FGPCNC 3-Axis Cooper Series user manual

Safety

Personal Safety - An Important Issue

Safety is always the number one priority – especially when dealing with hefty automated machinery. Please make sure that you are familiar with your machine and its tools, as well as the material you are working on. Failure to be knowledgeable may result in serious personal injury, damage to the machine or even to your shop. Common sense and adequate CNC knowledge will be your greatest defense.

a) Personal Clothing and Jewelry: Loose clothing or long hair must be kept away from any part of the machine. Make sure to keep sleeves away from translating and rotating components, especially machine gears, belts and the router bit. Frayed clothing, tie straps on shop aprons, and gloves are especially dangerous; you must be aware of these at all times and should cut them short, or tuck them out of the way. Long hair should be tied back at all times. Jewelry has absolutely no place in the workshop. Watches, bracelets, and necklaces may get caught in the

machine or in the tool bit. Make sure that under no circumstances is any part of your body or any foreign items (such as extra router bits, pens, screw heads, or tools) in the tool path while the machine is running.

b) Ears/Facial Protection: Eye protection is mandatory! Safety glasses or a face shield must be used at all times as spraying material is normal during machining operations. Appropriate measures must also be taken to protect your ears from the loud noises produced by normal operation of the machine, otherwise permanent hearing damage may occur. Others who work near the machine should also wear ear protection while the machine is under operation.

d) Air Quality: When cutting certain materials, particles and gasses may be released and become airborne. Many materials are carcinogenic and/or toxic and will be inhaled by the operator and surrounding persons unless the proper precautionary measures are taken. Adequate ventilation is always required prior to operation of the machine. Secondarily, face masks, re-breathers, or respirators may be required, especially when working with foam and plastic materials. Verify that face masks and respirators are suitable for the particles and gasses that will be emitted by the materials being machined. Misting systems may spray dangerous chemicals or coolants into the air; these must not be inhaled. Never use flammable or corrosive liquids in a mister or a sprayer.

Before Running the Machine
a) Inspect the Tool Bit: Before starting any job, a visual inspection of the machine and the tool bit should be performed. Any tool that is damaged or worn must be replaced before using the table. Pay particular attention to the use of carbide bits as they may shatter when damaged.
b) Use the Proper Tool: Each material requires use of the correct tool bit. Incorrect selection of the tool bit may result in damage to bit, motor, and/or material; tool failure may cause personal injury or the operator or persons in the surrounding area.
c) Keep an Organized Workspace: Always ensure the operator's area is clear. Remove unused material and secure wires, hoses, and cords from operator's area. Inspect cords for proper connections and damage.
d) Be aware of material camping devices: Before starting any job, familiarize yourself with the location of any clamps or screw heads being used to fasten the material to the table surface. Collision between camps or screw heads will almost always destroy the tool, and may lead to personal injury.

The FGP Controller Interface

Overview of the Interface
FGP controller runs on Mach3 back-end engine. The software includes a ton of features and an easy to use controller system for CNC routers. Mach3 works on most Windows PC's to control the motion of motors (stepper & servo) by processing G-Codes. While comprising many advanced features, it is the most intuitive CNC control software available. Mach3 is customizable and has been used for many applications with numerous types of hardware.

Some basic features

- Converts a standard PC to a fully featured, 6-axis CNC controller
- Allows direct import of DXF, BMP, JPG, and HPGL files through CAM software
- Visual G-code display
- Generates G-code via Wizards
- Fully customizable interface
- Customizable M-Codes and Macros using VBscrip
- Spindle Speed control
- Multiple relay control
- Manual pulse generation
- Video display of machine
- Touch screen capability
- Full screen ability

System requirements

Requirements if using the parallel port for machine control:

- Desktop PC (Laptops are <u>not</u> supported) with at least one parallel port
- **<u>32-bit</u>** version of Windows 2000, Windows XP, Windows Vista, or Windows 7 (64-bit versions will <u>not</u> work)
- 1Ghz CPU
- 512MB RAM
- Non-integrated Video Card with 32MB RAM*(Large G-code files, especially 3D files will require a video card with 512MB RAM or higher)*

Requirements if using an external motion device for machine control:

- An appropriate external motion controller (options can be found on the Plugins page)
- Desktop or Laptop with Windows 2000, Windows XP, Windows Vista, Windows 7, or Windows 8
- 1Ghz CPU
- 512MB RAM
- Video Card with 32MB RAM*(Large G-code files, especially 3D files will require a video card with 512MB RAM or higher)*

Main Screen
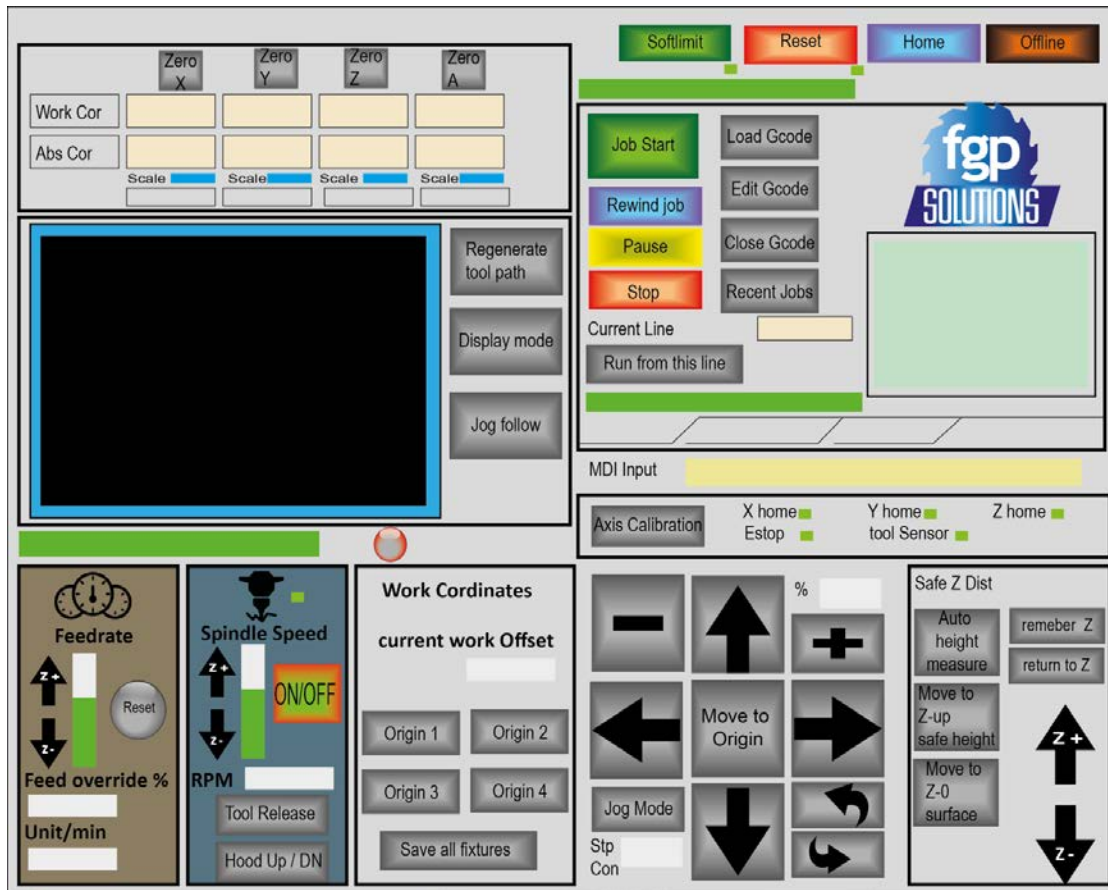
The controller interface is designed to be intuitive, for operators with varying levels of experience, by employing a windowed graphical environment. All buttons are given descriptive labels or

graphical symbols for improved simplicity. You will find that FGP is not only an easy system to use but also a very powerful one.

