

# Short instructions for initial preparation and installation of A4xx/A6xx machines



[www.accuratecnc.com](http://www.accuratecnc.com)

Jan 19, 2014

## **Short instructions for initial preparation and installation of A4xx/A6xx machines. .... 3**

|  |    |
|--|----|
| 1. Preparation of the system for usage. Software and drivers installation..... | 3  |
| 1.1 Cables connection.....   | 3  |
| 1.2 Software and drivers installation for PhCNC control software.....          | 4  |
| 2. Machine setup. ....   | 5  |
| 2.1 Machine homing.....  | 5  |
| 2.1 Placing the tools in the tool holders. ....                                | 6  |
| 3. PCB material (work piece) fixing on the table.....                          | 13 |
| 4. Gerber and drill files import. Tools selection. ....                        | 15 |
| 4.1 Gerber files import.....   | 15 |
| 4.2 Selecting the copper rubout region(s).....                                 | 17 |
| 4.3 Tools selection.....   | 17 |
| 5. Project positioning on the work piece and machining.....                    | 24 |
| 5.1 Project positioning.....   | 24 |
| 5.2 Project execution (machining).....   | 25 |

# Short instructions for initial preparation and installation of A4xx/A6xx machines.

The goal of this manual is to offer a compact information about initial installation and startup of our machines. We will call them further "systems" having in mind that the interaction between the physical machine and software that control it creates a system during the process of use.

Some of the operations described here need to be performed either once or in rare occasions.

As an example "Home Z" (when you have changes in your stack -> backing material + PCB thickness), "Rubout tools" (only if you decide to switch to different set) etc.

The video clips links below are designed to add more practical information about the topics discussed in this manual.

HomeZ & Placing Tool in Tool Holder Demonstration (video): <http://youtu.be/TRNha8g7z8Q>

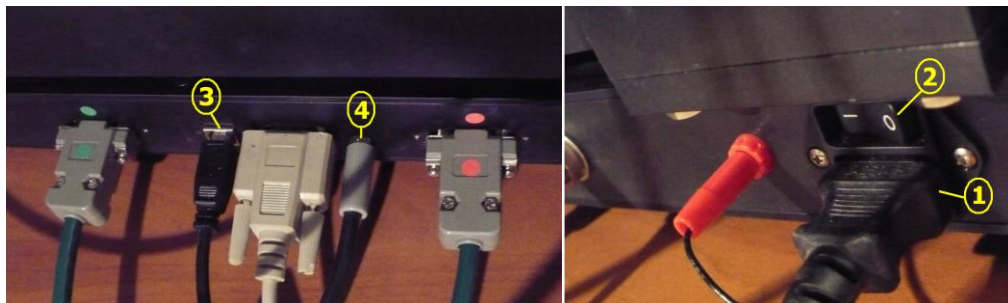
Import Gerbers, Tool settings & Project alignment (video): <http://youtu.be/yTY14RifLRc>

Fiducial registration (video): <http://www.youtube.com/watch?v=aGGKzJjflwU>

## 1. Preparation of the system for usage. Software and drivers installation.

### 1.1 Cables connection

- connect the system to grounded power outlet (Pos.1). It accepts any voltage between 100 and 250 V AC, without any voltage selectors. Do not turn it ON at this point. The power cable is normally included for most popular power outlets. In some cases we do not have access to the type of outlets in the country of destination. In this case customers have to obtain a grounded cable that is the same as power cables used to supply the desktop computers in the particular location. The connector to the machine end is the same as on most desktop computers and is also known as IEC 60320 C13.

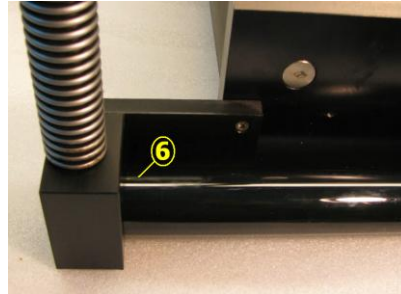


- connect the USB cable (included) to the machine (Pos.3) and to the computer that will be used for control. For best performance USB 2.0/3.0 port is recommended. USB 1.0 port will work too.
- connect the camera to another USB 2.0/3.0 port (extension USB cable is included).
- Connect the pressure air source (Pos.5, below). If you use our silent compressor it is factory preset to your needs. If you use other source you have to set your filter/regulator (recommended) to a value between 6-8 bar (87 to 116 PSI). Please do not exceed 8 bar/116 PSI value, this may damage the

pressure sensor embedded in the system. The procedure above is for ATC (Automatic Tool Change) models only. MTC (Manual Tool Change) models do not need pressure air.



- connect the vacuum hose to the vacuum dust collector. It is designed to accept standard 1.25 inches vacuum tubes. Usually they are conical and if you have loose connection you may cut 2-3 inches of the length to get more tight connection.



- connect the "Automatic vacuum starter" signal cable (Pos.4, 3.5 mm audio plug) for usage of commercial vacuums or the same type of plug that our vacuum/dust collecting units are equipped with. Connect the dust collecting unit to the power.

## 1.2 Software and drivers installation for PhCNC control software

- install the control software using the CD-ROM delivered with the system or a link offered by [support@accuratecnc.com](mailto:support@accuratecnc.com). The installation process is completely automated, but if you have any problems you can turn to [PhCNC User's Manual EN.pdf](#)

- APPENDIX-H: USB drivers installation for A36x/A56x/A4xx/A6xx
- APPENDIX-I: USB drivers installation for video camera/microscope (VC)
- APPENDIX-J: PhCNC control programs installation (A350/A36x/A56x/A4xx/A6xx)

During the installation process of PhCNC the installer program installs all needed drivers.

This is the reason to recommend the software installation before the first power up of the machine. After the installation you may turn on your machine. Windows now will find and activate all needed drivers for your system and camera. Drivers for the system and camera are independent from each other and it is possible that camera drivers are already activated.

At the first communication between the machine and PhCNC software, it will check the firmware of the CNC controller, PhACdrive and PhSTdrive. Normally the CD-ROM software is up to date with the current shipment, but this feature will help you if we have firmware updates in the future. All firmware updates will be installed automatically. The process takes some time

- PhCNC360 firmware 2-3 seconds
- PhACdrive 15 to 20 seconds
- PhSTdrive less than 60 seconds

**PLEASE DO NOT INTERRUPT THE PROCESS OF FIRMWARE UPDATE!**

## 2. Machine setup.

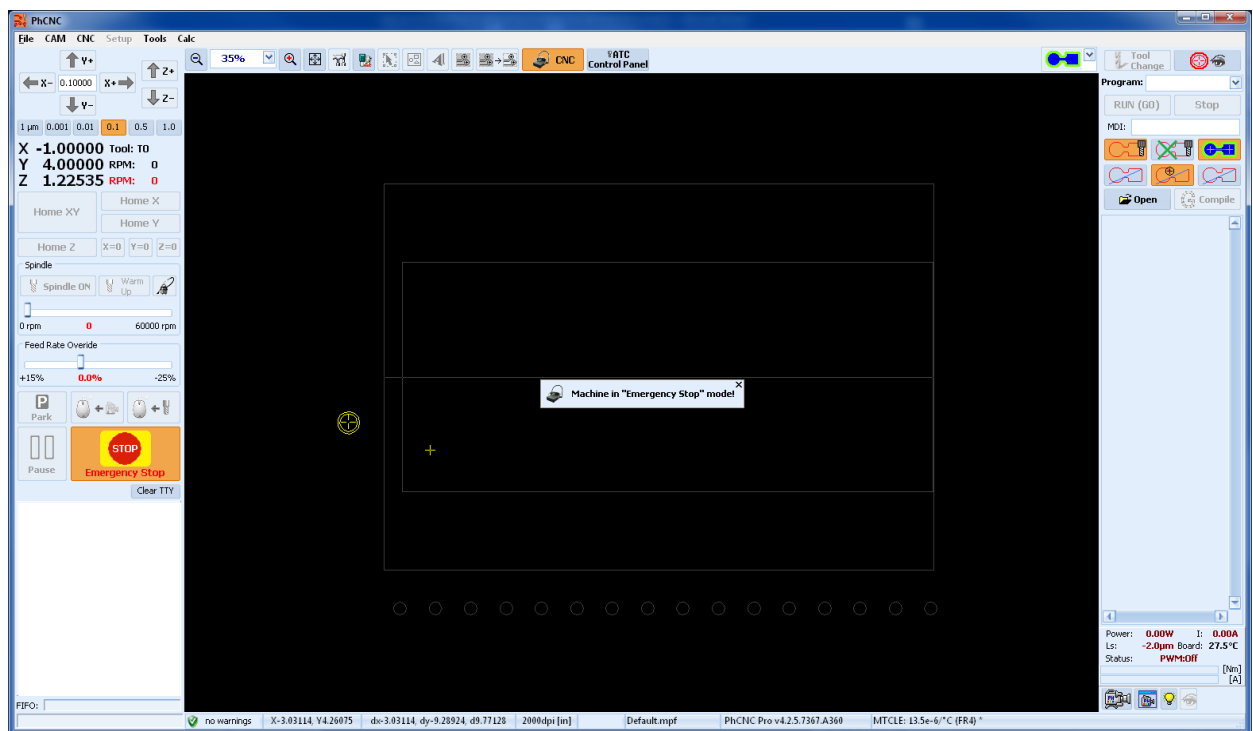
### 2.1 Machine homing.

After starting the PhCNC software, switch to CNC mode by pressing CNC button.

If you have a message that the machine is not found, it can be due to the following conditions

- machine power is off
- machine USB cable is not connected to the machine or to operating USB port on the computer.
- in rare cases USB drivers are not installed. This depend of your OS settings and antivirus barriers (programs) used. In this case you have to turn to our main manual and see the APPENDIX A - Manual USB drivers installation.

