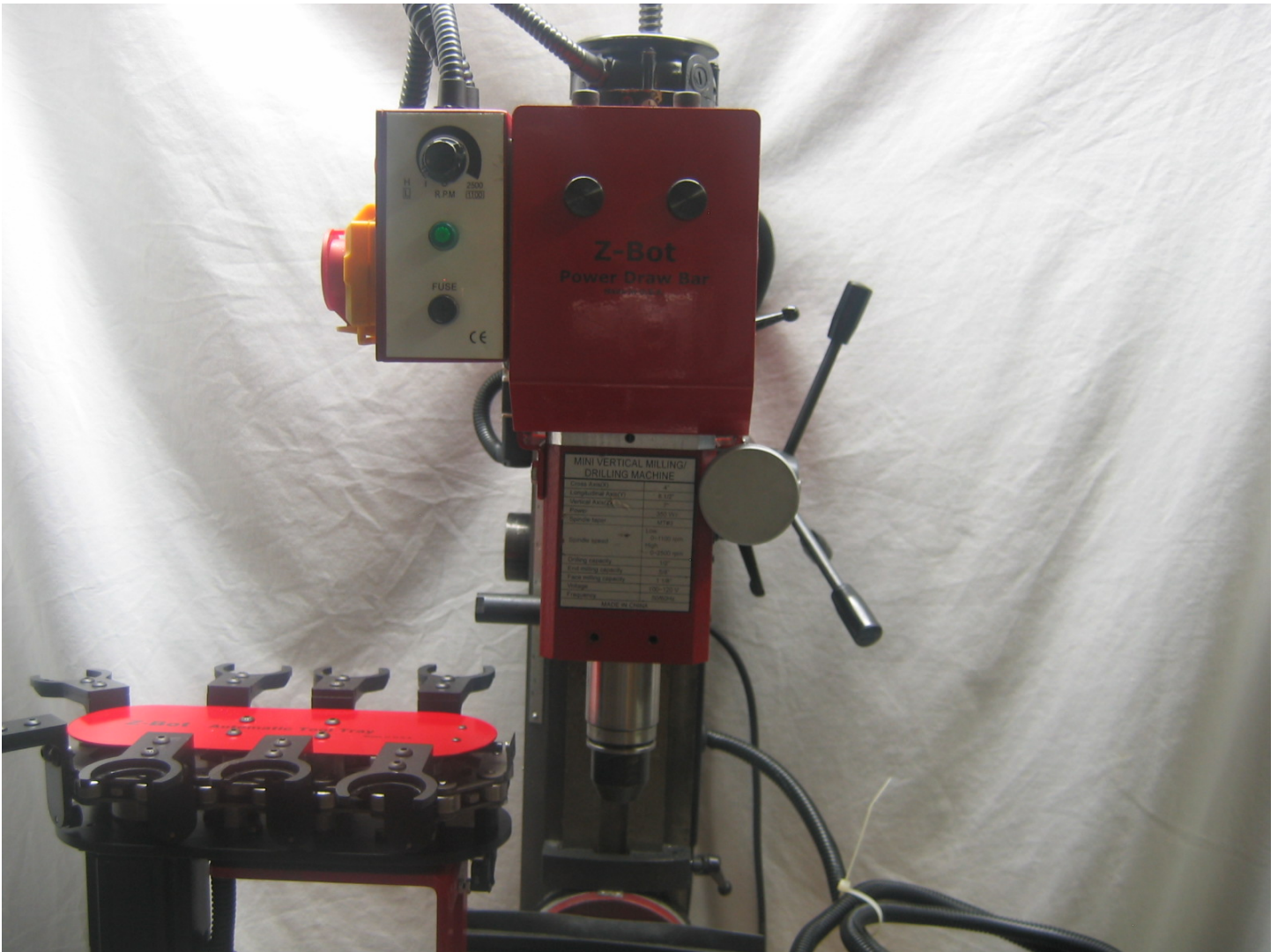


The premier source of tooling, parts, and accessories for bench top machinists.

The Z-Bot Automatic Tool Changer - model ATC-X2



The Z-bot Automatic Tool Changer is designed to work with the popular Tormach tooling system. This system employs an R8 or MT3 collet which remains in the spindle and accepts a $\frac{3}{4}$ " straight shank undercut tool holder. It is designed for a high degree of repeatability and is particularly suited to CNC milling. The system employs a chain driven tool tray, a compressor driven power draw bar, a solenoid air valve, a control module, integrated spindle control interface, a Mach3 plugin, custom Mach3 configuration, Mach3 macros, and a Mach3 screen set.

For more information on the Tormach Tooling System, visit www.LittleMachineShop.com/Tormach
The Z-bot Power Draw Bar incorporates a stack of Belleville spring washers that preload the drawbar into the tightened position. The force of the Belleville spring washers draws the collet into the spindle and retains the tool holder.

To release the tool holder, air from the compressor is directed through a four way valve to a double acting air cylinder. When the control handle is pushed downward, the air cylinder pushes the piston rod down, thereby moving the lever arm so that it bears on the top of the drawbar. The lever action multiplies the force of the air cylinder to provide more than 1000 lbs of force to overcome the action of the Belleville spring washers. This action releases the Tormach tool holder. Conversely, when the control handle is moved up, the piston rod is pulled up, which allows the lever arm to clear the top of the drawbar, and the Belleville spring washers pull the tool holder tightly against the spindle.

The height of the mechanism is adjusted so that the lever arm clears the top of the drawbar which allows free rotation of the spindle when milling.

A silencer/flow control is installed on the "up" air valve exhaust port to ensure the air cylinder does not return too violently. It is adjusted and thread locked at the factory. The "down" exhaust port has a simple air muffler as the Belleville washers slow its descent. Do not remove these air controls as it will result in shortened life of the air cylinder.

The tool tray is a stepper motor driven attachment chain with integrated "tool claws." Each tool claw employs a rigid fork to hold the tool, a plastic spring to clamp the tool into the holder, and a Delrin guide bearing for stability and positioning. The tray and holders are hard anodized aluminum for durability. The spindle end of the tool tray also employs an alignment bearing to ensure all tool holders achieve the same repeatable position when being inserted or removed from the mill. Tool claws and bearings are replaceable in case of collisions or other machining mishaps. The tool tray is mounted on a spring loaded suspension which is monitored with a pressure sensor below the table to detect misalignment errors and prevent crushing damage from the mill head. A reed sensor and magnet are used for detecting, calibrating, and monitoring the tool tray home position.

The software installation disc contains all necessary system and Mach3 components and modules to run the tool changer.

The control module contains an integrated spindle controller, stepper controller, and tool changing computer. A virtual com port emulator transforms USB communications into COMn type port communication for Mach3. The virtual com port emulator is supplied with the software installation disc and eliminates the need for extra Mach3 parallel port pins for operation. The only required parallel port resources are a single pin for error condition signaling. This will usually be a limit switch loop or e-stop loop that is already implemented. All tool changer errors are signaled via status indicator lights, and are also routed to a single circuit which emulates a normally closed switch. An error will open the connection and signal Mach3 to halt part program execution. **Do not operate the tool changer without it.** Details are contained below.

Z-Bot ATC X2 Contents

The following contents are included with the Z-Bot ATC-X2:

- Power draw bar mill head mechanism*
- Power draw bar solenoid 4 way air valve
- Z-Bot automatic tool tray w/motor
- MT3 or R8 spring loaded draw bar*
- Control module w/ integrated USB spindle controller, draw bar controller, and stepper driver
- USB cable
- Small roll double sided foam tape
- Two M6 x 16mm socket head cap screws
- Two aluminum stand-offs
- Two ¼-20 x .25 thumb screws*
- Four ¼-20 x .5 hex bolts*
- Two 6-32 x 1.75" socket head cap screws
- Owners manual CD
- Software and driver installation CD
- Two rubber grommets
- 1 female crimp connector
- Replacement air hoses (supplied with upgrade kit only)

**not supplied with upgrade kit*

You must furnish an air hose coupling or fitting for your compressed air hose with a ¼" NPT male thread.

Tools Required

You will need the following tools to install the Z-Bot Automatic Tool Changer:

- Electric hand drill
- Screw drivers
- Hex (Allen) wrenches
- End wrenches
- 4" capacity C-clamp
- Teflon plumber's thread seal tape
- Wire stripper and crimp tool
- 0.25" transfer punch or center punch
- #7 and #36 drill bits
- Transfer punches
- ¼-20 and 6-32 plug taps and tap wrench
- .75" spade or Forstner bit
- Tapping fluid
- Tin snips

Installing the Z-Bot Power Draw Bar

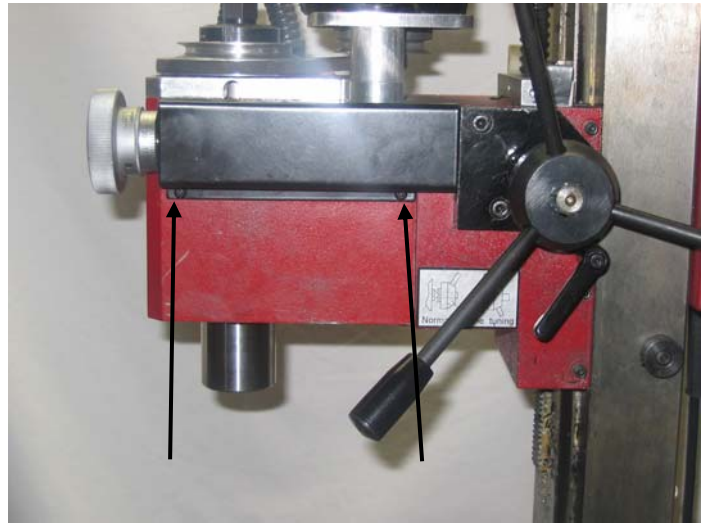
Follow these steps to install the Z-Bot Power Draw Bar. If you are upgrading from a hand operated Power Draw Bar installation take note of special instructions in bold text.

Unplug the Mini-mill's power cord before beginning!

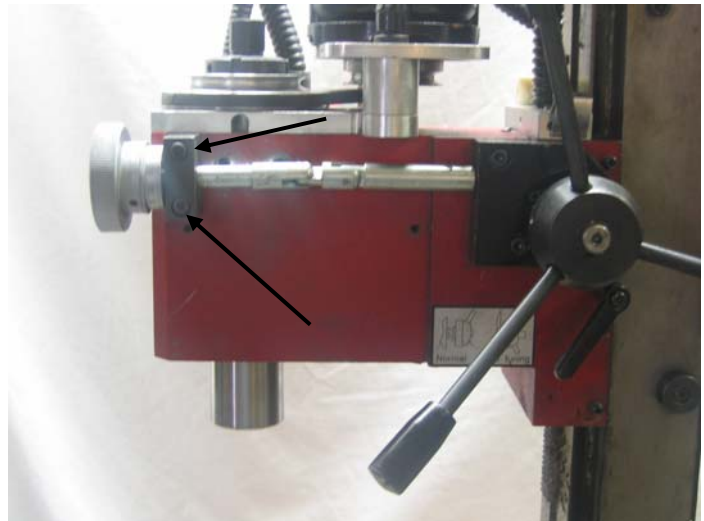
Preliminary

Upgrading from Power Draw Bar-
proceed to step 4.

1. Remove the two screws holding the sheet metal cover from the Z-axis fine feed linkage mechanism and set the sheet metal cover aside. Also remove the two socket head cap screws holding the front block to the mill head and let the linkage dangle down.



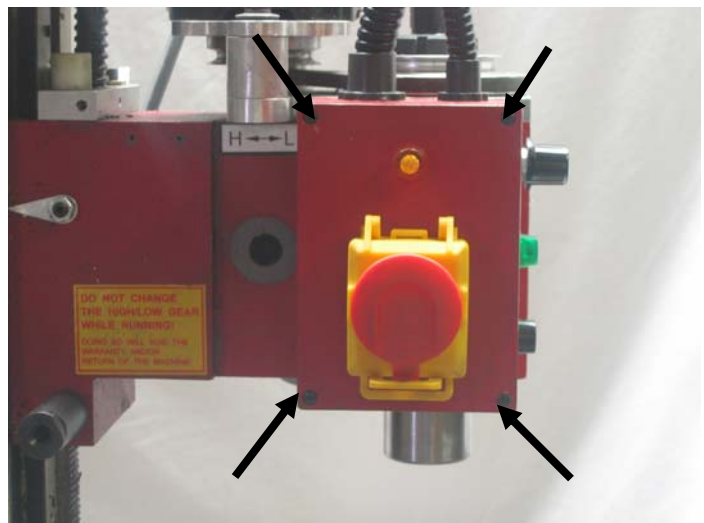
2. Remove the two socket head cap screws holding the Z-Axis knob mounting block.



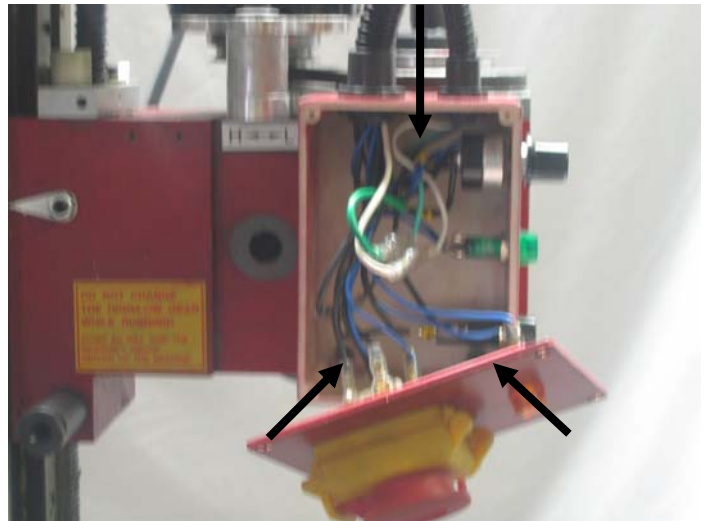
Let the Z-knob assembly hand down.



3. Remove the four screws holding the cover on the plastic control box.



4. Remove the screws holding the control box to the mill head from the back of the box.

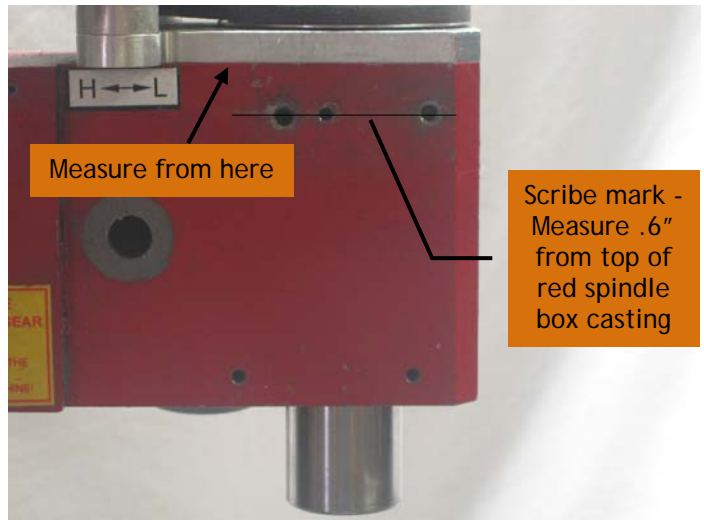


5. Reinstall the cover with the four screws. Push the control box aside temporarily.

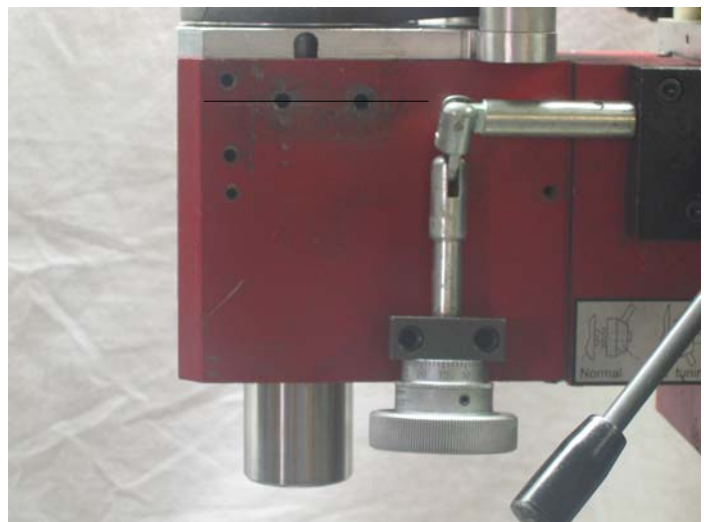


Upgrading from Power Draw Bar -
Proceed to step 7.

6. On each side of the mill head scribe a line 0.6" below the top of the red mill head casting (or bottom of the black casting). The model shown here has a belt drive conversion installed. The stock gear driven mill will have a black top casting. These lines will be used later to locate the holes for the drawbar actuator assembly mounting bolts.



Scribe line on other side of mill.



