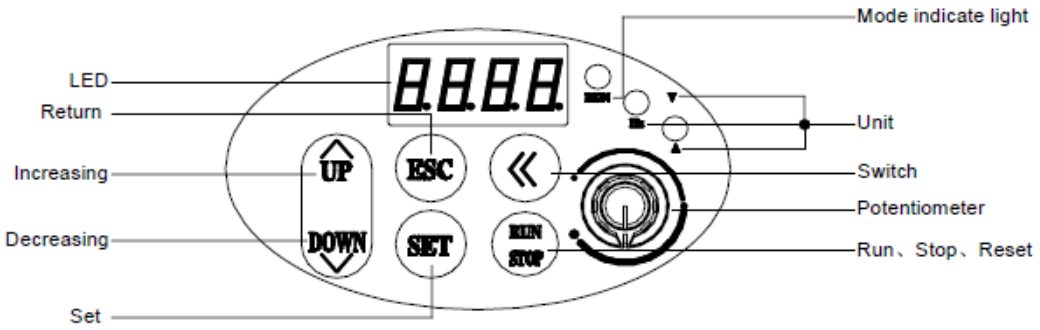


Figure 3-71

The chart below documents the front control panel for the Sunfar C300(a) VFD



4.1. Keypad functions

Item	Function
LED	It displays current state and setting parameter.
A、Hz、V	The corresponding unit of current display.
RUN	Operation indicator light. The inverter is running and U, V and W output voltage.
UP DOWN	Data modify key. It is used for modifying the function code and parameter. In state monitor mode, if F0.1 is 0, press this key will modify the frequency instruction.
ESC	Return key. Press this key in normal monitor state to enter query mode of not normal monitor state /monitor parameters to check running state. In any state, press this key to return the upper state.
SET	Set key. It affirms current state and parameter, and goes to the next function list.
RUN STOP	Run/Stop key. When F0.4 is 000#, this key is valid for panel control. When the inverter is stop and press this key, the inverter will run. When the inverter is stop and press this key, the inverter will stop. If inverter occur fault, press this key to reset it.
<<	Shift key. When modify data，Press the key to modify the digital bit, the modification bit will be displayed blink.
	Panel potentiometer. Running frequency is set by potentiometer on the panel Potentiometer turning left will reduce running frequency, potentiometer turning right will increase running frequency.

Figure 3-72 Sunfar C300(A) Front Control Panel

SUNFAR VFD FUNCTION SETTINGS

Certain Sunfar VFD factory function settings must be programmed before operating the Novakon PDB. The required function settings are shown in Table 3-1 Sunfar Function Settings.

Function Code	Name	Setting range	Factory Default Setting	Novakon Torus PRO Setting
F0. 4	Operation Channel selection	The first part of LED (form right to left): 0：Panel control 1：External terminals 2：RS485 interface The second part of LED： Function of key STOP 0：It is valid for panel control. 1：It is valid for all kinds of control method. The third and fourth part of LED(form right to left)： Reserved	0000	0001
F0. 5	Combination methods of running the command of terminals	0：Two-line mode 1 1：Two-line mode 2 2：Three-line mode	0	1
F2. 9	Analog output selection（AVO）	The first part of LED (form right to left)： AO1output 0：Output freq. 1：Output current 2：Output voltage 3：Rotational speed Of applied motor 4：PID setting 5：PID feedback The second and third and fourth part of LED：Reserved	0000	0001
F2.10	The lower limit of analog output AVO	0.0～(F2.11)	0.1	0.0
F2.11	The upper limit of analog output AVO	[F2.10]～12.0	10.0	10.0

F3.0	Function selection of input terminal 1 (0~25)	0：Control terminal is idle 1：Multi-speed control terminal 1 2：Multi-speed control terminal 2 3：Multi-speed control terminal 3 4：Wobble freq. is valid 5：State of wobble freq. reset 6：FWD jog control 7：REV jog control 8：Acc& Dec time selection terminal 1 9：Acc& Dec time selection terminal 2 10：Freq. setting channel selection 1 11：Freq. setting channel selection 2 12：Freq. setting channel selection 3 13：Freq. is controlled gradually: increase（UP） 14：Freq. is controlled gradually: increase（DW） 15：UP-DW freq. clear 16：Uncontrolled stop control 17：Fault signal of peripheral equipment input 18：Three-line mode running control 19：DC braking control 20：Inner counter clear 21：Inner counter timer 22：PLC running valid 23：PID running valid 24：Reserved 25：PLC state reset after stopping	1	6
F4.1	Start Frequency	0：Routine Mode 1：Detect Speed and Restart	0.5	2.0

Table 3-1 Sunfar Function Settings

1) Re-connect the 220 volt power cable to the Torus PRO's electrical control panel cabinet. Turn on the main power to the Novakon Torus PRO CNC Mill and boot the PC. After turning the Novakon Torus PRO Mill on, press the "Set" button on the VFD's control panel, and the VFD's display will show "*F0._0*". The "_" indicates that digit is blanked out as shown in Figure 3-73.

Figure 3-73

2) Pressing and releasing the "<<" button will highlight one of the displayed digits by making it blink, indicating that the digit can be modified using the "Up Arrow" and "Down Arrow" buttons. Press and release the "<<" button one or more times, as needed, until the left-most zero begins blinking. Continue pressing and releasing the "Up Arrow" button until "*F3._0*" is displayed on the LCD panel.

Figure 3-74

Figure 3-75

3) Press the “Set” button and the display will change, probably to display “*0*”. Use the “Up Arrow” and/or “Down Arrow“ buttons as needed to make the display show “*6*”. This enables the “jog” mode to be controlled by the “X1” input.

Figure 3-76

Figure 3-77

4) Press the “Set” button to save this change and the display will read “*F3._0*”.Press the “<<” button once, which will leave the “3” blinking. Press the “Up Arrow” button once to display “*F4._0*”. Press the “<<” button until the space left of the “*0*” begins blinking.

Figure 3-78

Figure 3-79

5) Press the “Up Arrow” button once to display “*F4.10*”. Press the “Set” button and the display will change, probably to display “*0*”. Use the “Up Arrow” and/or “Down Arrow“ buttons as needed to make the display show “*2.00*”. This sets the “jog” frequency to 2Hz. Press the “Set” button and the display will again read “*F4.10*”.

Figure 3-80

Figure 3-81

6) Now that you are familiar with programming, set F2._9 parameter to “*0001*”.

Figure 3-82

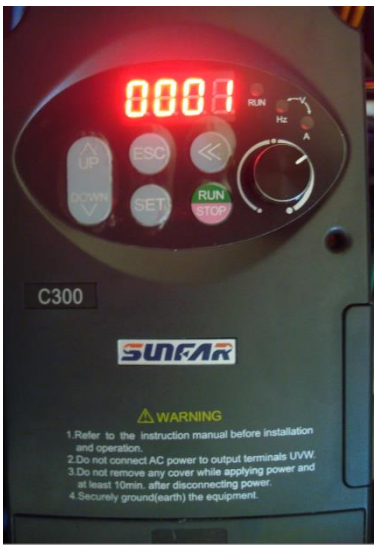


Figure 3-83

7) Set “F2.10” to “*0.0*”.

Figure 3-84

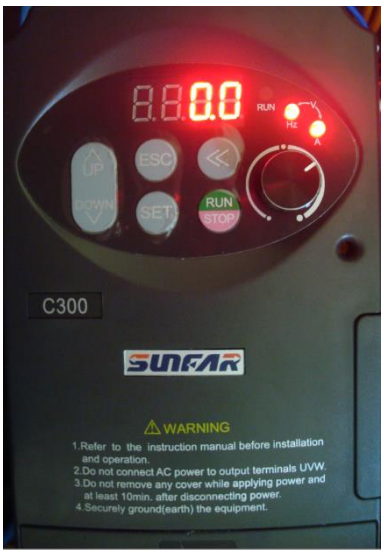


Figure 3-85

8) Set “F2.11” to “*10.0*”.

Figure 3-86

Figure 3-87

9) Verify" F0._4" is set to "*0001*".

Figure 3-88

Figure 3-89

10) Verify "F0._5" is set to "*1*". The VFD programing is now complete.

Figure 3-90

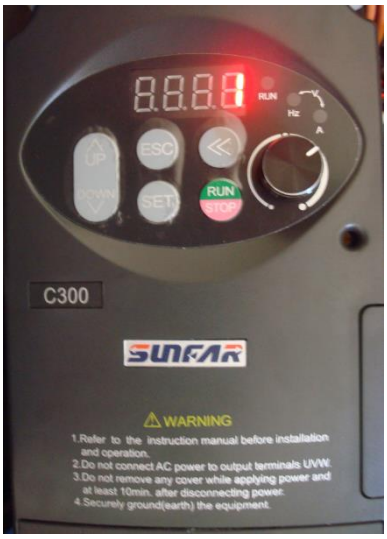


Figure 3-91

TESTING THE VFD

1) Turn on the Novakon Torus PRO CNC Mill, boot the PC and open Mach3. The PDB LCD display should show the "*Novakon PDB*" sign-on message on the first line, and "*RPM=0000*" and "motor load percentage" on the second line. If you look at the relay board (the largest of the three boards on the electronics panel), you should see a single red LED lit. If you now press down on the PDB assembly, to lower it about 1/8", you should see that LED go out. Releasing the PDB should cause the LED to re-light.

2) Spin the spindle by hand and you should see the RPM display on the PDB LCD update to show the current spindle RPMs.

3) Turn on the spindle through Mach3 and the RPM display will show true spindle RPM.

4) With the spindle turned OFF, press and release the PDB Down-Arrow button. You should hear a few relay clicks, the spindle should "jog", and you should then see a "*Lift Down*" error message on the PDB display. Press and release the "Down Arrow" button again to clear the error message.

5) Connect the black connector from the main wiring harness to the black mating connector from the battery. The battery and battery charger are located in the large electrical control panel cabinet. The large-gauge two-wire cable with red/brown wires and black connectors when connected, will supply 12 volt DC power to the electronic boards. Turn ON the air supply to the PDB.

6) Press the Down- Arrow button and the PDB should engage and loosen the drawbar approximately one turn. Never tighten the drawbar without a tool holder in the collet, as this can damage the collet.

