MITS Design Pro

CAM-TP

for FP-21T Precision

・Precautions

◆ Intended Use

The intended use of the PCB Prototyping Machine is to process and prototype PCB by milling, drilling and routing. **Any other uses are strongly prohibited**.

◆ While Processing

Keep away from the spindle head while processing/prototyping. Be sure to keep away and not to get your caught in the machine. Make sure to wear eye protective gear/goggle while processing.

◆ Power Voltage

The allowable voltage for FP-21T Precision is 85V～264V. Be sure to use voltage regulator if the voltage of your region is out of the range.

◆ Working Area

The working area of FP-21T Precision is 150mm x 150mm. Be sure to process within the working area of FP-21T Precision.

◆ Dry Run and Milling Speed

Dry Run ···· 20～30mm/sec
Milling Speed (Milling Bit) ···· 12～18mm/sec
Milling Speed (HF Milling Bit) ···· 2～6mm/sec
Routing Speed ···· 1～ 2mm/sec

If the speed is too fast during processing/prototyping or manual operation, step-out could occur to the machine.

◆ Milling/Drill/Routing Tool Settings

The machine will process with the settings in CAM Pref.→ Milling・Drill・Routing. If the parameter in the setting is missing or unintended value, there is a possibility of tools breaking or processing error occurring. Be sure to check the parameter in each setting.

◆ Vacuum Cleaner

Be sure to use Vacuum Cleaner while processing while processing. If the dust from the PCB piles up, not only the processing quality is affected by it, there also is a chance of spindle motor malfunction.

◆ CAD with Dongle Key

Make sure to remove Dongle key when you are using the prototyping machine.
Connection error may occur and prototyping machine may be unable to use.

◆ Tools and RPM

Set the RPM to 30~40 for processing. The unit in the software is x 1000RPM.
To drill 0.3~0.4mm size holes, set the Lower2 to 3~4mm/sec.

IMPORTANT

To drill 0.3~0.4mm size holes, go to CAM Pref. → Board Maker and set
the Lower2 to 3~4mm/sec. After setting the Lower2 speed slower, make sure
to set Drill Wait and Before Cutting longer than the default setting. If
not, there is a possibility of spindle head moving too early before the
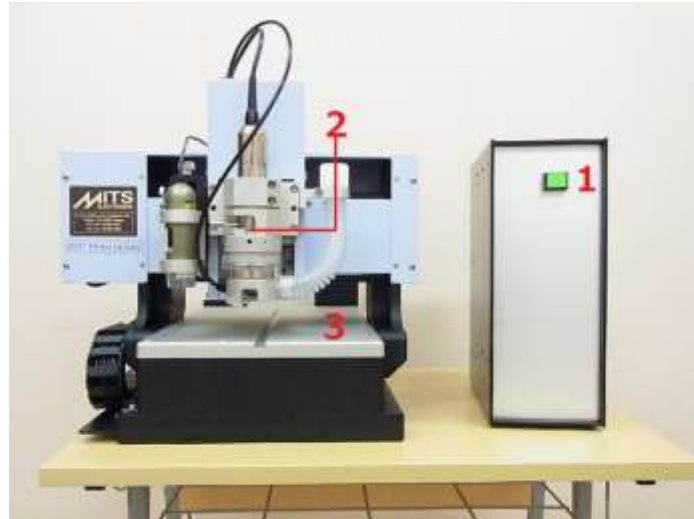drilling is completely penetrated.

◆ Transportation

Since the FP-21T Precision is a precision machine, use the container box
which was used for shipping. For long distant transportation using carrier,
make sure to select carrier with great handle care during the transportation.
Do not apply any force to the shaft, lead screw, or spindle head while
transportation. It could result to have the accuracy to drop.

◆ Spindle Motor Cleaning

Note that spindle motor and collet are ultra-precision parts in the PCB
prototyping machine. In order to keep the machine performance well, daily
checkup and cleaning is necessary. Spindle motor may result to malfunction
when dust or debris are caught between tool and collet, which decreases the
holding power of the tools. Make sure to check and clean the spindle motor
before and after using.

◆ Warranty

The term of warranty for PCB Prototyping Machine is 1 year with the intended
use. Note that spindle motor and consumable supplies are not included in
the warranty. Also note that even within the warranty period, below
circumstances will be considered as charged repair. Improper use,
inappropriate assembly, damage/breakage by carelessness, natural disaster,
abrasion, modification, use of non-genuine components/parts, use in
undesignated voltage. Please operate with great care when you are using the
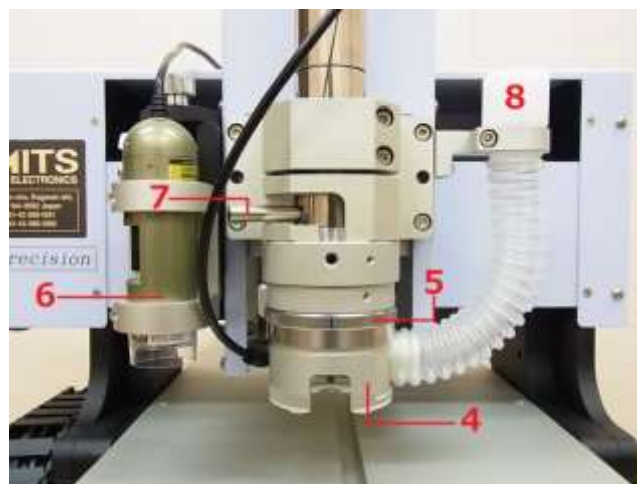machine without any training.