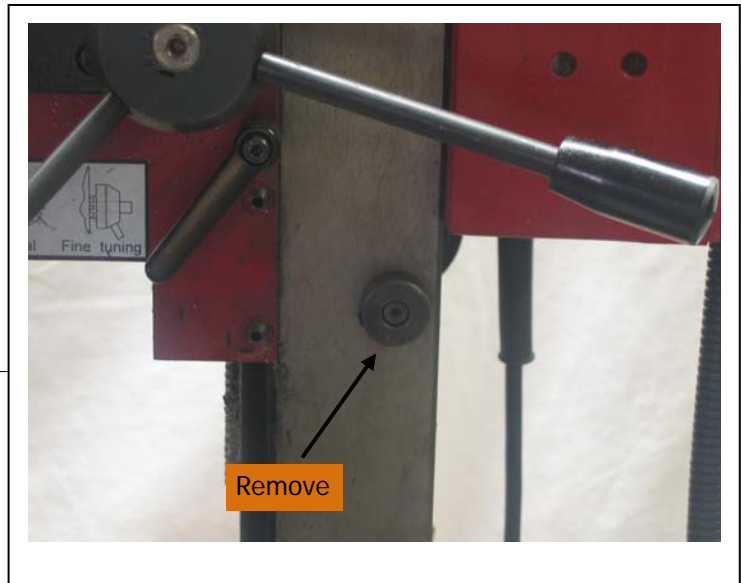
7. Remove the axle bolt from the torsion spring assembly.



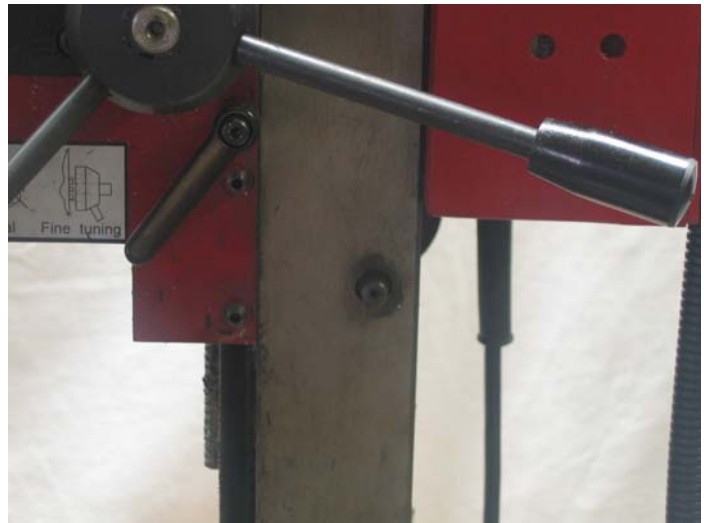
The spring will re-coil to its resting position.



8. Back out the set screw and remove the retaining collar from the torsion spring main axle on the other side of the column.



Collar removed.



9. Pull out the entire torsion spring assembly. The spring is not needed for CNC retro-fit mills, and will interfere with the tool tray assembly. Also unthread the stand-off bolt from the mill head.



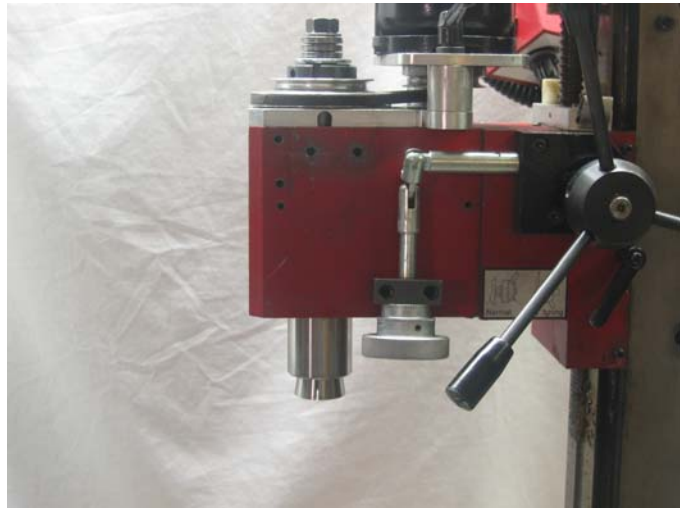
Install the spring loaded drawbar and collet

Upgrading from Power Draw Bar - skip this section.

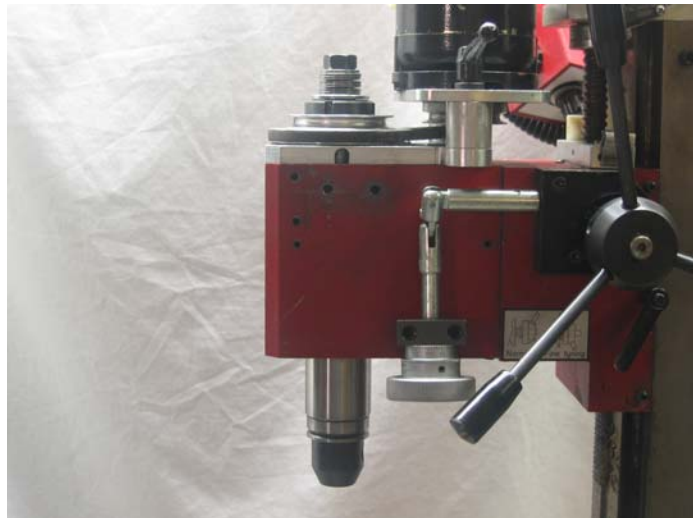
1. Remove the appropriate Z-Bot Spring Bar Assembly (R8 or MT3) from its packing. Make sure the Belleville washers and thrust washer are arranged as shown.



2. Insert the drawbar (with the Belleville washers installed) into the top of the spindle as shown.
3. Install a Tormach collet into the spindle and engage the drawbar.



4. Insert a Tormach tool holder into the Tormach collet and tighten the drawbar until it is finger tight.
5. Using a wrench, tighten the drawbar against the spring washers another one full turn. This is sufficient to hold the tool. You may need to adjust this again later when the draw bar is fitted and tested.



Install the drawbar mill head assembly

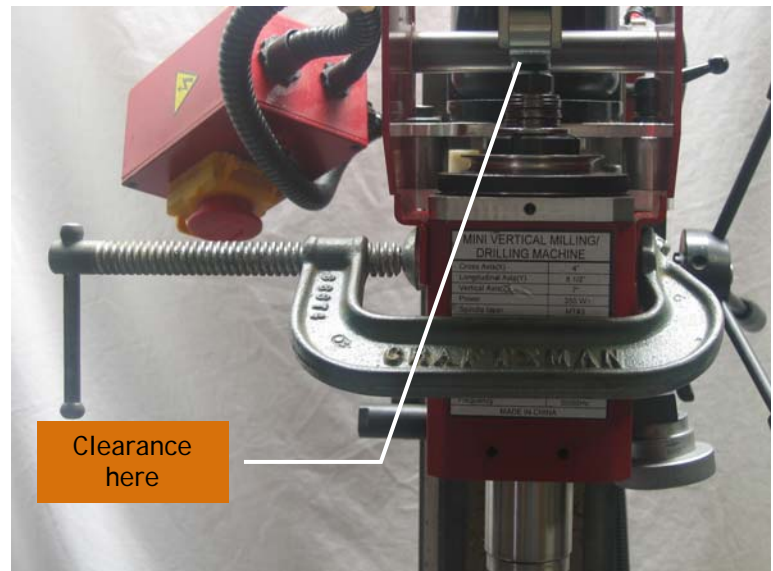
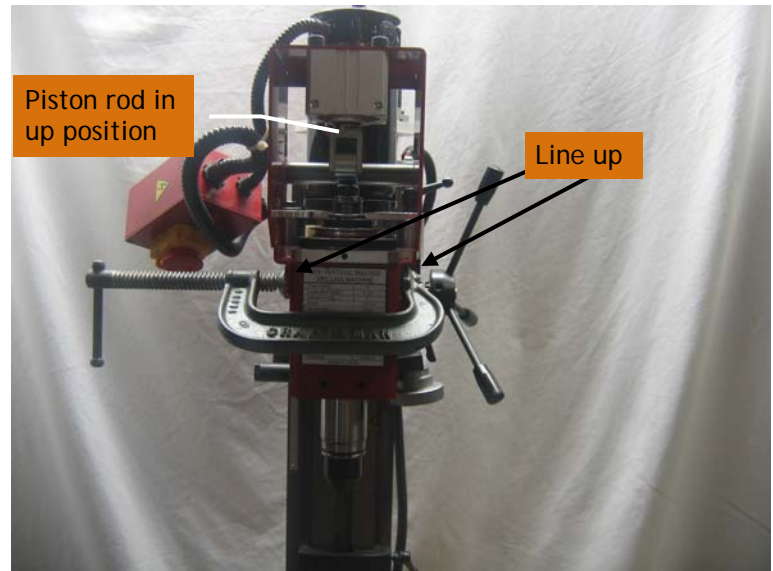
Upgrading from Power Draw Bar -
Proceed directly to step 7.

1. Push the cylinder piston rod to the up position if it is not already there. If you have a belt drive conversion kit, place the belt around the larger pulley to move the motor to its forward most position.

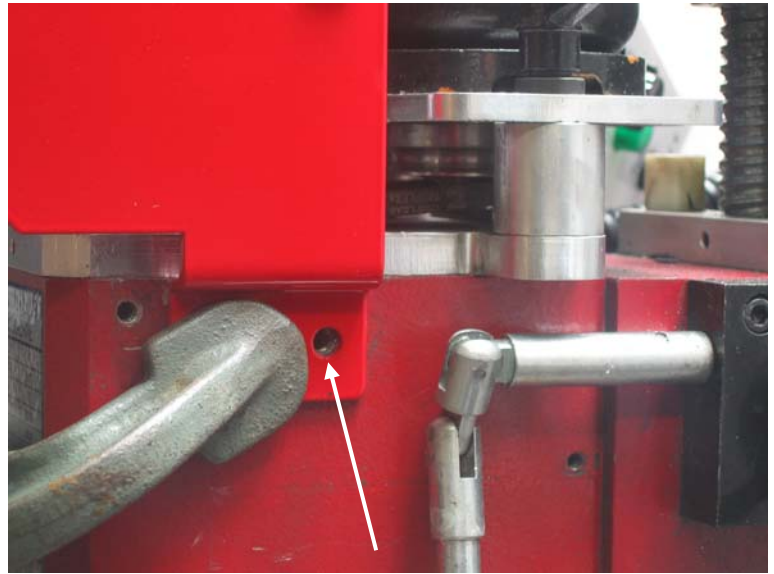
2. Place the drawbar actuator assembly so the center of the mounting holes line up with the center of the score lines.

Temporarily C-clamp the sides of the draw bar housing to the mill head so the mechanism is straight up and down. Cover the front holes on each side with the C-clamp pads.

3. Check the orientation of the lever arm and ensure it is in the position shown in the illustration above. Double check that the holes are centered on the score line. Check that there is clearance between the drawbar and lever arm. The spindle should spin without interference. Tighten the draw bar slightly, if necessary to allow the spindle to turn freely.



- Using a transfer punch or center punch, mark the locations of the rear holes for the mounting bolts. Mark the intersection of the line that you scribed and the center of the hole for each of the mounting bolt holes. Use a #7 (0.201") drill bit to drill the rear mounting holes 0.5" deep. Use a 1/4-20 plug tap and tapping fluid to tap the rear mounting holes to a depth of at least 0.4". Clear the chips from the holes. Thread 1/4-20 x .5" hex screws through draw bar housing into the tapped holes. Tighten the screws to clamp the draw bar housing firmly to the mill head.



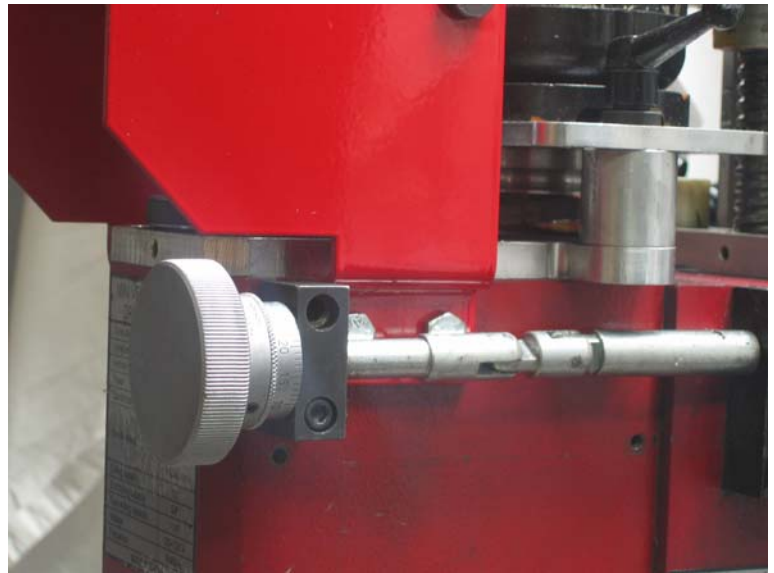
- Remove the C Clamp and drill, tap, and insert hex bolts in the front holes as above.



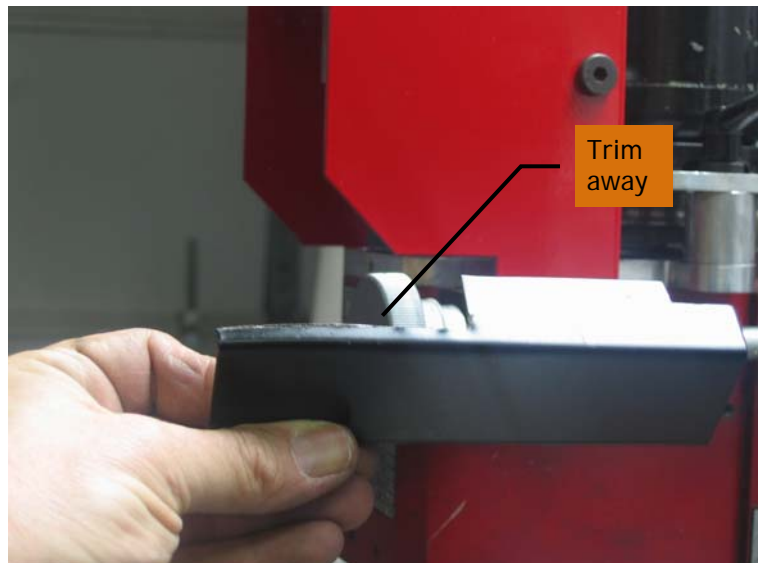
Hex bolts on other side of mill.



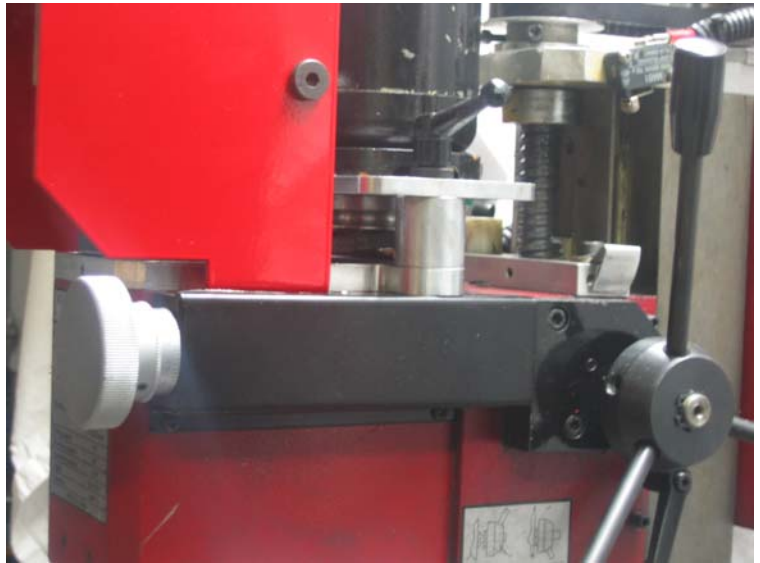
6. Reinstall the Z-axis micro feed mechanism block.



Optionally, use tin snips to trim the sheet metal from the Z-axis fine feed mechanism cover where it overlaps the draw bar housing. Alternatively, this cover may be left off the mill.



Cover installed after trimming.



- Using double sided tape, affix control box to side of housing as shown.



Control box re-installed with tape.

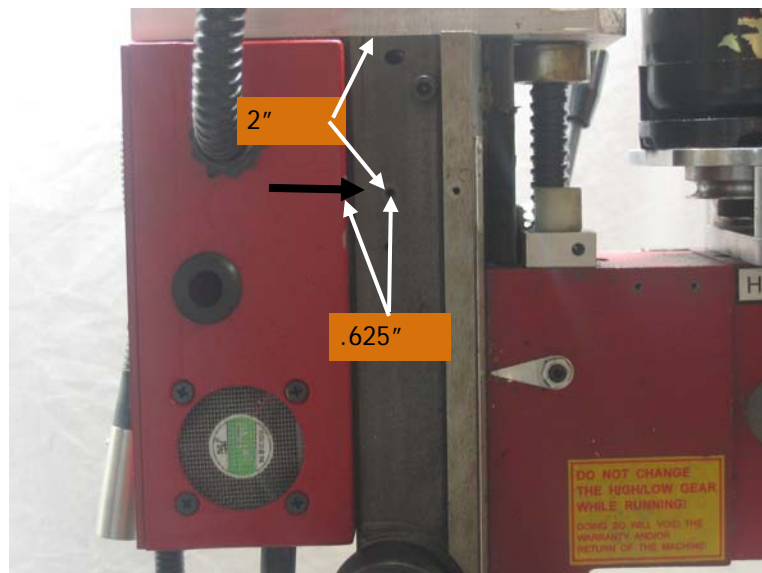


8. Install the sheet metal cover using thumbscrews.



Install the draw bar solenoid module

1. Mark the column side for the upper hole as shown, 2" from the top of the column casting, and .625" in from the rear edge of the column. Drill and tap the upper hole with a #36 drill and 6-32 tap. Use tapping fluid and proceed carefully.



2. Secure the solenoid to the column through the upper screw and standoff as shown. Using a transfer punch mark and drill the location of the lower hole. Drill and tap the lower hole for a 6-32 screw as above.