7) It is important to ensure that the lift sensor triggers BEFORE the pin contacts the top of the brake disc. This is indicated by the top-most LED on the relay board going out. If the pin is adjusted too long, the function will not work, and a Lift Down error will result. It is also still important that there be clearance between the bottom of the PDB socket and the top of the drawbar head (typically 1/8-1/4") at the point where the pin contacts the brake disc. The way to test the pin setting is to manually push the head down, until the pin contacts the brake disc. You can't tell just by watching the PDB operate - it's too quick.

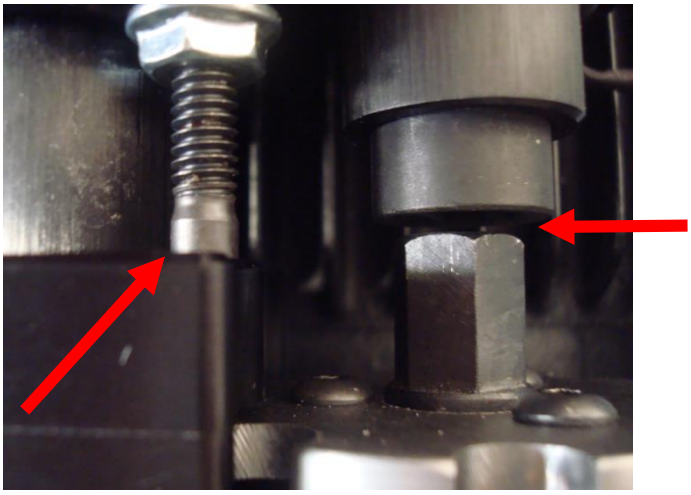


Figure 3-92

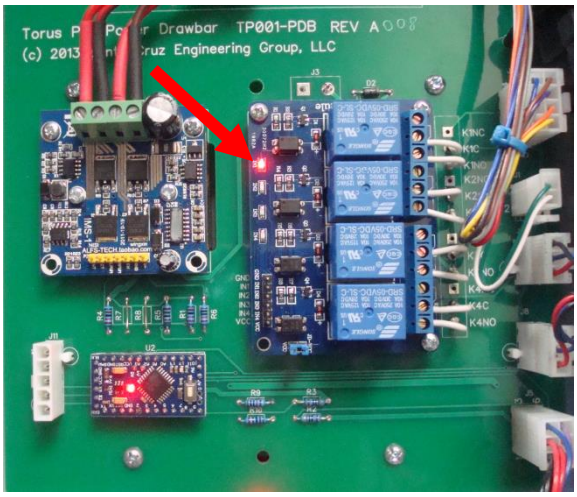


Figure 3-93

8) To ensure the PDB socket is centered to the spindle axis, perform the following test to ensure proper socket alignment. Rotate the spindle by hand to various locations and activate the “Up-Arrow” to check the PDB engagement operation. The draw bar should exhibit minimal eccentricity to the spindle center line. If the socket is exhibiting any binding while engaging the draw bar, the PDB base must be relocated to better center the socket to the spindle center.

Caution: Do not manually tighten the drawbar if it is already tightened, since the PDB cannot self-center the drawbar. Refer to “installing the PDB head “, page 3-16, should it be necessary to realign the PDB.

9) Press and Hold the “Down-Arrow” button and the drawbar should continue loosening until you release the button. Hold the button until the collet is completely released from the spindle.

10) Put the collet and tool holder back in the spindle, then press and release the “Up-Arrow” button. The drawbar should tighten until the tool holder is locked securely in the spindle. If you get the error message “Tighten Fail”, simply clear the error by pressing and releasing either button, then press the “Up-Arrow” button again. The “*Tighten Fail*” error is really more of a warning that the drawbar did not tighten fully within 10 seconds. In some cases, it will take more than 10 seconds to completely re-install an R8 tool.

4 OPERATING THE PDB

BASIC OPERATION

Any drawbar tightening operation in progress can be aborted by pressing the “Up-Arrow” button for one second. This is handy to prevent damage to the collet if a tightening operation is accidentally initiated when there is no tool holder in the spindle.

The LCD display on the PDB provides useful information to the user. When the PDB is not active, the display shows the current spindle RPM and if enabled, the current spindle load as a percentage of spindle rated power. When the PDB is operating, the display indicates the current operation in progress, as well as an error message should any fault occur. In addition, the PDB motor current or battery voltage can be displayed.

Basic operation of the PDB with quick change tooling could not be simpler:

To secure a quick change tool

- Insert the tool shank into the machine spindle.
- Press and release the Up-Arrow key on the PDB control panel.

To release a quick change tool

- Press and release the Down-Arrow key on the PDB control pane.
- Remove the tool from the machine spindle.

To release an R8 tool

- Press and hold the Down-Arrow key until the tool is fully released.

Operating Recommendations

- Loosen the drawbar and remove the tool holder when the machine is not in operation. This will help prevent the collet from sticking in the spindle.
- Never tighten the drawbar without a tool holder in the collet, as this can damage the collet.
- Ensure that the PDB battery charger is always powered, even when the machine is turned OFF. The charger is powered from the 220 volt AC line supplying power to the machine. Always turn the machine OFF using its built-in power switch, rather than turning OFF all power to the machine by unplugging the power cord, and/or turning OFF an external switch or circuit breaker.

5 CONFIGURATION MODE

PDB FIRMWARE

The PDB firmware contains a “Configuration” mode which allows changing the many parameters which control the operation of the PDB.

WARNING!

The operational parameters available through Configuration mode can drastically affect operation of the power drawbar. Incorrect settings can easily destroy the PDB electronics. For this reason, most settings are not documented and the user is strongly warned to refrain from changing any of the undocumented settings. All parameter changes are logged by the firmware, so a failure induced by unauthorized user changes to these settings WILL leave a distinctive “footprint”.

Configuration mode is accessed by the following sequence:

1) Press and hold the small rectangular (usually red or yellow) reset button on the MCU board.

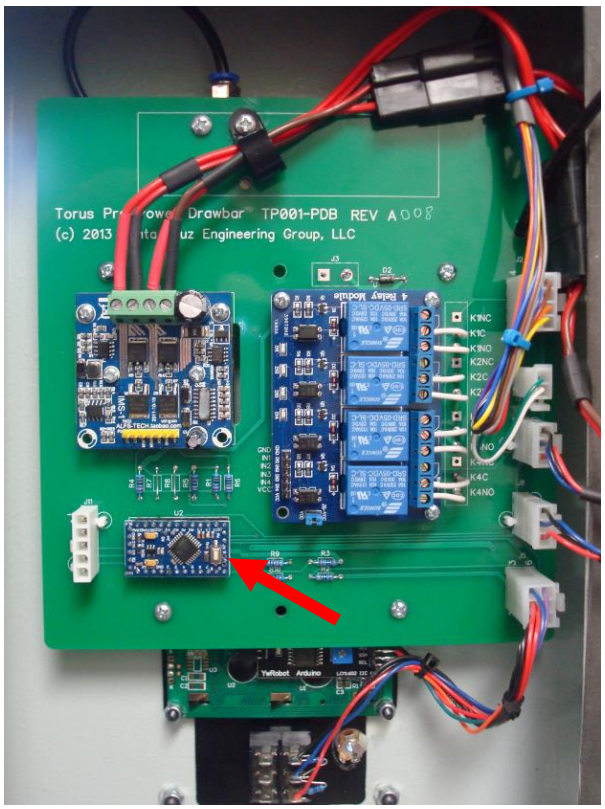


Figure 5-1

2) Press and hold the Up-Arrow button.

3) Release the reset button.

4) Wait for the LCD display to clear, then display “Novakon PDB”.

5) Release the Down-Arrow button.

6) The LCD display will change to show “*Cfg Mode*” on the first line. The second line of the display will show one of numerous parameters including the following user-settable options:

   - **SLD** – Enable spindle load-meter
   - **IVE** – Enable current/voltage display during PDB operation

A parameter is selected by pressing and releasing the Up-Arrow or Down-Arrow button. Pressing Up-Arrow will move to the next parameter in the list, while pressing Down-Arrow will move to the previous parameter in the list. The current value of the selected parameter will be displayed on the LCD display after an “equal” sign.

Once the desired parameter is displayed, its value can be enabled for editing by pressing and holding the Up-Arrow button for at least one second. Once enabled for editing, the parameter value will be preceded by a “*”. The parameter value can then be modified using the Up-Arrow and Down-Arrow buttons to increment or decrement the value. To save the updated parameter value and return to the parameter selection menu, press and hold the Up-Arrow button for one second. To discard any change and return to the parameter selection menu, press and hold the Down-Arrow button for one second.

The valid parameter values are as follows:

SLD – Spindle Load-Meter Enable

The default value for this parameter is “*1*”.

Setting this parameter to “*0*” will disable the spindle load meter display.

Setting this parameter to “*1*” will enable the spindle load meter display. The range of this display is 0-200%, with 100% indicating the spindle is running at rated load for the current RPM.

IVE – Current/Voltage Display Enable:

The default value for this parameter is "*0*".

Setting this parameter to "*0*" will disable display of motor current and battery voltage during PDB operation.

Setting this parameter to "*1*" will enable display of motor current during PDB operation.

Setting this parameter to "*2*" will enable display of battery voltage during PDB operation. This can be useful for monitoring battery performance as battery voltage under load, particularly when tightening the drawbar. A healthy battery, in a proper state of charge, should never drop below 9V. The drawbar torque drops as the battery ages and is caused by a drop in the battery's voltage.

6 IN CASE OF TROUBLE

MANUAL OPERATING MODE

The PDB firmware contains a “Manual” operating mode which is useful for testing the various parts of the PDB hardware. Manual mode is accessed by the following sequence:

- Press and hold the small rectangular (usually red or yellow) reset button on the MCU board
- Press and hold the “Down-Arrow” button
- Release the “reset” button
- Wait for the LCD display to clear, then display “*Novakon PDB*”
- Release the “Down-Arrow” button
- The LCD display should change to show “*Manual Mode*” on the first line

In Manual Mode, the second line of the display will show one of several functions as follows:

- *“Lift*” – Test the PDB lift function
- “*Jog*” – Test PDB spindle jog function
- “*Lock*” – Test the PDB spindle sense and interlock functions
- “*Btn*” – Test the PDB button functions
- “*IF*” – Measure PDB Fast mode current and voltage
- “*IT*” – Measure PDB Torque mode current and voltage

FUNCTIONS

A function is selected by pressing and releasing the Up-Arrow and Down-Arrow buttons. Pressing the Up-Arrow will move to the next function in the list, while pressing the Down-Arrow will move to the previous function in the list. Once the desired function is displayed, it can be activated by pressing and holding the Up-Arrow button for at least one second.