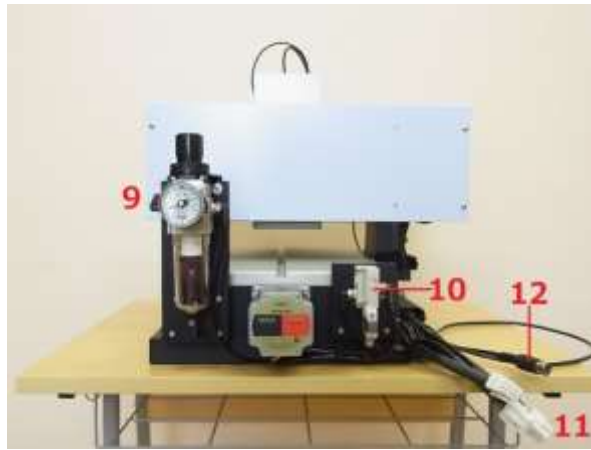# Table of Contents

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1. Power Switch
2. Spindle Head
3. Working Table

4. Pressure Foot
5. Depth Adjustment Screw
6. Camera
7. Tool Change Lever
8. Vacuum Nozzle

9. Air Regulator
10. Air Valve
11. Control Box Connector Cable
12. Spindle Motor Cable

13. RS232C Serial Port
14. Dip Switch
15. USB Port
16. Surface Detecting Device Connector
17. AC Inlet
18. Spindle Motor Connector
19. Fuse Holder
20. Control Box Connector
21. AC Out (Vacuum Outlet)
22. AC In (Power Plug)

In this section, we will be explaining about the connection of PCB prototyping machine to the computer with USB cable or RS-232C serial cable.

Machine Connection

Connect the power cable to AC In (Power Plug), power cable of a vacuum cleaner to AC Out, spindle motor cable to spindle motor connector and control box connector cable to control box connector.

Connect the control box connector cable to the correct cable indicated on the each end. Make sure to connect to the connector all the way.

Attach the vacuum hose to the vacuum nozzle and use the attached holder to fix it firmly. Fix the hose in the backside of the machine using the attached holder.
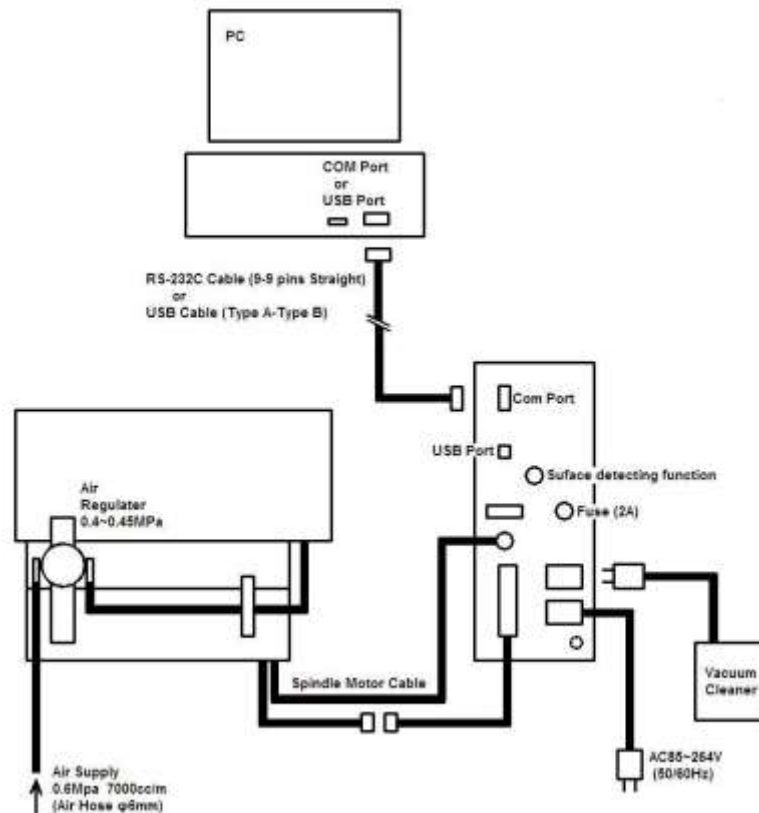
USB Cable Connection

Use the USB cable to connect FP-21T Precision and the computer as shown in the diagram above. Launch Design Pro and select **CAM-TP**. Go to **CAM-Prefs.** and select **Board Maker**. Select **USB** in **RS232C port** pull down menu.   Close Design Pro and software.

RS232C Serial Cable Connection

Use the RS-232C cable to connect FP-21T Precision and the computer as the diagram above. Launch Design Pro and select CAM-TP. Go to **CAM-Prefs.** and select **Board Maker**. Select **COM1** or correct port in **RS232C port** pull down menu.