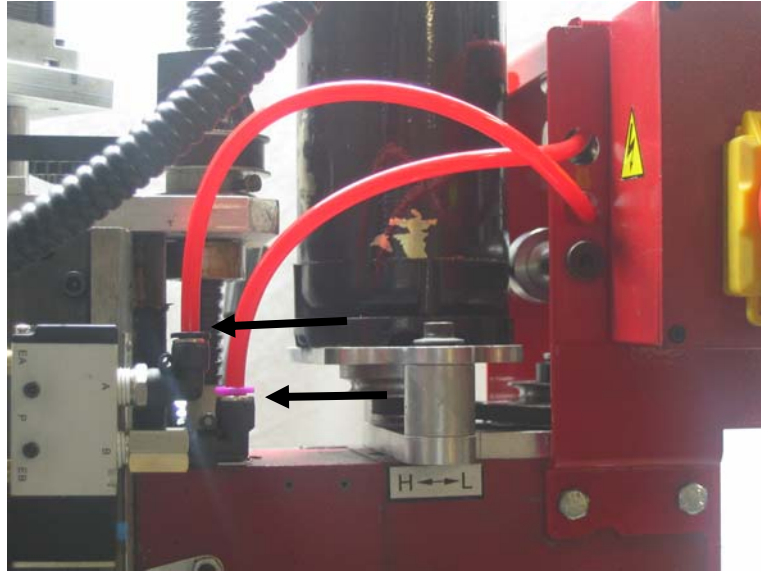
Remove the upper screw and thread both screws and standoffs onto the solenoid as shown.



Tighten securely to the mill column.



3. **Upgrading from Power Draw Bar only**-Remove the old hand valve and hoses as follows: Disconnect the compressor hose from the hand valve. Remove the air hoses from the cylinder elbows by pushing in on the plastic connector while gently pulling on each hose; cutting the hoses may make this easier. Discard old hoses. Uninstall the hand valve by removing the retaining nuts from inside the housing. Unthread and save the compressor hose connector. You can discard the hand actuator. Insert new hoses (supplied with upgrade kit) through the housing holes and into the cylinder elbows, making sure to push the hose with the black tape marker into the bottom cylinder elbow. When you are done, it should look exactly like the picture on the right.



4. **All users** - Push free ends of air hoses into the solenoid module, being careful to match the colors of the push connectors with the band on the hose. If done correctly, the top elbow of the cylinder connects with the bottom elbow of the solenoid.

5. Screw the appropriate quick connect for your air compressor hose into the center connector marked "P" (pressure) using Teflon tape to seal the threads. **Do not hook up the pressure air hose yet.**

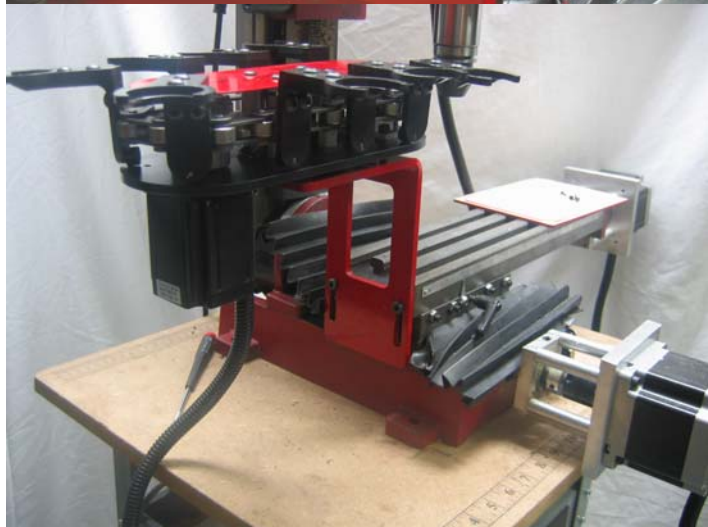


Install the tool tray

1. Back out retaining screws and remove the swarf gate from the end of the table; this will be replaced with the tool tray.

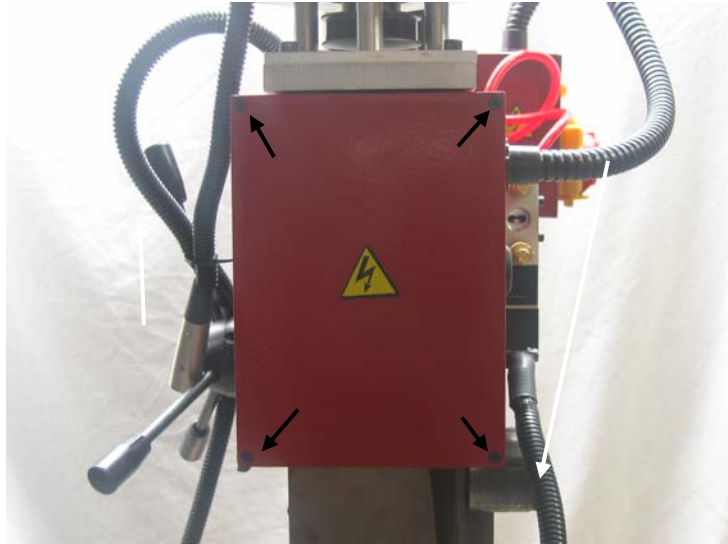


2. Secure the tool tray through the original swarf gate holes using the supplied M6 socket head cap screws. Tighten securely.

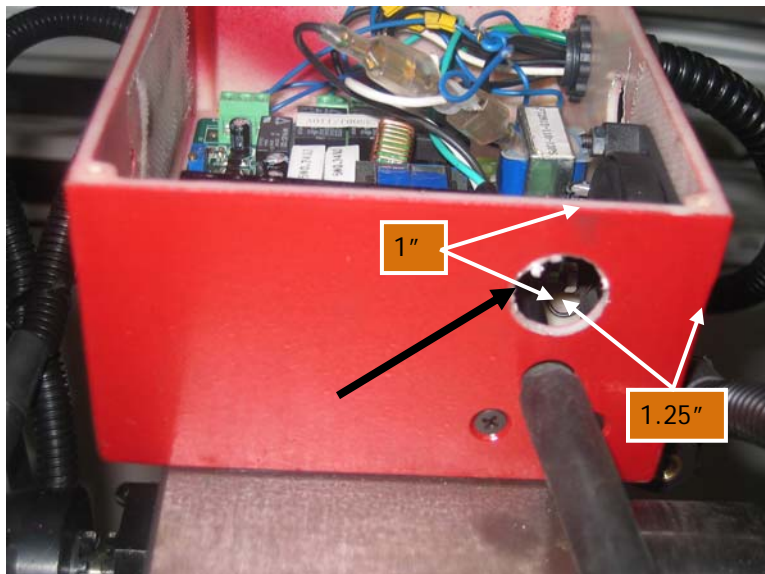


Install and wire the control module

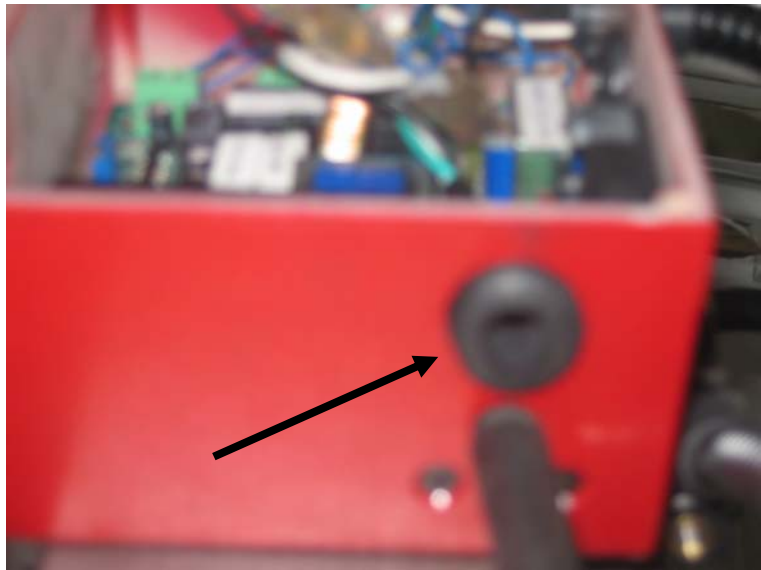
3. Remove the cover screws from the Mini-mill's spindle control box and set aside.



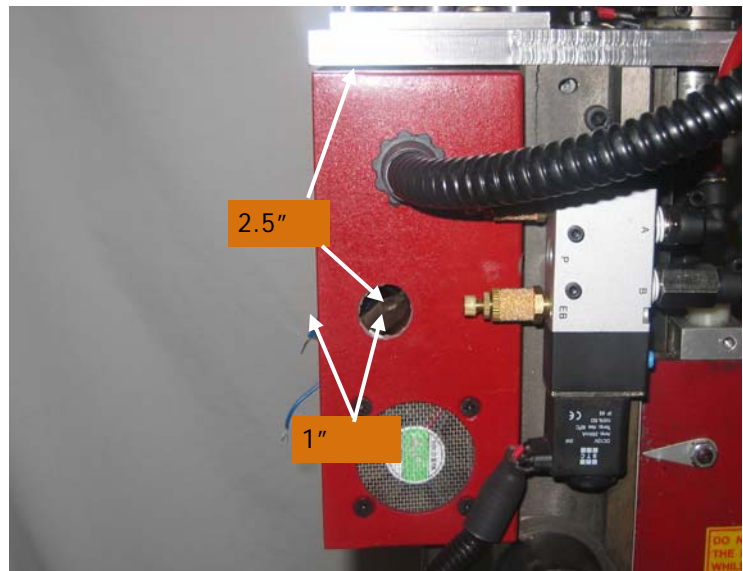
4. Using a .75" spade or a Forstner bit, drill an access hole in the bottom right side of the mini-mill control box as shown.



5. Insert a 1" grommet into the hole. You don't need glasses, this is an awful picture.



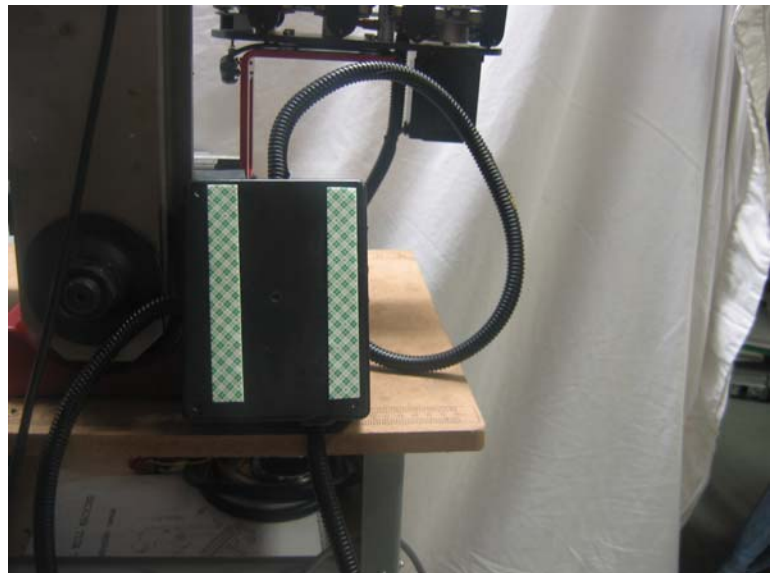
6. Drill a .75" access hole for the solenoid wires in the side of the spindle box in location shown.



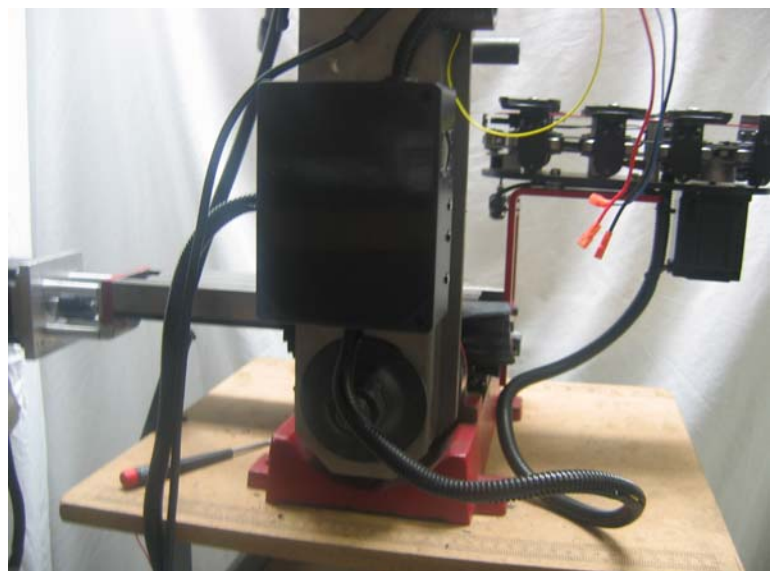
7. Insert a 1" grommet into the hole.



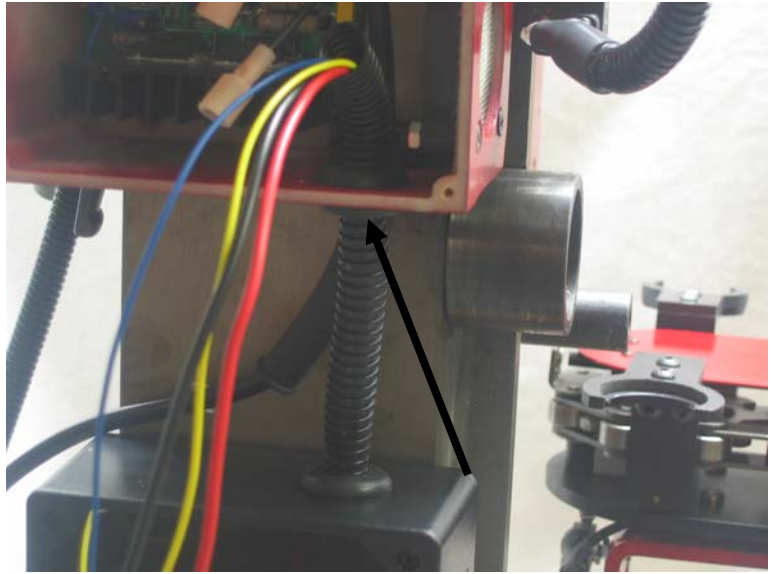
8. Remove the double sided tape strip from the back of the control box and stick it to the mill column. Clean the column with denatured alcohol or paint thinner before doing this to ensure good adhesion. Make sure the USB connector and switch are facing the floor.



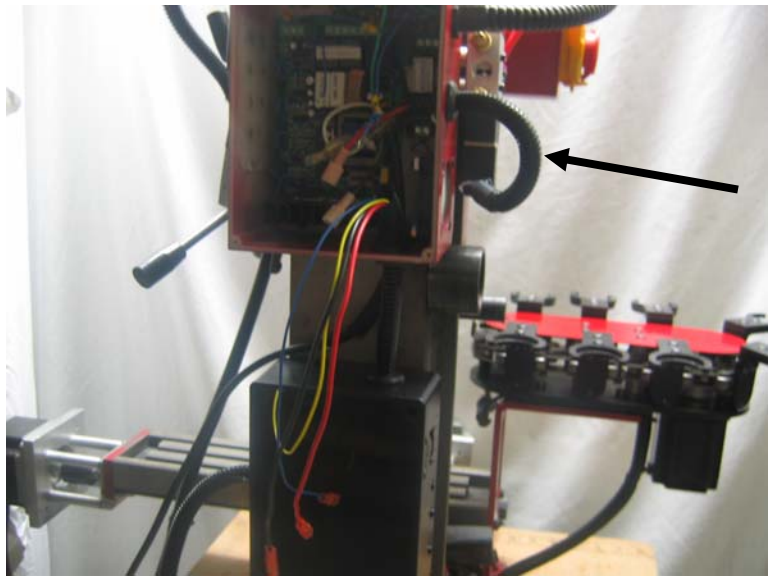
Control module attached with tape.



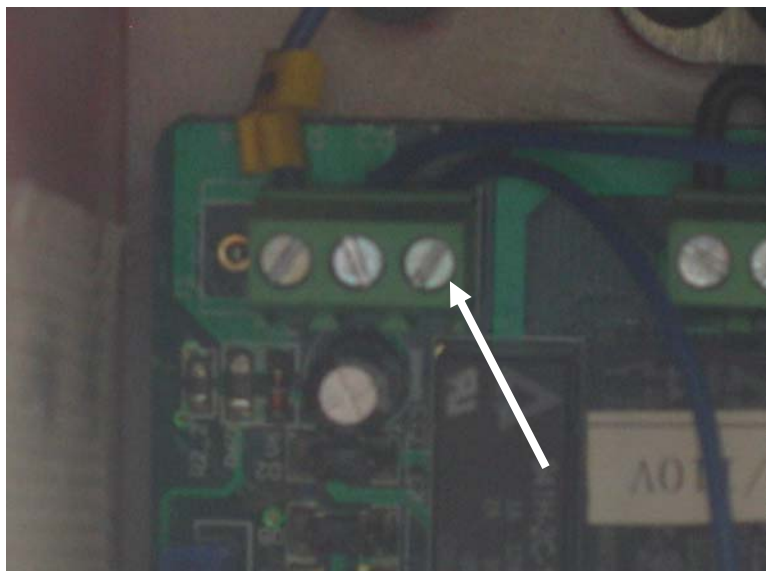
9. Thread the wires and upper loom tube into the spindle box through the lower access grommet. There are two pairs of wires in the tube, the black and red pair is for the solenoid; the blue and yellow pair is for the spindle control interface. Place a wire tie around the loom tube on the inside of the box.