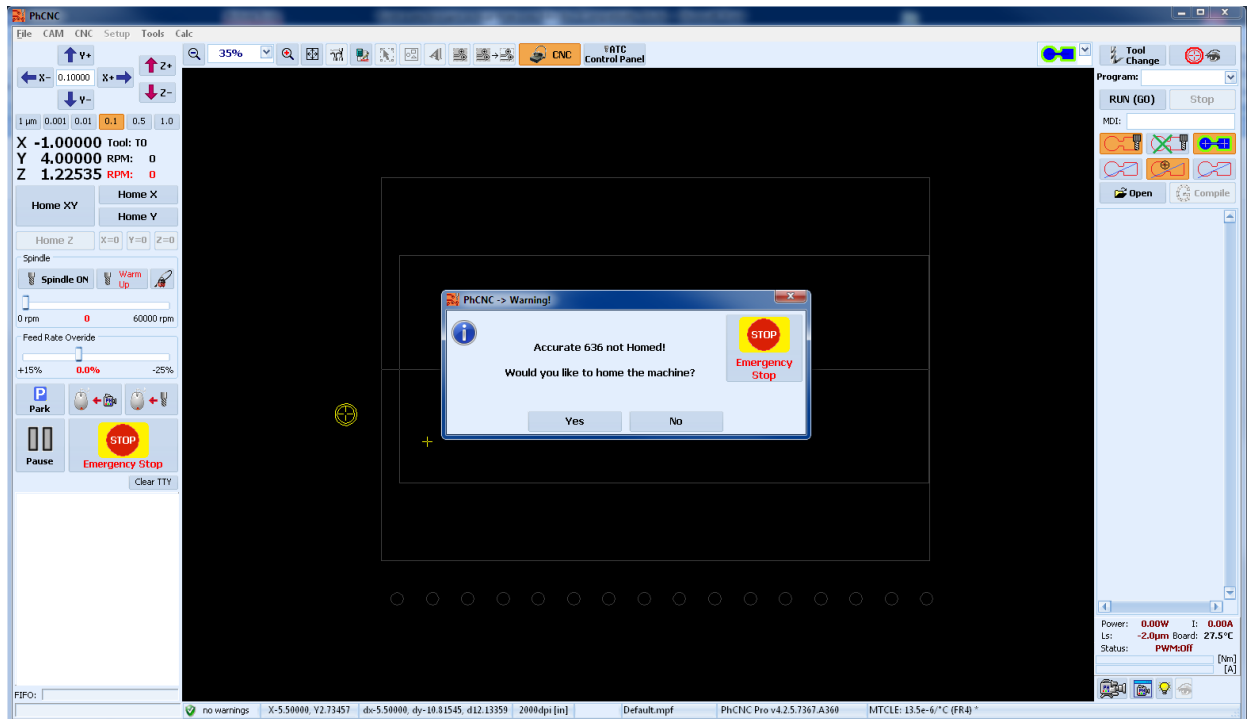
Shown below is the screen shot of CNC mode.



Always after the power up and going in CNC mode, the machine is in "Emergency Stop" mode.


To exit this mode you have to push/reliaise the "Emergency Stop button" (see above).

In the next step you will receive a prompt to Home the machine. If it is real first emtry in CNC mode after power up the mandatory answer is "Yes". If you use the "Emergency Stop" during the operation without power interruption you may select "No". Our systems do not loose coordinates during the "Emergency Stop" action.



After the homing the system is ready for use.

### Important:

If the air pressure indicator is blinking  you need to check the pressure air connection and pressure level.

## 2.1 Placing the tools in the tool holders.


In order to have fully automatic mode all tools needed for the project must be placed in to the machine tool holders. Conditionally speaking we divide the tools in two groups, permanent and specific. The permanent tools are the ones that are always needed. Typical arrangement includes.

- one tool for insulation process
- one tool for cutting (routing).
- 2, 3 or 4 tools for copper rubout
- the rest of tool holders (6 or 10 depend of the machine model) are for small diameter drill bits.


These are specific for the project.

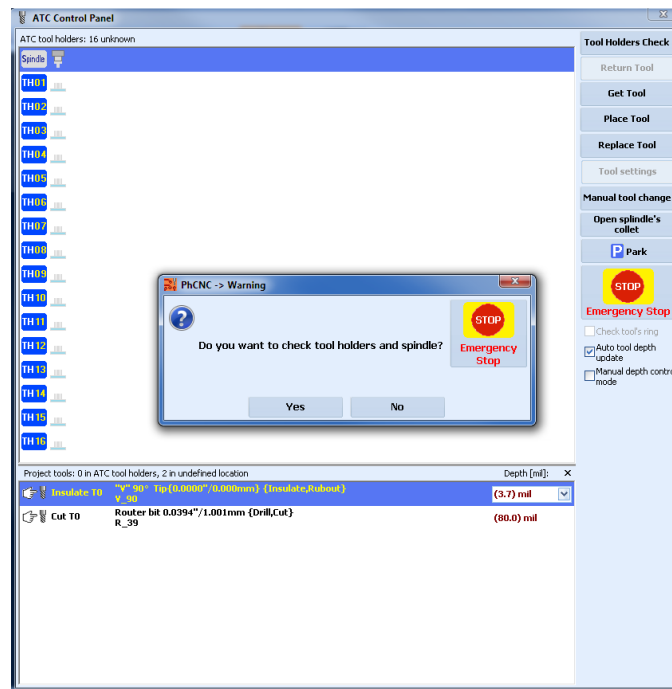
- drilling of holes that are larger than cutting tool can be assigned to the cutting tool and routed with it. This SW function reduces the number of tools needed and makes the drill diameter unlimited.

All ATC models allow manual tool change in case that it is needed.

The tools in the holders have to have description entered. They will be used in ATC mode only when the description matches the one in your "project tools" table. PhCNC will list them as placed in the tool holder number **TH03** or for manual tool change . If any particular tool is in the tool holder, but is still listed for manual tool change the description entered is different from the one in your "Project tools" table and need to be corrected.

Seems that the most practical way is to enter all descriptions in the "Tool Table" and select the existing description for the tool in the respective holder.

Using the ATC Control Panel  is the best way to handle all information related to the tools in use.



In the initial power up "ATC Control Panel" will ask you to check the status of the tool holders and spindle collet. Normally the machine comes with a blank tool in the collet (transportation tool) and empty tool holders. It is very recommended to answer "Yes" and see the result. It should show empty tool holders and "unknown" tool in the spindle collet.

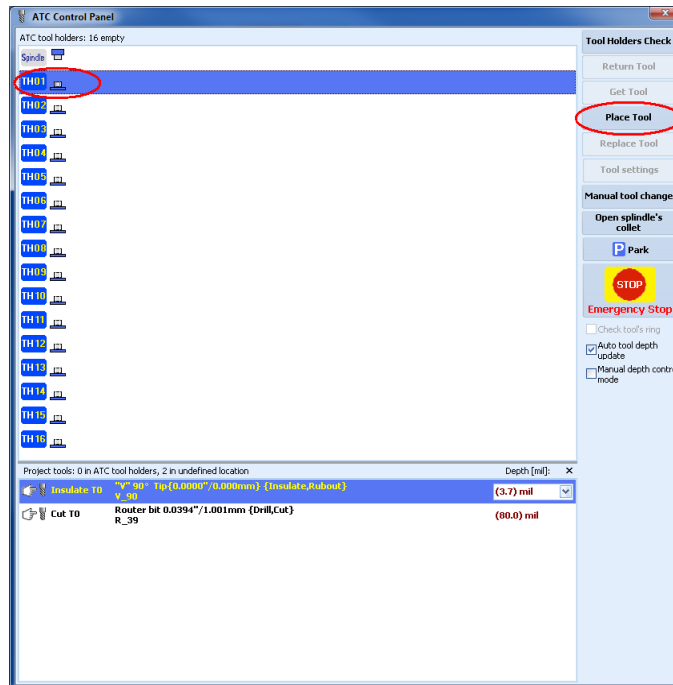
### Important:

The test above sets the information for tool logistics. It is very important. In addition the system checks the status of the particular tool holder before and after tool change operation to assure that the process is completed correctly. THIS FUNCTION CAN BE PERFORMED ONLY AFTER MACHINE HOMING!

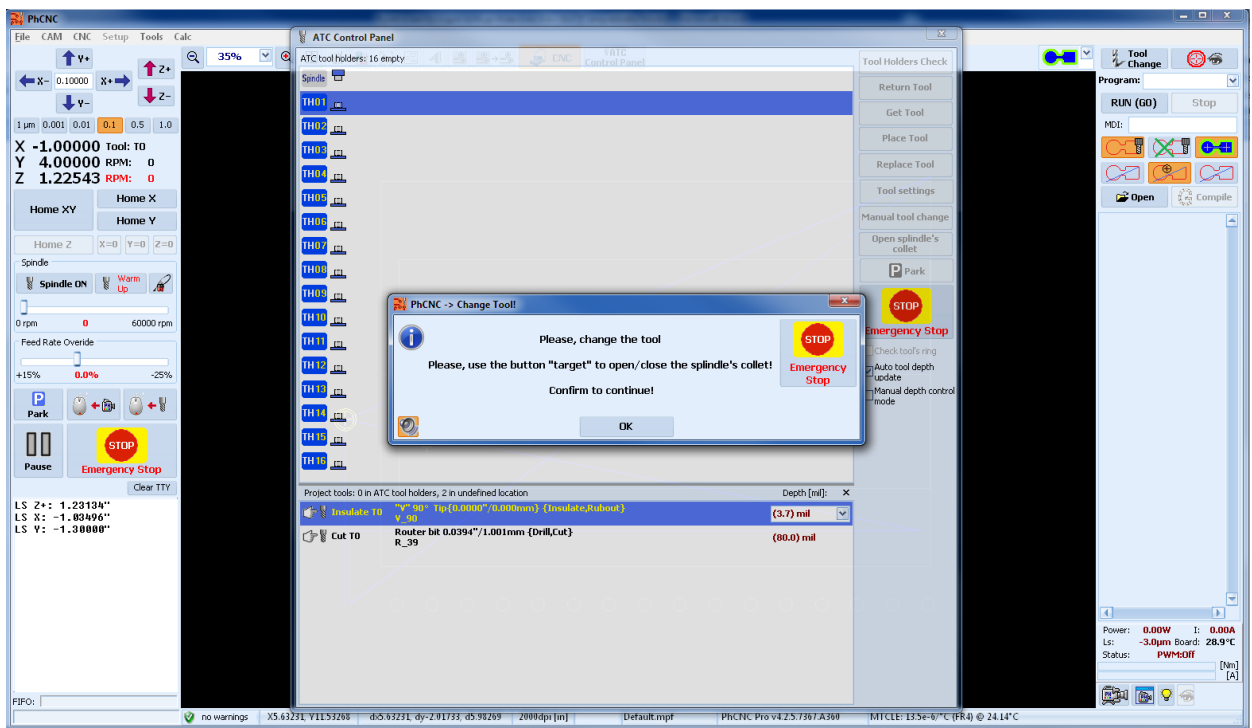
Placing and removing the tools in/out the tool holders.

Both placing and removing the tools in and out of tool holders by hand is physically possible, but we definitely **DO NOT RECOMMEND IT**. Here are the reasons:

- placing the tool in the tool holder by hand may leave the tool not strait up. As a result when the spindle is trying to pick the tool it may push it down and damage the infrared sensor located in each tool holder.
- hand removal do not impose any dangers, but in both cases you have to run "Tool Holders Check" in order to inform the system for the new tools logistic. As a bottom line this will not give you any advantages. Please use the process described below for tools placement and removal.



Select the tool holder that you like to place the tool (TH01 is shown on the screen shot above). Press **Place Tool**, If the spindle already has a tool in the collet it will place it in the TH01, if it is empty will come to the tool change position and will prompt you to place tool in the collet. After placing the tool in the collet it will check the actual tool existence and then will place it in the selected tool holder. As a first step we recommend you to request "Manual tool change" and remove the blank tool used for machine transportation.