Power On/Initial Position
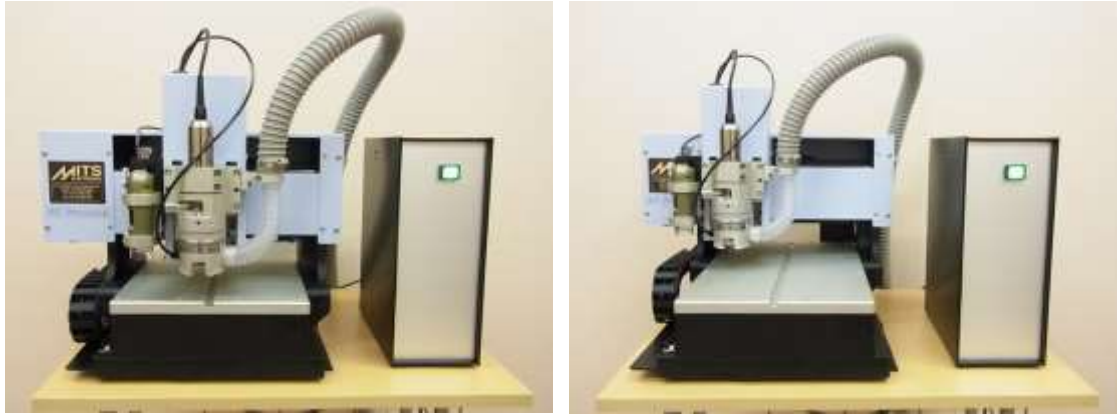
Turn the power on to check if the machine operates properly. The spindle head should move to the initial position, which is the back left corner of the working table.

WARNING: Please contact us if the machine does not move to the back left corner.

IMPORTANT: Do not connect the camera to the computer until the driver is installed

Note: Please refer to the **Software Installation Manual** for details regarding software installation.

┌───┐
│   │
│   ・Camera Driver Installation   │
│   │
└───┘

In this section, we will be explaining about installing driver for camera.

IMPORTANT: Do not connect the camera to the computer until the driver is installed

Camera Dino

Insert the software installation CD-ROM to the computer and go to **Drivers**, **Camera_Dino** and open **Setup.exe**. Installation will begin.

Note: Dino Capture 2.0 will be installed in your computer along with the driver. You will not use this software for PCB prototyping.

Camera UCAM

Insert the software installation CD-ROM to the computer and go to **Drivers**, **Camera_Dino** and open **Setup.exe**. Installation will begin.

After installation is completed, connect the camera USB cable to the computer. Launch **Design View** to check if the camera is working properly. When the Design View is displaying image from your computer camera, go to **Source** or click on

 and select the camera equipped on the machine.
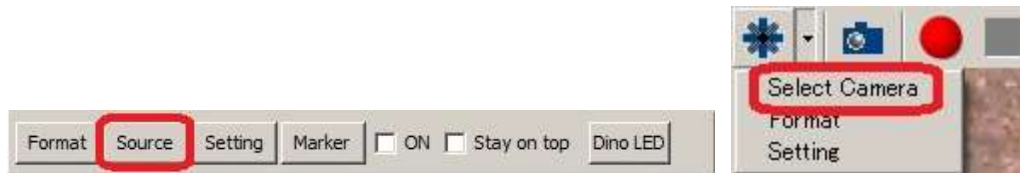
For further settings for Design View, refer to **Design View Setting** section in page 50.
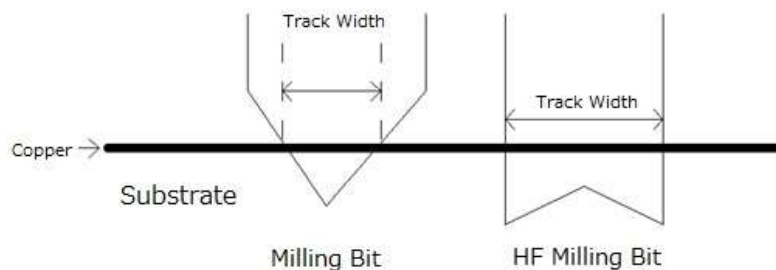
In this section, we will be explaining about the tools used in PCB prototyping.

Milling Bit (90 or 60 degrees)

Milling Bit	90° (Milling Width 0.2-0.4mm) 60° (Milling Width 0.1-0.2mm)	Single and double-sided substrate (Thickness 1.6mm)
		• Used to mill copper off from the substrate • Tapered/angled tip allows to change the milling width by adjusting the cutting depth • Length - 36mm

High Frequency (HF) Milling Bit

HF Milling Bit	0.05mm 0.1mm 0.2mm 0.3mm 0.5mm	Teflon, flexible substrate
		• Used to mill copper off from the substrate • Stub end tip to mill straight cutting edge, suitable for RF/microwave • Length - 38.1mm • Recommended to use with HP model (air flotation/non-contact pressure foot)

Drill Bit

Drill Bit	0.2mm ~3.175mm	• Used for drilling holes • Length - 38.1mm

Router Bit

Routing Bit	1.0mm 1.5mm	• Used for routing • Length - 38.1mm

Milling bit is 2mm shorter than drill and router bit, which guarantees drill and router bit to penetrate the 1.6mm substrate when the milling bit is in contact with the substrate.

＜Reference＞

Usage of different types of milling bits by their track width:

Milling bit 60 degrees:

Milling width 0.15mm-0.2mm for 18um copper foil

Milling width 0.2mm-0.3mm for 35um copper foil

Milling bit 90 degrees:

Milling width 0.2mm-0.4mm for 18um copper foil

Milling width 0.25mm-0.5mm for 35um copper foil

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┌─────────────────────────────────────────────────────────────┐
│                                                              │
│    ・Pressure Foot/Depth Adjustment Screw                    │
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In this section, we will be explaining about the function of Pressure Foot and Depth Adjustment Screw.