To de-activate any function and return to the function select menu, press and hold the Down-Arrow key for one second.

Once activated, the functions are used as follows:

Lift Test When in Manual Lift mode, the display will show either “*Lift = Up*” or “*Lift = Down*”. The display indicates the actual lift position as reported by the lift sensor on the PDB. Pressing the Up-Arrow button will command the lift to move up, while pressing the Down-Arrow button will command the lift to move down.

Jog Test When in Manual Jog mode, the display will show either "*Jog = Off*" or "*Jog = On*", depending on the currently commanded state of the PDB spindle Jog relay. Pressing the Up-Arrow button will command jog ON, while pressing the Down-Arrow button will command jog OFF.

Lock Test When in Manual Lock mode, the display will show either "*Lock = Off*" or "*Lock = On*", depending on the currently commanded state of the safety interlock relay. Pressing the Up-Arrow button will command the safety interlock ON, while pressing the Down-Arrow button will command the safety interlock OFF.

Button Test When in Manual Button Test mode, the display will show "*Btn = Up*" whenever the Up-Arrow button is pressed, "*Btn = Down*" whenever the Down-Arrow button is pressed, or "*Btn =*" when no button is pressed.

Note that the following two functions are intended for use by the factory and service personnel. These functions have the potential to damage the PDB electronics. It is STRONGLY recommended that the customer NOT use these functions unless instructed to do so by Novakon personnel. Misuse of these functions WILL void your warrantee!

IF Test This mode is used to measure and display PDB motor current and battery voltage when the motor is running in "Fast" mode. Pressing the Up-Arrow button will cause the motor to spin clockwise for about one second and display the measured motor current and battery voltage. Pressing the Down-Arrow button will cause the motor to spin counter-clockwise for about one second and display the measured motor current and battery voltage.

IT Test This mode is used to measure and display PDB motor current and battery voltage when the motor is running in High Torque mode. Pressing the Up-Arrow button will cause the motor to spin clockwise for about one second and display the measured motor current and battery voltage. Pressing the Down-Arrow button will cause the motor to spin counter-clockwise for about one second and display the measured motor current and battery voltage.

REMOVING THE PDB ELECTRONICS

Should it ever become necessary to remove the PDB electronics, it is very important that it be done by ***only*** using the following procedures:

1) Turn OFF the machine and disconnect AC power either by disconnecting the AC cord, or turning off the main circuit breaker to the outlet.

2) Disconnect the wiring harness from the PDB battery.

3) Disconnect or turn OFF the main air supply to the PDB.

4) Disconnect the 8-pin connector located at the top-right of the PDB electronics panel. To remove any connector, simply press the latch firmly and pull the connector out. Never pull directly on the wires, but rather pull only on the plastic connector shell.

5) Disconnect all remaining connectors from the PDB electronics panel.

6) Disconnect the air hose from the top of the PDB air cylinder.

7) Disconnect the air supply hose from the air solenoid at the top of the PDB electronics panel.

8) Remove the large electronic panel from the motor enclosure door.

9) Remove the PDB electronic display panel from the motor enclosure door.

RE-INSTALLING THE PDB ELECTRONICS

Should it ever become necessary to reinstall the PDB electronics, it is very important that it be done by ***only*** using the following procedures:

1) Turn OFF the machine, and disconnect AC power either by disconnecting the AC cord, or turning OFF the main circuit breaker to the outlet.

2) Disconnect wiring harness from the PDB battery.

3) Disconnect or turn OFF the main air supply to the PDB.

4) Connect the air supply hose coming from the PDB wiring harness to fitting on the top of the air solenoid at the top of the large PDB electronics panel.

5) Connect the short air hose coming from large PDB electronics panel to the fitting on the top of the PDB air cylinder.

6) Install the PDB electronic display panel in the opening on the front of the motor enclosure door.

7) Install the large electronic panel to the inside of the motor enclosure door.

8) Connect the heavy red/brown two-wire cable with a black connector coming from the PDB main harness to one of the black connector attached to the main electronics panel. The two black connectors attached to the electronics panel are polarized and can only be connected to a corresponding connector.

9) Connect the heavy red/brown two-wire cable with a black connector coming from the PDB motor to the other black connector attached to the main electronics panel.

10) Connect all connectors to the PDB electronics panel.

11) Re-connect the PDB battery.

12) Re-connect AC power to the machine and check for proper operation.

7 NOVAKON TORUS PRO PDB DIAGNOSTIC PROCEDURES

HARDWARE DESCRIPITION

The PDB hardware consists of the following sub-assemblies:

- Base/hub sub-assembly
- “Power-head” sub-assembly
- Electronics sub-assembly
- Battery/charger sub-assembly
- Wiring harness

The Base/hub sub-assembly anchors the power-head to the machine, and also contains an integrated spindle speed sensor, and the spindle brake. The spindle speed sensor operates via a Hall Effect sensor embedded in the base, and four magnets embedded in the underside of the brake disc. The spindle brake is a “pin brake”, with a pin mounted to the moving portion of the power-head assembly, which engages one of eight slots in the spindle brake disc attached to the spindle hub.

The power-head sub-assembly contains a small pneumatic cylinder for operating the PDB “lift”, an integrated sensor to confirm proper lift operation, the motor/gearbox assembly which actually tightens and loosens the machine drawbar, and an internal lift return spring. The lift sensor operates via a Hall-Effect sensor embedded in the moving portion of the power-head assembly, and magnet embedded in the power-head guide post. The pneumatic cylinder pushes the power-head down when air pressure is applied, and returns to the up position, via the return spring, when air pressure is removed. The motor is a small, but very powerful, 12V DC/83A motor, which operates through a 100:1 planetary gearbox. It is capable of applying well over 25 ft-lbs of torque to the machines drawbar.

The electronics sub-assembly consists of a “mother-board”, containing three smaller off-the-shelf boards, and a 12V pneumatic solenoid. The three smaller boards are an Arduino microprocessor board, which acts as the “brain” of the PDB, a relay board containing 4 SPDT relays, and a high-current FET H-bridge motor-driver board. The firmware running on the Arduino controls all aspects of PDB operation, to ensure safety, and reliability. The four relays on the relays board control the following actions:

- Relay #1 (top-most relay) – controls the primary safety interlock, which disables the spindle VFD whenever the PDB lift is NOT in its top-most position. This relay is controlled directly by the PDB lift sensor, with no firmware intervention. i.e. – any time the PDB lift is not fully up, the VFD is disabled.

- Relay #2 (second from top) – controls the spindle “jog” function, used to turn the spindle slowly to enable the spindle brake pin to engage one of the slots on the brake disc. This relay is controlled directly by the firmware. When this relay is active, the spindle is put in jog mode.

- Relay #3 (second from bottom) – controls the air solenoid, which in turn activates the pneumatic cylinder which operates the PDB lift. This relay is controlled directly by the firmware. When this relay is active, the lift will be activated to lower the PDB power-head.

- Relay #4 (bottom-most relay) – controls the Emergency Stop interlock. This interlock is activated in the event of a PDB failure which might result in an unsafe condition. This relay is controlled directly by the firmware. When this relay is active, Emergency Stop will be active, and all machine operation is inhibited until the fault is cleared by the operator.

Each relay has a red LED, along the left edge of the relay board, to indicate when it is active. Under normal conditions, when the PDB is not active, only the top-most LED will be lit.

The battery/charger sub-assembly consists of a standard 12V/8Ah sealed lead-acid battery, and AC-powered charger. The battery is commonly used in many household and commercial alarm systems, un-interruptible power supplies, and many other such devices. Replacement batteries are readily available from many source for under $20, and the battery should work for 3-5 years of normal operation, provided the charger is always powered.

The wiring harness connects the various sub-assemblies to each other, and to the machine. Much of the wiring harness is dedicated to safety interlocks, to ensure the safety of the operator and the machine.

OPERATIONAL SEQUENCE

The firmware running on the Arduino MCU ensures proper sequencing of operations when the PDB is active. As each action is taken, proper operation is confirmed, with few exceptions. If any action fails, operation is aborted, and an error message is displayed on the LCD screen. The basic operational sequence is the same for tightening and loosening:

Operator presses either UpArrow (tighten) or DownArrow(loosen) button

- The firmware confirms that the spindle is NOT turning, by monitoring the spindle speed sensor. If the spindle is turning, operation is aborted.

- The firmware commands the PDB lift to lower, by activating Relay 3, the lift relay. This energizes the air solenoid, which provides air pressure to the lift air cylinder.

- The firmware monitors the lift sensor, to ensure that the lift operation actually takes place. If it does not see the lift sensor change state within 500 mSec, operation is aborted.

- The firmware activates Relay 2, the jog relay, which commands the spindle to rotate slowly for about half a turn, so the spindle brake can engage.

- The firmware allows 500 mSec for the jog to take place, then disables Relay 2, to stop the spindle.

- The firmware activates the PDB motor, to either loosen or tighten the drawbar, as commanded.

- The entire time the PDB motor is running, the firmware monitors the motor current draw. The current draw measurement is used to ensure the motor driver is always operated in its “safe zone”, and also to detect when the drawbar has been successfully loosened or tightened. When actually tightening, or loosening the drawbar, the motor is operated in a high-torque/low speed mode. When simply spinning a loose drawbar, the motor is operated in a low-torque/high-speed mode.

- Once the drawbar is successfully tightened or loosened as commanded, the PDB lift is de-activated by turning off Relay 3.

- The firmware monitors the lift sensor to ensure the PDB head returns to the fully up position. If it does not see the lift sensor change state within 500 mSec, operation is aborted.

In the event of a fault, in most cases there will be an error message displayed on the LCD screen which will indicate the exact nature of the fault. In a few rare cases, there will be failures that do not result in an error message on the LCD. In these cases, carefully watching the PDB and the relay LEDs will often give a good indication of where the problem lies, by seeing where in the above sequence operation fails.

PDB MANUAL MODE

The PDB firmware has a built-in test mode which is provided specifically to aid in testing several key aspects of PDB operation. The sequence for entering Manual Mode is detailed in the “MANUAL OPERATING MODE” section, page 6-1.

DIAGNOSTIC PROCEDURES:

In most cases, the PDB will detect any problems, and report the nature of the problem on the LCD display. It should be noted that in the majority of cases, incorrect operation of the PDB is the result of incorrect installation and adjustment and/or improper maintenance of the PDB. It is absolutely critical that the Periodic Maintenance operations detailed in this Manual, be followed to the letter. Failure to perform this maintenance can and will, in addition to causing incorrect operation of the PDB, lead to damage to both the PDB and the machine itself. So, the first step in diagnosing any problems should always be to ensure the PDB is properly maintained, and adjusted.