Main control

Main control is area to pay close attention to. It is in fact the place where operator must start everything.

- **Reset:** it is a software Estop as well as a reset to natural state of software. When first open Mach controller rest is active. On display bar message "…Press Reset, Emergency Mode Active …" is shown. Operator must press Reset in order to operate machine.
    - o **Note:** if hard stop is pressed Reset could not be released. Hard stop must be released first before software reset.
    - o **LED:** If in reset state green LED becomes active. Once released LED turns off
- **Home:** reference all axes to machine zero. Machine zero is a stationary point in machine set by factory. Machine needs to be homed every time after power ON.
    - o **LED:** three LED indicators are for X, Y, Z axis. Before any operations ensure 3 LED lights are ON.
- **Softlimit:** Softlimit or machine limits are set by factory and represent machine effective work area. Turning softlimit ON, limits machine movements within effective work area

boundaries. If softlimit is OFF then it is possible machine runs off beyond limits and crash to mechanical stops. Generally softlimit should ALWAYS stay ON.

- **Offline:** "disconnects" all the output signals of Mach3. This is intended for machine setup and testing. Its use during a part program will cause you all sorts of positioning problems.

Jog Keys
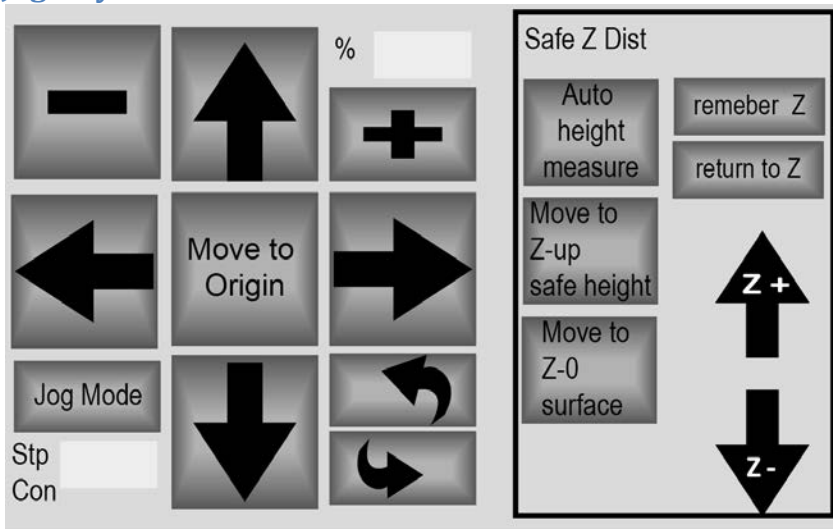
The FGP machine can be jogged through, arrow shaped, Jog keys found on the FGP main screen. Clicking and holding the arrow shaped jog keys will position the machine in the direction corresponding to that of the Jog key pressed. Units are either inches per second or millimeters per second depending on machine setting.

- **Arrow keys:** Pressing and holding on the UP/Down or Right/Left keys will move the machine in the corresponding XY axis.
- **Turning arrows:** This is typically used on a 4-axis machine for rotary axis. Not enabled on 3-axis models.
- **+/-:** To reduce and increase percentage of jog rate that is set by factory. Percentage display on right
- **Move to origin:** moves machine to X, Y, Z coordinates set on fixtures. For more details see work coordinates
- **Jog Mode:** pressing jog mode toggles between continuous and step jogging. Display on the right shows units of step jog. User can also click display and enter the jog unit. i.e. 0.5 inch per step
- **Auto height measure:** this feature automatically lowers Z-axis until the cutting bit inside the spindle touches the tool probe. Once the tool probe is detected, Z-axis retracts and Z-zero is set. Z-zero is the top of material being cut.
- **Move to Z-up:** moves Z axis to safe Z distance. Save Z is set at config→safe Z setup.
- **Move to Z-0 surface**: moves Z axis to Z-0, this is where the cutting bit touches top of material
- **Remember Z & Return to Z**: these two functions are used to store the position of Z axis and return back to it. This function is useful when stopping a job in the middle, storing the current position on Z-axis, and later returning to the same cutting height.

Work coordinates

Work Cordinates

current work Offset

| Origin 1 | Origin 2 |

| Origin 3 | Origin 4 |

Save all fixtures
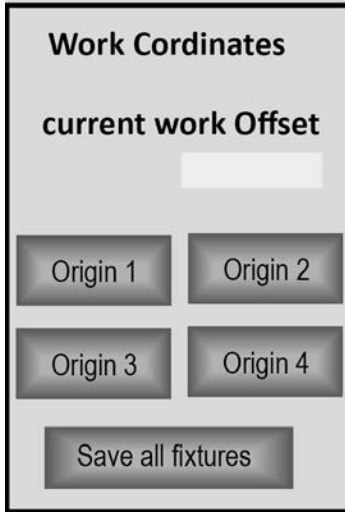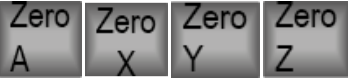
Coordinates or fixtures are job starting points. Normally referred to as G54, G55, G56 and so on, these coordinates are the 0, 0, 0 point where a job initiates. Work coordinate is different from machine coordinate in a way that machine coordinate is a stationary point determined by machine sensors and cannot be changed. Work coordinate on the other hand could be set on different points on the CNC table as required by the operator.

FGP uses 4 coordinate systems on the main user interface screen. Operator could use additional fixtures by going to Config → Fixtures where he has access to 200 unique coordinate points.

Most operators use G54 as the main starting point to run a job.

 In order to set G54:

- click on Origin 1 (Display on top right shows active work offset)
- Jog or command machine to X,Y,Z position where you want to start a job

- Once on desired position, zero all axis by pressing Zero A Zero X Zero Y Zero Z
    o Note: if machine does not have rotary axis, you do not need to Zero A-axis.
- You can follow same procedure to set up other work origins.

Coordinate system DRO

	Zero X	Zero Y	Zero Z	Zero A
Work Cor				
Abs Cor				
	Scale	Scale	Scale	Scale
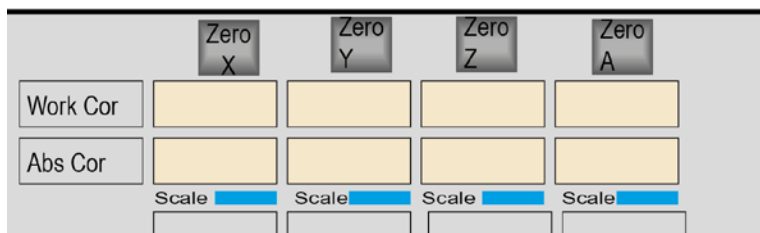
FGP controller, like all machine controllers, allows you to move the origin of the coordinate system or, in other words where it measures from (i.e. where on the machine is to considered to be zero for moves of X, Y Z etc.) This is called **offsetting** the coordinate system.

FGP interface displays two different coordinate systems:

Top work coordinate systems displays machine position relative to work offset (G54, G55, G56, and so on...)

Second row displays machine coordinate systems in relation to machine home position. This is the absolute coordinate based on where machine home is set by the manufacture.

- **Zero X, Y, Z, A:** pressing zero will set current location of the machine as work coordinate. Operator needs to press X, Y, Z, A one by one to set them to zero point.