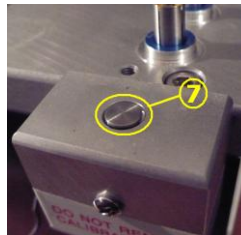
Placing a tool in the spindle collet is a process that is very easy and is well assisted with the "Manual tool changer". It comes included in all of our systems.



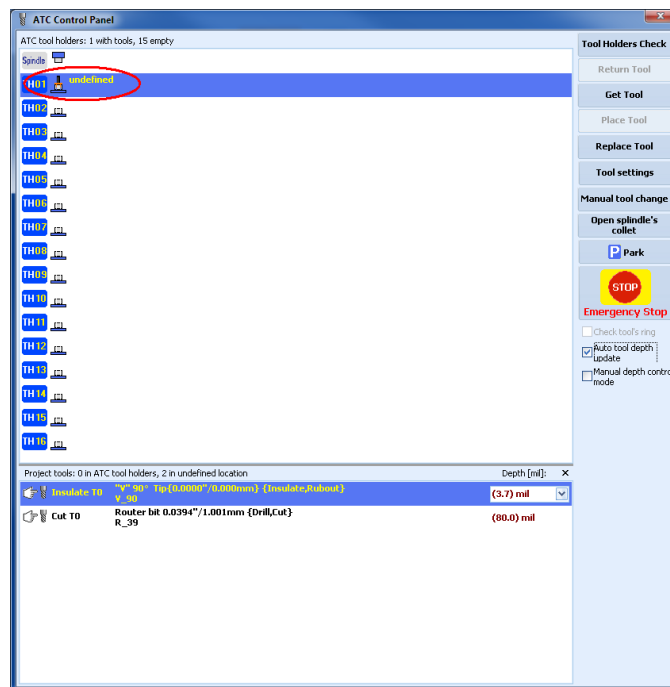


Manual tool changer

Once in a manual tool change position you will be able to control the spindle collet. Pushing the button on the calibration pad will open the spindle collet. During the inserting the tool, apply small up force in order to have the plastic ring touching the collet lips during the closing. Release the button to close the spindle collet (Pos.7).



In order to place the tool in the tool holder you have to click on the "OK" button. SW will check for the real tool existence in the collet and its proper position (using the calibration station) and will place it in the selected tool holder. Screen shot is shown below.



Next step is to enter/edit the tool description. Double click on the description field will call the tool table

|     | Diameter [m]   | Type          | Operation         | Speed [rpm] | Plunge rate [in/m] | Feed rate [in/m] | Tool Tip [mm] | Comment    |
|-----|----------------|---------------|-------------------|-------------|--------------------|------------------|---------------|------------|
| #1  | 0.010          | Stub End Mill | All               | 50000       | 35.0               | 7.5              | -             |            |
| #2  | 0.016          | Stub End Mill | All               | default     | default            | default          | -             | SEM_15     |
| #3  | 0.0197 (0.5mm) | Stub End Mill | All               | default     | default            | default          | -             |            |
| #4  | 0.025          | Stub End Mill | All               | default     | default            | default          | -             |            |
| #5  | 0.0313 (1/32") | Stub End Mill | Insulate & Rubout | default     | default            | default          | -             |            |
| #6  | 0.0625 (1/16") | Stub End Mill | All               | default     | default            | default          | -             | SEM_63     |
| #7  | 0.125 (1/8")   | Stub End Mill | All               | default     | default            | default          | -             | SEM_125    |
| #8  | 0.0135         | Drill bit     | Drill             | default     | default            | -                | -             | DRL_13.5   |
| #9  | 0.022          | Drill bit     | Drill             | default     | default            | -                | -             | DRL_21.65  |
| #10 | 0.026          | Drill bit     | Drill             | default     | default            | -                | -             |            |
| #11 | 0.0313 (1/32") | Drill bit     | Drill             | default     | default            | -                | -             | DRL_31     |
| #12 | 0.035          | Drill bit     | Drill             | default     | default            | -                | -             | DRL_39     |
| #13 | 0.047          | Drill bit     | Drill             | default     | default            | -                | -             | DRL_47     |
| #14 | 0.079          | Drill bit     | Drill             | default     | default            | -                | -             | DRL_79     |
| #15 | 0.1181 (3.0mm) | Drill bit     | Drill             | default     | default            | -                | -             | DRL_118    |
| #16 | 0.125 (1/8")   | Drill bit     | Drill             | default     | default            | -                | -             | DRL_125 #1 |
| #17 | 0.125 (1/8")   | Drill bit     | Drill             | default     | default            | -                | -             | DRL_125 #2 |
| #18 | 0.125 (1/8")   | Drill bit     | Drill             | default     | default            | -                | -             | DRL_125 #3 |
| #19 | undef          | "V" 30°       | Insulate & Rubout | default     | default            | default          | 3.5           | V_30       |
| #20 | undef          | "V" 45°       | Insulate & Rubout | 45000       | default            | default          | 6.5           | V_45       |
| #21 | undef          | "V" 60°       | Insulate & Rubout | default     | default            | default          | 5.8           | V_60       |
| #22 | undef          | "V" 90°       | Insulate & Rubout | default     | default            | default          | 4.0           | V_90       |
| #23 | 0.0313 (1/32") | Router bit    | Cut & Drill       | default     | default            | default          | -             | R_31       |
| #24 | 0.0394 (1.0mm) | Router bit    | Cut & Drill       | default     | default            | default          | -             | R_39       |
| #25 | 0.049          | Router bit    | All               | default     | default            | default          | -             | R_49       |
| #26 | 0.050          | Router bit    | Cut & Drill       | default     | default            | default          | -             | R_50       |
| #27 | 0.0984 (2.5mm) | Router bit    | Cut & Drill       | default     | default            | default          | -             |            |
| #28 | 0.1181 (3.0mm) | Router bit    | Cut & Drill       | default     | default            | default          | -             |            |

If the tool is not existing in the tool table it can be added using  Add button

|     | Diameter [m]   | Type          | Operation         | Speed [rpm] | Plunge rate [in/m] | Feed rate [in/m] | Tool Tip [mm] | Comment    |
|-----|----------------|---------------|-------------------|-------------|--------------------|------------------|---------------|------------|
| #1  | 0.010          | Stub End Mill | All               | 50000       | 35.0               | 7.5              | -             |            |
| #2  | 0.016          | Stub End Mill | All               | default     | default            | default          | -             | SEM_15     |
| #3  | 0.0197 (0.5mm) | Stub End Mill | All               | default     | default            | default          | -             |            |
| #4  | 0.025          | Stub End Mill | All               | default     | default            | default          | -             |            |
| #5  | 0.0313 (1/32") | Stub End Mill | Insulate & Rubout | default     | default            | default          | -             |            |
| #6  | 0.0625 (1/16") | Stub End Mill | All               | default     | default            | default          | -             | SEM_63     |
| #7  | 0.125 (1/8")   | Stub End Mill | All               | default     | default            | default          | -             | SEM_125    |
| #8  | 0.0135         | Drill bit     | Drill             | default     | default            | -                | -             | DRL_13.5   |
| #9  | 0.022          | Drill bit     | Drill             | default     | default            | -                | -             | DRL_21.65  |
| #10 | 0.026          | Drill bit     | Drill             | default     | default            | -                | -             |            |
| #11 | 0.0313 (1/32") | Drill bit     | Drill             | default     | default            | -                | -             | DRL_31     |
| #12 | 0.035          | Drill bit     | Drill             | default     | default            | -                | -             | DRL_39     |
| #13 | 0.047          | Drill bit     | Drill             | default     | default            | -                | -             | DRL_47     |
| #14 | 0.079          | Drill bit     | Drill             | default     | default            | -                | -             | DRL_79     |
| #15 | 0.1181 (3.0mm) | Drill bit     | Drill             | default     | default            | -                | -             | DRL_118    |
| #16 | 0.125 (1/8")   | Drill bit     | Drill             | default     | default            | -                | -             | DRL_125 #1 |
| #17 | 0.125 (1/8")   | Drill bit     | Drill             | default     | default            | -                | -             | DRL_125 #2 |
| #18 | 0.125 (1/8")   | Drill bit     | Drill             | default     | default            | -                | -             | DRL_125 #3 |
| #19 | undef          | "V" 30°       | Insulate & Rubout | default     | default            | default          | 3.5           | V_30       |
| #20 | undef          | "V" 45°       | Insulate & Rubout | 45000       | default            | default          | 6.5           | V_45       |
| #21 | undef          | "V" 60°       | Insulate & Rubout | default     | default            | default          | 5.8           | V_60       |
| #22 | undef          | "V" 90°       | Insulate & Rubout | default     | default            | default          | 4.0           | V_90       |
| #23 | 0.0313 (1/32") | Router bit    | Cut & Drill       | default     | default            | default          | -             | R_31       |
| #24 | 0.0394 (1.0mm) | Router bit    | Cut & Drill       | default     | default            | default          | -             | R_39       |
| #25 | 0.049          | Router bit    | All               | default     | default            | default          | -             | R_49       |
| #26 | 0.050          | Router bit    | Cut & Drill       | default     | default            | default          | -             | R_50       |
| #27 | 0.0984 (2.5mm) | Router bit    | Cut & Drill       | default     | default            | default          | -             |            |
| #28 | 0.1181 (3.0mm) | Router bit    | Cut & Drill       | default     | default            | default          | -             |            |
| #29 | undef          | undef         | undef             | default     | default            | default          | -             |            |

Below is an example of new tool description.

- Diameter: undef (V tools are typical insulation tools and allow different insulation gaps related to the tool penetration).
- Type: V90 (90 deg conical cutter)
- Operation: Insulation & Rubout (the tool will be used in selected operations)

- Speed [rpm]: default (will set default speed for the operation selected)
- Plunge rate [in/m]: default - the speed that the tool will penetrate in the material. Will use the penetration rate for selected operation.
- Feed rate [in/m]: default - the movement speed in XY plane during the machining. Will use the speed rate for selected operation.

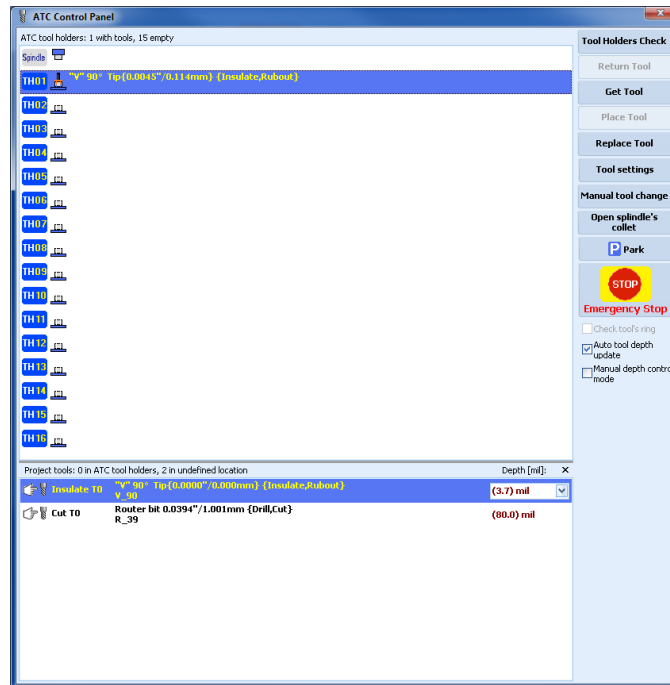
**Note:**

All default values can be changed to particular values using the drop down menus.