10. Push the black and red solenoid module wires and loom tube into the side access grommet. The solenoid wires terminate with mating connectors to the matching colors pushed through the lower access hole. Place a wire tie around the loom tube on the inside of the box.

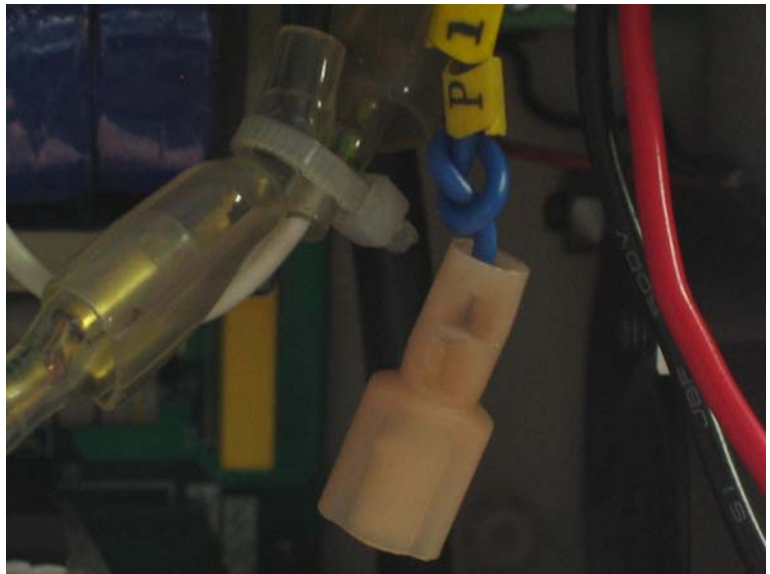


11. If you are using the Z-Bot spindle controller, back off the connector screw to the terminal marked "P1" on the upper left corner of the spindle controller board and remove the blue wire. The "P1" wire is labeled on the circuit board. Tie a knot in the wire to prevent the yellow labels from falling off as you work. Strip the end of the blue wire. Using a crimp tool, crimp the supplied female spade connector to the end of the blue wire you just removed. This will be connected to the blue wire pushed through the lower access

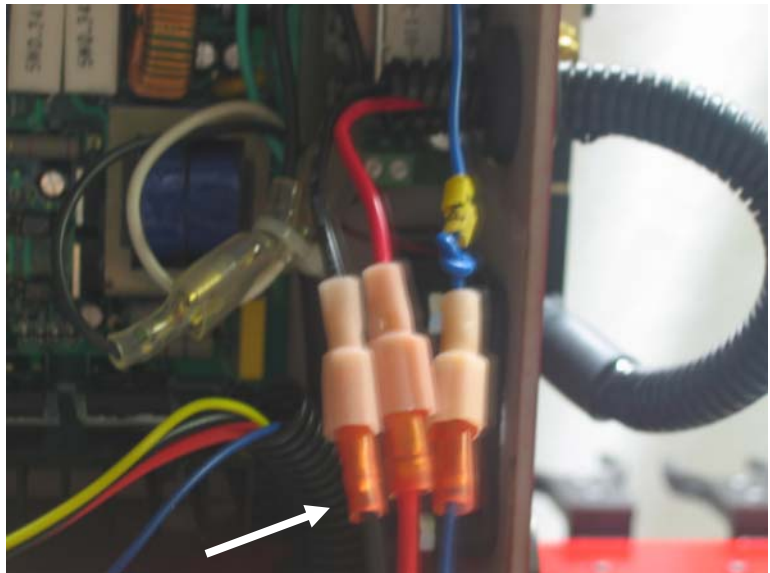


hole .

"P1" wire with female connector crimped on.

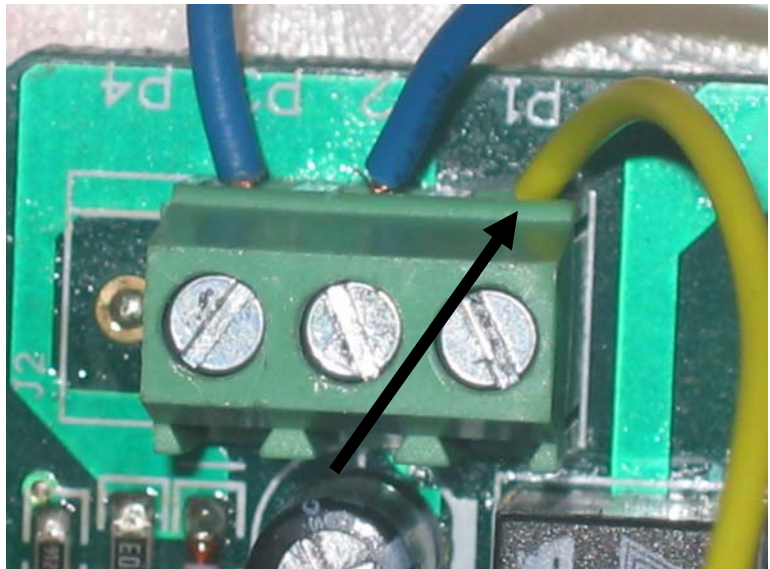


12. Push connectors for corresponding color wires as shown, black to black, red to red. **If you are using the Z-Bot spindle controller, also hook up blue to blue.** If you have your own spindle controller, tape off and leave the blue wire unconnected.



13. **If you are using the Z-Bot spindle controller, screw the yellow wire to terminal P1 as shown.** **If you are not using Z-Bot spindle control tape off and leave the yellow wire unconnected.**

DOUBLE CHECK YOUR WIRING!! IT SHOULD BE EXACTLY AS ILLUSTRATED IN THIS PICTURE AND THE PICTURE IN STEP 12. A MIS WIRED SPINDLE INTERFACE WILL DAMAGE THE INTERFACE CIRCUIT IN THE CONTROL MODULE.



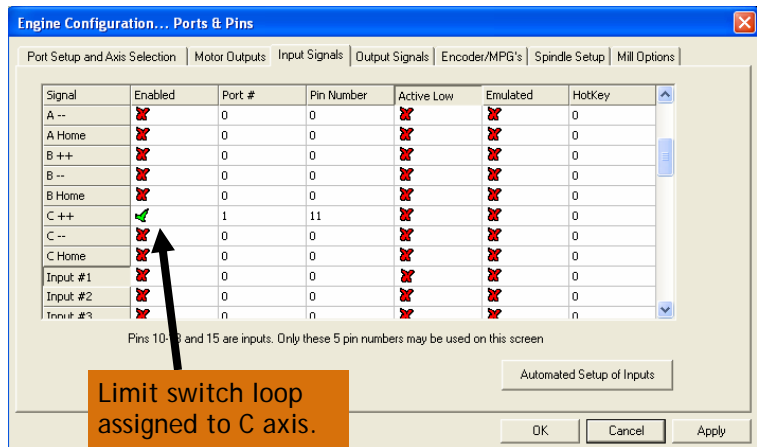
- Tuck the wires neatly into the control box as shown. Replace the cover on the spindle control box.



Spindle control box cover reinstalled.

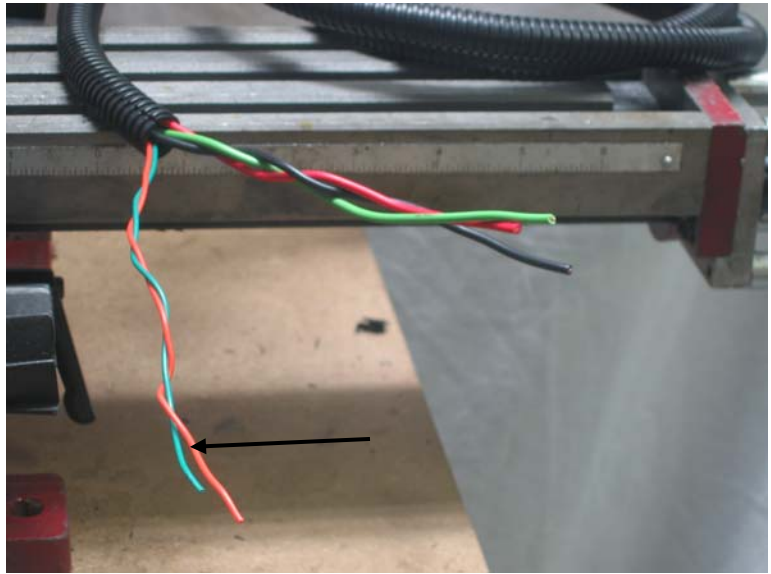


- The loom tube exiting on the right side of the control box (looking from the front of the mill) is for power supply and limit switch connections. Connect the lighter gauge green and orange wires to either your limit switch loop or your E-stop loop. These two wires emulate a normally closed switch (just like a limit switch). Any sensed error conditions in the changer will cause this circuit to open and trigger Mach3. This connection will ultimately terminate in an "Active High" Mach3 input pin assigned to either

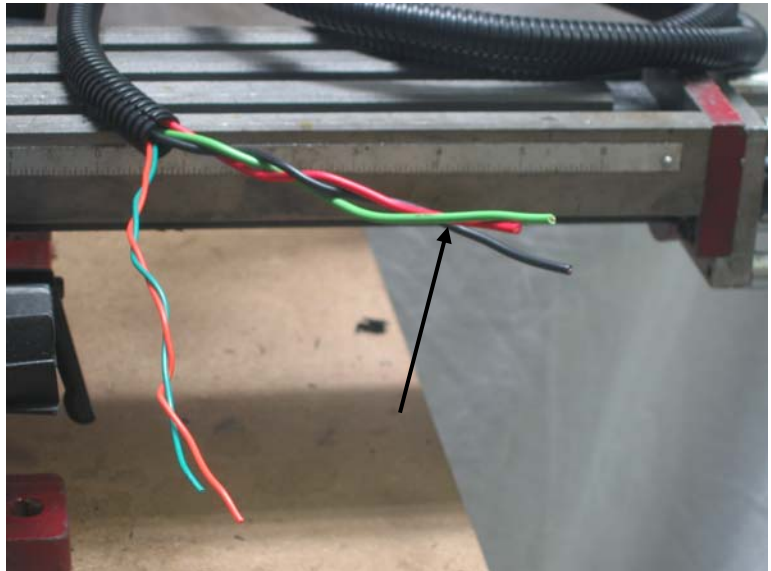


Mach3 Estop or limit switch functions.

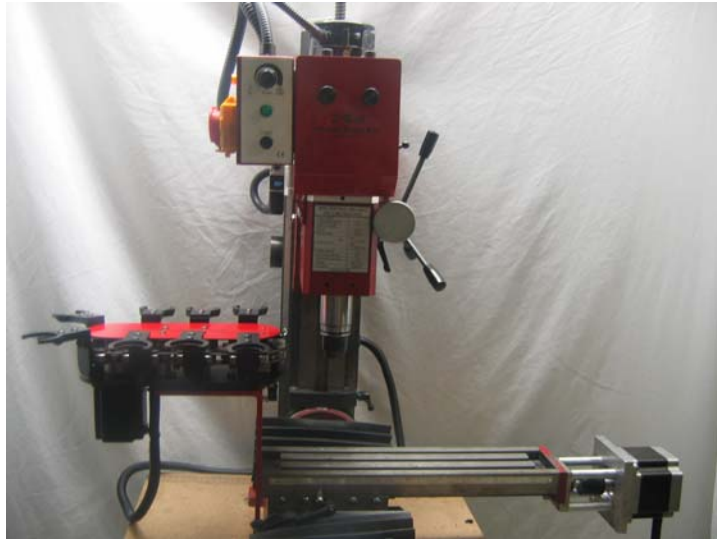
DO NOT, UNDER ANY CIRCUMSTANCES, OPERATE YOUR TOOL CHANGER WITHOUT AN ACTIVE LIMIT SWITCH OR E/STOP INPUT TO MACH3! THIS CIRCUIT STOPS THE MILL WHEN MISALIGNMENT OF THE SPINDLE TO THE TOOL HOLDER IS SENSED OR WHEN A NUMBER OF OTHER ERRORS CAUSE A CHANGER MALFUNCTION. FAILURE TO TRIGGER A STOP TO MACH3 IN THESE CIRCUMSTANCES WILL DAMAGE THE TOOL CHANGER AND/OR THE MILL. FAILURE TO IMPLEMENT A STOP LOOP WILL INVALIDATE YOUR WARRANTY!



16. Finally hook up a 24V power supply using the heavier gauge wires. The red wire is the 24V DC line, the black wire is 0V, and the green wire is earth ground. If your power supply does not have an earth ground connection, you can either connect this to the mill column, or leave it unconnected. There's a connection terminal at the top of the spindle control box for earth ground if you elect to hook this up. A minimum of 2.5A is required to turn the tool tray effectively.



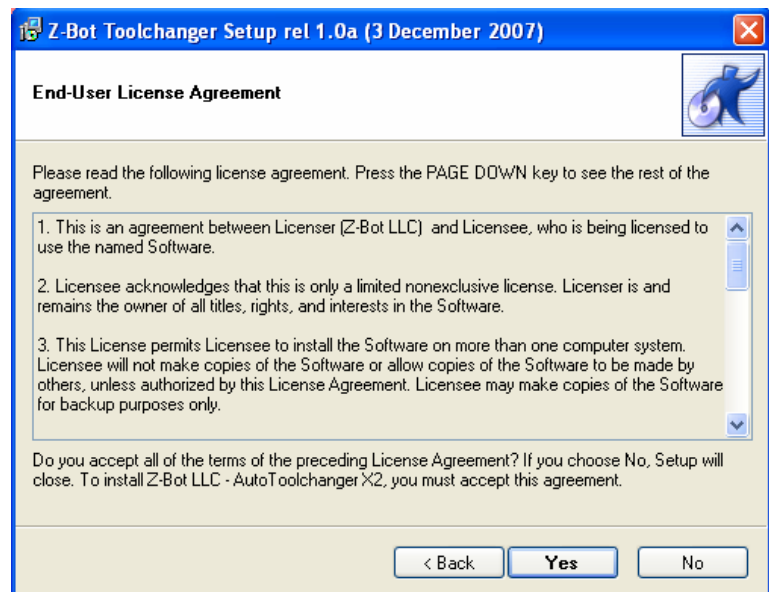
17. Your completed installation should look like this.



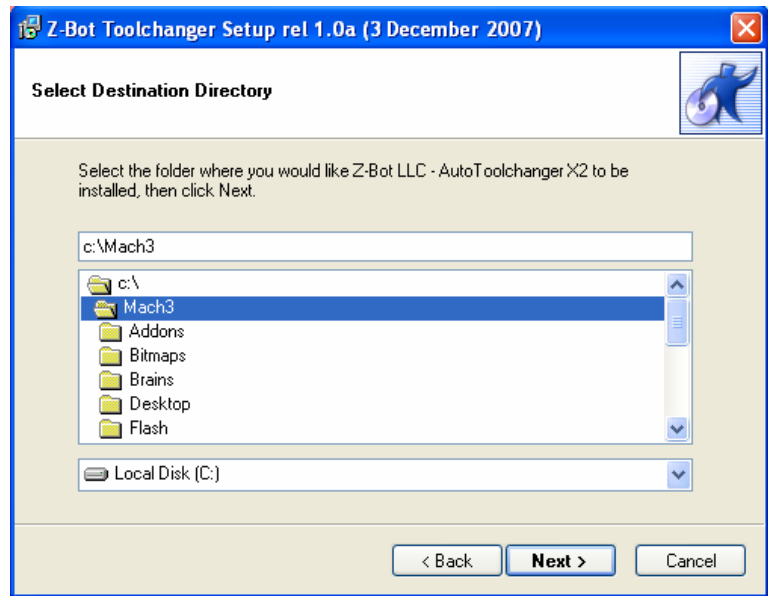
Install software

Before you begin check the release of Mach3 you are running. Z-Bot recommends Release 2.61 or higher. You can find your release level under "Help->About Mach3 Controller" on the top menu of the main screen of Mach3.

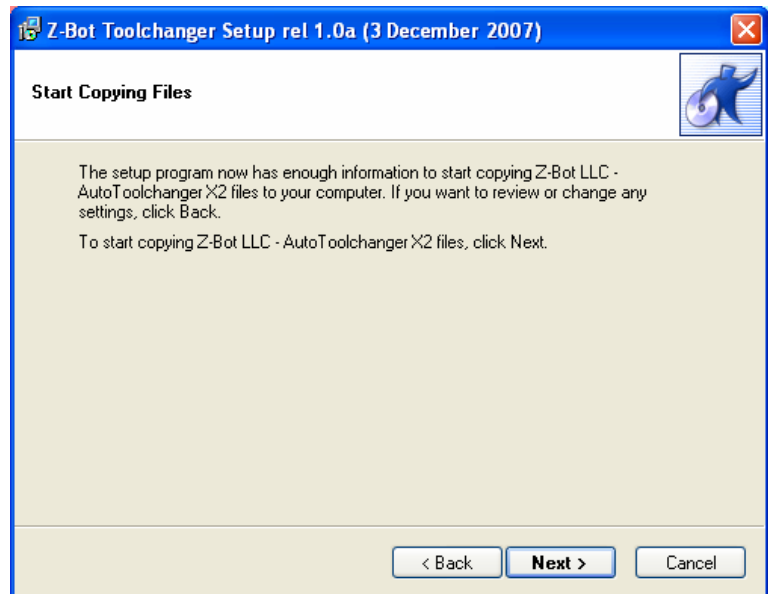
1. Insert the CD entitled "Drivers and Software Installation" into your CD-ROM drive. The installation will launch automatically.
2. Left click on "NEXT".
3. If you agree, accept the End-User License Agreement by clicking on "YES."