Pressure Foot

Pressure Foot is installed to the spindle head which holds the substrate down during the operation. FP-21T Precision is installed with non-contact head pressure foot, which is a pressure foot with air shooting out downwards to hold and avoid contact with the substrate.
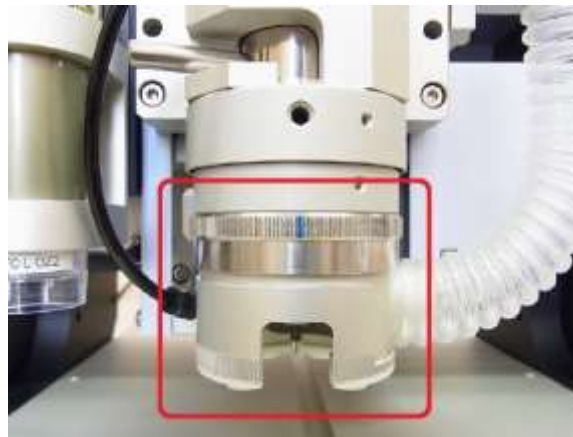

The machine will mill with the tip of the tool where it is projecting from the pressure foot. It will also keep the substrate down along while moving, therefore the milling width and depth will be even.
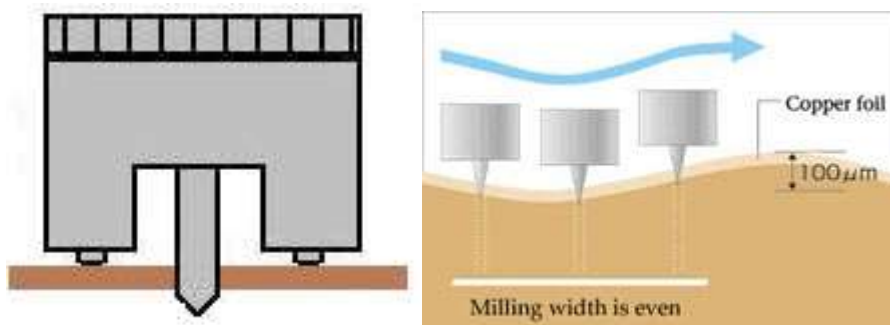

Note: Make sure to connect air compressor to the FP-21T Precision before operation. Compressed air used to hold the substrate down will not be supplied to the pressure foot if it is not connected.

Depth Adjustment Screw

Depth Adjustment Screw is a turning screw/knob on Pressure Foot which moves and adjusts the height of tool installed.
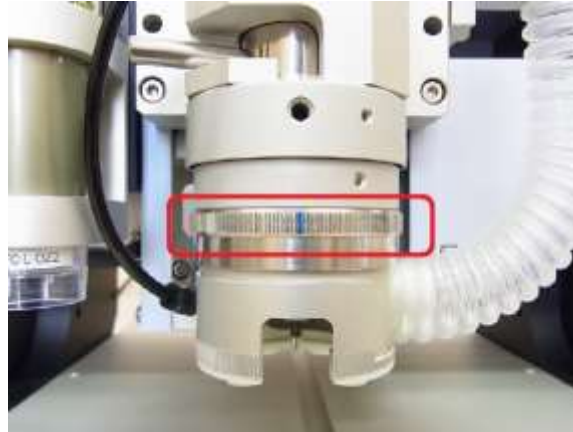
The tool will move down when the depth adjustment screw is turned clock-wise and up when turned counter clock-wise. The tool will move 3um with 1 click and 1 revolution will move 0.5mm.
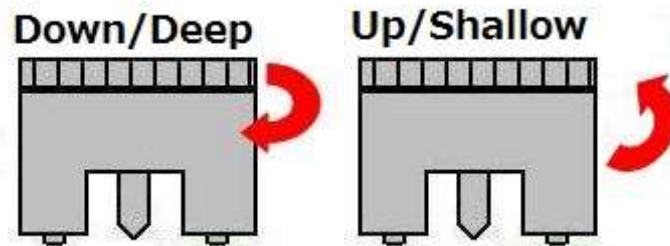
When using Milling Bit 90 or 60 degrees, the milling width/track width will change by adjusting the depth adjustment screw. The lower the tool goes, wider the milling width will be and vice versa.

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┌─────────────────────────────────────────────────────┐
│                                                     │
│   ・Air Compressor                                   │
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In this section, we will be explaining about the air compressor for FP-21T Precision. The air supply is necessary for non-contact head pressure foot.

Air Compressor Specification Requirement

Pressure - 0.5 Mpa (73 psi) or higher

**Flow Rate** - 60 liter/min (2.1 CFM) or higher

Filter - Since the air filter ability of filter on FP-21T Precision is restricted and small, another filter on the air compressor side is necessary.

Oil less (Preferable) – If your air compressor is not oil-less, you need to prepare not only the water filter but also the oil filter.

Low Noise (Preferable) – Air Hose Connection Prepare the air hose with 6mm diameter. Connect between the compressor and the regulator on the back side of machine.