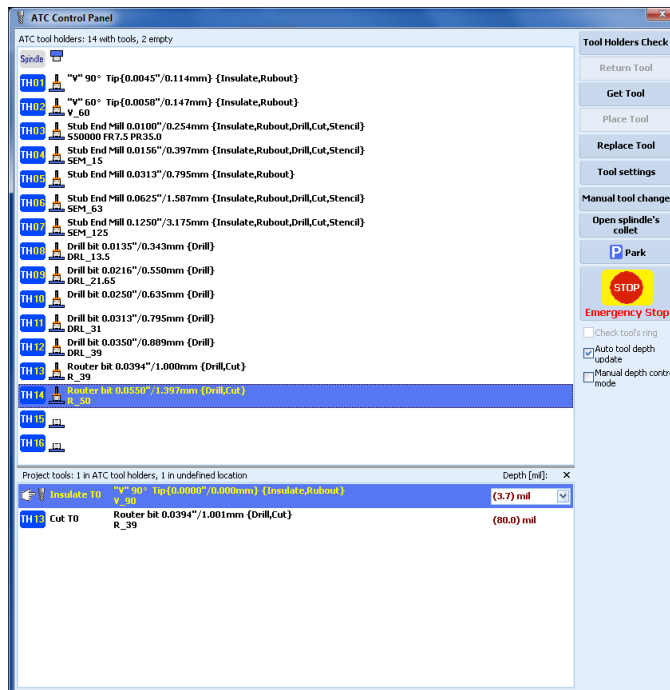
- Tool Tip [mil]: important parameter that apply for V tools only. If not published by the vendor or manufacturer it can be measured using a measuring microscope or found by "tool test" function embedded in PhCNC software. Typical tip diameter for the V tools is 4-5 mil.

| #   | Diameter [in]  | Type          | Operation         | Speed [rpm] | Plunge rate [in/m] | Feed rate [in/m] | Tool Tip [mil] | Comment    |
|-----|----------------|---------------|-------------------|-------------|--------------------|------------------|----------------|------------|
| #1  | 0.010          | Stub End Mill | All               | 5000        | 35.0               | 7.5              | -              |            |
| #2  | 0.016          | Stub End Mill | All               | default     | default            | default          | -              | SEM_15     |
| #3  | 0.0197 (0.5mm) | Stub End Mill | All               | default     | default            | default          | -              |            |
| #4  | 0.025          | Stub End Mill | All               | default     | default            | default          | -              |            |
| #5  | 0.0313 (1/32") | Stub End Mill | Insulate & Rubout | default     | default            | default          | -              |            |
| #6  | 0.0625 (1/16") | Stub End Mill | All               | default     | default            | default          | -              | SEM_63     |
| #7  | 0.125 (1/8")   | Stub End Mill | All               | default     | default            | default          | -              | SEM_125    |
| #8  | 0.0135         | Drill bit     | Drill             | default     | default            | -                | -              | DRL_13.5   |
| #9  | 0.022          | Drill bit     | Drill             | default     | default            | -                | -              | DRL_21.65  |
| #10 | 0.026          | Drill bit     | Drill             | default     | default            | -                | -              |            |
| #11 | 0.0313 (1/32") | Drill bit     | Drill             | default     | default            | -                | -              | DRL_31     |
| #12 | 0.035          | Drill bit     | Drill             | default     | default            | -                | -              | DRL_39     |
| #13 | 0.047          | Drill bit     | Drill             | default     | default            | -                | -              | DRL_47     |
| #14 | 0.079          | Drill bit     | Drill             | default     | default            | -                | -              | DRL_79     |
| #15 | 0.1101 (3.0mm) | Drill bit     | Drill             | default     | default            | -                | -              | DRL_110    |
| #16 | 0.125 (1/8")   | Drill bit     | Drill             | default     | default            | -                | -              | DRL_125 #1 |
| #17 | 0.125 (1/8")   | Drill bit     | Drill             | default     | default            | -                | -              | DRL_125 #2 |
| #18 | 0.125 (1/8")   | Drill bit     | Drill             | default     | default            | -                | -              | DRL_125 #3 |
| #19 | undef          | "V" 30°       | Insulate & Rubout | default     | default            | default          | 3.5            | V_30       |
| #20 | undef          | "V" 45°       | Insulate & Rubout | 4500        | default            | default          | 6.5            | V_45       |
| #21 | undef          | "V" 60°       | Insulate & Rubout | default     | default            | default          | 5.8            | V_60       |
| #22 | undef          | "V" 90°       | Insulate & Rubout | default     | default            | default          | 4.0            | V_90       |
| #23 | 0.0313 (1/32") | Router bit    | Cut & Drill       | default     | default            | default          | -              | R_31       |
| #24 | 0.0394 (1.0mm) | Router bit    | Cut & Drill       | default     | default            | default          | -              | R_39       |
| #25 | 0.049          | Router bit    | All               | default     | default            | default          | -              | R_49       |
| #26 | 0.050          | Router bit    | Cut & Drill       | default     | default            | default          | -              | R_50       |
| #27 | 0.0984 (2.5mm) | Router bit    | Cut & Drill       | default     | default            | default          | -              |            |
| #28 | 0.1101 (3.0mm) | Router bit    | Cut & Drill       | default     | default            | default          | -              |            |
| #29 | undef          | "V" 90°       | Insulate & Rubout | default     | default            | default          | 4.5            |            |

After final entry of the parameters (of a new tool) or selection of existing one you have to click on "Select" button and this will transfer the description to the currently selected tool holder. Shown on the screen shot below.



This procedure have to be performed for each tool that is in the tool holders in order to be used in ATC mode. It may looks to complicated, but once your tool table contains all tools that are in use it takes just a few seconds to select the description for the particular tool holder. Shown below is ATC control panel with tools descriptions entered.



### 3. PCB material (work piece) fixing on the table

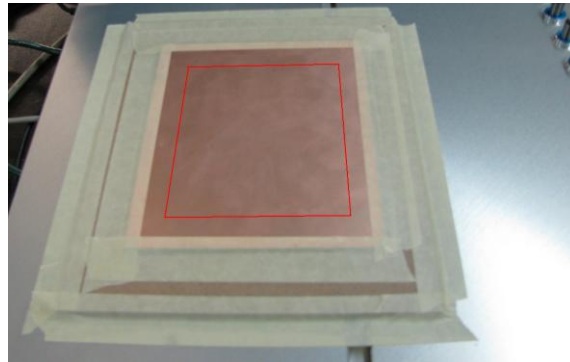
We offer 4 different ways of fixing (mounting) of the PCB and backing material on the machine table. The usage is related to the configuration (camera/microscope, vacuum holding table). The systems equipped with vacuum table may use all mounting options.

First of all we like to remind the operator that exact position of mounting the material (to be machined) is not important. The positioning match of the material and project can be synchronized later, moving/placing the project on the desired position over the material.

Below are the 4 ways of mounting

**1.** Taping all four sides of the backing material to the table, then taping all four sides of the material on the backing (can be used with camera option only).

- Advantages: easy, fast and inexpensive way
- Disadvantages: inserts positioning error that may exceed 1 mil (25 microns) in any directions due to the tape flex. Lost of usable surface due to the fact that the pressure foot (1" dia, 25 mm) don't have to go over the tape. Usable surface is inside the red rectangle shown below.



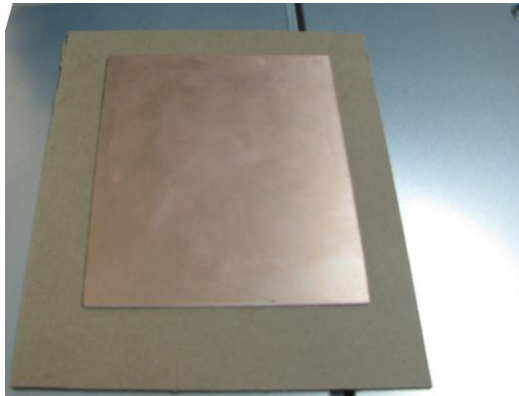
**2.** Using double sided (double sticky) tape to mount the backing material on the table and to mount the material (to be machined) on the backing material (can be used with camera option only).

- Advantages: No any kind of losses in accuracy. Behaves the same way as "Vacuum holding table". No lost surface of the material under machining (important when expensive RF materials are used). No need of relatively expensive vacuum table and generator. Significant savings in energy consumption. The most recommended for use.

- Disadvantages: Slightly more expensive tape is used.



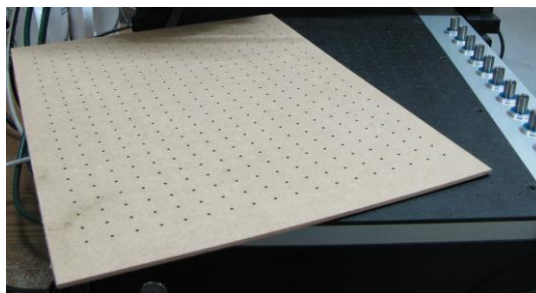
Shown above is application of 1/2 inch (~ 13 mm) tape. It should be placed on the bottom side of backing material and your work piece. Shown below is assembled stack. Entire surface of the PCB material can be used.



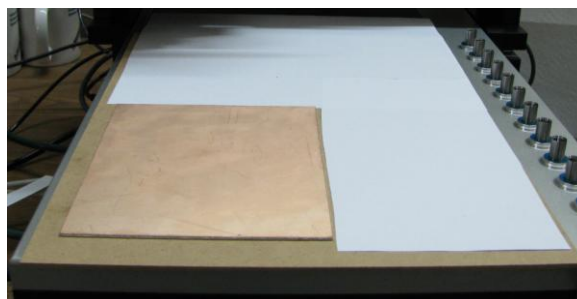
**3. Using vacuum holding table (can be used with camera option only).**

- Advantages: No losses in accuracy. The best way to handle very thin substrates down to 5 mil (0.12 mm).
- Disadvantages: More expensive configuration. Vacuum table and vacuum generator option need to be included in configuration. More energy usage during the operations due to constantly running vacuum generator.

Shown below is the predrilled backing material. Sample of it comes with the system. Also included in the PhCNC is automatic generation of G code for any size of backing material to be predrilled at needed pattern. Recommended hole size is 0.08 inches (2 mm). To create your backing material place two layers of it on the table and generate the needed G code for drilling.



Shown above is the pre drilled backing material. 2 small pins 1/16 (1.5 mm) needed to align the holes are included.



Shown above is mounted PCB material. You have to cover unused part of the table with standard printer paper. Minimum size of work piece is 10 square inches (64 square cm).