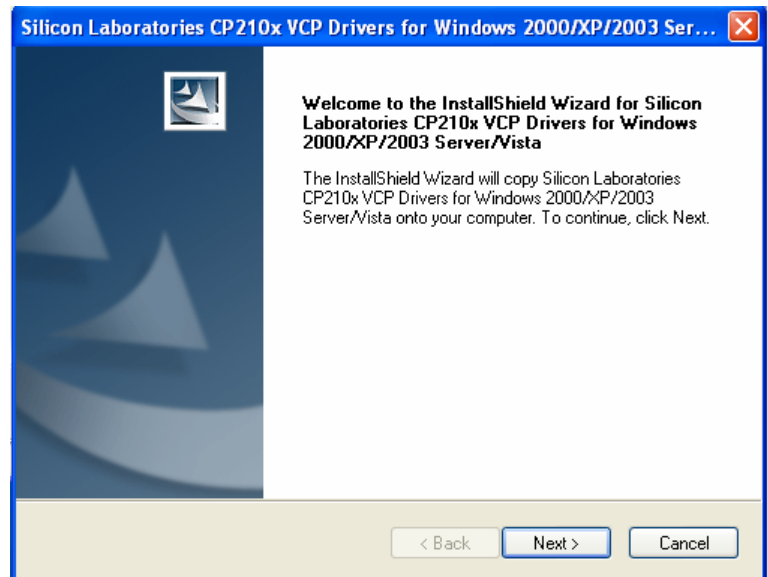
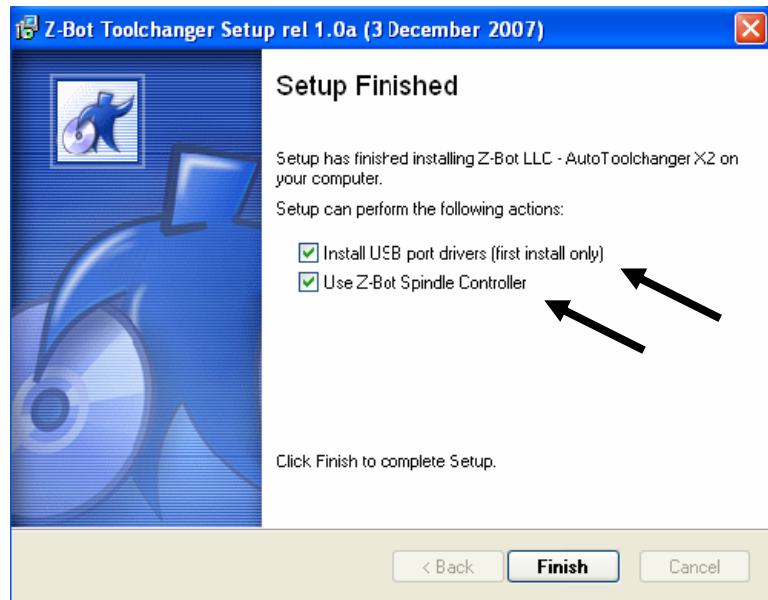
- The installation folder defaults to "Mach3" as does the original Mach3 installation. If you have renamed the Mach3 folder, or installed Mach3 to a different location, navigate to, and select it here. Otherwise, just click "NEXT".



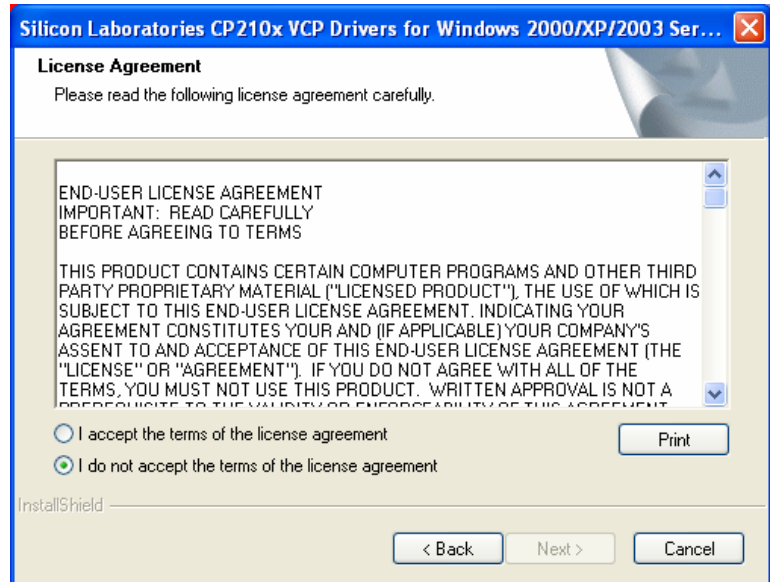
- Click "NEXT." The required files will now be copied to your Mach3 installation folders.



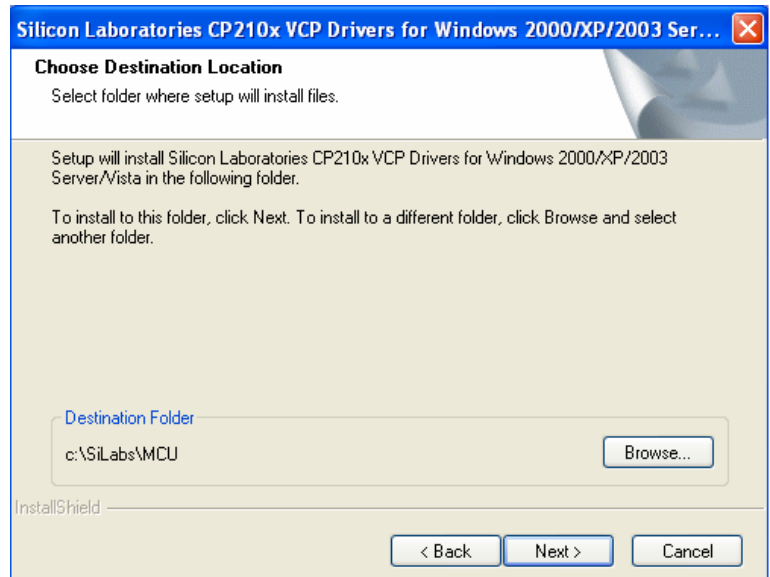
6. **VERY IMPORTANT!!!!** If this is the first time you are installing the tool changer on your system, you must install the USB port drivers to communicate with the control module. On subsequent installs you can uncheck this action.
7. If you are using the Z-Bot spindle control module then leave the second radio button checked. If you have your own spindle control, then **UNCHECK** this button. Making the correct selection here ensures that the correct Mach3 tool change (M6Start) and spindle macros (M3,M5) are installed.
8. When installing the USB driver, complete steps 9 through 13. Otherwise the software installation is complete. Proceed to the next section, "Configuring the Z-Bot tool changer"



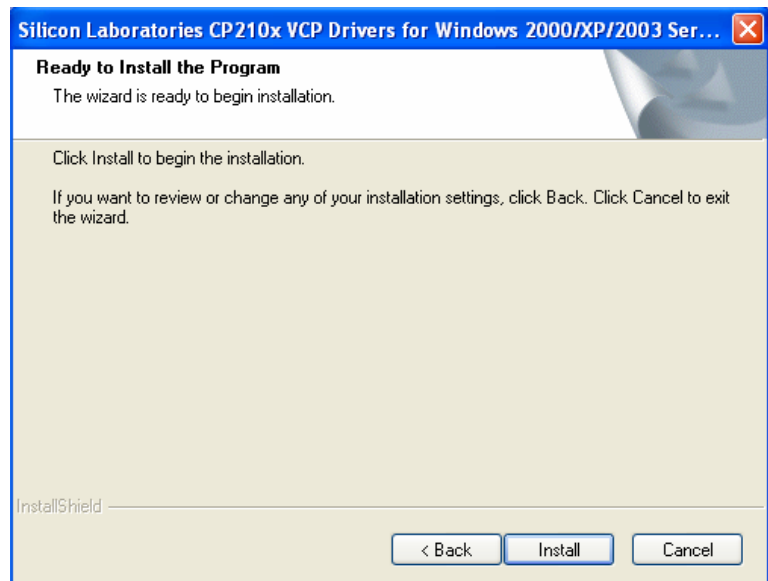
9. Accept the agreement for the USB drivers, and click "NEXT."



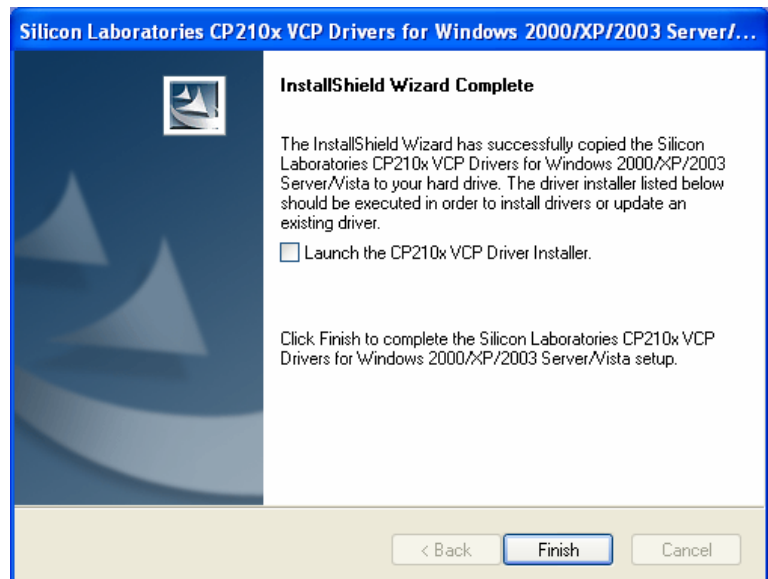
10. Click "NEXT."



11. Click "INSTALL."



12. Check "Launch the CP210xVCP Driver Installer" box. This installs the drivers now, instead of waiting for the hardware wizard to discover and install them when the device is plugged in.

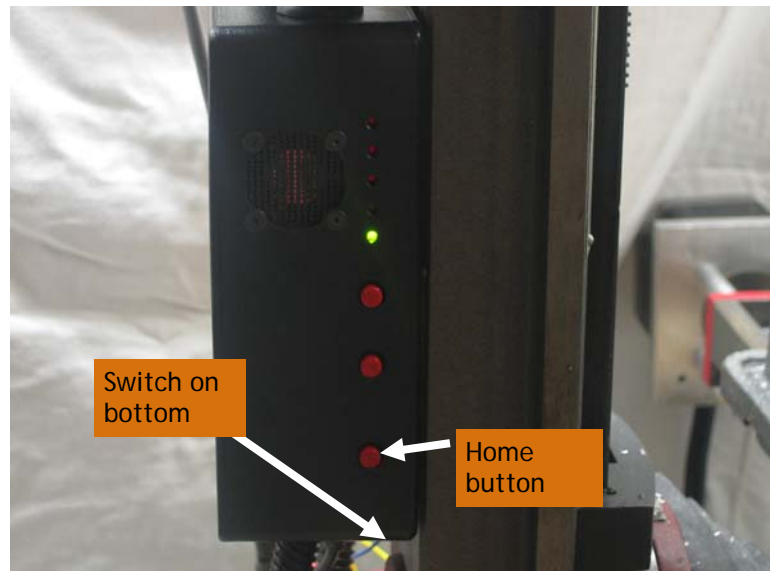


13. Your software is now installed.

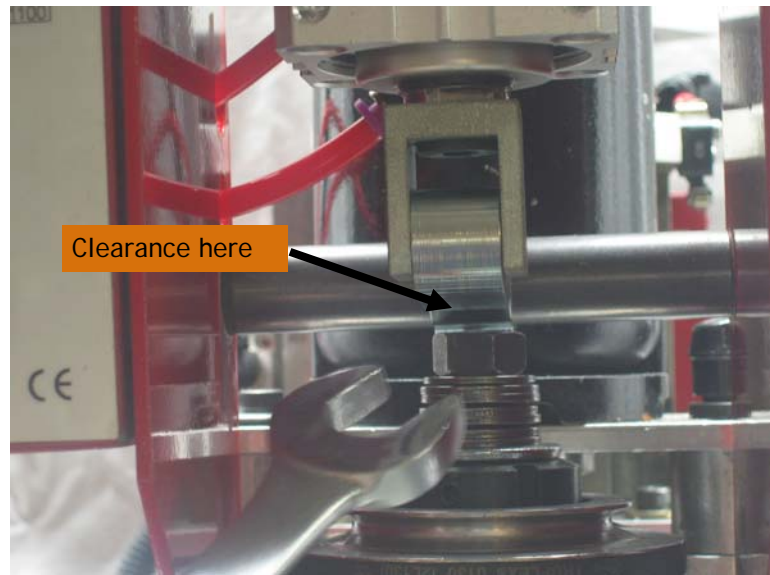
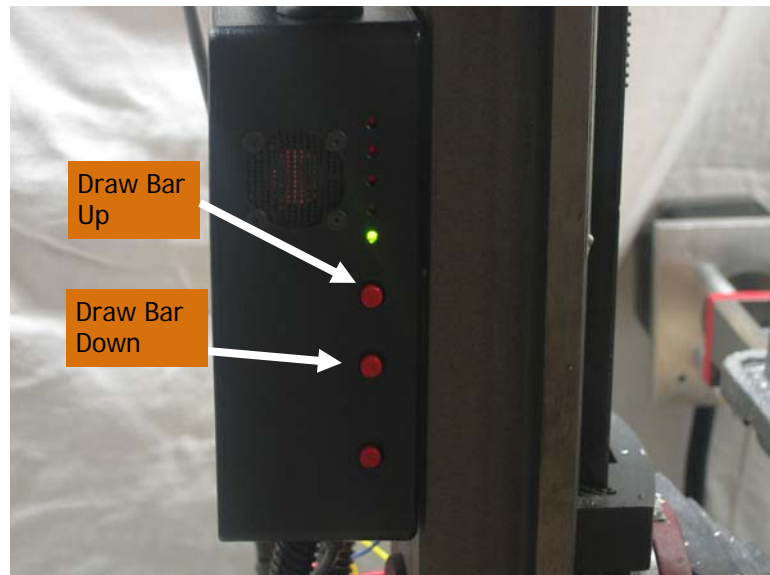
Configuring the Z-Bot Automatic Tool Changer

WARNING: Never operate the Z-Bot Tool Changer before going through, and completely understanding, the setup and operating procedures contained in this section! Do not operate without an E-Stop loop or limit switch loop hooked up to the changer (step 20). An automated tool changer is a complex machine. Operation under Mach3 requires a thorough understanding for safe, reliable/repeatable operation. The instructions below also serve as a mini-tutorial on changer operations.

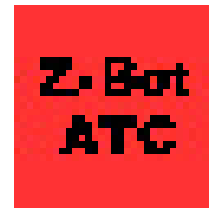
1. Plug a USB cable into the tool changer and into the computer. Plug the Mini-mill power cord into an AC outlet.
2. Turn on the tool changer control module by flipping the toggle switch under the unit. The green LEDs will light, and the tool changer will find its HOME position by sensing the magnet on the open tool chain position. The unit automatically calibrates to home every time it is turned on, or when the HOME button is pressed.
3. Verify the draw bar operation. Connect a pressure air hose to the connector installed in the "P" air port of the solenoid.



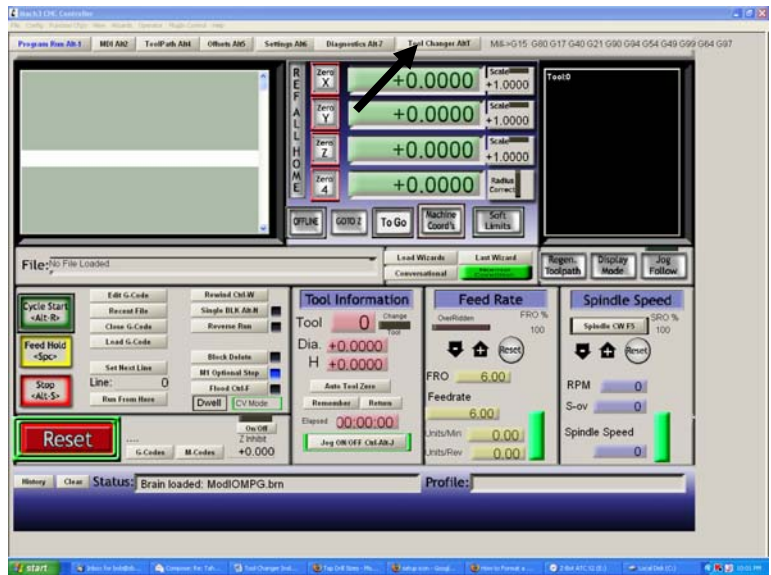
4. You should still have a Tormach tool holder in the collet. Using the red buttons on the side of the tool changer control module, momentarily press Draw Bar Down. You should hear the solenoid fire, and be able to withdraw the Tormach tool holder installed in the spindle. If you cannot extract the holder, then hit the Draw Bar Up button. Back off the draw bar 1/8th turn with an 11/18" end wrench and repeat. Keep backing off the bar until firing the draw bar releases the tool holder. When the draw bar is up you should not be able to extract the tool, and the top nut should clear the lever mechanism. When it is down, it should slide easily in and out.