In the event of a failure which does result in an error message on the LCD display, the error message itself will generally indicate the nature, and source, of the error, as follows:

SPINDLE ON ERROR:

This simply indicates that an attempt was made to activate the PDB while the spindle was still turning. In most cases, simply re-trying the operation is all that is required. Should this error occur when the spindle is not moving, the spindle speed sensor has almost certainly failed.

LIFT DOWN ERROR/LIFT UP ERROR

This indicates either a failure of the lift mechanism (solenoid valve, air cylinder, lift hardware), or the lift sensor. A Lift Down or Lift Up Error is flagged whenever the firmware commands the lift to move, but no confirmation is received from the lift sensor. If the lift appears to be operating correctly (i.e. – the PDB head moves as commanded), then most likely the lift sensor has failed. If the lift does not appear to be operating correctly, then the first thing to do is to check and adjust the PDB brake pin length, and check and adjust the alignment of the PDB drawbar socket to the drawbar itself. Misalignment is, by far, the most common cause of Lift Down and Lift Up errors. Otherwise, the problem is most likely a fault in the lift relay (Relay 3), the solenoid valve, the air cylinder, the air "plumbing", a mechanical jam in the power-head, or a problem in the 12V wiring (the solenoid valves operates via the 12V battery).

HICURRENT/LOCURRENT ERROR

This indicates that an abnormally high, or low, motor current was observed by the MCU. In most cases, re-trying the operation will be successful. If not, then there is most likely a fault in the motor driver, and the electronics will need to be returned for repair or replacement.

IANOMOLY ERROR

This indicates an abnormal current "profile" was observed by the MCU. In most cases, re-trying the operation will be successful. If not, then there is most likely a fault in the motor driver, and the electronics will need to be returned for repair or replacement.

LOOSENFAIL/TIGHTENFAIL ERROR

This indicates that a loosen or tighten operation did not complete successfully. The most common cause of both of these problems is failure to perform the Periodic Maintenance of the PDB, as detailed in Chapter 8-1. A LoosenFail error will occur when the PDB is unable to loosen the drawbar. This can occur when the drawbar is manually tightened. A TightenFail error will occur when the PDB is unable to tighten the drawbar. This will most often occur when installing R8 tools, simply because the drawbar was loosened so much that it takes more than 15 seconds for the PDB to tighten it. In most cases, simply re-trying the operation will be successful.

NO/LOW BATTERY ERROR

This indicates low battery voltage, due to either the battery being disconnected, or discharged to the point that the PDB can no longer operate correctly. This can be due to a failing battery, a failed charger, or a loose connector/bad connection in the battery/charger wiring.

In the event of a failure that does not result in an error message on the LCD display, the following tests can be performed to test each component of the PDB. These steps should be performed in order.

TESTING LIFT AND LIFT SENSOR OPERATION:

First, remove any tool holder from the spindle, ensure the spindle is positioned so the brake pin passes through one of the slots in the brake disc, and the drawbar head is rotated so it is aligned to easily engage the socket on the PDB. Manually push the PDB head fully down, and allow it to return up by means of its internal return spring. If the PDB head cannot be moved fully up and down, or does not quickly return to the fully up position by itself, there is a mechanical problem that must be resolved before proceeding further. In most cases, all that is needed is more careful alignment of the PDB to the drawbar, to ensure the lift operates smoothly and freely. Refer to “INSTALLING THE PDB HEAD”, page 3-16 for alignment details.

Once it is confirmed that the lift is moving smoothly and freely, put the PDB into Manual Mode, by following the instructions in the “MANUAL OPERATING MODE” section, page 6-16-1. Use the Manual Mode Lift Test to check operation of the PDB lift controls and sensing.

In the Manual Mode Lift Test, the “Up” or “Down” indication on the LCD display shows the state of the lift sensor, rather than the commanded position of the lift. Whenever the lift is commanded down, the lift should immediately move down, and the LCD display should show “Lift = Down”. Whenever the lift is commanded up, the lift should immediately move up, and the LCD display should show “Lift = Up”.

If the lift does move as commanded, but the LCD display does NOT reflect the actual lift position, then the lift sensor is either not properly connected, or has failed. Ensure that the lift sensor cable (the one that comes from near the top of the PDB power-head) is properly connected to the upper 3-pin connector on the PDB electronics. If it is properly connected, but is not working correctly, then the power-head and electronics will have to be returned for repair or replacement.

If the lift does not move as commanded, check each of the following in turn:

- First, verify that you have air pressure on the input side of the PDB air solenoid, by disconnecting the air line from the top of the PDB electronics, and ensuring a good flow of high-pressure air. Do not proceed until you have a proper air supply to the solenoid.

- Whenever lift down is commanded, the Relay 3 LED should be lit, and the Relay 1 LED should NOT be lit. Whenever lift up is commanded, the Relay 3 LED should NOT be lit, and the Relay 1 LED should be lit. If this does not happen, then there is a fault in the PDB electronics, and they will have to be returned for repair or replacement.

- Once the Relay 3 LED is operating properly, the air solenoid should be energized whenever the Relay 3 LED is lit. You should be able to hear a "click" when the solenoid turned on or off. You can verify solenoid operation by disconnecting the air line from the top of the PDB power head, and ensuring that when Relay 3 is lit, there is high-pressure air coming out of the air hose. If not, then there is a fault in the PDB electronics, and they will have to be returned for repair or replacement.

- If high-pressure air is present at the PDB power-head, but the lift still does not operate, then there is an internal problem in the power-head, and it will have to be returned for repair or replacement

TESTING SPINDLE SPEED SENSOR

If the spindle speed display is not working, most likely the spindle speed sensor has failed. The sensor can be easily tested by plugging the sensor cable into the lift sensor connector on the PDB electronics. The lift sensor connector is the upper 3-pin connector on the PDB electronics. With the spindle speed sensor connected to the lift sensor connector on the PDB electronics, slowly rotate the spindle by hand, and watch the Relay 1 LED on the relay board. The LED should turn on and off 4 times for each full rotation of the spindle. If this does occur then the sensor is ok, and the fault lies in the electronics, which will have to be returned for repair or replacement. If this does not occur, then the sensor has failed, and the PDB mounting bracket will have to be returned to have the sensor replaced.

TESTING SPINDLE JOG OPERATION

Put the PDB into Manual Mode, by following the instructions in the "MANUAL OPERATING MODE" section, page 6-1. Use the Manual Mode Jog Test to check operation of the PDB Jog control. Whenever Jog is enabled, the spindle should rotate slowly clockwise. Whenever Jog is disabled, the spindle should be stopped.

If spindle jog does not work, check the Relay 2 LED on the PDB electronics. Whenever jog is enabled, the Relay 2 LED should be lit. If it is not, then there is a fault in the PDB electronics, and they will have to be returned for repair or replacement.

If the Relay 2 LED operates as expected, put a voltmeter across the two white wires connected to Relay 2. Whenever jog is enabled, there should be 0V between those two connections. Whenever jog is disabled, there should be 5V between those two connections. If you always see 5V, Relay 2 has failed, and the electronics will need to be returned for repair or replacement. If you always see 0V, then there is most likely a faulty connection between the VFD and the PDB. Refer to the Novakon PDB Installation Manual to ensure the PDB wiring harness is properly installed. If you see the correct voltage readings, but the spindle does not jog, then the VFD is not properly configured, or is faulty. This can be tested by using a short piece of wire to jumper the VFD "X1" terminal to the VFD "GND" terminal, which should put the VFD into jog mode until the jumper is removed.

TESTING PDB MOTOR OPERATION

The PDB motor is extremely robust and is easily tested by simply unplugging both the battery and motor connectors from the PDB electronics, and plugging them into each other. This will power the motor directly from the battery, and should make the PDB motor spin very quickly. If it does not, then either the motor has failed completely (extremely unlikely), or (FAR more likely) there is a fault in the battery wiring.

TESTING/ADJUSTING SPINDLE BRAKE

The spindle brake is a simple mechanical device, almost entirely dependent upon both the PDB lift and Jog functions for proper operation. However, there is one critical adjustment – the length of the brake pin. To check this, do the following:

- Ensure that with the PDB is idle, and that the Relay 1 LED (top-most LED) is LIT
- Rotate the spindle so the brake disc blocks the brake pin
- Manually pull the PDB head down, until the brake pin hits the brake disc, and check the following:
    - Ensure that the Relay 1 LED is NOT lit. If it is, loosen the lock nut on the brake pin, and shorten the brake pin until the LED goes out.
    - Ensure there is roughly 1/8" clearance between the bottom of the PDB drawbar socket, and the top of the drawbar head (Refer to Figure 3-48, page 3-20). If there is not 1/8" clearance, adjust the brake pin until there is. When done, re-check to ensure the Relay 1 LED is NOT lit when the brake pin contacts the brake disc.

8 PERIODIC MAINTENANCE

The PDB requires some periodic maintenance to ensure consistent operation. The following maintenance operations and intervals are recommended.

EVERY WEEK

Remove the quick change collet from the spindle and thoroughly clean the collet as well as the inside of the spindle with a good no-residue solvent. Acetone is recommended. Be sure to clean both the inside and outside of the collet. Also clean all tool holder shanks. Once clean and dry, put a VERY thin coat of anti-seize on the collet taper, on the ground straight-shank section at the top of the collet and on the collet threads. Be sure no anti-seize gets on the inside surfaces of the collet, or on any tool holder shanks.

Examine the drawbar head and the PDB socket for signs of wear. Both the PDB socket and the drawbar are considered “wear items” that will require periodic replacement. With proper PDB installation and operation, the socket and drawbar should last several years before requiring replacement.

Insert a tool holder into the spindle and tighten the drawbar. Using wrenches, gauge by feel or by using a torque wrench the tightness of the drawbar. Target torque is 25-30 ft-lbs. After some years of service, the PDB battery will require replacement. The first indication of this will be a gradual loss of drawbar tension. Replacement UB1280 batteries are readily available Novakon.

EVERY TWO TO FOUR WEEKS OR AS REQUIRED

Rotate the PDB head to access the drawbar. Apply anti-seize to the underside of the drawbar head and both sides of the drawbar thrust washer.