Spindle Speed and Feedrate
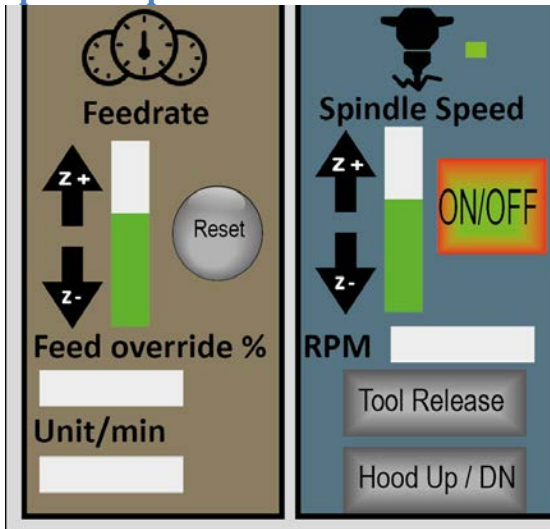
Both spindle speed and feed rate are used to override cutting speeds set through CAM software.

Feedrate screen

The Prog Feed DRO gives the feed rate in current units (inches/millimeters per minute). It is set by the F word in a part program or by typing into the F DRO. This speed as the actual rate of the coordinated movement of the tool through the material. If this rate is not possible because of the maximum permitted speed of any axis then the actual feed rate will be the highest achievable.

- **+ / - :** Increase and decrease set speed
- **Green scroll:** is used to drag speed up and down (same function as + / -)
- **Reset:** to reset feedrate to pre-set value programmed by CAM

Spindle Speed

- **+ / - :** Increase and decrease set speed
- **Green scroll:** is used to drag speed up and down (same function as + / -)
- **ON /Off:** manually turn spindle ON/OFF (Green LED indicator on top shows status of spindle)
- **Tool release:** Only for machines with ATC (auto tool change) releases tool currently holding
- **Hood Up/DN:** Only on ATC machines, moves dust hood up and down
- **Tool# display:** indicates current tool holding. If 0 then machine does not know tool # it is holding. User must manually enter valid tool number.

Job control
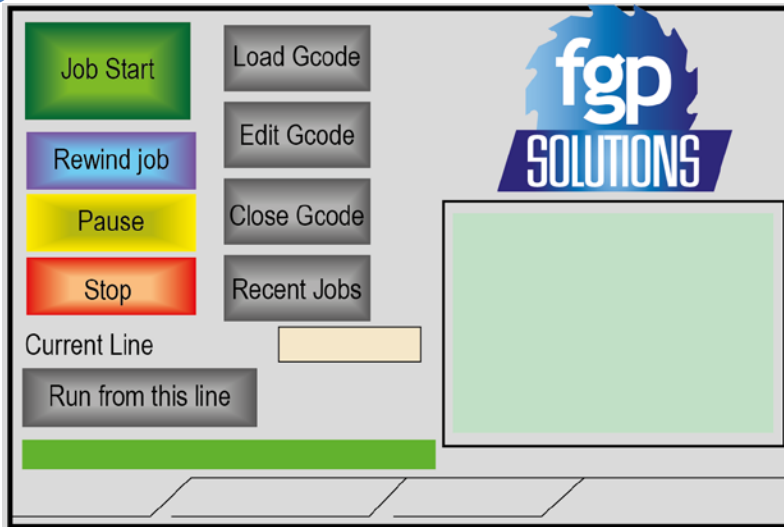
Job control handles all features related to loading and running jobs.

- **Load G-code:** loads G-code file into machine. (Review G-code in this manual for more info)
- **Edit G-code:** Allows onscreen edit to G-code text file. After each edit, operator must *save* file for it to take effect.
- **Close G-code:** Closes currently active G-code file. In order to fully stop operation on files and for safety it is highly recommended that if not running a job with an operator present, **close active G-code files.**
- **Recent jobs:** Functions similar to job queue, recent jobs opens all files that have recently been loaded into machine memory.
- **Cycle Start (Job start):** start the job that is currently active It is good practice for a part program to make no assumptions about the state of the machine when it starts. It should therefore include 17/G18/G19, G20/G21, G40, G49, G61/G62, G90/G91, and G93/G94. Mach3 controls and running a part program Rev 1.84-A2 6-17 Using Mach3Mill You should ensure that the axes are in a known reference position - probably by using the *Ref All* button. You need to decide whether the program starts with an S word or if you need to set the spindle speed by hand or by entering a value in the *S* DRO. You will need to ensure that a suitable feedrate is set before any G01/G02/G03 commands are executed. This may be done by an F word or entering data into the *F* DRO. Next you may need to select a Tool and/or Work Offset. Finally, unless the program has been proved to be valid you should attempt a dry run, cutting "air" to see that nothing terrible happens.
    1. Check the status bar to ensure that the correct file name is loaded
    2. Check G-code display on right to ensure job is on its first line of code. Very important to have first line of G-code selected. Machine could act random if it is running from middle of a job!
    3. Check work coordinates and set X,Y,Z zero points (G54)
    4. Have an operator stand by near E-stop
    5. If everything is a go, press Cycle Start (Job start) to initiate
- **Rewind job:** Rewinds G-code to first line. If for some reason program was stopped in the middle of operation G-code does not automatically return to first line of code. User MUST rewind to first line of code to avoid accidents.

- **Pause:** To pause job with spindle ON and machine holding it's X'ING, Y, Z position. Pause is a temporary hold on operation and is not recommended for long delays. To resume pause press *Job start* again.
- **Stop:** completely stop execution of the job. If safe Z is set up (Config → safe_Z) then Z-axis would retract to safe Z point.
- **Run from this line:** very handy function for running big jobs and returning to where operation was stopped. This feature runs from any selected line of G-code. *Run from here* performs a dummy run of the part program to establish what the modal state (G20/G21, G90/G91 etc.) should be and then prompts for a move to put the controlled point in the correct position to for the start of the line in *Line Number.* You should not attempt to *run from here* in the middle of a subroutine.
  1. Load G-code
  2. Left click on the G-code display screen (Display screen background turns light green)
  3. Scroll down to position where you want to start the program. As scroll through G-code corresponding machine operation is displayed simulation window.
  4. Once on correct line of code press *Run from this line*
  5. Note on the status bar (left side, under simulation window) asks "Press CycleStart for preparation move. Check spindle"
  6. Press Cycle start. New window pop up showing X, Y positions. Also below check mark to "start spindle". Press OK
  7. Status bar again displays message "Press CycleStart to execute from here". Now press Cycle start once again