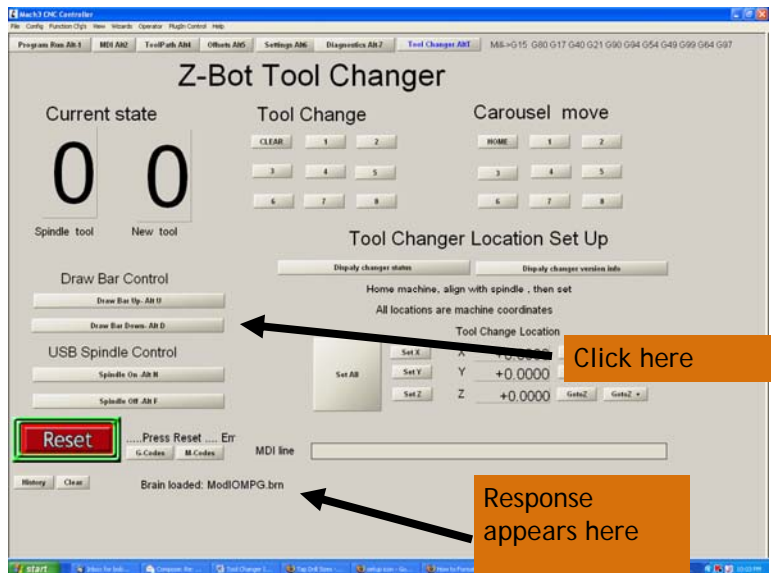
5. Make sure all drivers and software are installed. The tool changer must be up and running before you start Mach 3. Launch the icon on the desktop to start the default Z-Bot Mach3 configuration named Z-Bot TCX2. When Mach3 starts, a Mach3 "plug-in" will find the tool changer and appropriately configure Mach3 communication parameters.



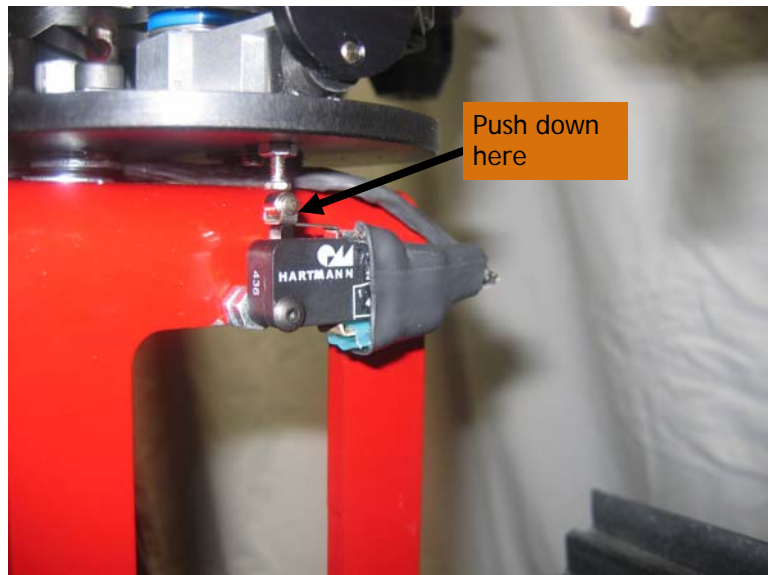
6. This profile is identical to the default Mach3 configuration with some important additions. It looks and behaves just like the stock Mach3 screen set but has been preconfigured for device discovery, USB communications, has an automatic tool changing application, and has several added macros. Configure it as you did your Mach3 setup for input/output signals, parallel port pins, motor tuning, and other general configuration parameters. An alternative to duplicating your definitions in this profile is to make the required changes to the profile you are using to support tool changing. For a complete description of changes required to your profile see Appendix A.



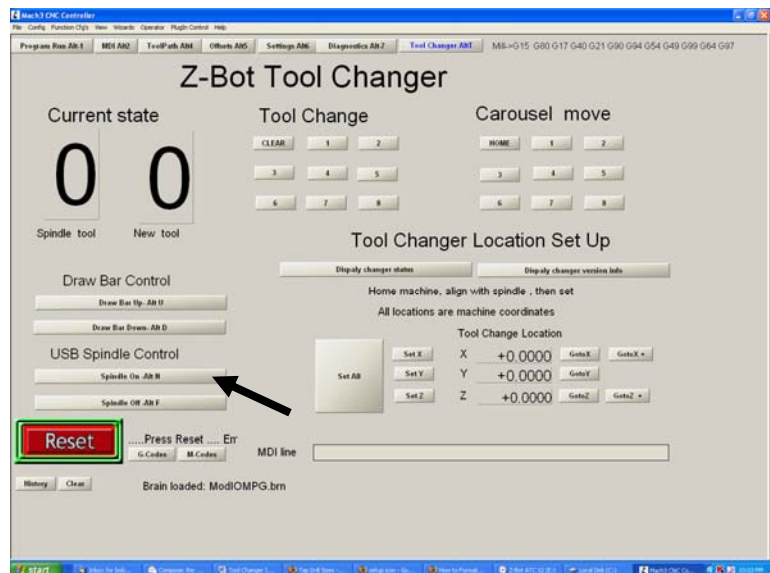
7. Click on the Tool Changer button along the top bar (shown above). The main tool changer application screen (on right) will appear. The first thing to do is verify the communication path. Click on the “Draw Bar Down” button. You should hear the solenoid fire, and see a confirmation response in the Mach3 message line. You should also see the yellow LED on the tool changer control module light up whenever there is traffic on the USB line. If you get a timeout error message, then re-start Mach3 and try again. If the problem is still there, double check the software installation and repeat if necessary.



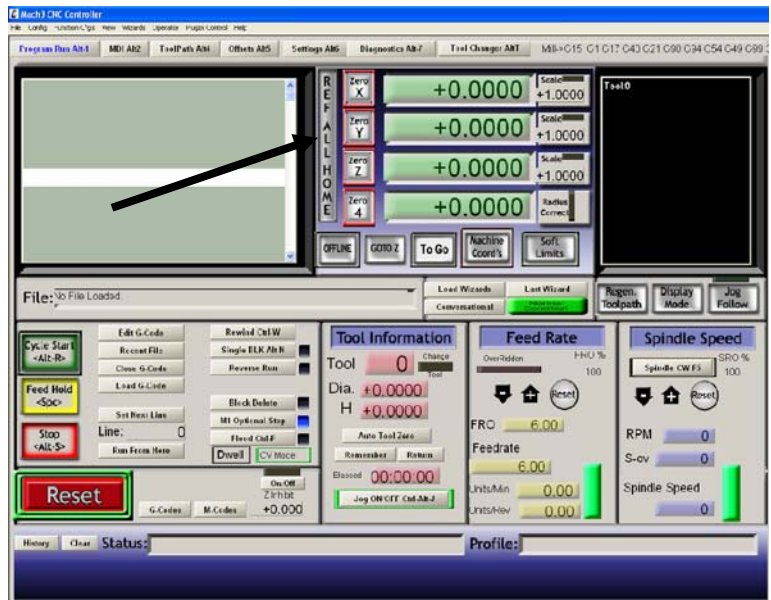
8. Validate the fault circuit operation. Depress the pressure switch under the tool table. Mach3 should indicate "Limit switch triggered", or "E/Stop signaled," depending upon your pin assignments. If it does not, check your wiring, and your Mach3 definitions. **DO NOT PROCEED UNTIL THIS CIRCUIT IS VERIFIED TO BE FULLY OPERATIONAL!** Failure to do so can and will cause permanent damage to the tool claw in the event of spindle to tool misalignment.



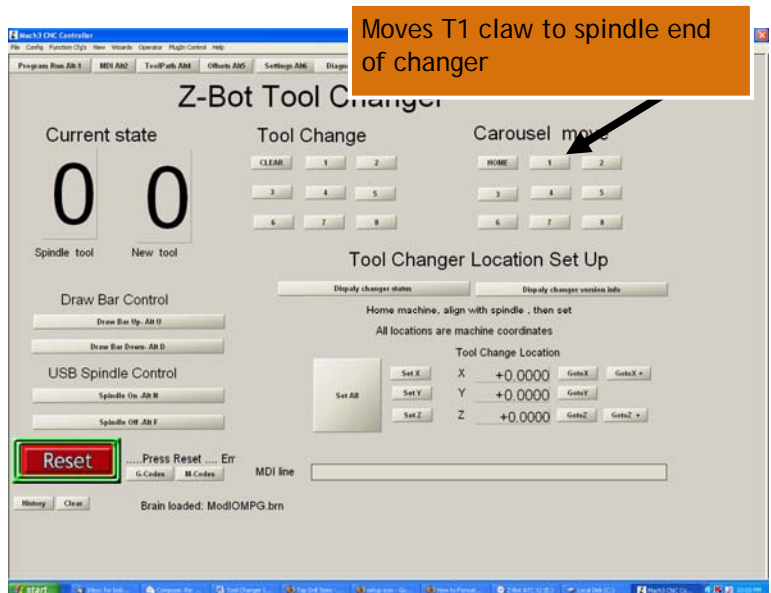
9. Verify the spindle module. If you have your own spindle controller installed, skip this step. The USB Z-Bot module is not a speed controller, but an on/off capability. It works by interfacing with the front controls on the Mini-mill. When the spindle is ON or enabled, the spindle motor will obey the setting of the knob on the mill. When the spindle is disabled, the motor is turned off, regardless of the knob setting. Therefore, remember to enable the spindle for manual operations. Turn the Mini-mill knob off, then press the "Spindle on" button. Turn the control knob clockwise to the desired speed. The spindle should start and turn as it normally would. If it does not, double check the wiring for tight connections, and correct hook up. Now click the "Spindle off" button. The spindle should stop. You may also start and stop the spindle with M3 (on) and M5 (off) commands on the MIDI line.



10. The next step is to tell Mach 3 where the tool change location is. Ideally, your machine should have repeatable homing switches. If you haven't done so already, **home your machine now**. When using a tool changer, the XYZ axis should always be homed prior to setup and use. **If you don't have homing switches**, you can still use the changer, however, you must repeat the changer location setup procedure every time you bring up Mach3. This will establish the current location as machine home for as long as this Mach session is up and running. It really doesn't matter where you establish this machine home (when there are no home switches), as long as it isn't changed from here on out. Mach will locate the tool changer relative to this arbitrary position. *Note: if you use your hand cranks, this entire procedure will have to be repeated. It is better to jog the machine using Mach3 so calibration is never lost.*



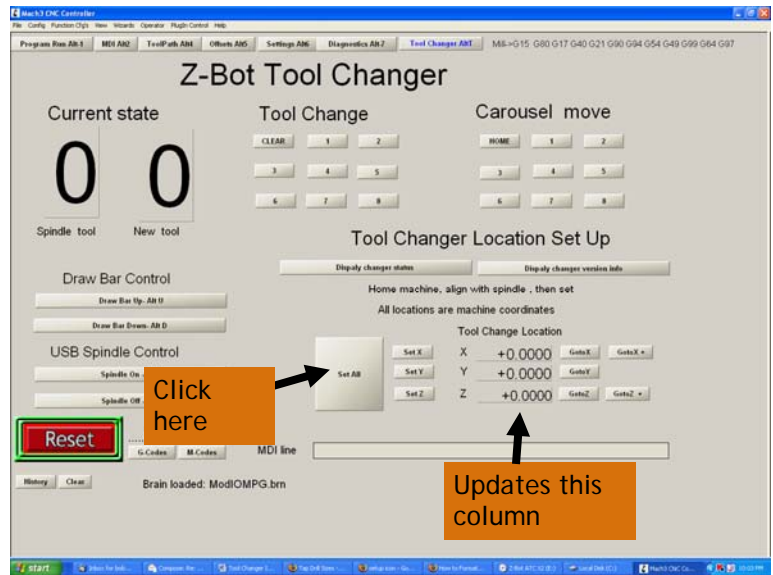
11. Jog the table so the tool tray is clear of the spindle and the column, and free to rotate. Hit "1" under Carousel move buttons, and the tool tray will rotate the #1 tool claw to its spindle end. Hit "Draw Bar Down" and place a tool holder in the spindle. Now, hit "Draw Bar Up" to lock the tool in. Jog your machine so it engages the tool holder slot as shown on the right. It is very important to accurately set the X,Y,Z location of the tool changer. The forks should engage the slot cleanly and easily without binding. Once you have it set, jog X in and out of the tool location to make sure you have smooth engagement and disengagement. During tool changing, the macro will



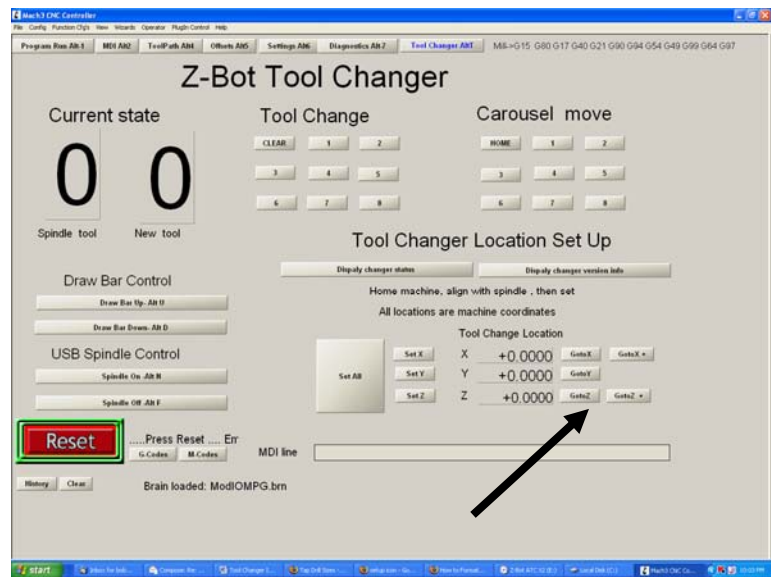
actually engage with the Z-axis a little higher than this setting so that the bevels on the fork and slot ride together. The macro will also “compress” the z axis a little lower than this setting to make sure the tool holder registers against the spindle. Make sure this setting has the top of the forks aligned with the top of the slot. It may take a little trial and error to get it right.



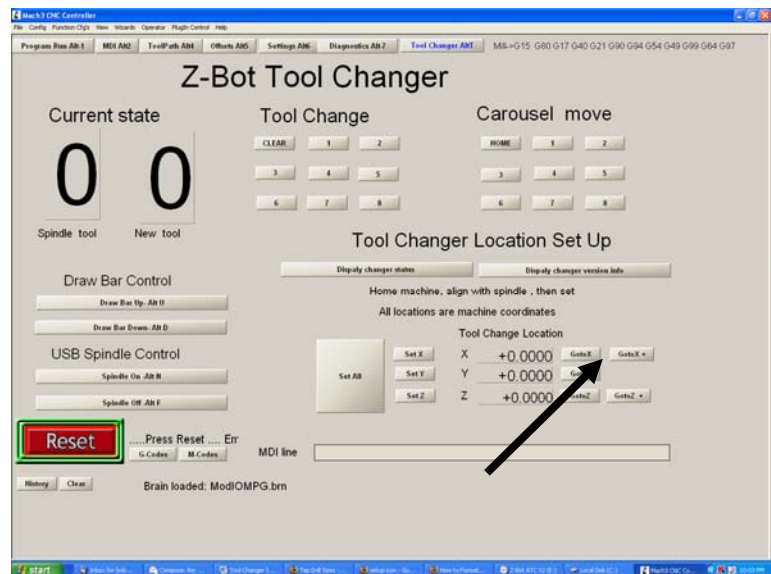
12. Now click on “Set All” to populate the machine coordinates of the tool changer in the “Tool Change Location”. If you need to tweak in the location at any time, just jog to where you want the tool change location to be, and hit “Set All, or Set X,Y,or Z for one axis only. You can also, manually add or adjust the numbers in the tool change location column and hit enter. Remember, these numbers are machine coordinates relative to wherever machine home has been set. They have nothing to do with where your part program thinks it is. During the course of machining, you will be setting and resetting the current work x,y,z coordinates so your part program knows where “zero” is on your part. This will not affect the tool changer settings in any way, as these are always remembered as machine coordinates. In other words, you can set the x,y, or z axis to any value you want without affecting the machine address of the tool changer as long as machine HOME remains the same.