As shown below the optimum vacuum is 80 inches (2 meters) of water column. If it tends to go below 60 inches (1.5 meters) due to large openings in the project, the operator need to increase the speed of vacuum generator in order to get the needed vacuum. Vacuum column below 60 inches may cause moving of the work piece and unpredictable errors in the machined surfaces.



**4.** Using registration pins. This option is offered in all system (except these with vacuum holding table) as a second option for material installation.

- Advantages: strong "in position" holding. Recommended for (non ferrous) metals machining. No need of camera option. Saves about a minute needed for fiducial (optical) registration after board flip over.

- Disadvantages: less accurate compare to fiducial (optical) registration. Requires predrilled backing material and material under machining for the holes needed for the registration pins.

Once the material is mounted on the table it is needed to perform **Home Z** command. Place the milling head over your material and click on "**Home Z**" button. The reading from this procedure remains valid until the next "**Home Z**" procedure. In other words you need to repeat it only when you have change in the height of your stack (backing material + work piece).


In the video clip below you can see the procedures mentioned above.

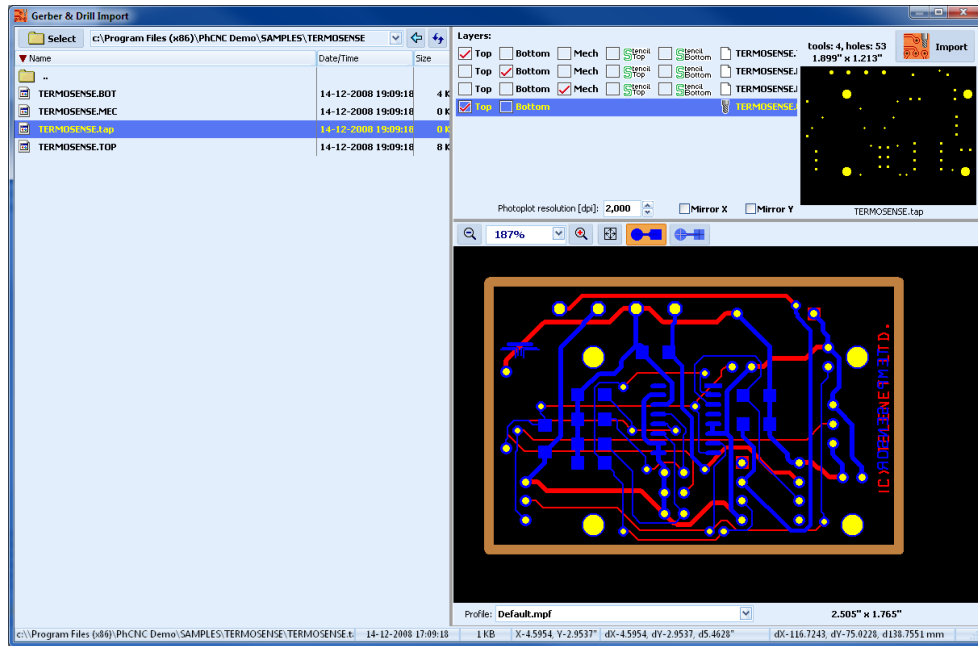
HomeZ & Placing Tool in Tool Holder Demonstration: <http://youtu.be/TRNha8g7z8Q>

## **4. Gerber and drill files import. Tools selection.**

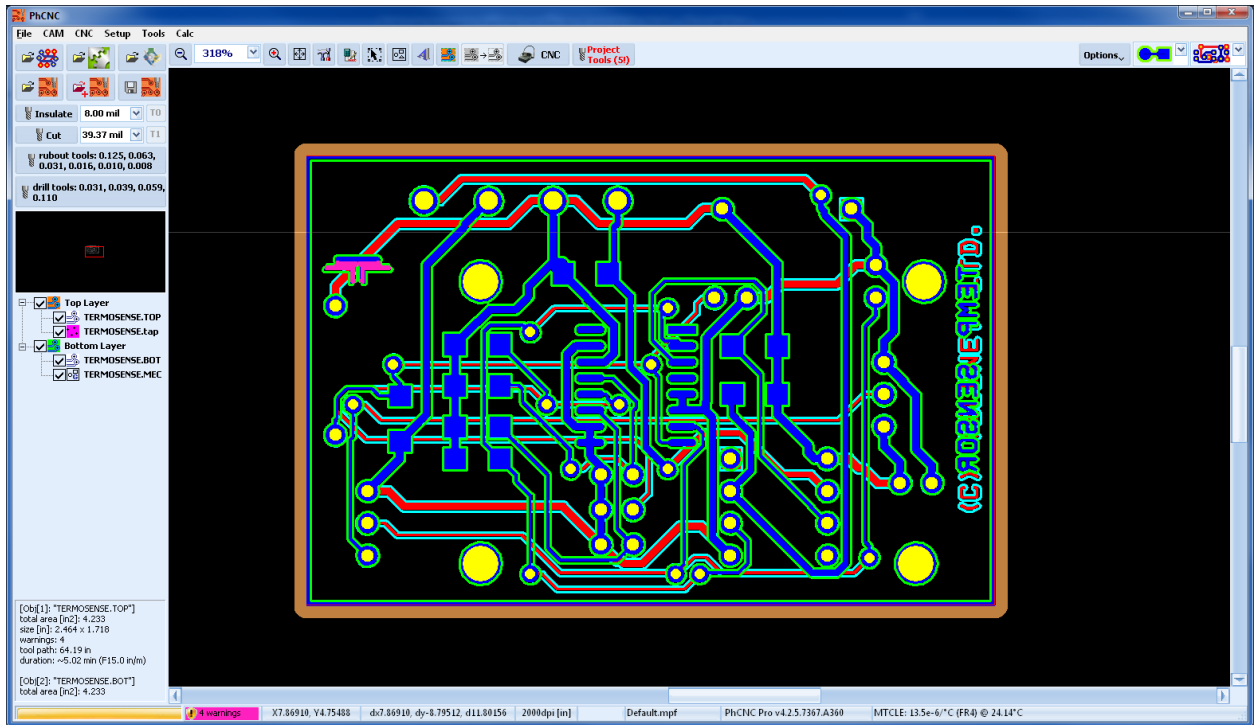
### **4.1 Gerber files import**

In order to create a board using our system you have to import the files generated from a PCB CAD system. Typically they are a set of a few files, containing all information that is needed for the complete description of the board. This set of files is the same that you have to send to the board shop in order to manufacture board(s) for you. Normally the set consist of Gerber files for TOP COPPER, BOTTOM COPPER, MECHANICAL for inside and outside cutouts and drill file in Excellon format. In order to start this

process you have to click on this button (CAM mode) . Shown below is a screen shot of this process. After you finish, click on "Import" button (upper right corner of the screen)




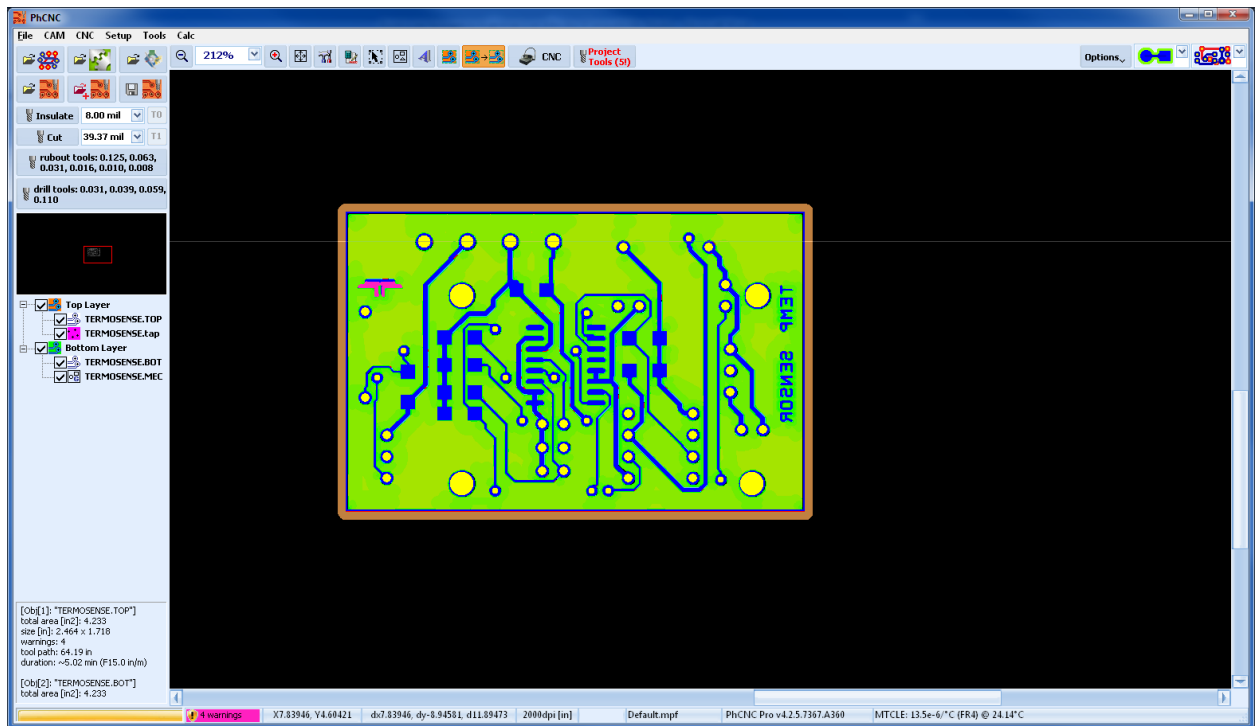
Shown below is the screen shot of the imported project in PhCNC:






## 4.2 Selecting the copper rubout region(s)

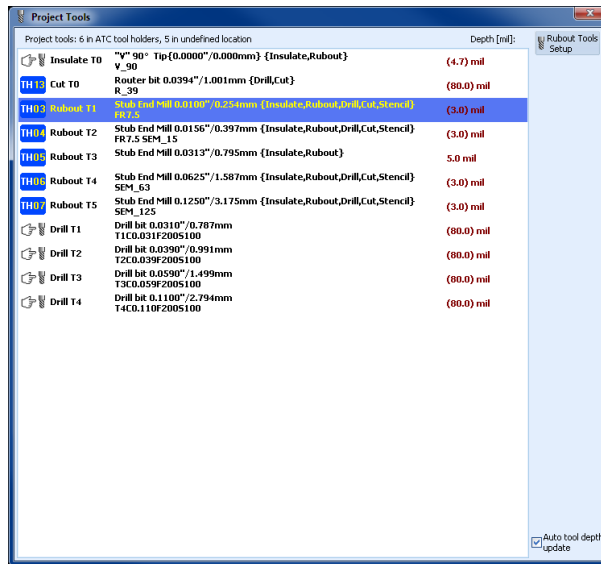
When complete copper removal is needed you have to select the region(s) to be treated. Common case is that the entire board surface is selected. You can have many different selections including different regions on top and bottom of the board. Number of selected regions is unlimited. For more details of this process turn to main manual. To start the selection click on this button . Using your mouse select the region(s).