Job simulation (tool path display)
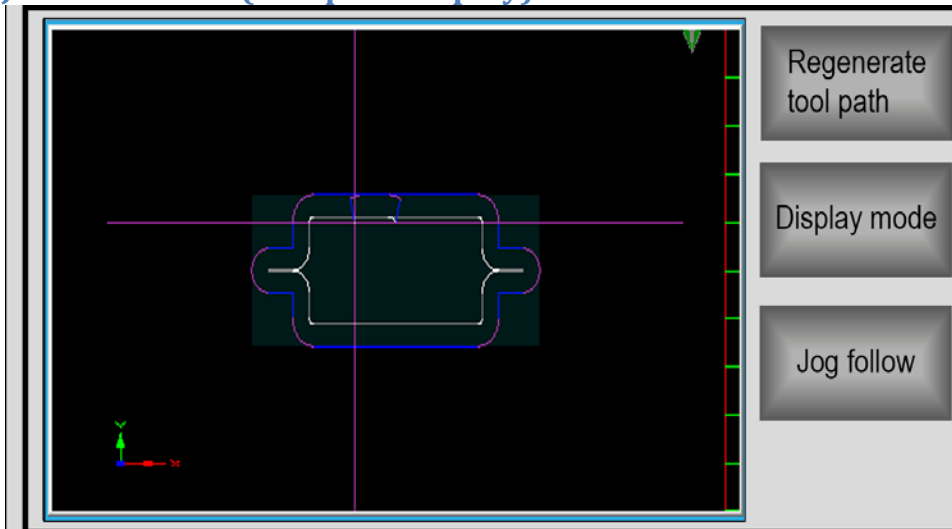
The currently loaded part program is displayed in the G-code window. The current line is highlighted and can be moved using the scroll bar on the window. The Tool path display shows the path that the controlled point will follow in the X, Y, Z planes. When a part program is executing the path is over painted in the color selected in Config>Toolpath. This over painting is dynamic and is not preserved when you change screens or indeed alter views of the toolpath. On occasions you will find that the display does not exactly follow the planned path. It occurs for the following reason. Controller prioritises the tasks it is doing. Sending accurate step pulses to the machine tool is the first priority. Drawing the tool path is a lower priority. Controller will draw points on the toolpath display whenever it has spare time and it joins these points by straight lines. So, if time is

short, only a few points will be drawn and circles will tend to appear as polygons where the straight sides are very noticeable. This is nothing to worry about. The *Simulate Program Run* button will execute the G-code, but without any tool movement, and allow the time to make the part to be estimated. The *Program Limits* data allow you to check the maximum excursion of the controlled point to be reasonable (e.g. not milling the top off the table). The screenshot also shows axis DROs and some Program Run controls. If you have defined softlimits which correspond to the size of your machine table then it is often useful to use the *Display Mode* button to toggle from Job to Table mode to show the toolpath in relation to the table.

The toolpath display can be rotated by left clicking and dragging the mouse in it. It can be zoomed by shift-left clicking and dragging and can be panned by dragging a right click. The *Regen*erate button will regenerate the Toolpath display from the G-code with the currently enabled fixture and G92 offsets. **Note:** It is very important to regenerate the Toolpath after changing the values of offsets both to get the correct visual effect and because it is used to perform calculations when using G42 and G43 for cutter compensation.

- **Regenerate Toolpath:** regenerates Toolpath display onscreen. Every time display mode changes operator needs to regenerate Toolpath as well
- **Display Mode:** toggles display between full table and work offset display
- **Jog Follow:** Display follows tool head. Jog follow demands much more computing power from PC and might cause glitch in running jobs on slower PC.

Quick Start Guide

Machine power ON

1. Turn main switch ON
2. Turn PC ON
3. Release E-stops
4. Press controller green start button to enable all drives

Software start

1. Press reset to release software stop
2. Home machine on all axis
3. Turn Softlimit ON if not already
4. Enter tool number currently loaded into the spindle
5. Set work origin #1 (X,Y,Z)
   a. Can use Auto Z to set Z value for work origin
6. Load Gcode
7. Check job screen to ensure correct job is loaded
8. Ensure job is reminded to first line of code
9. Move Z to a safe height
10. Press Cycle Start to run the job (On new jobs always stand by E-stop for emergencies)

Setting up Auto Z0 (Auto height measure)

Auto height detects top of work piece to set as zero point for Z axis. Therefore, if material top is 0 point of Z then all cut values are a negative number. Simply place tool sensor on top of material

and under spindle head and press "Auto height measure". Script for auto height measure slowly lowers spindle head until tip of tool touches tool sensor. Once complete Z axis moves up to a safe distance and G54 value for Z is zeroed.

Manual tool change

Manual tool change as the name suggests refers to running a job and manually loading desired tools. There are two methods of operation:

Single tool

Single tool ignores all tool change commands and treats every tool as tool #1. This means even if a Gcode program calls for an M6 command, the controller ignores this and continues without any pause.

Semi ATC

In this setting, M6 command is active and every time a tool change is requested controller pause and asks operator to change tool and then press CycleStart "Job start".

To activate this mode go to config →General Config → Tool change section and activate "Spindle stop and wait for cycle start".

Note: on manual tool change machines after a new tool is placed in Z0 value changes and tool length need to be compensated manually by the operator.

Collets and spindle wrench

- Most spindles under 5KW of power rating use ER25 collet size and if more than 5KW ER32 collet size. If not sure check with FGP rep.
- To open and close tool ER25 collet wrench and #27 wrenches are required.

Auto tool change

Auto tool change function enables operator to run a job using various tools. Most of FGP routers are designed for six position tool changer but it is possible to have more as an add-on option. FGP equips machines with standard HSD or HSD compatible spindle heads. Quick-change air-cooled spindles are ideal solution for machining of wood, aluminum and plastics. The spindles are characterized by their extremely high reliability and the wide range of powers and operating speeds. Most FGP spindles are rated between 5-7KW and 18,000 to 24,000 RPM. The declared power ratings are guaranteed during continuous service, while the power available for machining can be up to 100% higher during discontinuous operation.

Tools holders, collets and wrench

- All auto tool change spindles provided by FGP are ISO30 taper
- Collet size ER32
- And ER32 spindle wrench is required to open and close tools

Setting tool position

Tool change runs on M6 script which is found under Mach3, macros folder. M6 script commands which procedures need to take place every time an M6 code is executed.

To open this script and make changes:

1. On main controller screen go to Operator top menu and select VB script editor
2. Navigate to C:\Mach3\Macros folder and select appropriate profile (i.e. FGP)
3. Select M6start and open this file
4. Anytime script is changed make sure to *save* all the changes before closing.

Once this file is open scroll down to middle of the page, where you find X, Y coordinates of six tool forks.

'INITIALIZATION OF VARIABLES
SafeZ=0
Z_Down=-236
ForkOffset=130
ToolX1=366.49
ToolY1=3372

Here you can modify X, Y coordinates of each tool fork to match your machine settings. To acquire the exact coordinate for tool forks
1. Load a tool into the spindle head
2. Jog to back of table where tool rack is located
3. Using hand held pendant slowly jog tool holder back into tool fork
4. Make a note of absolute machine coordinates
5. Enter these coordinates for whichever tool position you are editing.
6. Save and close M6start file.

Test run ATC

Auto tool change command is generated with CAD/CAM software. Each time there is a tool change in the program an M6 code is generated. For instance if tool 1 is used to do rough passing and tool 2 for clean pass then your code would look like:

M6T1
G01 X….
M6T2
G01 ….

To test auto tool change function manually you can use MDI feature. Click on MDI input bar to activate it and type M6T1 (this command will try to grab tool 1 from tool fork)

Warning: Before running any tool command ensure machine knows the current tool it is holding and also tool that you want to grab is available in tool bar.

Machine operation

Work piece setup, vacuum and rigid fixtures

FGP CNC router systems are extremely versatile production centers, with literally unlimited possibility for the types of operations that can be performed in a wide verity of materials. With each material or operation there will be a method of securing the material that will more appropriate than another. This securing of the material is known as fixturing and it is often more important to consider the method of fixturing for production than the actual production its-self. The quality of the fixture is the largest contributing factor in the quality, success and profitability of a job; unfortunately, there is no universal fixture.