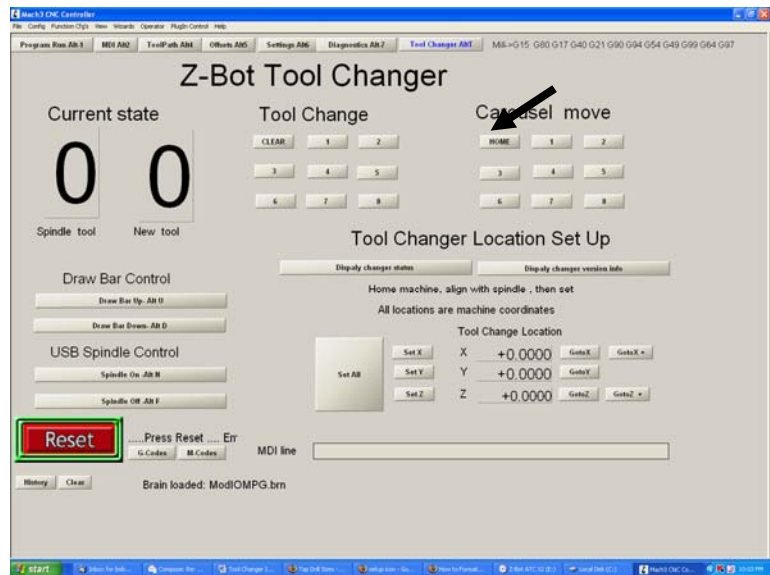
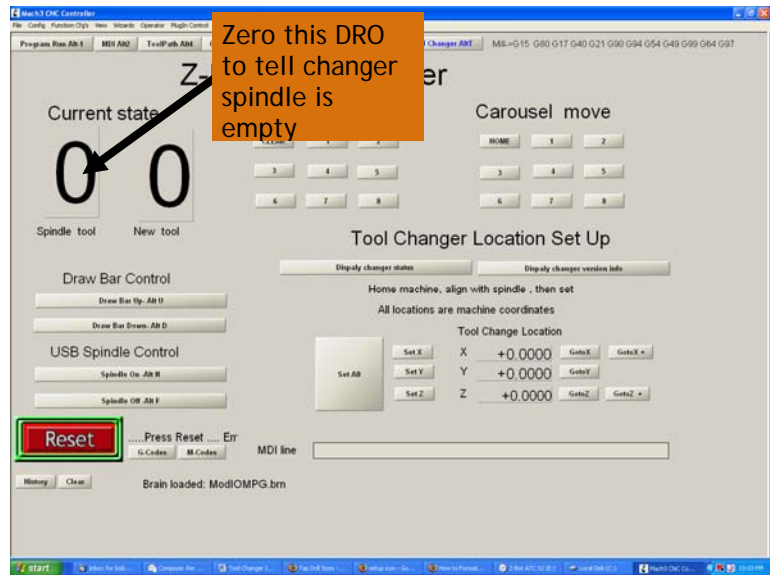
13. Verify spindle to tool alignment. Notice "Go to" buttons to the right of the tool change locations. These are for convenience in alignment verification. Now that the tool change location is established, hit "Go to Z" to fire the draw bar down and send the Z axis directly above the tool holder. This is the staging location where the Z axis goes before it lower onto, and after it disengages a tool holder. Hit "Go To Z". This will send the Z axis to the location it uses to insert the tool holder shank into the spindle. The Z buttons have a built in draw bar down functions as a safety measure. The tool should slide smoothly into the spindle without binding. If you notice misalignment or chatter, a limit switch error, or binding, just jog the X or Y axis to adjust the location and hit "Set X" or "Set Y" to tune it in.



14. Now we can verify the operation of the the X axis of your mill with the tool changer location. Hit "Go to X+". to jog to the X axis staging location. The mill will always approach the tool holder from this location to clip on, and will always retreat to this location when it releases the tool claw from the holder. The forks should smoothly engage into the tool holder slot, and the X axis should stop when the tool claw is centered on the tool holder. You should not see any strain on the tool tray mounting when the "Go to X" position is reached. When you are comfortable that the location is accurately set, with no binding or stress, hit the "Set X" button. If the forks hit at the wrong level for the slot, adjust the Z axis and hit "Set-Z."



15. All the tool changer functions are individually verified and aligned. We're ready for the first automated tool change test. To prepare for the test:
 - 1) Eject the tool holder from the spindle using the "Draw Bar Down" button or screen control. Remove any tool holder from the spindle. Make sure you have a tool holder in tool claws 1 and 2.
 - 2) Enter "0" in the spindle tool DRO. To tell the tool changer that there is no tool in the spindle. Any time you take a tool out of the spindle, you tell the changer you've done so, by entering "0" in the Spindle Tool DRO, or Current Tool DROx anywhere in Mach3. Remember, if the tool changer thinks it has a tool in the spindle, it will try to return the Spindle Tool before fetching a new tool with an M6 macro.
 - 3) Hit the "Home" button on the changer or the "Carousel Move" bank of buttons to home the tool tray so we can verify the changer is rotating to the correct tool tray position. Assuming the home position to be 12:00 o'clock, then tool one is at 1:00 o'clock.
 - 4) Click the "1" under the "Tool Change" bank of buttons or type "M6 T1" into the MDI line. Since there is no tool in the spindle, the tool changer will skip over returning the spindle tool and go directly to fetching tool 1. The message line will display the steps in the process as the changer progresses. You should end up with Tool 1 in the enabled spindle, and the table returned to its home position. The changer always returns the table to the position it was in prior to the issuance of an M6 or tool change command.

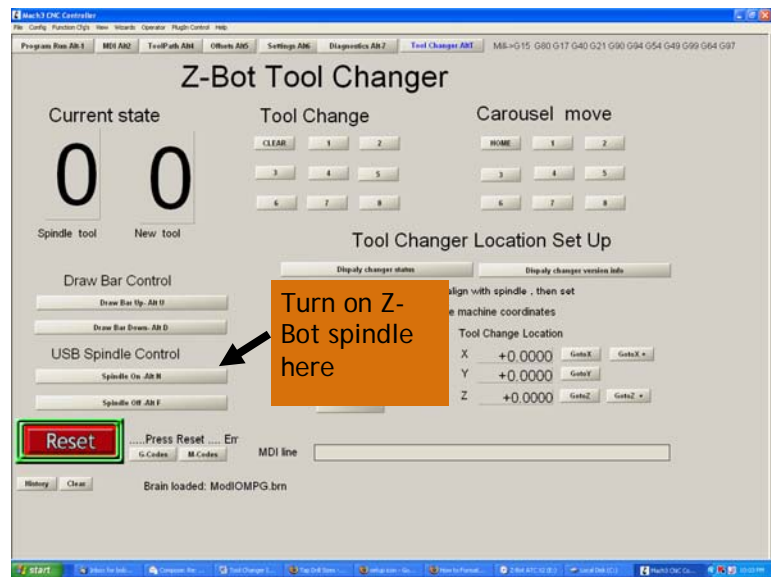


16. The next step is to go the whole tool change sequence. Make sure you have a tool holder in claw 2.

1) If using your own spindle controller, you must restart the spindle after tool changing. If using the Z-Bot spindle controller, it is handled for you as an M6 function. To prepare for the next test, enable and turn on the spindle to be sure it's being stopped by the control module before tool change.

2) Click the "2" button under the "Tool Change" bank of buttons.

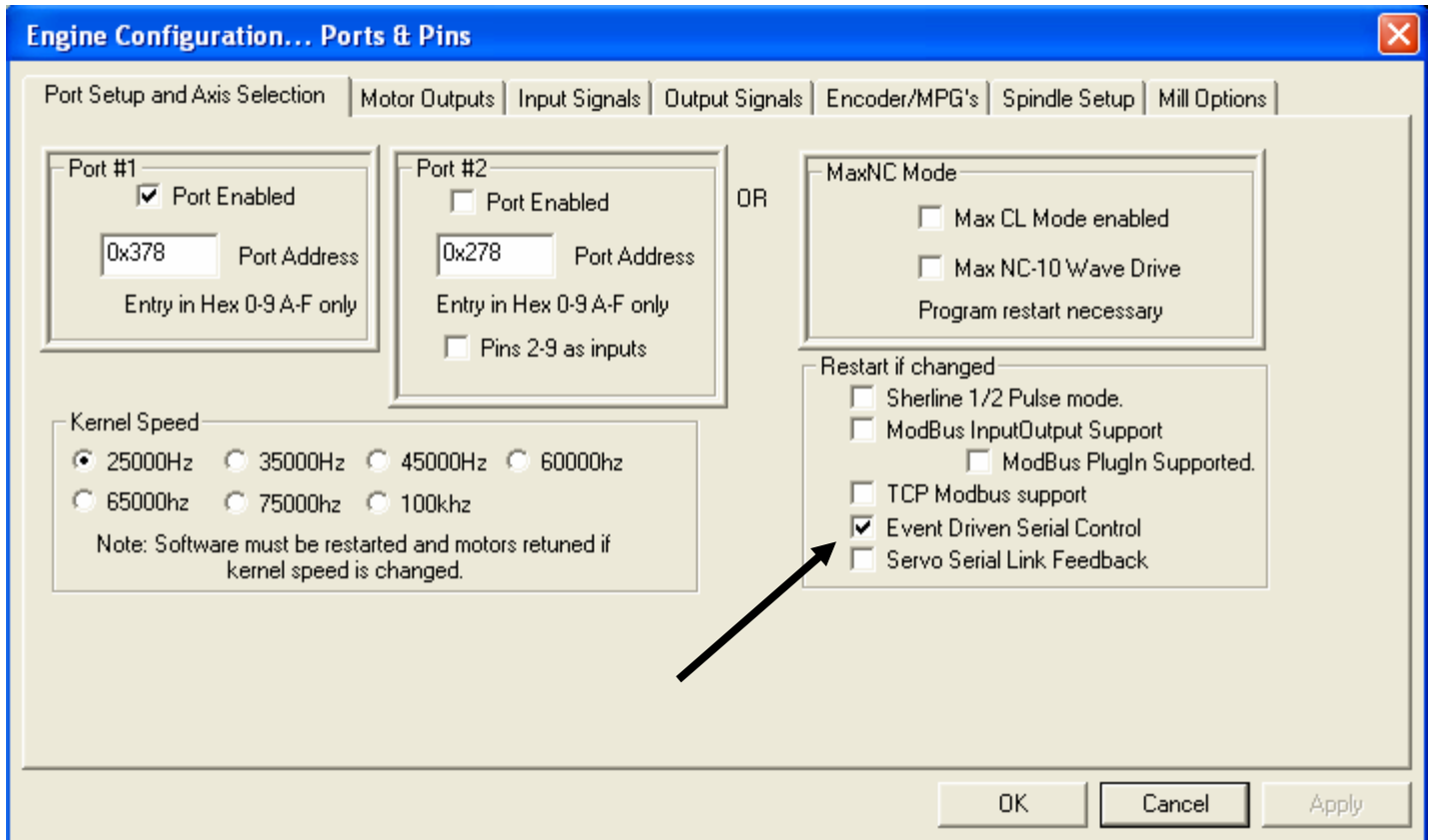
3) The tool change should now stop the spindle, return Tool 1 to its claw and then fetch Tool 2 and establish it as the spindle (current) tool. Notice that the Spindle Tool DRO is set to "0" as soon as the spindle is cleared of the old tool. It is only changed to Tool 4 after the draw bar locks the new tool in. This is done in case an error (mis-alignment, dropped tool, tool tray error, etc.) interrupts the process before completion. The Spindle Tool should then be set to the proper value to re-drive the tool change.



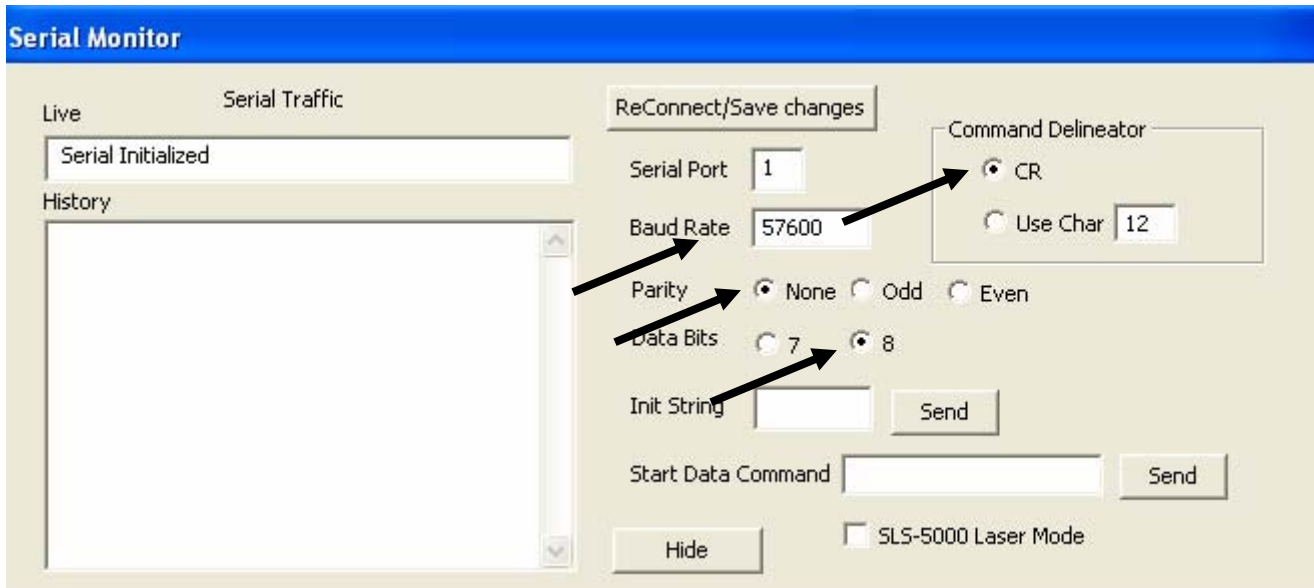
Appendix A – Configuration requirements

This appendix contains the information needed to modify any configuration to work with the Z-Bot tool changer in USB mode.

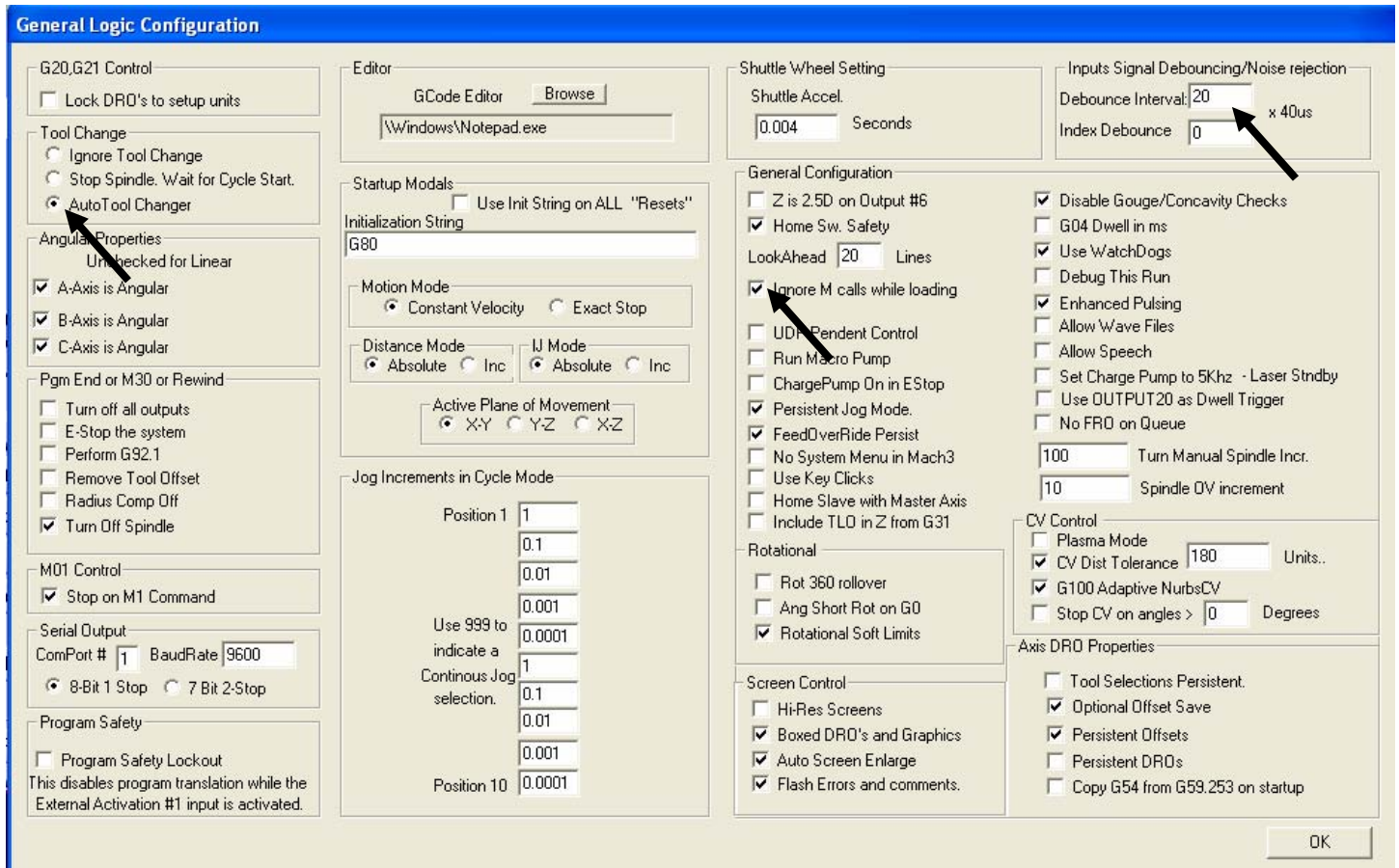
Under Config ->Ports and Pins, turn on “Event Driven Serial Control”. Close and re-launch Mach3. This enables the use of two way serial communications over a USB connection. The USB drivers installed with the tool changer emulate a serial port to Mach3. When Mach restarts, the serial port can be configured (see next step).