Air Regulator Connection/Setting

Prepare the air hose with 6mm diameter and connect the air compressor and the regulator on the back side of the machine.
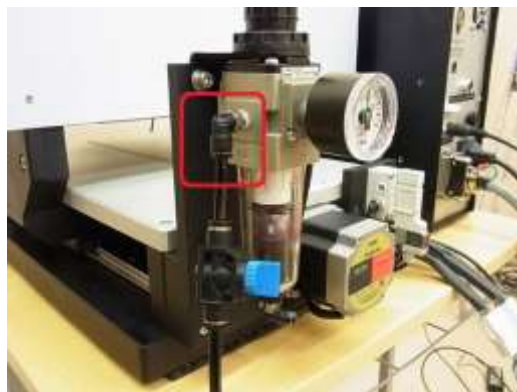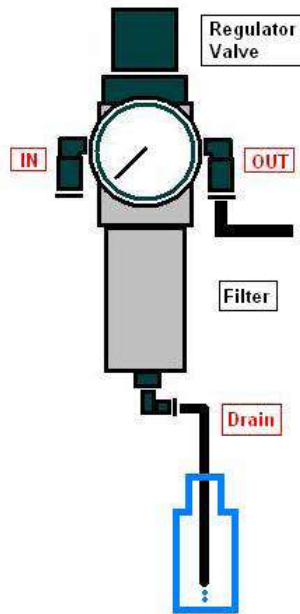
Connect the attached drain hose to the drain port of the regulator. Other end of the hose should be into a bottle. Water removed by filter will be drawn into the bottle. (Note: The water which drips out will only be minimal, therefore
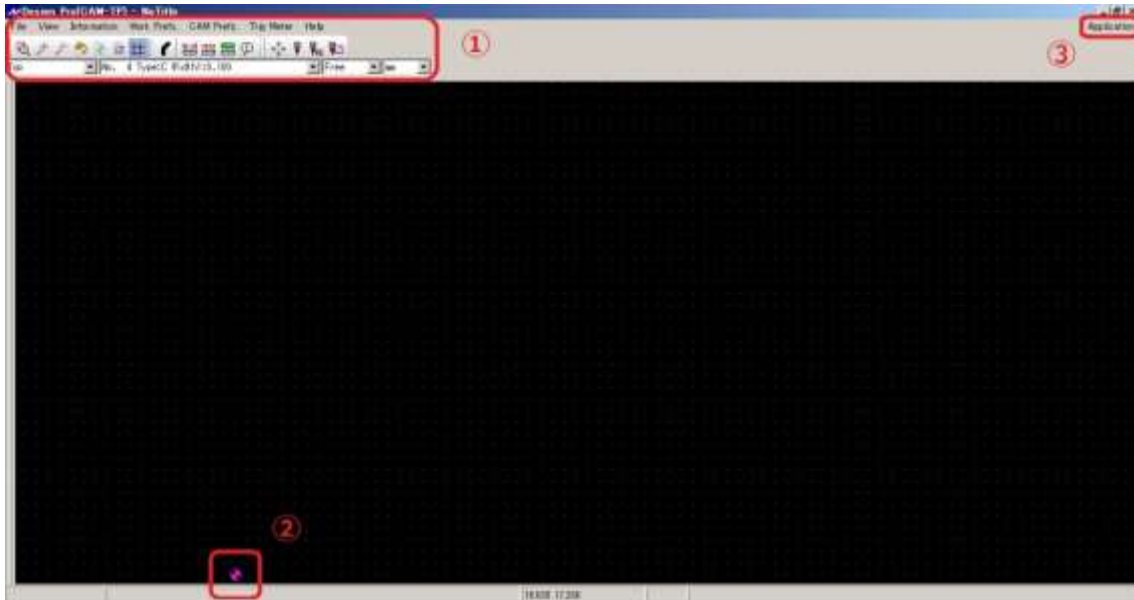

Turn the air compressor on. Pull up and open the valve of the air regulator and turn to adjust the air supply level to **0.5Mpa**.

Be sure to check and remove the water in the drain tank of the air compressor occasionally. If not, excessive water may flow into the machine and the spindle motor which may cause malfunction.

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┌········································································┐
:                                                                        :
:    ・CAM-TP Screen  Basic Operation                                    :
:                                                                        :
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```

CAM-TP Screen

① － Command Icons
② － CAD Origin
③ － Application

Basic Operation

Mouse
Scroll ： Move Up/Down
Shift + Scroll ： Move Right/Left
Ctrl + Scroll ： Zoom In/Out

Keyboard
Esc ： Pause Milling
Backspace ： Undo
Shift + Backspace ： Redo
Delete ： Delete Selected Element

┌───┐
┊   ┊
┊   ・Command Icons   ┊
┊   ┊
└───┘

In this section, we will be explaining each command icons and tool bar sub menus on CAM-TP.

File   View   Information   Work Prefs.   CAM Prefs.   Trip Meter   Help

Top ▼ | No.   4 Type:C Width1:0.100 ▼ | Free ▼ | mm ▼

<div align="right">From left to right</div>

Command Icons

Zoom window – Zooms into selected window area

Zoom in – Zoom into the design

Zoom out – Zoom out from the design

Readjust window – Readjusts window to show the full design

Redraw – Refreshes the window

Assign Layer – Assigns each layer on the design

Show grid on or off – Turns grid on or off

Change view of elements – Changes view of the elements into 3 patterns; center line, tool path, tool path colored in

Display distance between selected two elements – Measures center point distance and nearest distance between two elements

Display distance between two points – Measures distance of two points

Display information of element – Displays information of selected element

Display information of elements – Displays information of selected elements

 Manual operation – Opens Manual Operation window

 Start job – Starts processing the milling/drilling/routing data

 Restart manufacturing unfinished – Restarts from unfinished data

 Mill selectively – Process selected data

Tool Bar Sub Menus

File
Open – Opens MIT files
Exit- Exits Design Pro

View
Redraw – Refreshes the window
Fit – Readjusts window to show the full design
Zoom Window – Zooms into selected window area
Zoom in – Zoom into the design
Zoom out – Zoom out from the design
View Toggle – Changes view of the elements into 3 patterns; center line, tool path, tool path colored in
Grid Toggle – Turns grid on or off