In CNC router production there are fixtures that are more common than others. This generally due the size of materials that are processed, and the types of industries that CNC routers better cater. The most common fixtures used with CNC routers are: vacuum platen, vacuum pods, and rigid fixtures. The vacuum platen is the most common fixture for CNC routers, as it is the easiest to use. However, vacuum platens are somewhat restricted to securing flat sheet material as the effective of the vacuum is proportional to the size of the sheet; larger is better. The quality of hold will be reduced as more cuts are made, creating more vacuum leakage. **Vacuum platens may not be effective on small or complex parts with low vacuum area. Some methods to improve this would be onion layering and using work piece tabs.**

Vacuum pods are very effective on small work pieces as a large amount of vacuum can be delivered to a localized area. Vacuum pods may not be effective on large work pieces as the small points of contact may not preserve the flatness of the material being cut; this is especially the case in sheet materials. However, with rigid materials, vacuum pods can be the ideal compromise between ease of use and hold.

Rigid fixtures are the most effective way to secure material or a piece, in terms of securing strength, but also require the most thought in their design and must often be custom manufactured for each particular job. Rigid fixtures do not use any vacuum, they secure the material though the use of camps or threaded fasteners. They can be as simple as screwing the material to platen sacrificial, or as complex as one can imagine.   If the job requires a large amount of repetitive, work rigid fixtures are almost always the best solution.   A well designed rigid fixture will incorporate index features, so each iteration of the repetitious job can be performed without manually resetting the job origin. Rigid fixtures are most effective in the fixturing of irregular shapes, and is usually preferred in the cutting of non-ferrous metals and hardwoods due to the greatly increased cutting loads.

As you become more familiar in the use of the machine, there will be times where combinations of the above common fixtures may be used to maximize the simplicity, holding power, and cycle time of the jobs. Common examples of these are adding index fences to the vacuum platen; or designing a rigid fixture that uses a vacuum pod in lieu of mechanical fasteners; or creating a complex custom vacuum pod, much like a vacuum secured rigid fixture.

Vacuum platen and sacrificial surface

Your FGP machine (unless a custom solution was purchased at time of sale) is equipped with a composite vacuum platen. However, this platen has not been designed to be cut on directly, it is intended to have a sacrificial surface placed on top, and all cutting operations to be performed on this sacrificial material. The composite vacuum platen is constructed with a "waffle" grid pattern, this will allow you, the operator, to configure vacuum zones to most effectively deliver vacuum where you want it. There is nothing permanent about this type of configuration and the machine can be reconfigured as often as you like. In the composite platen will be 6, 8, or 10 vacuum ports, depending on the size of the table. Using 3/8 inch (10mm) neoprene foam sealing cord, zones may

be defined out from these ports; the zones will be sealed when the sacrificial material is installed over the composite vacuum platen.

The purpose of the sacrificial material is self explanatory. To produce your jobs against a sheet of easily replaceable, low cost material placed over the much more expensive FGP composite vacuum platen. By cutting against a sacrificial your CAM program can be created more aggressively, to cut all the way though the process material or deeper without fear of damaging the much more costly composite vacuum platen. The sacrificial will also allow for fastening the process material using screws, tape or adhesive or for adding semi-permanent index fences and fixture devices. Lastly, the sacrificial will be your last line of defense against programming errors, hopefully destroying the sacrificial material and not the costly composite material.

The most commonly recognized sacrificial in the CNC router industry is ¾ inch MDF (medium-density fiberboard) or ULDF (ultra-low density fiberboard), both of these materials are surprisingly porous allowing effective air flow, providing an suitable sacrificial paten surface with a minimal amount of disruption to the effectiveness of the vacuum hold-down. Of course, some industries may have found other sacrificial materials more suitable.

As produced MDF/ULDF have a wax polish finish, this polish seals the sheet in terms of vacuum flow, and this will greatly impede the effectiveness of the vacuum platen. Additionally, the sawn edge of sacrificial will flow air effectively, creating a large vacuum leak, also impeding the effectiveness of the vacuum platen. To maximize the effectiveness of the vacuum platen it is recommend that the surfacing operation be performed on both sides of the MDF/ULDF sheet as well as sealing the sawn edges.

Note: Sacrificial material sheets are not included with the purchase of a new FGP CNC router system and are the responsibility of the owner/operator to insure their correct usage. Failure to properly use sacrificial materials and/or damage to the composite vacuum platen will not be covered through the FGP limited warranty.

Preparing MDF/ULDF sacrificial sheet

While ¾ inch thick MDF/ULDF is the recommended sacrificial material, it is not recommended that it be used as purchased. For optimal vacuum performance some simple machining operations and a small amount of edge preparation is highly recommended.   As produced MDF/ULDF have a wax finish, this finish seals the sheet and significantly blocks air flow, and this will greatly reduce the effectiveness of the vacuum platen. Likewise, the sawn edge of MDF/ULDF will flow air effectively, creating a vacuum leak, again reducing the effectiveness of the vacuum platen

Determine the desired layout for the sacrificial sheet(s); very large table may require several sheets of MDF/ULDF to be tiled to cover the entire platen area. Perform any trimming of the sheets now. Once fit is confirmed and sheet(s) trimmed if required, remove sheets and seal the cut edges by painting them with PVA (white, wood-working) glue. This should be done neatly if multiple sheets are to be tiled, trim excess. Once dry, select vacuum zones in the composite grit surface and seal with neoprene foam cord, either for the final desired outcome or temporary zone(s) for the purpose of preparing the sacrificial MDF/ULDF. If multiple tiles sheets are used, the vacuum zones must be designed and neoprene foam cord placed in such a way that the vacuum is not lost though the seams between the sheets. Replace the MDF/ULDF sheet(s) on the table. It is not imperative that the sheet be placed perfectly at this time as long as it will create a vacuum seal between the composite surface and the neoprene foam cord; however, a reasonable attempt to place the sheet as square as possible should be made.

Create a CAM program to remove a small amount of material from the whole sheet surface. The goal is the remove the wax polish from both sides of the MDF/ULDF sheet, thus a depth of cut should be chosen to effectually remove this polish, not so conservative that variation in the

MDF/ULDF sheet could leave unmachined areas but not so deep that we significantly reduce the thickness of the sheet, 0.050 – 0.100 inch (1.3 – 2.5mm) is recommended. A significant overlap of the machining passes is also recommended to insure the sacrificial sheet surface remains as flat as possible.

As this type of surfacing operation is long, it is recommended that wide surfacing tool be used. This type of surfacing operation is not performed often, and as MDF/ULDF are very soft materials, an inexpensive tool may be used. 1 inch (25mm) is the minimum recommended diameter, and is generally the largest tool that is commonly and affordable available from "big-box" hardware stores.

After the machining operation is completed on the top surface, flip the sheet(s) and re-run the operation to remove the wax polish from the other side.   Now, replace the, skimmed both sides and edges sealed with PVA glue, sacrificial in the final "permanent" location on the composite vacuum platen, inspecting that the neoprene foam cord was not disturbed in the during the flip operation. If a temporary vacuum zone was defined for the purpose of only producing the sacrificial, the desired vacuum zones should now be defined with the neoprene foam cord. Place and position the sacrificial as in the final position, care should be taken to avoid sliding the sheet(s) and this will almost always disturb the foam cord. The sacrificial will be secured with the vacuum active; however, it may be desirable to secure the sacrificial from accidental movement when the vacuum is not active with the use of screws or tape.

Preparing the sacrificial in this manner will insure a quality working surface while minimizing vacuum loss though the MDF/ULDF sheet. The CAM programs generated for this operation should be archived, as by the nature of a sacrificial table surface, I will need to be replaced in time.

Electrical setup, Controller

The FGP controller can be configured to accommodate several different electrical systems to allow for easy installation for all sizes of facilities as well as insuring international electrical compatibility. At the time of publishing, the FGP controller may be configured for the following electrical supplies, each configuration requires class 'D' breaker(s):

220V ±10%, 40 A , 1-phase, 4 wire, 50/60Hz

220V ±10%, 40 A , 1-phase, 3 wire, 50/60Hz

Additional electrical supply configurations may be available as custom engineered solution if none of the above are compatible with your facility or location.