This button  will show/hide the copper rubout region(s). The first click on it will initiate the tools paths calculations.

## 4.3 Tools selection


All tools in the project are listed in the Project Tools window. To see it click on .

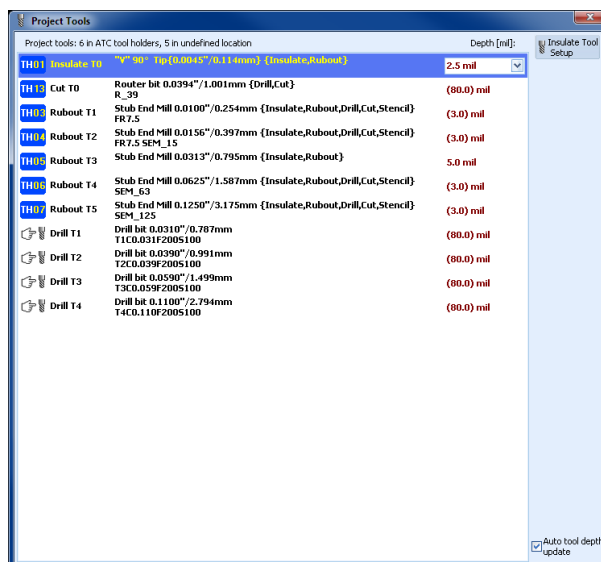


All tools that have a description matching the description of the tool located in a tool holder will be assigned to ATC process (ATC models only). For example **TH03**.

Tools that have this symbol  do not have the description that match the tool needed in your project and will require manual tool change during the machining process. If you think that the tool needed is already in a tool holder, simply review the description and find what is the difference that prevent the proper selection and correct it. In a classic case you will have differences only in small drill bits diameters. The best solution is to replace them in the tool holders and run fully automatic mode.

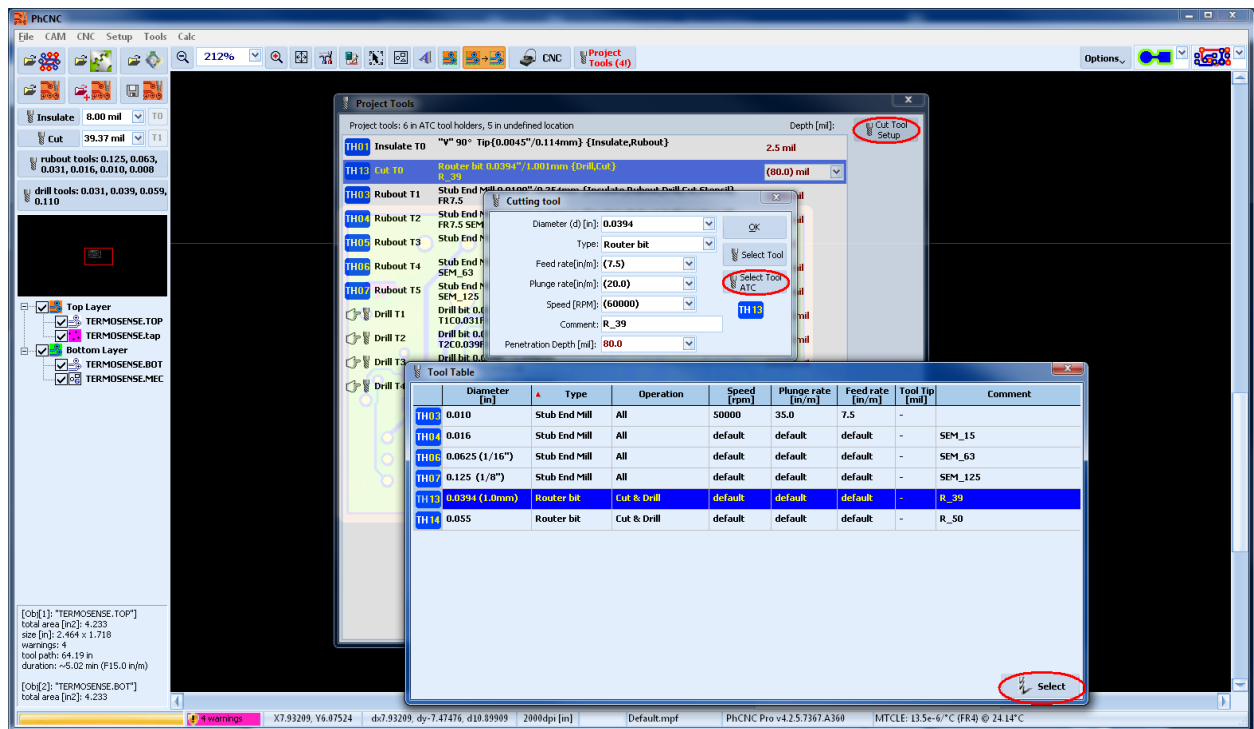
### 4.3.1 Insulation tool

You can select your insulation tool according to requirements of your project. Using the button . You can set the needed insulation tool and select it from existing in tool holders. In the example below it is located in TH01.



### 4.3.2 Cutting tool

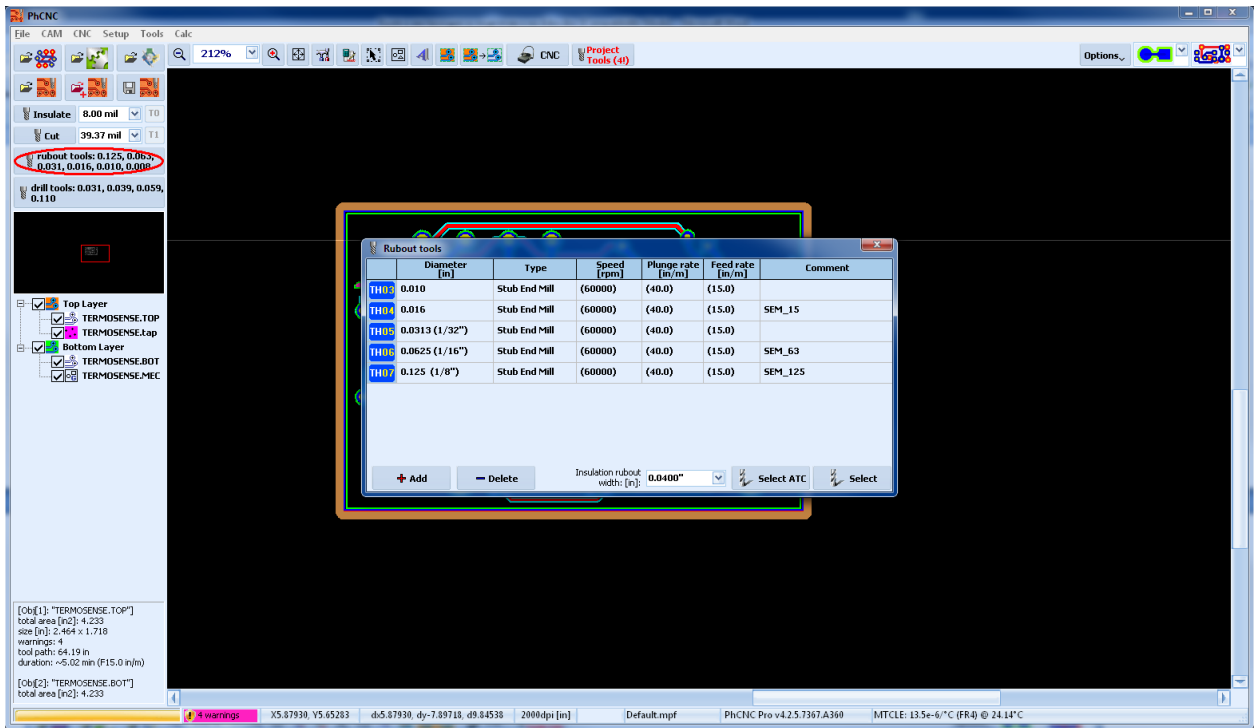
Similar to the insulation tool is the selection of the cutting tool. In most cases (when the project are coming from the same designer) these tools are permanent as a size and penetration settings.



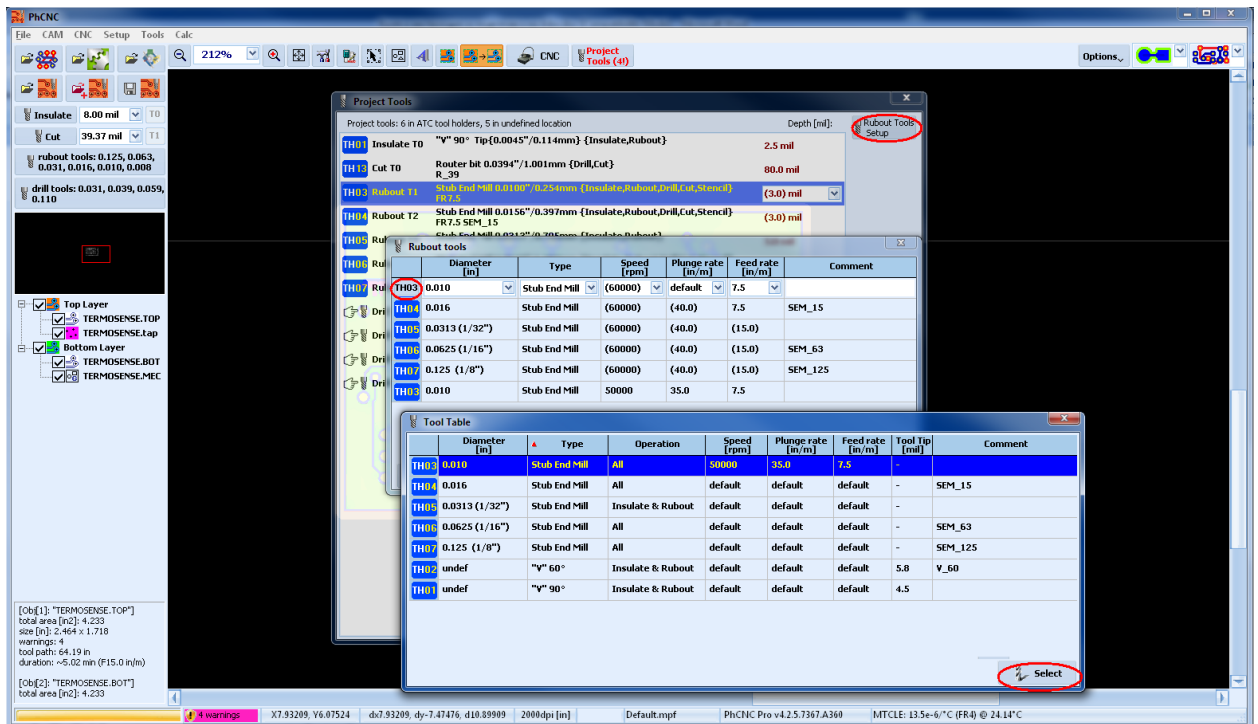
Selected cutting tool is located in TH13.