Information
2p Distance – Measures center point distance and nearest distance between selected two elements
2e Distance – Measures distance of selected two points
Clearance check – Checks the clearance between selected layer
Element - Displays information of selected element
Tool List – Opens Tool List window

Work Prefs.
Home – Changes the origin/home point to the selected point
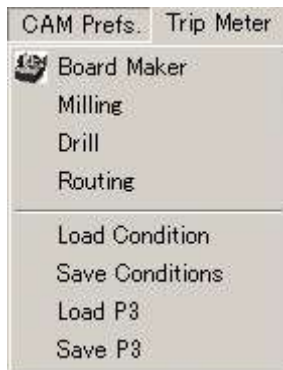
CAM Prefs.

Board Maker – Opens Board Maker Setting window

Milling – Opens Milling Tool Setting window

Drill – Opens Drill Setting window

Routing – Opens Routing Tool Setting window

Load Condition – Loads saved condition for prototyping

Save Condition – Saves current prototyping condition

Load P3 – Loads saved P3 position

Save P3 – Saves current P3 position

Trip Meter

Trip Meter – Opens Trip Meter Setting window

Load Trip Meter – Loads saved trip meter data

Save Trip Meter – Saves current trip meter data

Help

Help – Opens the Help menu

About – Displays version information

License Information – Displays license information

・File

In this section, we will be explaining about Open and Exit under File.

<u>Open</u>

Opens selected MIT file to Design Pro

*MIT file is a file type which is saved on Design Pro. The extension is .mit.

Name ▲	Type	Size
mdemo.mit	MIT File	116 KB

<u>Exit</u>

Closes and exits from Design Pro

In this section, we will be explaining about each function under View.
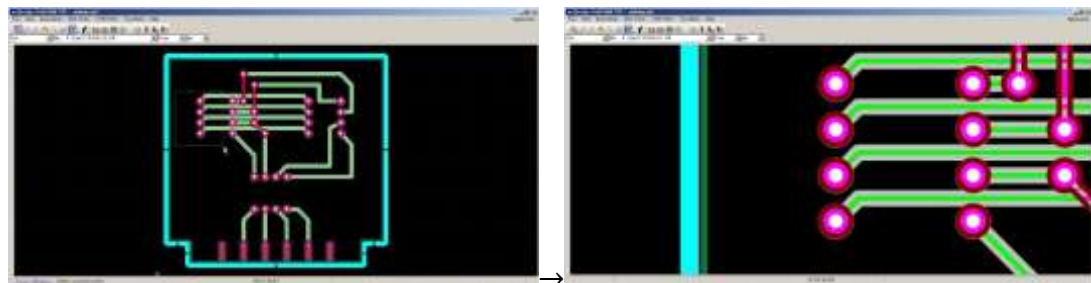
<u>Redraw</u>

Refreshes the screen

<u>Fit</u>

Readjusts window to the full design
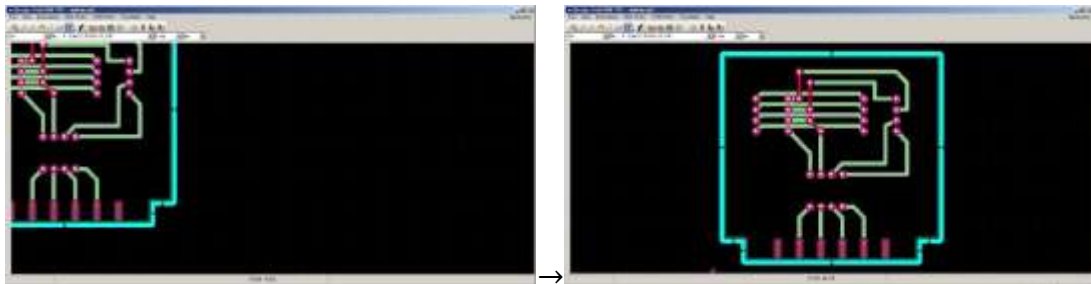
→

<u>Zoom Window</u>
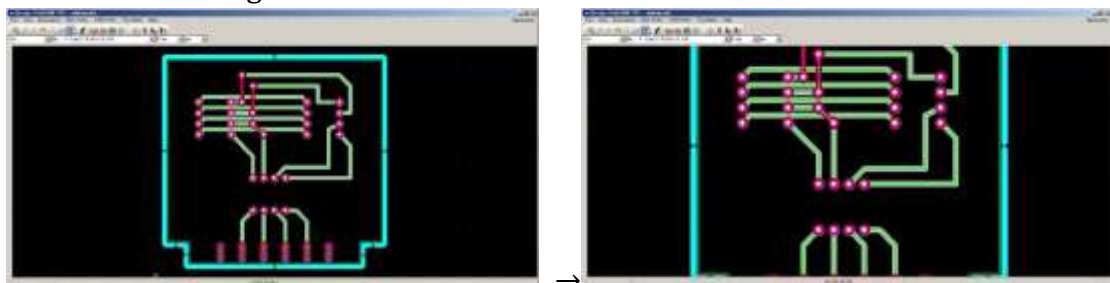
Zooms into selected window area