Failure to do this will result in accelerated wear of the drawbar, thrust washer and top of the spindle, which will eventually lead to random “Current Anomaly” errors and tool holder pull-out.

9 WARRANTY

NOVAKON WARRANTY

Novakon warrants its PDB for a period of one (1) year from the date of invoice. If within one (1) year from the date of invoice, a Novakon PDB fails due to a defect in material or workmanship, then Novakon will, at its discretion, repair and/or replace the components with a new manufactured part(s) free of charge. This warranty does not cover labor for repairing costs or replacing parts. Customers have 14 days from date of delivery to check the PDB functionality and report any damages. Novakon will pay for return freight of damaged or defective part(s) from carrier's mishandling at its discretion. Claims must be made within this 14-day time frame or the customer will be responsible for the return freight.

This warranty does not apply to defects due directly or indirectly to misuse, abuse, negligence, accidents, repairs, lack of routine maintenance or an act of God. This warranty is also void if the serial number of the machine has been removed (where applicable), altered or modified.

An investigation will be made by Novakon to determine whether the warranty applies. To qualify, listed below are some of the causes of machine failure that this warranty does not cover.

Normal Wear – All mechanical devices need periodical parts service and replacement. This warranty will not cover repair when normal use has exhausted the life of a part(s) or component(s).

Improper Maintenance – The life of the PDB depends upon the conditions under which it operates and the care it receives. Applications of the PDB may be in dusty and dirty environments, which can cause what appears to be premature wear. Such wear when caused by dirt, dust, cleaning grit or any abrasive material is not covered under warranty.

Non Original Novakon Parts – Problems caused by part(s) that are not original Novakon CNC machine parts.

Machine Installations – Improper installation of the PDB and/or electronics may cause unsatisfactory performance and can shorten life of the PDB.

Faulty Lubrication -- Part(s) which are broken due to operation with insufficient or contaminated lubrication, or incorrect grade of lubrication.

Repair or adjustment of associated part or assemblies which are not manufactured by Novakon.

Part(s) damaged by excessive speed or overheating. Refer to the instruction in this manual for the recommended working environment and maintenance schedules.

Part(s) broken by excessive vibration caused by improper mounting of the machine or tools, installation, unbalanced set-up, improper attachment of work pieces or other abuse in operation.

Part(s) which are determined to have failed due to improper use or excessive wear caused by continuous use in a production environment. In cases such as this, Novakon will inspect the machine or part(s) and will be the sole judge of the merit of the claim.

Mishandling, improper operation, using the tool or control system for operations other than what was the intended use.

Warranty will be voided if modification to the original equipment has been made.

Transportation charges of part(s) submitted for repair and/or replacement under this warranty are the responsibility of the purchaser. Prior to the return of the machine or component, a Return Merchandise Authorization (RMA) number must be assigned by Novakon in order for Novakon to accept the return shipment(s).

Transportation charges for part(s)/machine submitted for repair and/or replacement under this warranty will be the customer's responsibility. If the part(s) or machine returned is found to be functional, an inspection fee and the return freight charges will be charged to customer. (A $100.00 US hourly fee will be applicable for such an inspection and a minimum charge of $100.00 will be billed). If the part(s) is determined to be non functional upon an in-house inspection, Novakon will repair and/or replace the part(s)/machine and pay for the return freight and insurance to customer. No warranty registration is required. Please provide your invoice as proof of purchase. In the event that the invoice is not provided, Novakon will establish the purchase date and this date will be used to determine the warranty period.

10 PDB DRAWINGS

Drawings will be added as they become available.

11 WIRING SCHEMATICS and OTHER INFO

PDB WIRING DIAGRAM (Revision B)

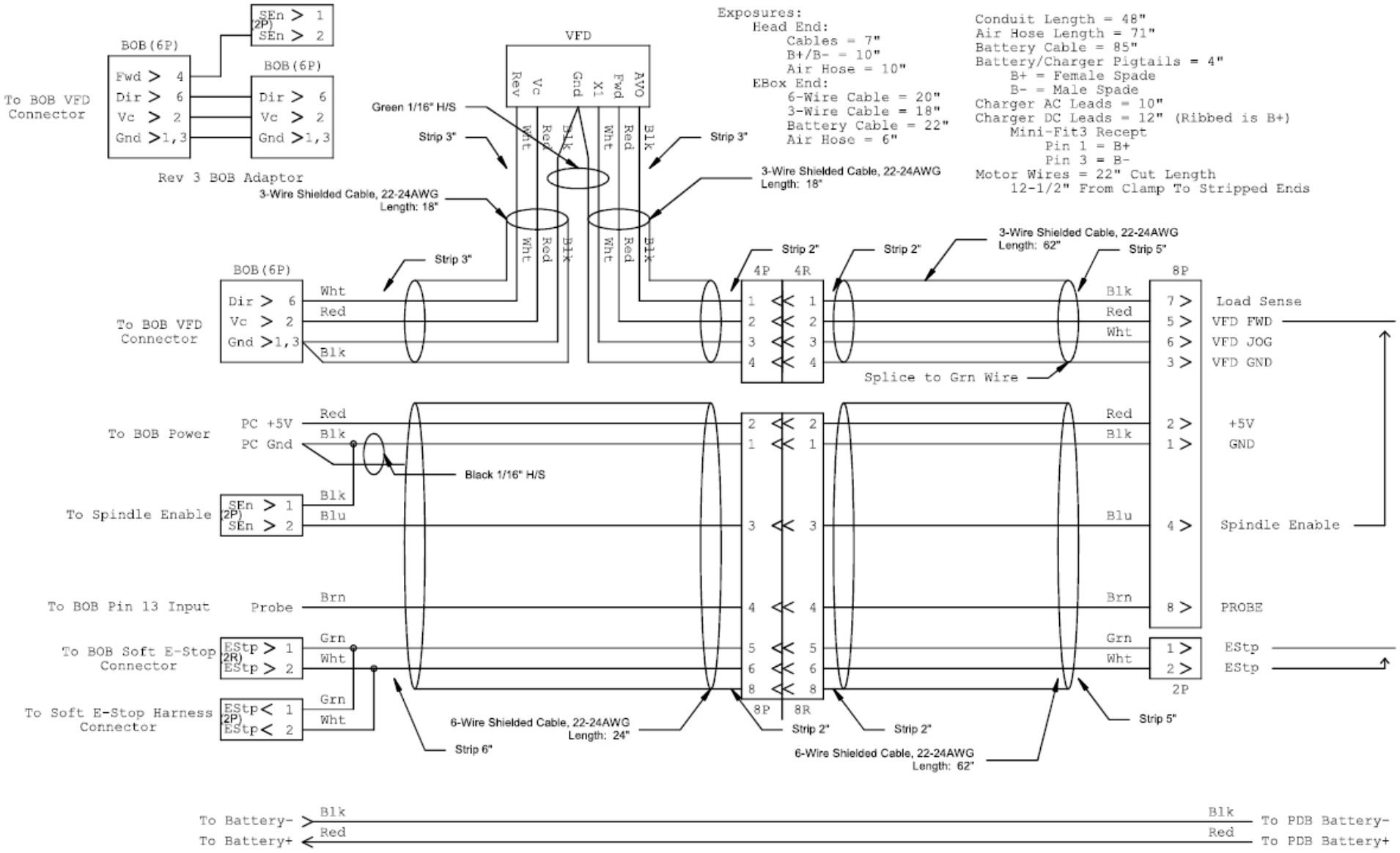


Figure 11-1 PDB Wiring Revision B

PDB WIRING DIAGRAM (Revision D)

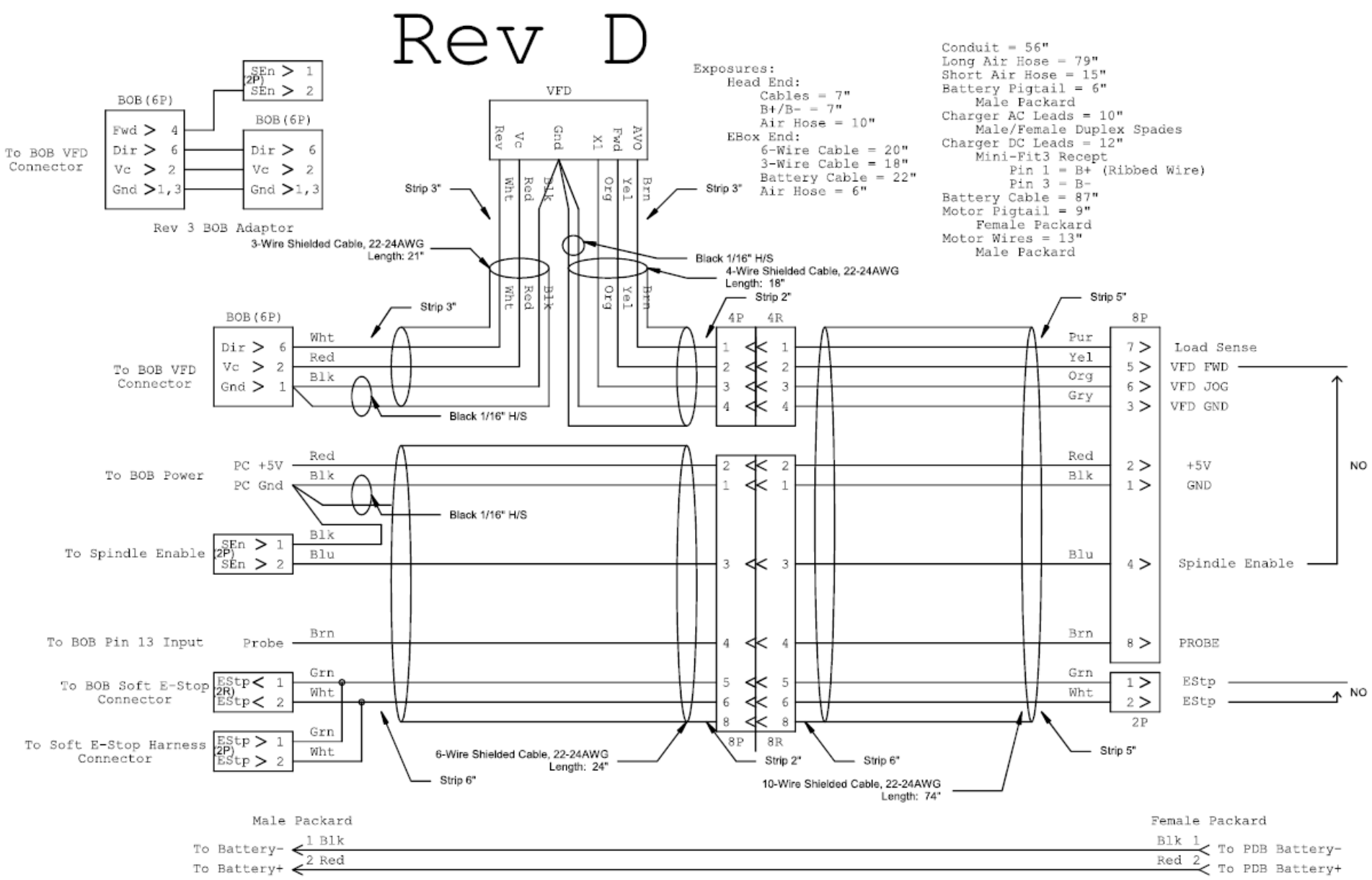


Figure 11-4 PDB WIRING DIAGRAM (Revision D)