> If configured for single phase four wire power supply, 4 wire input is required: L1/L2/N/G. 8-6AWG, 10sq.mm min. N (neutral) / G (earth ground) must be separate conductors. Class 'D' panel breaker(s) are required.
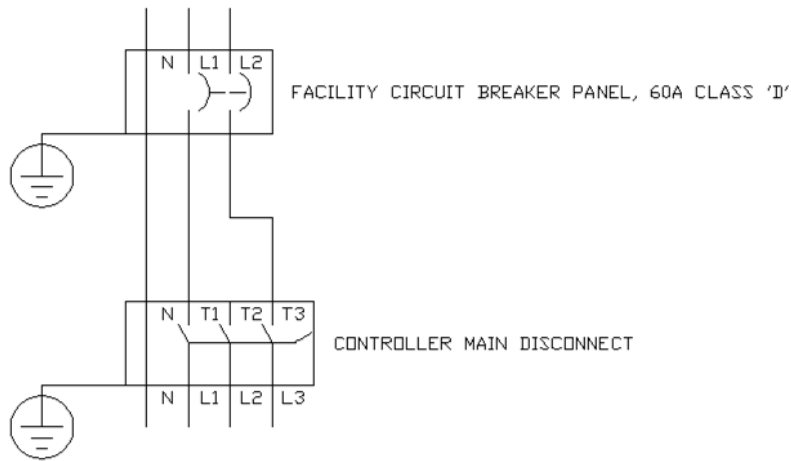
Figure 26: 1 phase, 4 wire connection

If configured for single phase three wire power supply, 3 wire input is required: L1/L2/G. 8-6AWG, 10sq.mm min. Class 'D' panel breaker(s) are required.
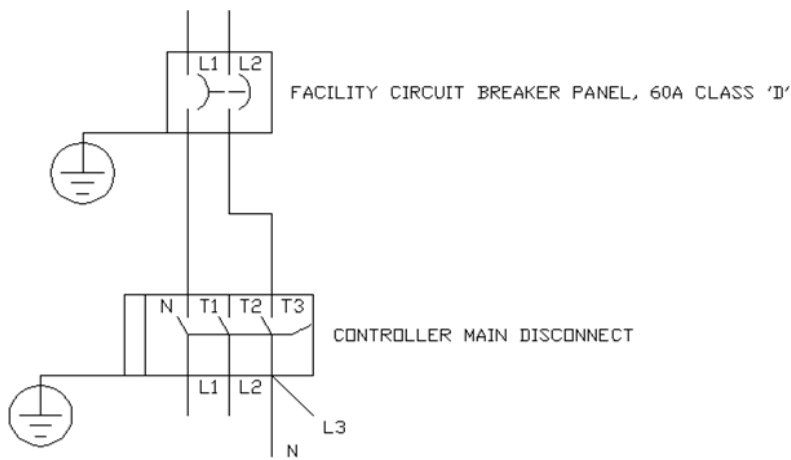
Figure 27: 1 phase, 3 wire connection

It is expected that the control system's main disconnect switch will be "hard wired" to an approved electrical panel via appropriate class "D" circuit breakers. All cable, conduit and related accessories are the responsibly of the machine purchaser and will not be supplied by FGP. The electrical connection of the control system to the facilities electrical system is the responsibility of the purchaser and is recommended that this connection be performed by a licensed journeyman electrician.

Your new FGP CNC system will be factory configured to the specifications provided at the time of purchase. However, the FGP controller can be reconfigured if the electrical specifications of the facility change or if the machine is to be relocated.

> *Note: 220V or 380V is measured between lines.*
>
> *Prior to completing electrical connections on 3-phase systems, a test of voltage between all lines and neutral should be performed. These measurements should result in ~110V (on a 208V 3-phase system) measured voltage. This test is used to confirm the presence of a 220v "high-leg" delta facility configuration. This type of connection is uncommon; however, If a high leg delta connection is confirmed THE HIGH LEG MUST BE CONNECTED TO PHASE B, L2 OF THE FGP CONTROL SYSTEM. An improperly handled high-leg will cause severe damage to the CNC controller.*

> *Caution: FGP technical support should be contacted prior to making changed to the controller electrical supply as internal configuration changes may also be required. This is especially the case if changing from 220v to 380v or vice versa. Errors in changes to the electrical system will invariably cause severe internal damage to the controller which may not be covered by the FGP limited warranty.*
>
>
> *While often used successfully, FGP does not recommend the use of "phase converters", electro-mechanical or solid-state, with the use of it's electronic products. If a phase converter is deemed necessary any electrical damage to the servo-motion controller or poor servo / spindle performance may not be covered by the FGP limited warranty.*

Maintenance

Daily Maintenance

The following maintenance tasks should be performed daily:

Check the machine's air pressure regulator

Some CNC routers, including FGP routers, feature an air pressure regulator that helps to control incoming air pressure. On a FGP machine, the air pressure regulator is located at either the back of the machine on the right frame rail or in the middle of the right side of the machine's frame. The regulator should be adjusted so the incoming pressure to the machine is within the manufacturer's specification (between 4-6 bar). To adjust the regulator, pull up on the center cap and rotate to set the desired pressure. After pressure is adjusted push down on center cap to lock in place.

Clean the spindle fan (if spindle is air-cooled)

Dust accumulates on the spindle's cooling fan and can cause it to become out of balance. Use compressed air to blow off the fan daily.

Check computer connections

It is very important for all computer cables to be firmly attached. Most important is the Ethernet or USB cable that connects between PC and controller board. If this cable is disconnected you could see a popup error screen indicating that *CTftp: Wakeup Client Board does not reply.*

Check status of motor drives and VFD

After turning main machine switch ON open controller front and back door to check on status of VFD and motor drives. Ensure none of them showing fault before operation

Sweep work area

Having a clean work environment can prevent accidents and improve work efficiency.

Examine tools before cutting

Very important to have tools firmly placed in the collet. Make sure tool tips are not broken.

Warning: **Spindle runs at high RPM and if tool is not firm inside collet there is a chance tool or collet could shoot off and cause serious injuries**

Check dust collector bins/bags (if equipped) and empty if needed

Weekly Maintenance

The following maintenance tasks should be performed weekly:

Lubricate bearings and screws

CNC routers can use a combination of rack-and-pinion, ball screw, and lead screw devices to create motion. Each of these requires regular lubrication, and end users should find out from their dealer how many of each of these devices are on the machine and where they are located.

On a standard FGP machine configuration there are 12 linear bearings that need to be lubricated once a week. The X-Axis has 4, the Y-Axis has 4 and the Z-Axis has 4. The Z-Axis of the machine has a ball screw or lead screw that needs to be cleaned and re-lubricated once a week. This is very important!

Lubricant type

Machines without auto lubrication pump

Machines without central lubrication system **multipurpose lithium grease** used for all bearings and ball screw. Also a grease gun and grease needle is required to push grease into bearing fittings.

Machines with central lubricating pump

Fill pump with special lubricant for bearings and sideways. It is recommended to use 50W or 60W, generally higher viscosity prevents dripping.

Click on this link for a sample of this product

Clean vacuum pump filters

Vacuum pump filters should be checked and cleaned each week and replaced when necessary. *Take great care when removing and cleaning the filters not to let any debris enter the vacuum pump inlet.*

Clean tool holders and collets

Tool holders, collets, and collet nuts must be rust-free and clean. Use a mild scotch-bright pad to clean any rust. Apply a very light oil to prevent oxidation, and then remove excess oil with a clean, soft rag. Never use abundant oil or grease. Typically these components need to be cleaned weekly, but frequency really depends on the amount of moisture in the air and how quickly rust develops. Components should look like they are new at all times.