→

<u>Zoom in</u>

Zoom into the design

→

Zoom out

Zoom out from the design
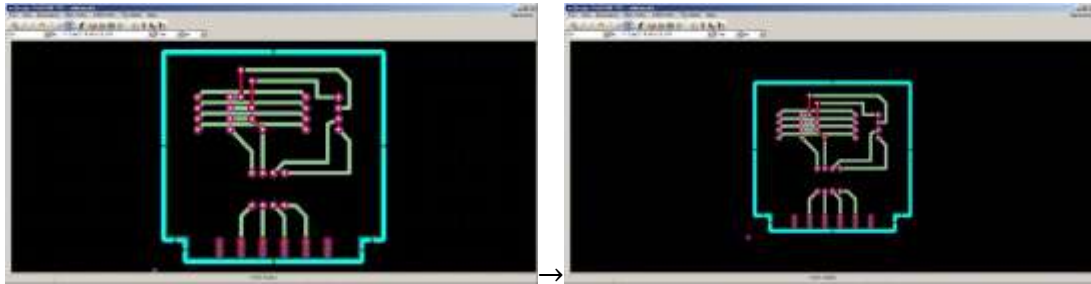
View Toggle

Changes view of the elements into 3 patterns; center line, tool path, tool path colored in

Center Line   Tool Path   Colored In

Grid Toggle

Turns grid on or off
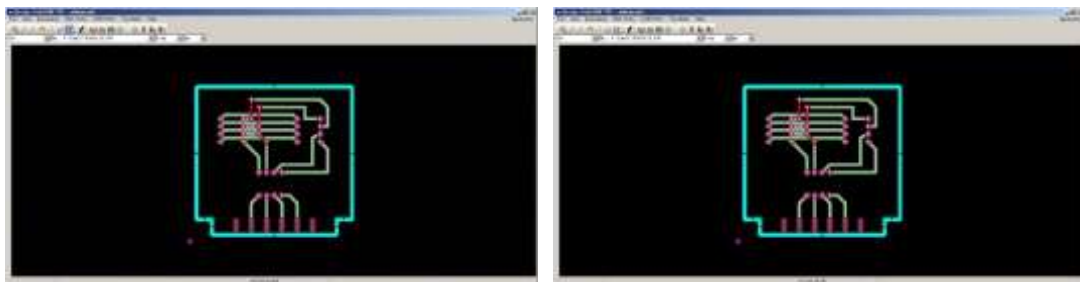
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┌······················································································┐
:                                                                              :
:    ・Information.                                                             :
:                                                                              :
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```

In this section, we will be explaining about each function under Information.

2p Distance
Measures distance of two selected points
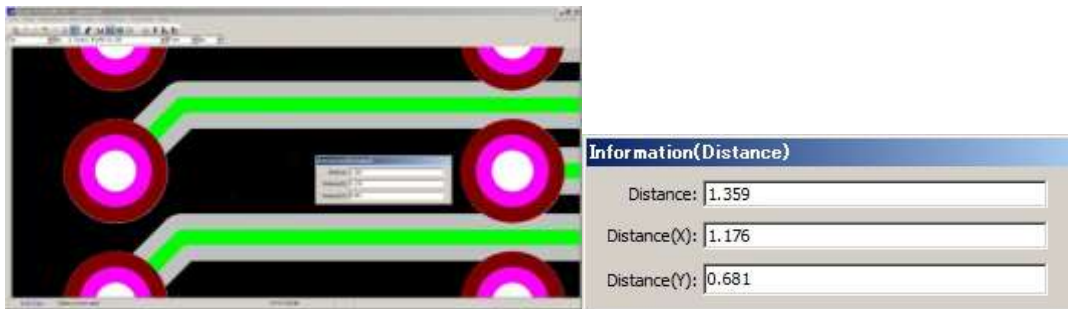
2e Distance
Measures center point distance and nearest distance between selected two elements
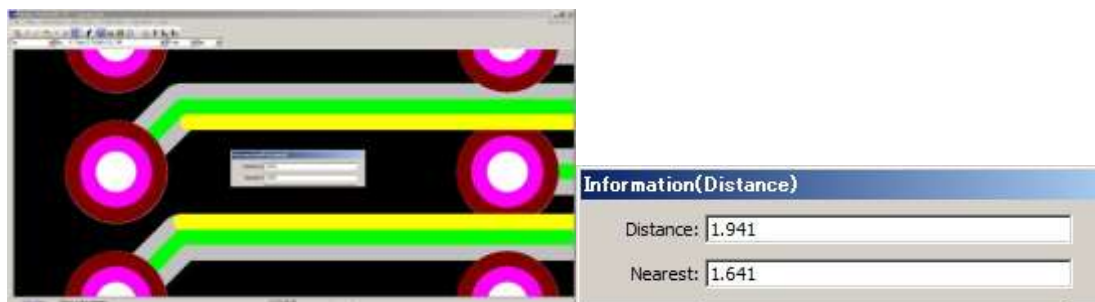
Clearance check
Checks the distance from center line of the elements of the selected layer

Select the layer for the clearance check. The Design Pro will automatically scan and check for distance within the Range

Default Range: 0.05 – 1 mm.
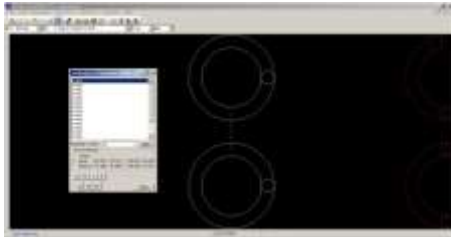
threshold – under: Views and filer out results less than the inputted value

Whole: Views the whole/full design

Area: Views the area of the clearance

Narrow: Views the narrow area of clearance

U: Moves up

D: Moves down

L: Moves left

R: Moves right

Zi: Zoom in

Zo: Zoom out

W: Readjust the design to the window size

The results will be listed. The figures on the list are the distance from centerline of elements within the range. You can click to see where each distance is on the layer.