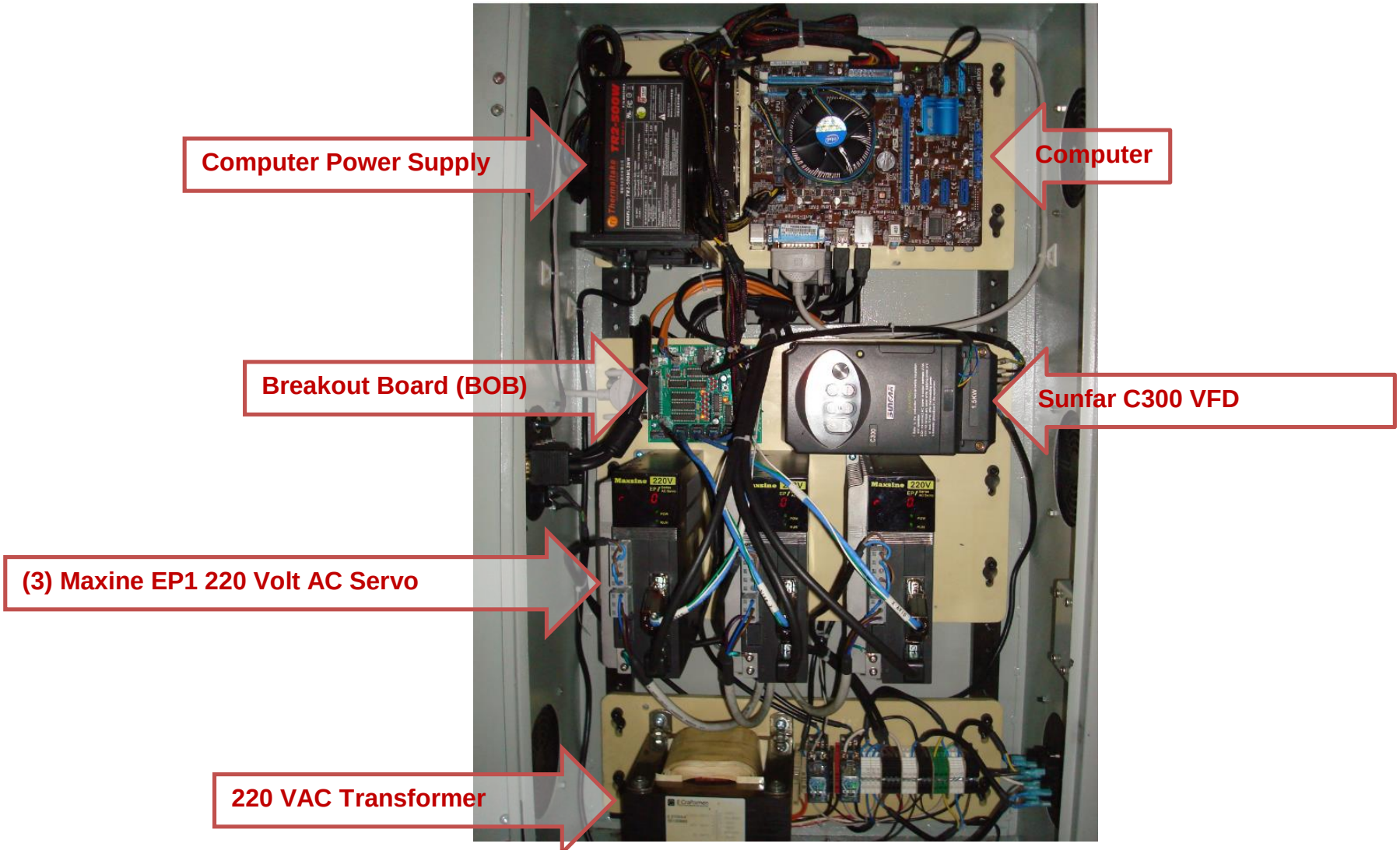


Figure 11-5 Typical Torus PRO Electrical Control Panel

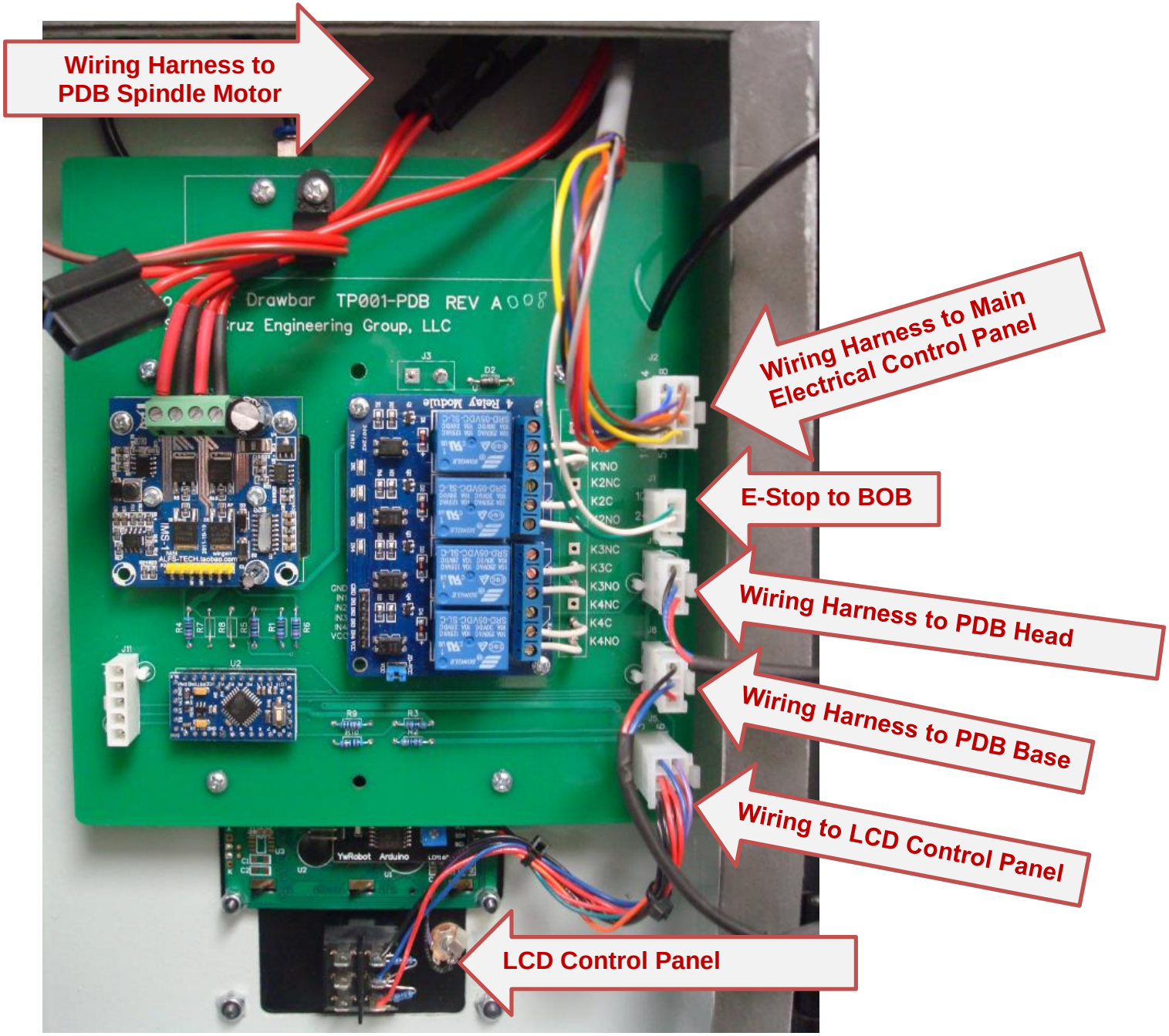


Figure 11-6 PDB Electronics

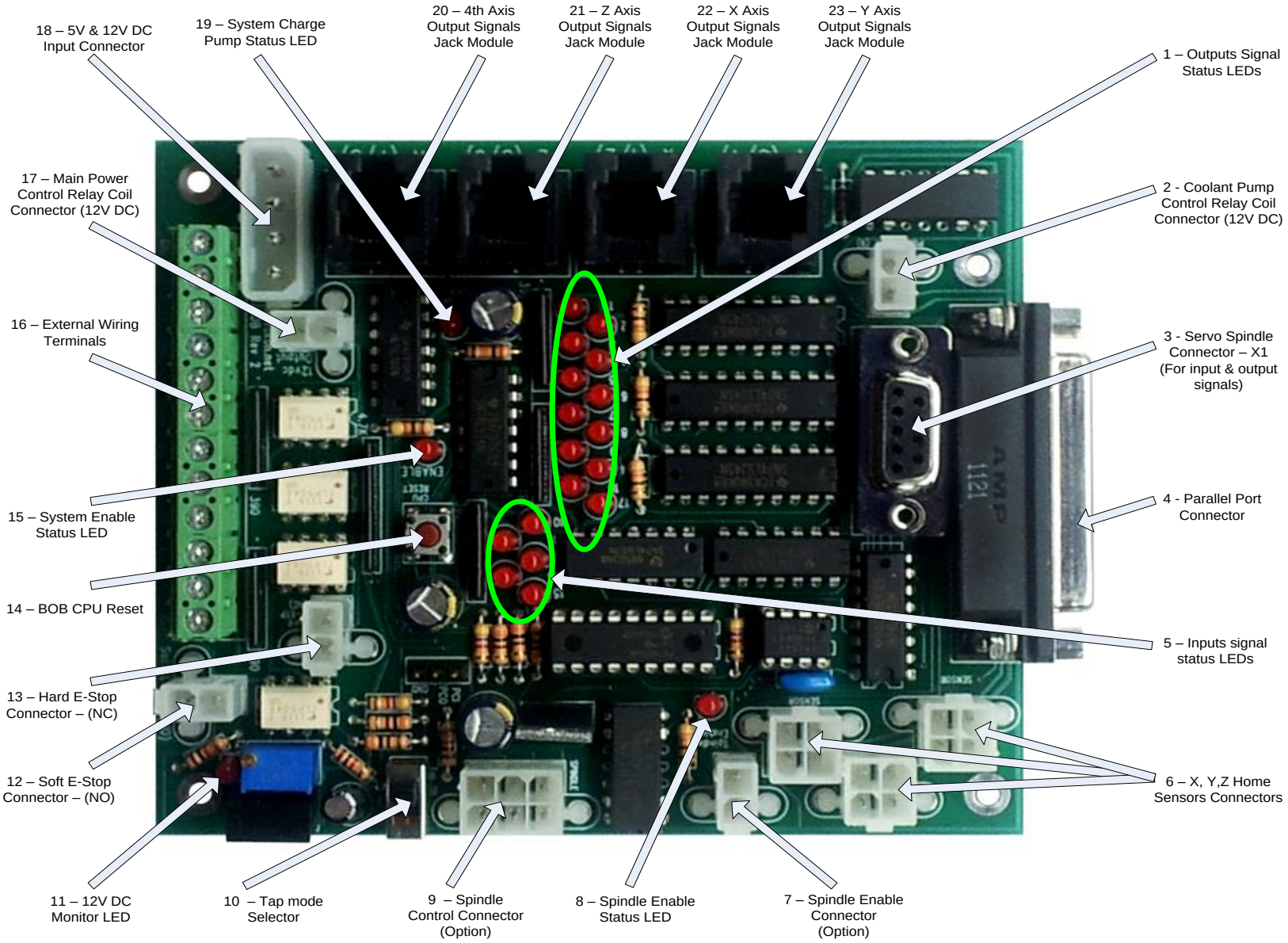


Figure 11-7 Novakon BOB Revision 2

Novakon BOB Rev 2 Item Description			
NO.	**Item**	**Description**	
Connectors			
2	Coolant Pump Control Relay Coil Connector	Output 9 controls 12 VDC output for relay coil to turn on/off coolant pump 220 VAC power	2 Wires
6	X, Y, Z Axis Home Sensors Connectors	The sensors share Input 11 to monitor HOME position. Any one of 3 axes reaches their home position will trigger the input	3 Wires (GND, 12 VDC, Signal)
7	Spindle Enable Connector (Option)	This connector can be used on some VFDs that have ENABLE terminals to enable/disable the VFD	2 Wires
9	Spindle Control Connector	Used by the VFD for signal input/output except for Servo Drive	3 Wires for Torus PRO Mill
12	Soft E-Stop Connector (N.O.)	Input 10 monitors E-stop status to enable/disable Mach3 Reset	2 Wires
13	Hard E-Stop Connector (N.C.)	Connector is used to cut off the machine's main power when E-stop is pressed through the main power relay	2 Wires
17	Main Power Control Relay Coil Connector	Provides 12 VDC for main power relay coil when BOB becomes activated	2 Wires
18	5 &12 VDC Input Connector	This power comes from the PC power supply	

MOD JACK 6P6C			
20	4th Axis Output Signals Jack Module	The Jack module outputs signals to stepper drivers (Puls+, Puls-, Dir+, Dir-) through Outputs 7 & 8	Pin 7: Puls+; Pin 8: Dir+; GND: Puls-, Dir-
21	Z-Axis Output Signals Jack Module	The Jack module outputs signals to stepper drivers (Puls+, Puls-, Dir+, Dir-) through Outputs 5 & 6	Pin 5: Puls+; Pin 6: Dir+; GND: Puls-, Dir-
22	X-Axis Output Signals Jack Module	The Jack module outputs signals to stepper drivers (Puls+, Puls-, Dir+, Dir-) through Outputs 1 & 2	Pin 1: Puls+; Pin 2: Dir+; GND: Puls-, Dir-
23	Y-Axis Output Signals Jack Module	The Jack module outputs signals to stepper drivers (Puls+, Puls-, Dir+, Dir-) through Outputs 3 & 4	Pin 3: Puls+; Pin 4: Dir+; GND: Puls-, Dir-
Button & Switch			
10	Tap Mode Selector	When selected Tap ON	