### 4.3.3 Rubout tools

If the project contains copper rubout region(s) the "Project tools" table will have them listed. They have to be changed in rare cases. The philosophy of the sizes can be described this way. First rubout tool is always the insulation tool. All other sizes are twice the diameter of the previous. This create a maximum efficiency in the process. In some cases (small size of surface to be treated) the larger tools can be eliminated. We are typically using (in addition to the insulation tool) the following sizes 15 mil, 32 mil, 62 mil, 125 mil. Any metric values similar to this will do the job fine. The only requirement is to enter the real diameters of the tools. This will allow the software to create the right tool pats for the process.



Rubout tools can be selected in the "Project Tools" table too.



### 4.3.4 Drill tools

During the import of a new project "Drill Tools Table" contains the diameters of the tools that are actually in your project.

| Drill Tool Table |           |               |           |             |                    |                  |                  |
|------------------|-----------|---------------|-----------|-------------|--------------------|------------------|------------------|
| #                | hole [in] | Diameter [in] | Type      | Speed [rpm] | Plunge rate [in/m] | Feed rate [in/m] | Comment          |
| #1               | 0.031     | 0.031         | Drill bit | (60000)     | (40.0)             | -                | T1C0.031F2005100 |
| #2               | 0.039     | 0.039         | Drill bit | (60000)     | (40.0)             | -                | T2C0.039F2005100 |
| #3               | 0.059     | 0.059         | Drill bit | (60000)     | (40.0)             | -                | T3C0.059F2005100 |
| #4               | 0.110     | 0.110         | Drill bit | (60000)     | (40.0)             | -                | T4C0.110F2005100 |

default router: T0 0.0394"/1.000mm Router bit 560000 FR7.5 PR20.0 R\_39

Apply default router tool    Select default router tool    Reset drill table    Select ATC    Select

It is necessary to select the tools needed for the project. In a classic case (when the project comes from the same designer) most of the drilling tools are already in the tool holders (ATC models). The option **Select default router tool** allow you to select a router bit to cut all holes that are larger than the bit diameter. This makes the hole diameter unlimited and saves on tools that you have to have at hand.

The screenshot shows the PhCNC software interface with the 'Tool Table' dialog box open. The dialog box contains a table with the following data:

| #  | Diameter [in]  | Type       | Operation   | Speed [rpm] | Plunge rate [in/m] | Feed rate [in/m] | Tool Tip [mm] | Comment |
|----|----------------|------------|-------------|-------------|--------------------|------------------|---------------|---------|
| #1 | 0.0313 (1/32") | Router bit | Cut & Drill | default     | default            | default          | -             | R_31    |
| #2 | 1.0394 (1.0mm) | Router bit | Cut & Drill | default     | default            | default          | -             | R_39    |
| #3 | 0.049          | Router bit | All         | default     | default            | default          | -             | R_49    |
| #4 | 0.055          | Router bit | Cut & Drill | default     | default            | default          | -             | R_50    |
| #5 | 0.0984 (2.5mm) | Router bit | Cut & Drill | default     | default            | default          | -             |         |
| #6 | 0.1101 (3.0mm) | Router bit | Cut & Drill | default     | default            | default          | -             |         |

The '1.0394 (1.0mm)' row is highlighted in blue. The 'Select' button at the bottom right of the dialog box is circled in red. Below the dialog box, the 'Select default router tool' button in the main software interface is also circled in red.

Shown below is the selection of 1mm (39.4 mil) router bit.

| hole     | Diameter | Type      | Speed   | Plunge rate | Feed rate | Comment          |
|----------|----------|-----------|---------|-------------|-----------|------------------|
| [in]     | [in]     |           | [rpm]   | [in/m]      | [in/m]    |                  |
| #1 0.031 | 0.031    | Drill bit | (60000) | (40.0)      | -         | T1C0.031F200S100 |
| #2 0.039 | 0.039    | Drill bit | (60000) | (40.0)      | -         | T2C0.039F200S100 |
| #3 0.059 | 0.059    | Drill bit | (60000) | (40.0)      | -         | T3C0.059F200S100 |
| #4 0.110 | 0.110    | Drill bit | (60000) | (40.0)      | -         | T4C0.110F200S100 |

default router: T0 0.0394"/1.000mm Router bit S60000 FR7.5 PR20.0 R\_39

Apply default router tool    Select default router tool    Reset drill table    Select ATC    Select

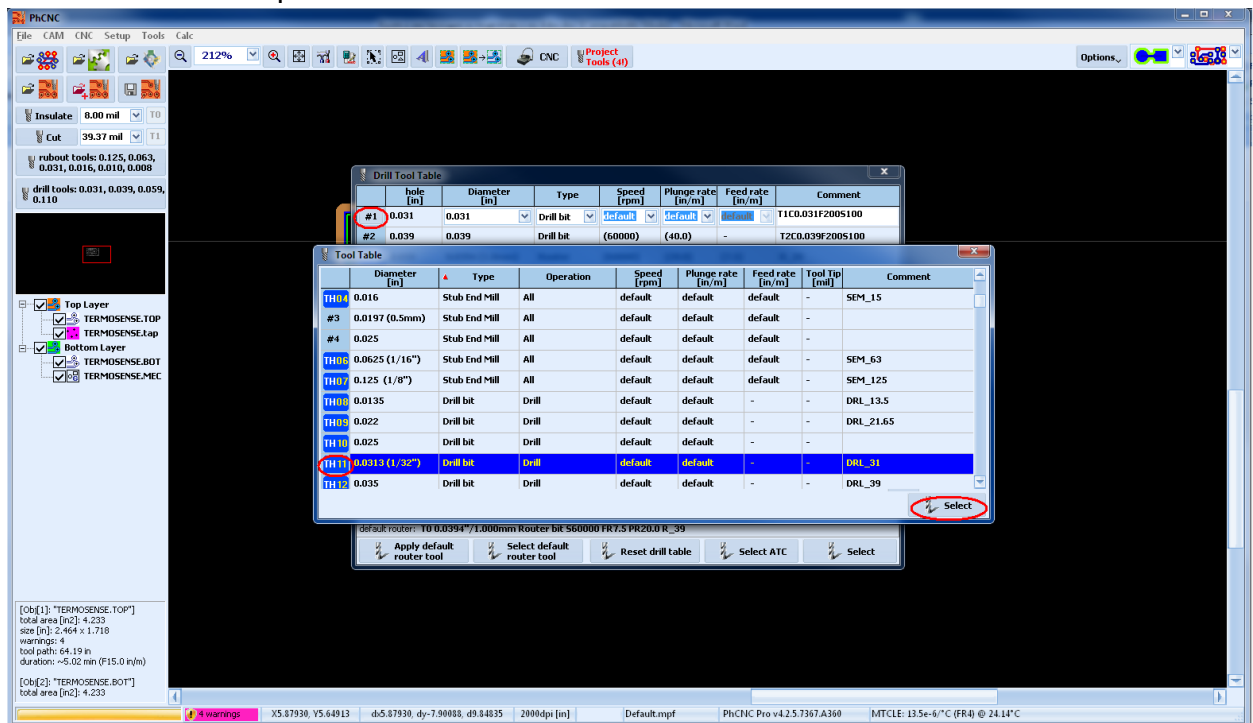
Clicking on the button  automatically sets the holes that have to be routed.

| hole              | Diameter       | Type      | Speed   | Plunge rate | Feed rate | Comment          |
|-------------------|----------------|-----------|---------|-------------|-----------|------------------|
| [in]              | [in]           |           | [rpm]   | [in/m]      | [in/m]    |                  |
| #1 0.031          | 0.031          | Drill bit | (60000) | (40.0)      | -         | T1C0.031F200S100 |
| #2 0.039          | 0.039          | Drill bit | (60000) | (40.0)      | -         | T2C0.039F200S100 |
| <b>TH10</b> 0.059 | 0.0394 (1.0mm) | Router    | (60000) | (20.0)      | (7.5)     | R_39             |
| <b>TH10</b> 0.110 | 0.0394 (1.0mm) | Router    | (60000) | (20.0)      | (7.5)     | R_39             |

default router: T0 0.0394"/1.000mm Router bit S60000 FR7.5 PR20.0 R\_39

Apply default router tool    Select default router tool    Reset drill table    Select ATC    Select

Shown below is an example of 31 mil drill bit selection from the main tool table.



The screenshot shows the PhCNC software interface. The 'Tool Table' dialog box is open, displaying a list of tools. The tool with diameter 0.0313 (1/32") is selected and highlighted in blue. The 'Select' button at the bottom right of the dialog is circled in red. The background shows the main software window with various tool settings and a project tree.

| hole                       | Diameter       | Type          | Operation | Speed   | Plunge rate | Feed rate | Tool Ttp | Comment   |
|----------------------------|----------------|---------------|-----------|---------|-------------|-----------|----------|-----------|
| [in]                       | [in]           |               |           | [rpm]   | [in/m]      | [in/m]    | [min]    |           |
| #1 0.031                   | 0.031          | Drill bit     | All       | default | default     | default   | -        | SEM_15    |
| #2 0.039                   | 0.039          | Drill bit     | All       | default | default     | default   | -        | SEM_15    |
| #3 0.0197 (0.5mm)          | 0.0197 (0.5mm) | Stub End Mill | All       | default | default     | default   | -        | SEM_53    |
| #4 0.025                   | 0.025          | Stub End Mill | All       | default | default     | default   | -        | SEM_125   |
| TH10 0.0625 (1/16")        | 0.0625 (1/16") | Stub End Mill | All       | default | default     | default   | -        | SEM_125   |
| TH10 0.125 (1/8")          | 0.125 (1/8")   | Stub End Mill | All       | default | default     | default   | -        | SEM_125   |
| TH10 0.0135                | 0.0135         | Drill bit     | Drill     | default | default     | -         | -        | DRL_13.5  |
| TH10 0.022                 | 0.022          | Drill bit     | Drill     | default | default     | -         | -        | DRL_21.65 |
| TH10 0.025                 | 0.025          | Drill bit     | Drill     | default | default     | -         | -        | DRL_21.65 |
| <b>TH10 0.0313 (1/32")</b> | 0.0313 (1/32") | Drill bit     | Drill     | default | default     | -         | -        | DRL_31    |
| TH10 0.035                 | 0.035          | Drill bit     | Drill     | default | default     | -         | -        | DRL_39    |

Next screen shot shows completed Drill Tool Table.

|      | hole [in] | Diameter [in]  | Type      | Speed [rpm] | Plunge rate [in/m] | Feed rate [in/m] | Comment |
|------|-----------|----------------|-----------|-------------|--------------------|------------------|---------|
| TH11 | 0.031     | 0.0313 (1/32") | Drill bit | (60000)     | (40.0)             | -                | DRL_31  |
| TH12 | 0.039     | 0.035          | Drill bit | (60000)     | (40.0)             | -                | DRL_39  |
| TH13 | 0.059     | 0.0394 (1.0mm) | Router    | (60000)     | (20.0)             | (7.5)            | R_39    |
| TH14 | 0.110     | 0.0394 (1.0mm) | Router    | (60000)     | (20.0)             | (7.5)            | R_39    |

default router: T0 0.0394"/1.000mm Router bit 560000 FR7.5 PR20.0 R\_39

Buttons: Apply default router tool, Select default router tool, Reset drill table, Select ATC, Select