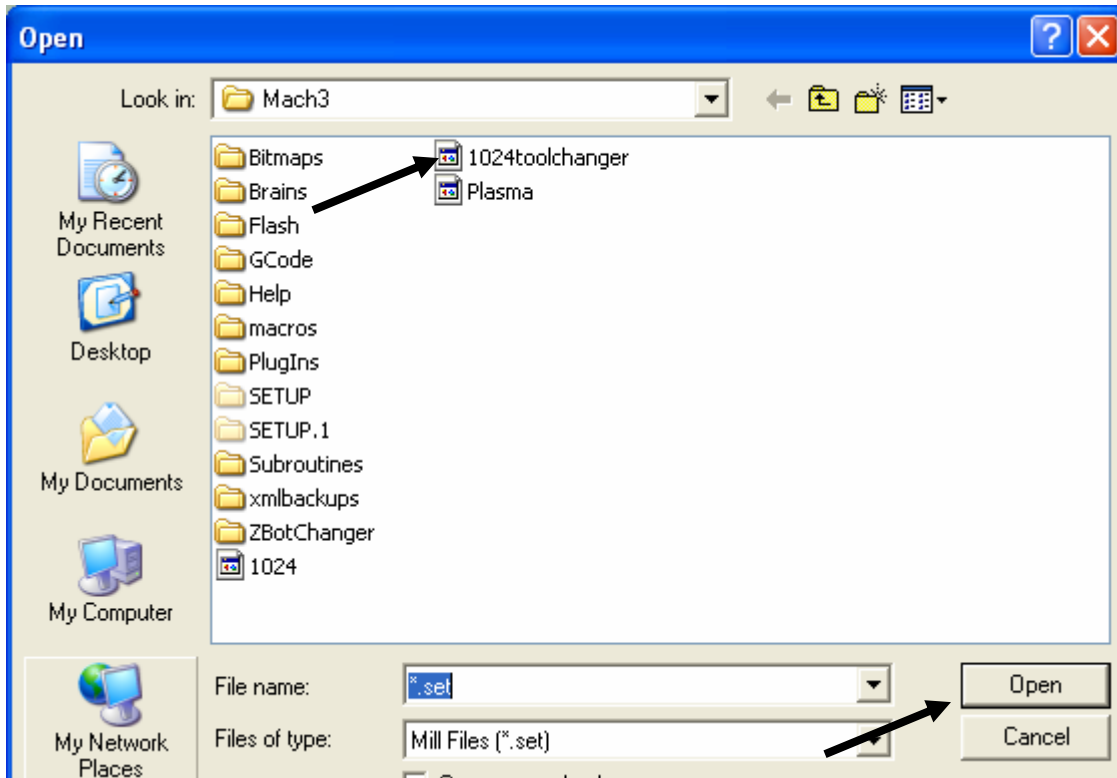
After restart, under Function Cfg's ->Serial Monitor, configure the serial port as follows. There is no need to set the Serial Port number as it is automatically set by a plug in each time Mach3 starts up.



Under Config ->General Configuration, set the following fields:



Finally, under View->Load Screens, select screen set file "1024ToolChanger.set" to gain access to the tool changer control application:



Advanced users can use the 1024toolchanger screen set as an example for modifying their own user interfaces. Embedded VB scripts can be saved and copied with the Mach3 VB script editor.

Appendix B – Macro reference

The following macros are supplied with the Z-Bot tool changer system:

M6start - code M6 Tn where *n* represents the new tool to be placed in the spindle. M6Start is invoked by Mach3 when an M6 command is issued. The tool changer will return the current tool (spindle tool), if any, to the tool tray before inserting the new tool. If using your own spindle controller, the spindle must be started after a tool change. If you implemented the Z-Bot spindle controller, the M6start macro will start the spindle on your behalf. To clear the spindle of any tool, code M6 T0. When clearing the spindle, it will not be re-started after purging. M6start will apply the tool offset from the tool table before returning.

Examples:

M6 T0 Returns the current tool to the tool tray, and leaves the spindle stopped.
M6 T4 Returns any tool to the tool tray, inserts T4 in the spindle, applies tool offsets for tool 4, and starts the spindle (Z-Bot spindle control only).

M6000 Pn Qn - code M6000 Pn Qn - where P is a function number, and Q is an optional value of 0 or 1. Coding Q1 will suppress messages to the Mach3 message line. This macro is used to invoke primitive functions of the tool changer. These functions can be used in lieu of the M6start to perform tool changer functions in open G-code part programs. These functions can also be used from the MDI line. Due to Mach3 limitations, do not embed these macro calls in another macro or VB script.

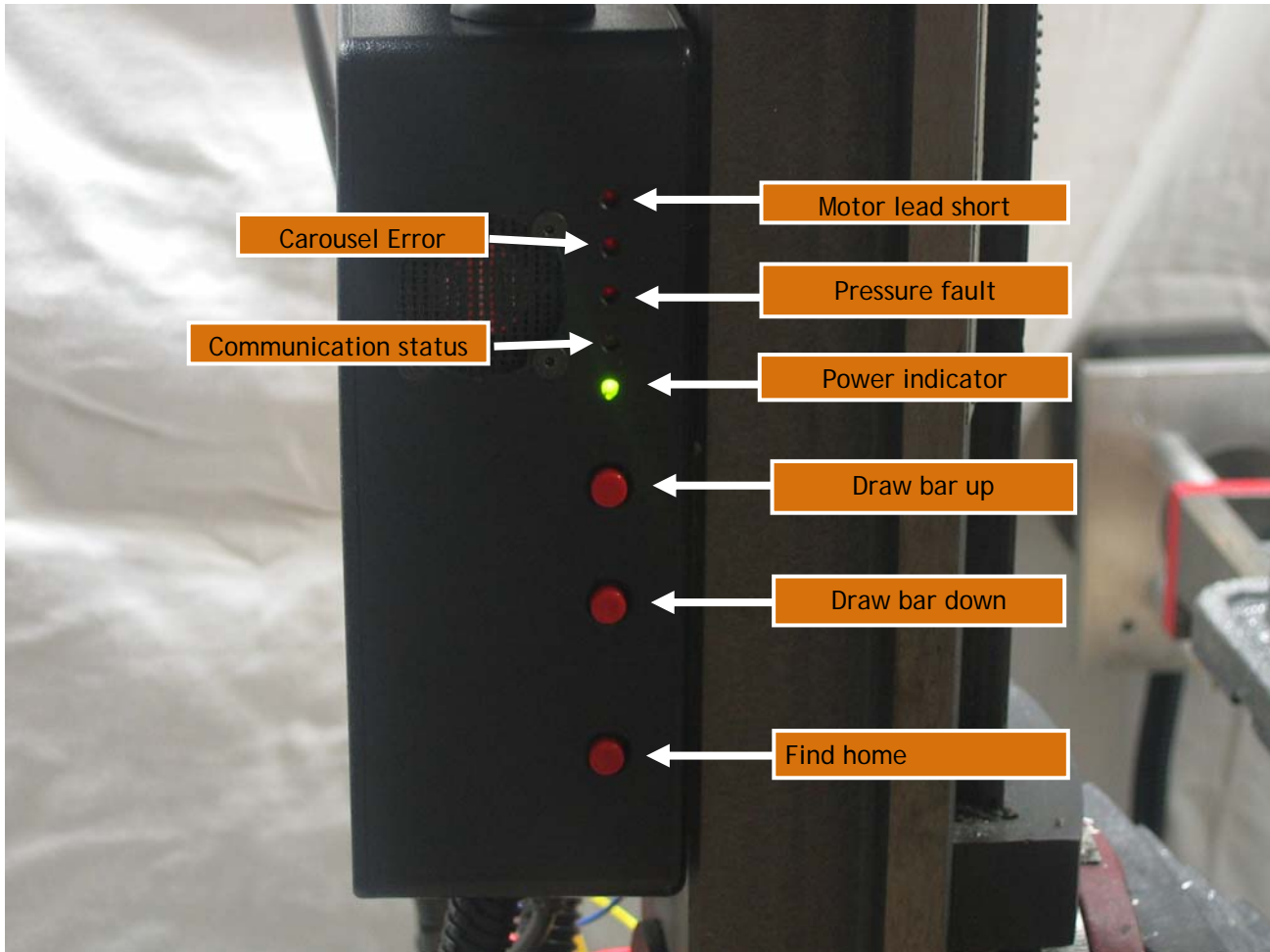
P function codes as follows:

P0 "home" the tool tray
P(1,...,8) rotate tool tray to Tn, where n is 1-8
P50 draw bar up
P51 draw bar down if spindle stopped
P60 deactivate USB spindle
P61 activate USB spindle if draw bar up
P70 retrieve tool changer status
P51 retrieve tool changer version information

Examples:

M6000 P0 Homes the tool tray.
M6000 P4 Q1 Rotates the tool tray to T4, and suppresses messages
M3 - If you installed the Z-Bot spindle option this will enable the spindle control box on the Mini-mill.
M5 - If you installed the Z-Bot spindle option this will disable the Mini-mill control box.

Appendix C – Controller module indicators and functions



The control module has 3 manual operation buttons and 5 indicator lights. It contains a micro-processor for the embedded tool changer functions, an integrated stepper driver module, and the Z-Bot X2spindle controller.

Buttons:

Find home	The tool tray uses a reed sensor to find the magnet on the home position. Pressing this button will find and calibrate the tray to the home position. Use it to reset the carousel error condition.
Draw bar up	Pull the collet closed, lock onto the tool holder.
Draw bar down	Push the collet open, release the tool holder. If active, the spindle will be stopped before proceeding.

Indicator lights:

Power indicator-green	Lights when power is applied and unit is switched on.
Communication status indicator -yellow	Lights when traffic is flowing over the USB connection.
Pressure fault indicator-red	Pressure sensor under the tool table is triggered. When the spindle is misaligned with the tool holder, this switch prevents damage to the mechanism. This condition will close the circuit connected to the fault loop (Install and wire control module - step 20). Reset by jogging the Z-Axis up. Usually recalibrating with the "Find home" button is required as the tool tray is misaligned. If this happens frequently, realign the tool changer position coordinates (Configuring the tool changer - step 10) for a more accurate location.
Carousel fault indicator-red	The tool changer monitors the home position as the tool tray is turning. If the reed sensor does not pick up the home position where it is expected, it will signal a carousel fault. This condition will close the circuit connected to the fault loop (Install and wire control module - step 20). To remedy, re-calibrate the device using the "Find home" button.
Motor short indicator-red	Motor leads are shorted. Check wiring to the motor. A severe short will cause a soft fuse to blow in the stepper driver. This condition will close the circuit connected to the fault loop (Install and wire control module - step 20). Once the wiring issue is remedied, the fuse will reset when the unit is turned off and on.

Appendix D – Messages

All tool changer functions issue informational messages during execution. Messages all follow a common naming and numbering structure:

ZBT nnn I -informational message

ZBT nnn E -informational message

Version request response:

ZBT000I Version data: Z-Bot Automatic Tool Changer Vn.nn

Information messages issued by M6Start (tool change macro):

ZBT600I Tool Change Initiated

Macro has begun execution

ZBT600I Disabling Spindle

Z-Bot spindle controller will disable Mini-mill spindle

ZBT600I Returning Tn

Beginning to return the current tool to the tool tray

ZBT600I Clearing Spindle

Beginning to clear the current tool

ZBT600I Fetching Tool

Fetching the new tool specified in T argument of macro

ZBT600I New Tool in Spindle is Tn

Clamped Tn in the spindle with draw bar

ZBT600I Enabling Spindle

Turn on the Mini-mill spindle

ZBT600I Clearing for Milling

Homing the tool tray and returning to the original XY coordinates

ZBT600I Tool change complete!

Exiting tool change macro successfully

Information messages issued by M6000

ZBT600I Homed

Tool tray at home

ZBT600I Carousel at Tn

Carousel is rotated to tool position n

ZBT600I Draw bar up

Draw bar is in up position

ZBT600I Draw bar down

Draw bar is in down position

ZBT600I Spindle deactivated

Z-Bot spindle is de-activated

ZBT600I Spindle activated

Z-Bot spindle is activated

Error condition and error status messages

ZBT600I Status data :

Returns a sentence with discrete status for changer functions separated by commas as response from status inquiry as follows:

Examples:

HO, D-, 1-, 2-, 3-, S+, DRAW BAR DOWN

T3, D+, 1-, 2-, 3-, S-, CAROUSEL ERROR, SPINDLE ACTIVE

T3, D+, 1-, 2-, 3-, S-, SHORT ERROR

Legend:

HO tool tray is homed

D+,- draw bar down,up

1+,- solenoid 1 on, off (not used on X2 model)

2+,- solenoid 2 on, off (not used on X2 model)

3+,- solenoid 3 on, off (not used on X2 model)

S+,- spindle enabled,disabled

CAROUSEL ERROR home not sensed when expected

TOOL ERROR pressure switch is activated (circuit opent)

SHORT ERROR motor miswired or shorted

DRAW BAR DOWN USB spindle activate command was issued when draw bar down

SPINDLE ACTIVE USB draw bar down command was issued when spindle turning

ZBT609E Unknown tool changer command

A bad command was passed to the embedded processor in the tool changer. Check for correct software installation. Disable any conflicting Windows services. Disable the all network connections while machining.

ZBT609E Device error

Any number of errors has occurred. See subsequent status message for more information.

ZBT609E Unexpected response error

The tool changer has transmitted an unexpected response to Mach3. Check for correct software installation. Disable any conflicting Windows services. Disable all network connections while machining.

ZBT699 P word out of range

An invalid P argument was specified to the M6000 macro.

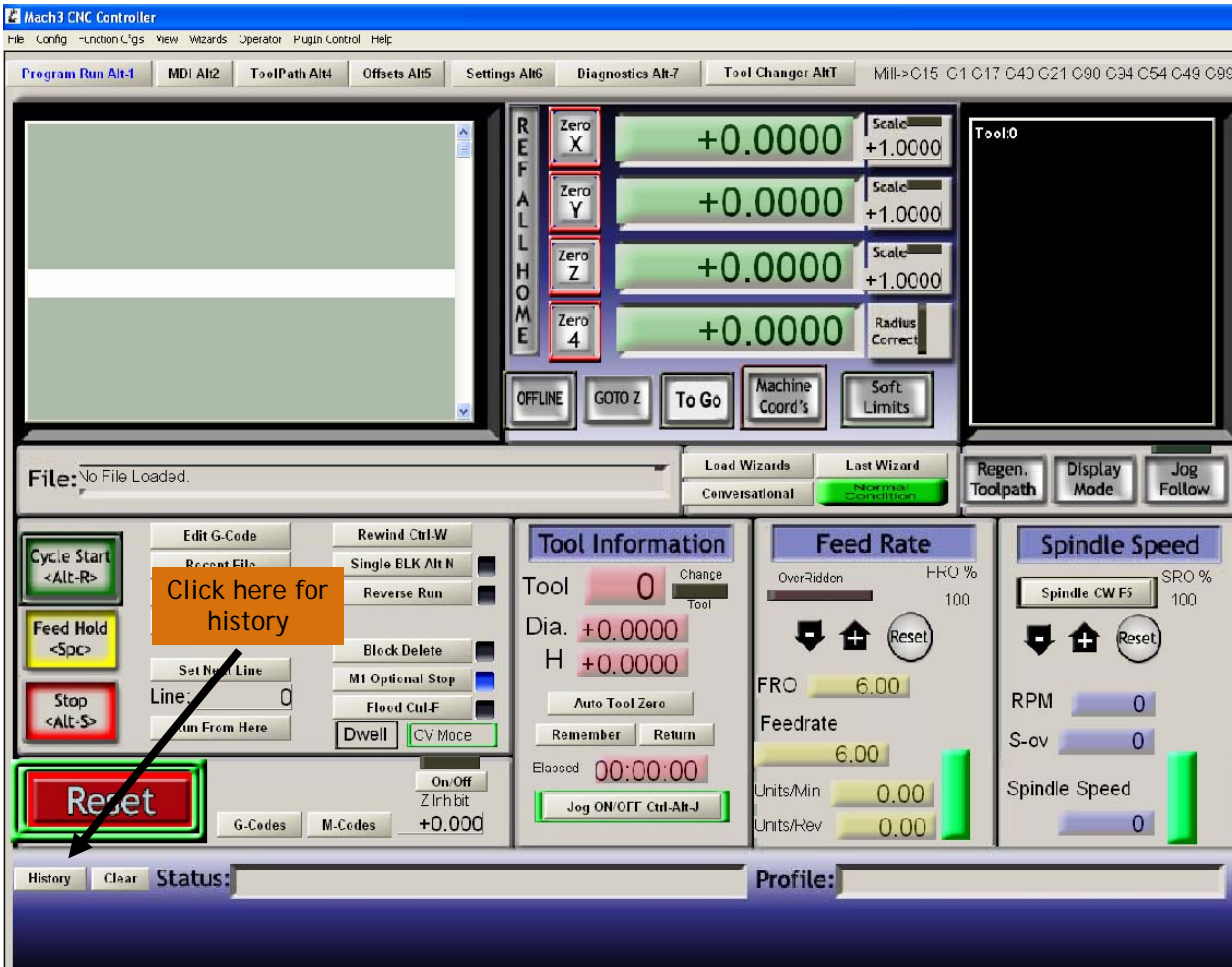
ZBT900E Tool changer timeout

No response was received from the tool changer. Check for correct software installation. Disable any conflicting Windows services. Disable all network connections while machining.

ZBT999E Tool Change Error - System halted!

An internal system stop has been issued. Remedy the condition and hit cycle start

It is helpful, when an error occurs to view message history. Proceed as follows:



This will display, in Notepad, all Mach3 messages as they occurred during the current session.

Warranty

Z-Bot LLC, warrants this product to be free of defects in original workmanship and material for a period of 90 days from date of sale. During this period, a defective unit may be repaired or replaced, at the discretion of Z-Bot LLC., by returning it in its original packaging with a copy of your receipt. This warranty does not cover damage resulting from tampering, lack of prudent care, accident or misuse (including contravention of cautions stated in the instructions), or any cosmetic damage not reported within 15 days of purchase. All liability for damage is limited to the cost of the product and does not include incidental injury or peripheral damage to other equipment, persons, or property. Z-Bot LLC. is not responsible for personal injury resulting from faulty installation. A service charge may be applied to any returned product requiring cosmetic attention, or to the repair of any damage not covered under this warranty