14	BOB CPU Reset	Press the reset button; the BOB will reset the CPU program	
Terminals			
16	External Wiring Terminals	The terminal can accept external inputs and be used for input/output source for +12DC, +5VDC and GND	
D-sub Connectors			
3	Servo Spindle Connector – X1	For servo spindle drive (if available), the connector is used for input and output signals	DB9 Female
4	Parallel Port Connector	The parallel port connector is used for communicating between the computer and Mach3	DB25 Female

Status LEDs			
1	Outputs Signal Status LEDs	Indicates the status of all the outputs (High or Low)	
5	Inputs Signal Status LEDs	Indicates the status of all the inputs (High or Low)	
8	Spindle Enable Status LED	Indicates the spindle VFD; Enable: light is ON; Disable: light is OFF	
11	12 VDC Monitor LED	Indicates that the 5 to 12 VDC converter is working; Good: light is ON; Failing: light is OFF	
15	System Enable Status LED	Indicates Mach3 is in control of the system; Yes: light is ON; No: light is OFF	Depressing the Mach3 Reset button, the LED should be ON
19	System Charge Pump Status LED	When BOB is power ON, the LED will blink at a SLOW rate; When the PC is communicating properly, the LED will blink at a FAST rate; When the LED is OFF or steady ON, the BOB will need resetting	

Note: BOB VER 2 input voltage:

Computer power supply 5 VDC & 12 VDC

5 VDC load current; 400-420mA

12 VDC load current; 80-90mA without running coolant pump relay; 160mA when coolant pump is on

12 MODIFICATIONS TO THE MOTOR ENCLOSURE ACCESS DOOR

This section provides guidelines and specifications required to cutout openings and drill mounting holes in the motor enclosure access door.

Extreme care must be taken when making cutouts and drilling holes in the motor enclosure access door. It is difficult to secure the door for operations of this type.

Figure 12-1 shows the motor enclosure access door before modifications, and Figure 12-2 shows the door after making the cutouts and drilling the mounting holes.

Figure 12-1 Before Modifications

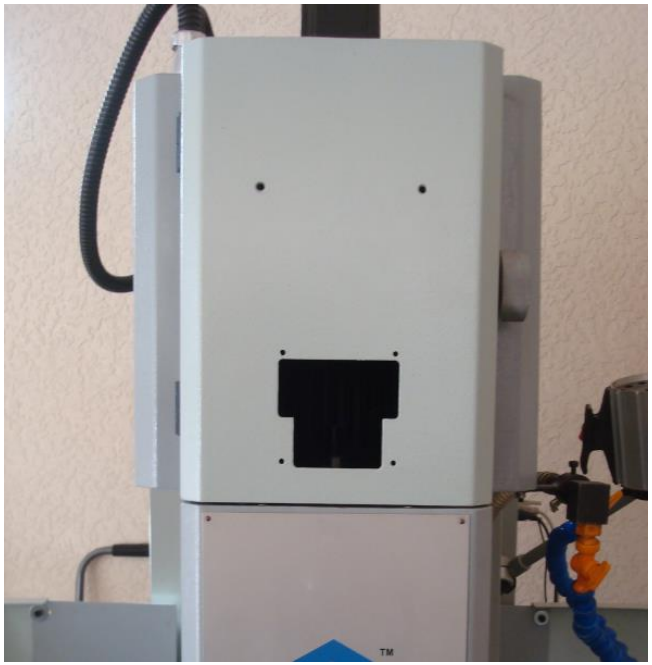


Figure 12-2 After Modifications

DOOR PANEL CUTOUT AND DRILLING SPECIFICATIONS

Use this drawing for locating cutouts and drill holes.