Clean the spindle taper

Cleaning the spindle taper should be done once a week. Wipe the taper very well with a green scotch bright pad, use compressed air to blow the taper out, and then wipe with a clean dry cloth.

For FGP video on ATC spindle cleaning see this video

Wipe off excess grease

Double check all connections

Monthly Maintenance

The following maintenance tasks should be performed monthly:

Lubricate racks

If the machine features any rack-and-pinion devices, the racks should be lubricated monthly. A typical FGP machine has 3 gear racks, 2 on the X-Axis and 1 on the Y-Axis.

Check for loose bolts on machine and tighten as needed

Quarterly Maintenance

The following maintenance tasks should be performed quarterly:

Check machine square

For various reasons the work table can lose their alignment and perpendicularity of axes, then we say that the table is off square.

In this section, we will consider first how to check the perpendicularity of the axes of the table and later how to correct the table in case we have the table off square

1.1. In a MDF panel, drill four points making a rectangle, make the rectangle as big as possible (see figure1)
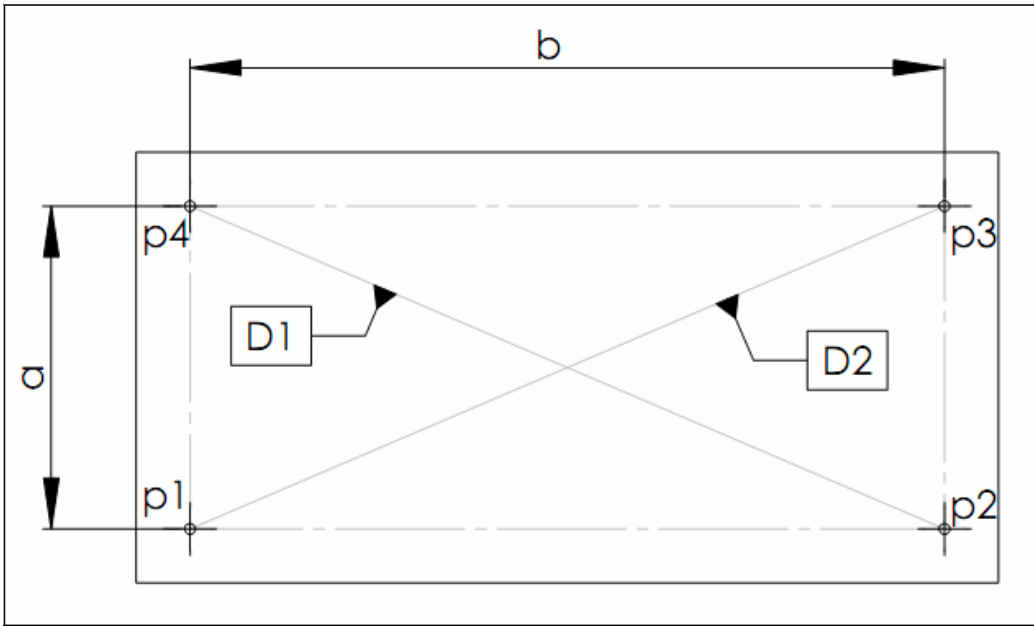
1.2. Take measure of diagonals   sketch1

1.2.1. (D1 - D2) should be less than 1mm

1.2.2. (D1 - D2) if greater than 1mm, table off square.

Note: Be sure we take the measure right, always (D1 and D2) measuring from inside circle or outside (picture1)
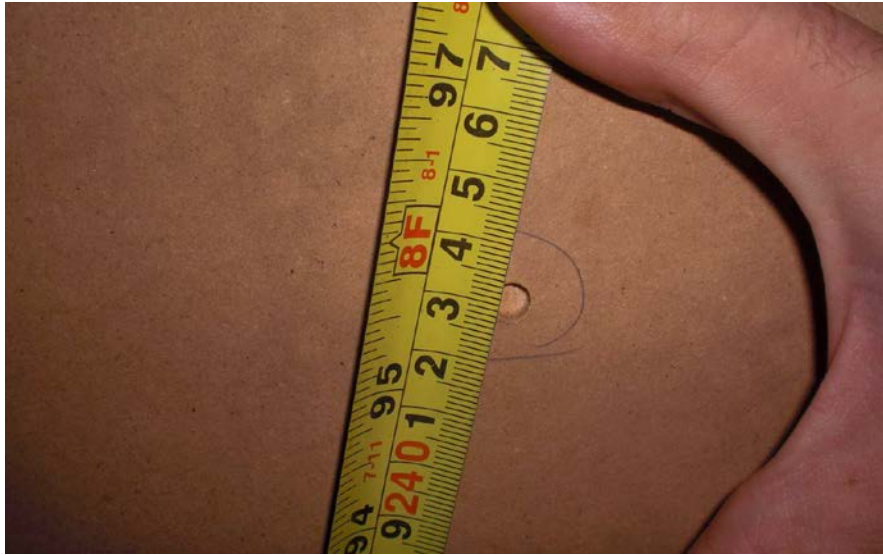
If the table is off squared, gantry is skewed similar to sketch2 which shows D2>D1
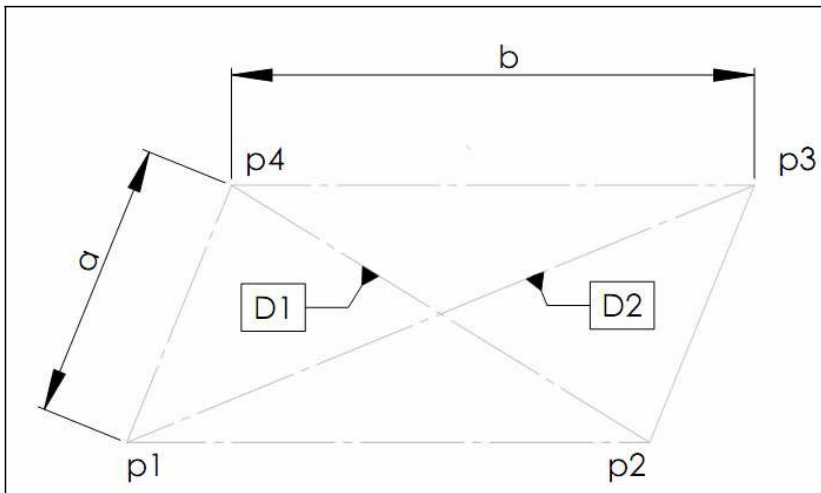
Correct gantry square

Now, we know the table is off square, we are going to fix the table.