### 4.3.5 Project Tools

After all tools used in the project are entered, the Project Tools table will be as shown below.

|      | Tool        | Parameters  | Depth [mil] |
|------|-------------|---|-------------|
| TH01 | Insulate T0 | "Y" 90" [w/ (0.00415" / 0.11 mm)] {Insulate, Rubout}                  | (2.5) mil   |
| TH10 | Cut T0      | Router bit 0.0394"/1.001mm {Drill, Cut}                               | (80.0) mil  |
| TH03 | Rubout T1   | Stub End Mill 0.0100"/0.254mm {Insulate, Rubout, Drill, Cut, Stencil} | (3.0) mil   |
| TH04 | Rubout T2   | Stub End Mill 0.0156"/0.397mm {Insulate, Rubout, Drill, Cut, Stencil} | (3.0) mil   |
| TH05 | Rubout T3   | Stub End Mill 0.0313"/0.795mm {Insulate, Rubout}                      | (3.0) mil   |
| TH06 | Rubout T4   | Stub End Mill 0.0625"/1.587mm {Insulate, Rubout, Drill, Cut, Stencil} | (3.0) mil   |
| TH07 | Rubout T5   | Stub End Mill 0.1250"/3.175mm {Insulate, Rubout, Drill, Cut, Stencil} | (3.0) mil   |
| TH11 | Drill T1    | Drill bit 0.0313"/0.795mm {Drill}                                     | (80.0) mil  |
| TH12 | Drill T2    | Drill bit 0.0350"/0.889mm {Drill}                                     | (80.0) mil  |
| TH13 | Drill T3    | Router bit 0.0394"/1.000mm {Drill, Cut}                               | (80.0) mil  |
| TH14 | Drill T4    | Router bit 0.0394"/1.000mm {Drill, Cut}                               | (80.0) mil  |

Project tools: 11 in ATC tool holders, 0 in undefined location

Buttons: Insulate Tool Setup, Auto tool depth Update

You can edit the tool penetration in the Project Tools table. Our recommendation is to use default values (shown in brackets) and if needed, on repeated basis, change the default values in order to save time during the setup.

Have in mind that penetration tool settings smaller than 3 mil do not work fine on all materials.

Basically this depend of the hardness of the substrate and the type of tool in use. For example, relatively soft (Teflon based) substrates, combined with non center cutting tools (all V tools), will yield down and will not remove the copper in some spots during the process of insulation.

Typical values of the tool penetration using 1/16 thick FR4 material are:

- insulation, 3-4 mil if end mill is used or calculated depth if V tool is used
- copper rubout, 3-4 mil
- drilling and routing 80 mil.

## 5. Project positioning on the work piece and machining

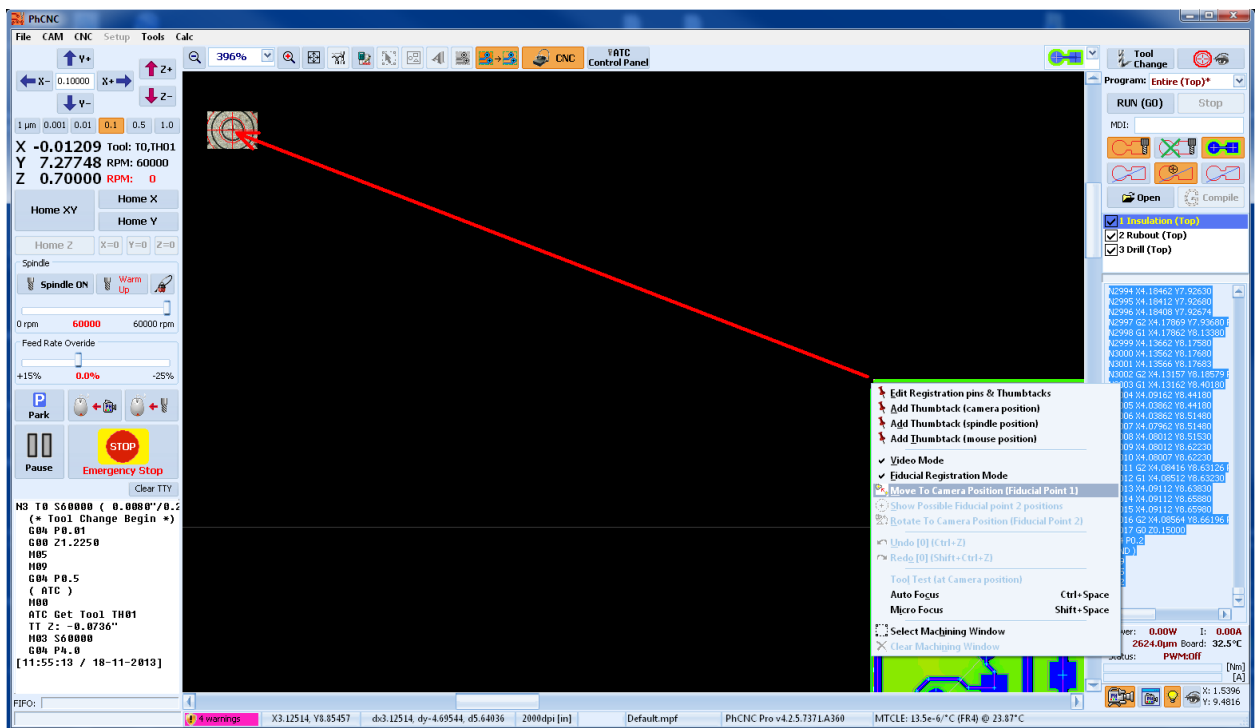
### 5.1 Project positioning

After all needed files are imported and the material is mounted on the machine table we need to position the project on the material.

The positioning of the project can be done many ways but the easiest and most accurate is to use fiducial registration with the machine camera.

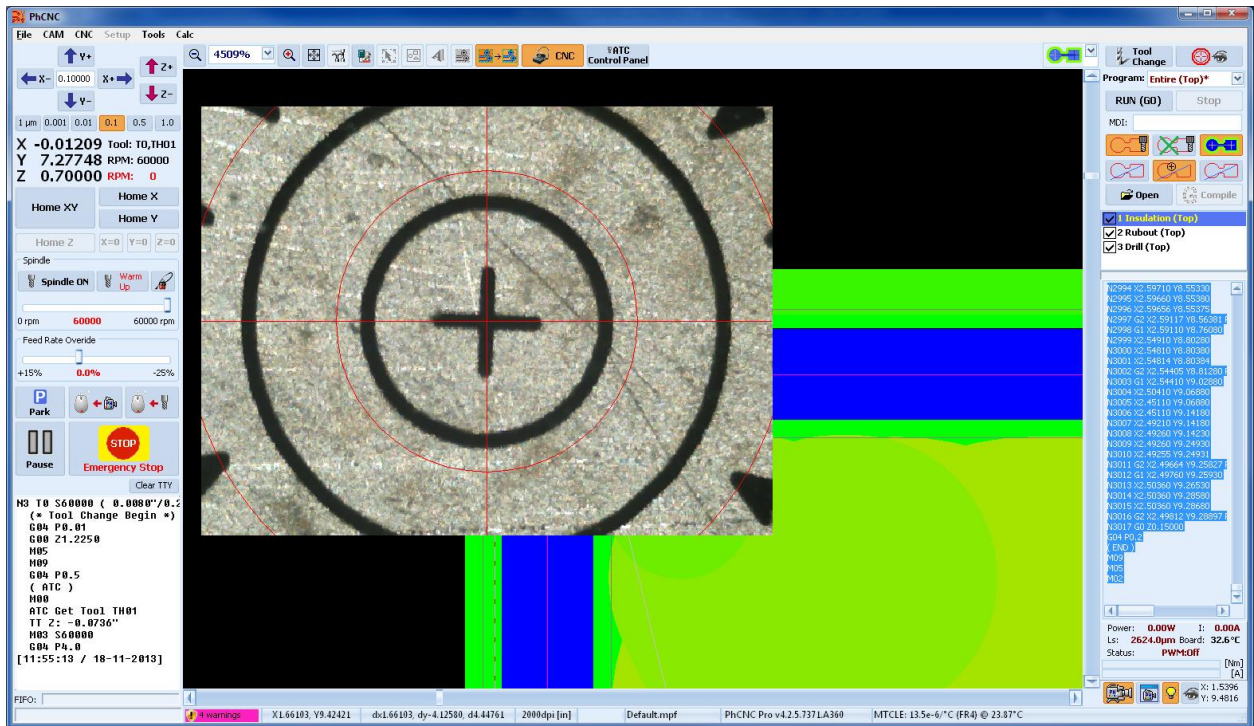
- place the center of the photo-tool (supplied with the system) on the upper left corner of the material. Recommended is to have 1/2 inch (12-13 mm) distance from the material edges. This will allow the pressure foot to be always on the material surface. It has 1 inch (25.4 mm diameter).

- turn the camera on and focus it on the photo tool
- find the photo tool center
- using the mouse find (zoom in as needed) the upper left corner of the project and make a right click.
- select "Move to Camera Position (Fiducial Point 1)" from the popup menu.



The upper left corner of your project now will move to the desired point. In the center of the photo-tool.





The project is now ready for machining.

In the video clip below are shown the operations related to the import of the project, project tools handling and project positioning.

Import Gerbers, Tool settings & Project alignment (video): <http://youtu.be/yTY14RifLRc>

## 5.2 Project execution (machining)

After all tools are arranged and the project is positioned on the material, we can start machining it. The process will be started after you click on **RUN (GO)**, it will execute currently selected process.

We will recommend you to use processing that links all programs related to the side under machining. For example "Entire Top". In a typical case it will run 3 process "Insulation top", "Rubout top" (if selected rubout region(s) exist) and "Drill top". After finish all it will wait for the operator to flip the board. After flipping the board and performing the fiducial registration for the bottom side you can select "Entire bottom". It is recommended to use center of the table to have the project registration holes for camera access.

In the video clip below you can see the process of fiducial registration between top and bottom sides of the board. This system of the registration between the board (layers) is many times more accurate than any mechanical registration.

Fiducial registration (video): <http://www.youtube.com/watch?v=aGGKzJjflwU>

---

**Accurate CNC, Inc.**

6016 A. High View Dr,  
Fort Wayne, IN 46818  
USA

**Phone:** +1 (260) 489-7600

**Email to:** [support@accuratecnc.com](mailto:support@accuratecnc.com)  
[phcnc@accuratecnc.com](mailto:phcnc@accuratecnc.com)

**Web:** [www.accuratecnc.com](http://www.accuratecnc.com)

**Business hours**

Monday- Friday: 8AM-5PM EST

Saturday: 9AM-2PM EST