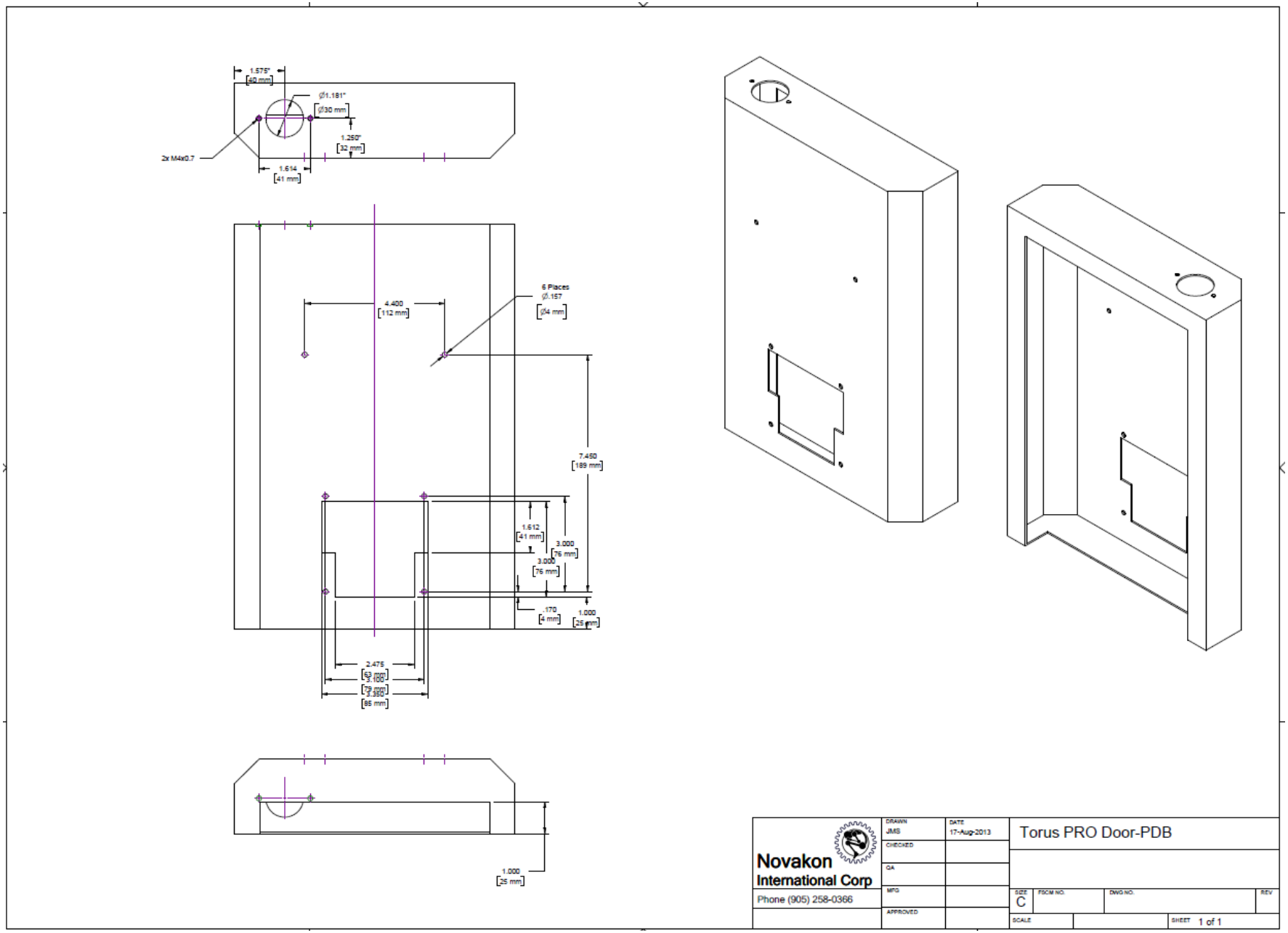


Figure 12-3

SECURING THE MOTOR ENCLOSURE ACCESS DOOR

The Torus PRO can be used to cutout the hole for the PDB control Panel and drilling small holes. The bottom cutout should be done manually using a cutoff saw, band saw, and/or jig saw.

If you are using the Torus PRO to make cutouts and drill holes in the motor enclosure access door, be sure to securely mount the door to the mill table.

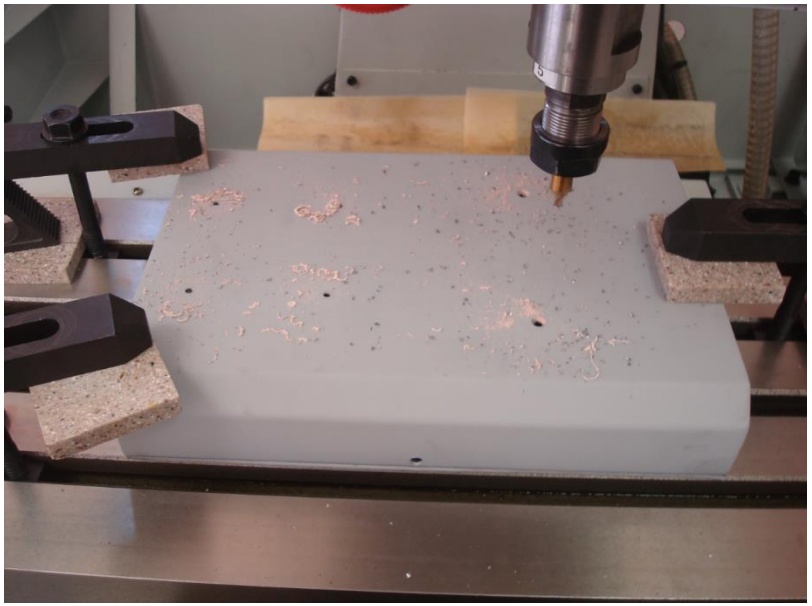


Figure 12-4

Figure 12-5

Do not attempt to drill the large hole located on the top of the motor access door using the Torus PRO CNC Mill. It is better to center drill the large hole and then use a step drill to finish drilling the hole.

Figure 12-6

Figure 12-7

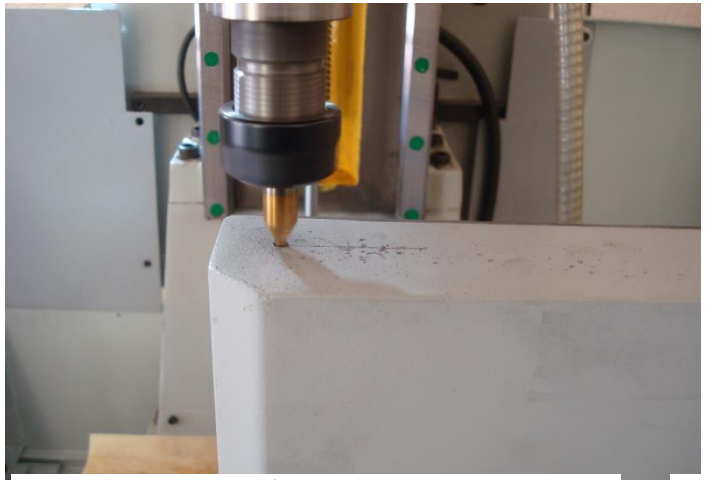


Figure 12-8

Figure 12-9

THE FINISHED MOTOR ENCLOSURE ACCESS DOOR

Figure 12-10

Figure 12-11

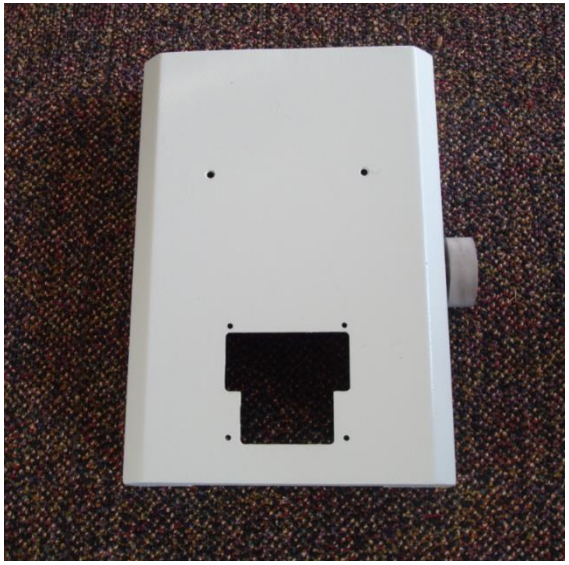


Figure 12-12

Figure 12-13

PDB SPINDLE CENTERING TEMPLATE

A template to assist in drilling the PDB mounting holes in the Novakon Torus PRO spindle head is available from Novakon when ordering the PDB kit.

Place the template over the spindle drawbar with the wider side towards the front of the Novakon Torus PRO CNC Mill. Drill one small hole using a #7 drill bit. Thread this hole using a ¼ x 20 tap. Secure the template to the head of the Torus PRO CNC Mill. Drill the other hole. Remove the template and tap the remaining hole.

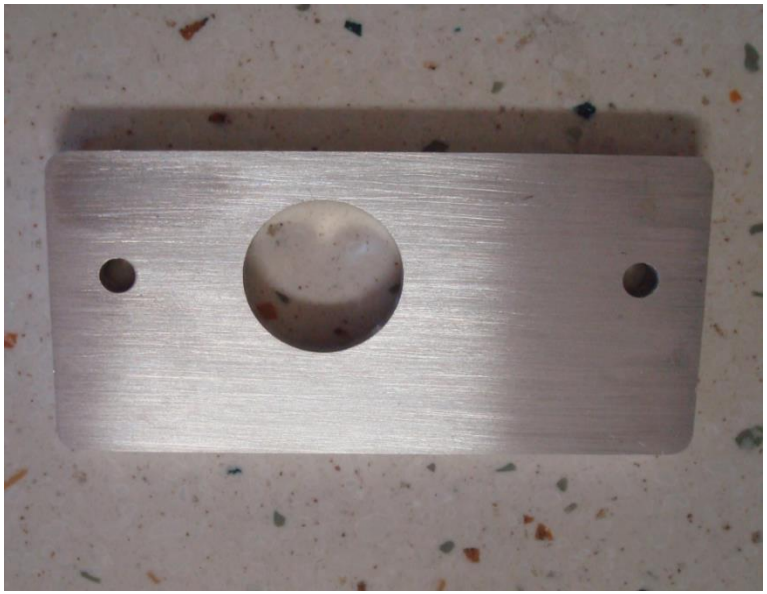


Figure 12-14

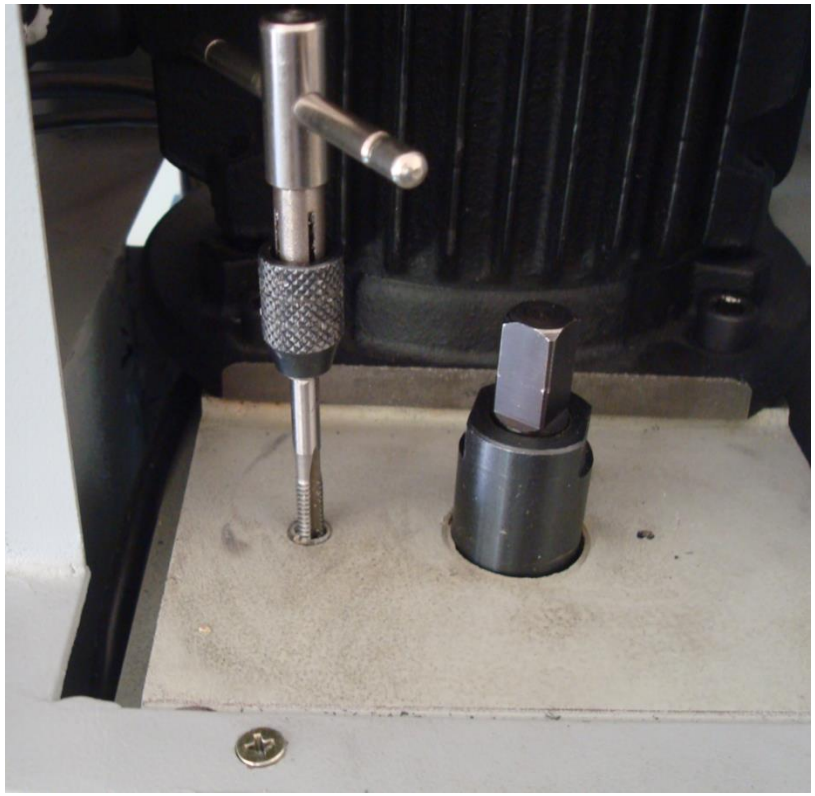


Figure 12-15