To fix the table, we have to ways depending how much the table is off square:

1.2.3. <u>Without opening gantry</u>

1.2.4. With the help two people, we have to push in the gantry how the sketch 3 shows us. You have to **draw a sketch of your table to know what is the correct direction to push (in the sketch, D2>D1)**
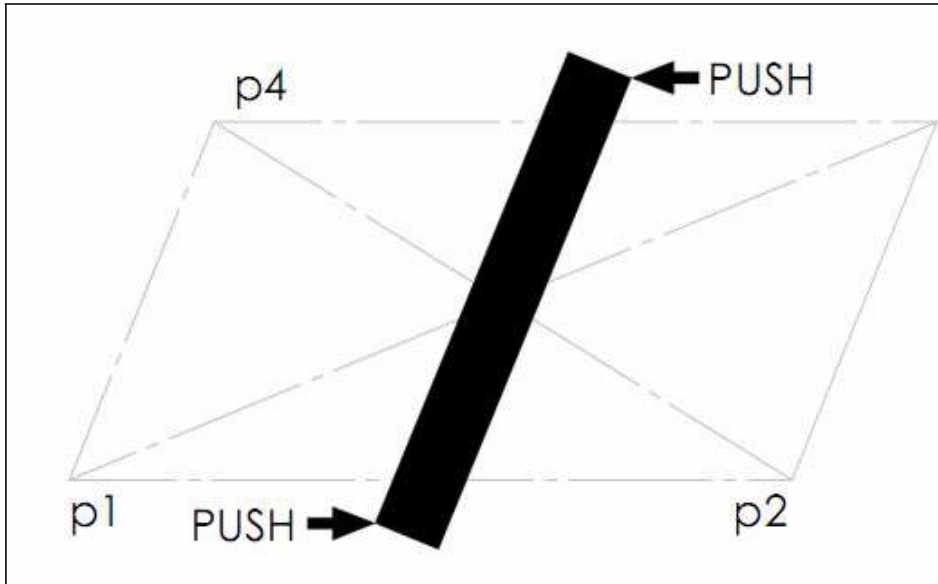
1.2.5. Repeat steps above section 1(check the square) D1 - D2 < 1mm, **DONE**

2.1.2.1.1. If we have got closer, repeat again section 2.1(without modify gantry)

2.1.2.1.2. If we are very far to get it, we have to modify the gantry

1.3. <u>Modify the gantry</u>

1.3.1. Remove the screws of one lateral of the gantry

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1.3.2. Whit the help of mechanical jack pick up the gantry a couple centimeters and remove the pins

1.3.3. Move the lateral of gantry

1.3.4. Drill the screw holes to make them bigger
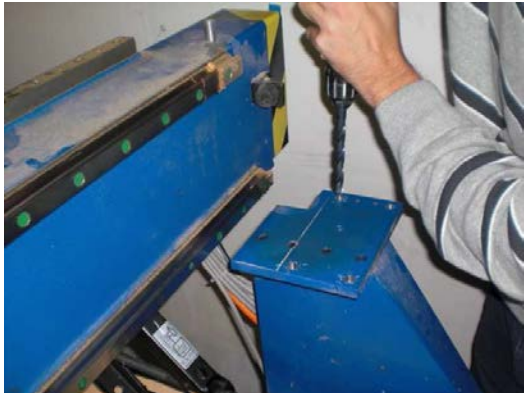
1.3.5. Place the screws without tightening it

1.3.6. **With** the help two people, push in the gantry how the sketch 3. You have to **draw a sketch of your table to know what is the correct direction to push (in the sketch, D2>D1)**

1.3.7. Tighten the screws

1.3.8. Repeat steps above section 1 (check the square) D1 - D2 < 1mm, Done

1.3.9. If we are very far to get it, we have to modify other lateral of gantry and repeat section (modify gantry) in the other lateral of the gantry

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```
                    ┌─────────────────┐
                    │ 1.1 MAKE A      │
                    │   RECTANGLE     │
                    └────────┬────────┘
                             │
                    ┌────────▼────────┐
                    │ 1.2 TAKE MESSURE│
                    └────────┬────────┘
   ┌─────────────────────────┴──────────────────────────────┐
   │         ┌──────────┐              ┌──────────┐          │
   │         │ D1-D2<2  │              │ D1-D2>2  │          │
   │         └──────────┘              └─────┬────┘          │
   │                                         │               │
   │     ┌──────────────┐          ┌──────────────────┐      │
   │     │ TABLE SQUARE │          │ TABLE OFF SQUARE  │      │
   │     └──────────────┘          └────────┬─────────┘      │
   │                               ┌────────▼──────────┐     │
   │        DONE                   │ HAVE YOU TRIED 2.1 │     │
   │                               │ WITHOUT MODIFY     │     │
   │                               │ GANTRY?            │     │
   │                               └─┬──────┬────────┬──┘     │
   │                            ┌────▼─┐ ┌──▼─┐ ┌────▼──┐     │
   │                            │ NO   │ │ *  │ │ YES   │     │
   │                            └──┬───┘ └────┘ └───┬───┘     │
   │                        ┌──────▼──────┐  ┌──────▼──────┐  │
   │                        │ 2.1 WITHOUT │  │             │  │
   │                        │ MODIFY      │  │ 2.2 MODIFY  │  │
   │                        │ GANTRY      │  │ GANTRY      │  │
   │                        └─────────────┘  └─────────────┘  │
   └─────────────────────────────────────────────────────────┘
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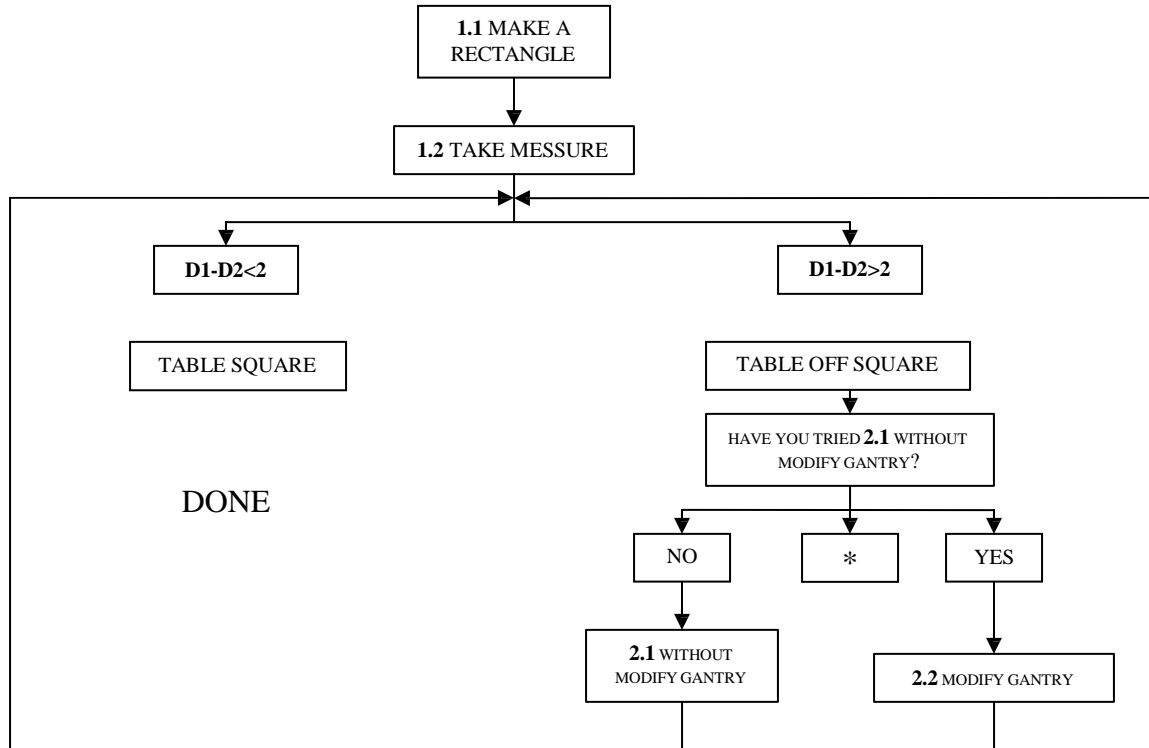
Resurface MDF sacrifice sheet

Clean or replace pump filter, if applicable

Change vacuum pump oil, if applicable

Change grease cartridges, if applicable

Clean rack-and-pinion and re-lubricate

Clean overall machine