Note: Please note that Clearance Check does not measure the nearest distance of the elements.

Element
Displays information of selected element
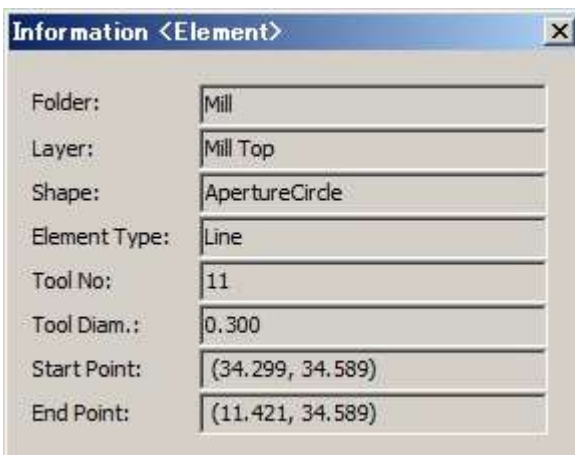
Folder: Name of the folder that element is in

Layer: Name of the layer the element is in

Shape: Aperture shape of the element

Element Type: Type of the element

Tool No.: Tool number of the element
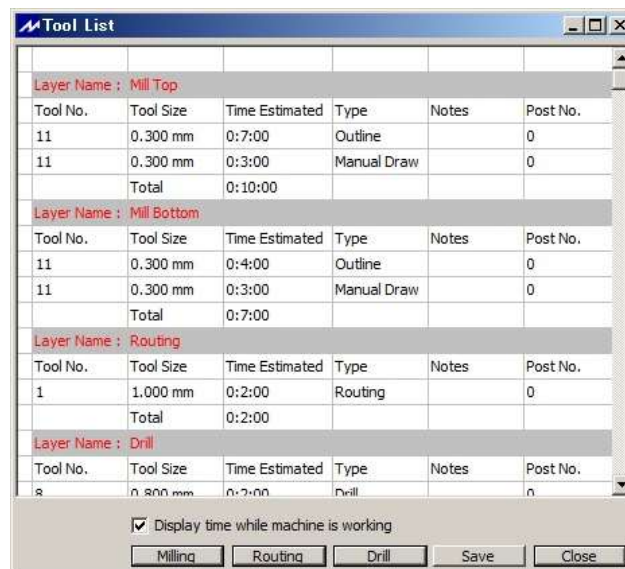
Total Diam.: Tool diameter of the element

Start Point: Starting coordinates of the element

End Point: End coordinates of the element

Tool List

List of tools used to process/prototype the design

Layer Name: Name of layer

Tool No.: Tool No. for each layer

Tool Size: Size of the tool

Time Estimated: Estimated time to complete the job of the layer

Type: Data type of

Post No.: Post No. of the tool (used in automatic tool change models)

Note: Keep the checkbox on for Display time while machine working. If not, Design Pro will not show the time while prototyping and Time Estimate window will not be displayed after Milling Sequence window. Refer to page 50 for details.

You can change the setting for each process from corresponding button.

Milling: Opens Milling Tool Setting window

Drill: Opens Drill Setting window

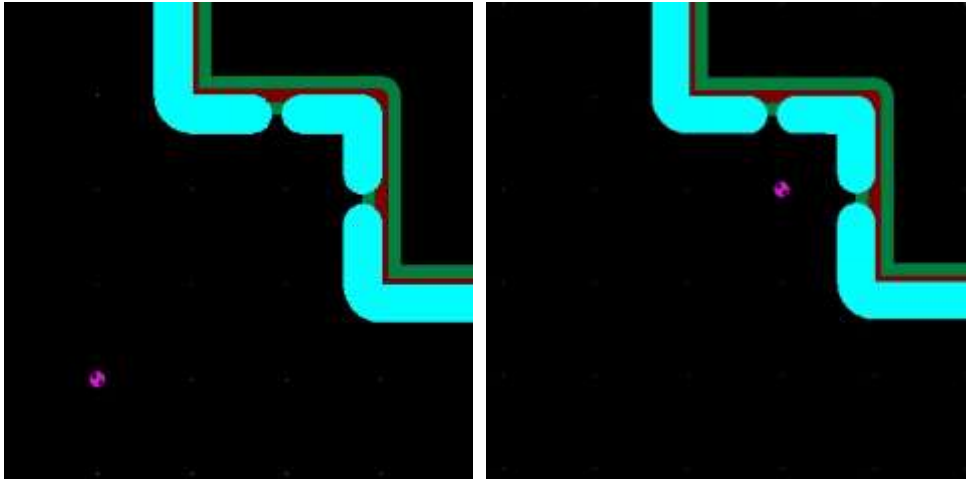Routing: Opens Routing Tool Setting window

Save: Saves the tool list

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┌────────────────────────────────────────────────────────────┐
│                                                            │
│    · Work Prefs.                                           │
│                                                            │
└────────────────────────────────────────────────────────────┘
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In this section, we will be explaining about each function under Work Pref..

<u>Home</u>
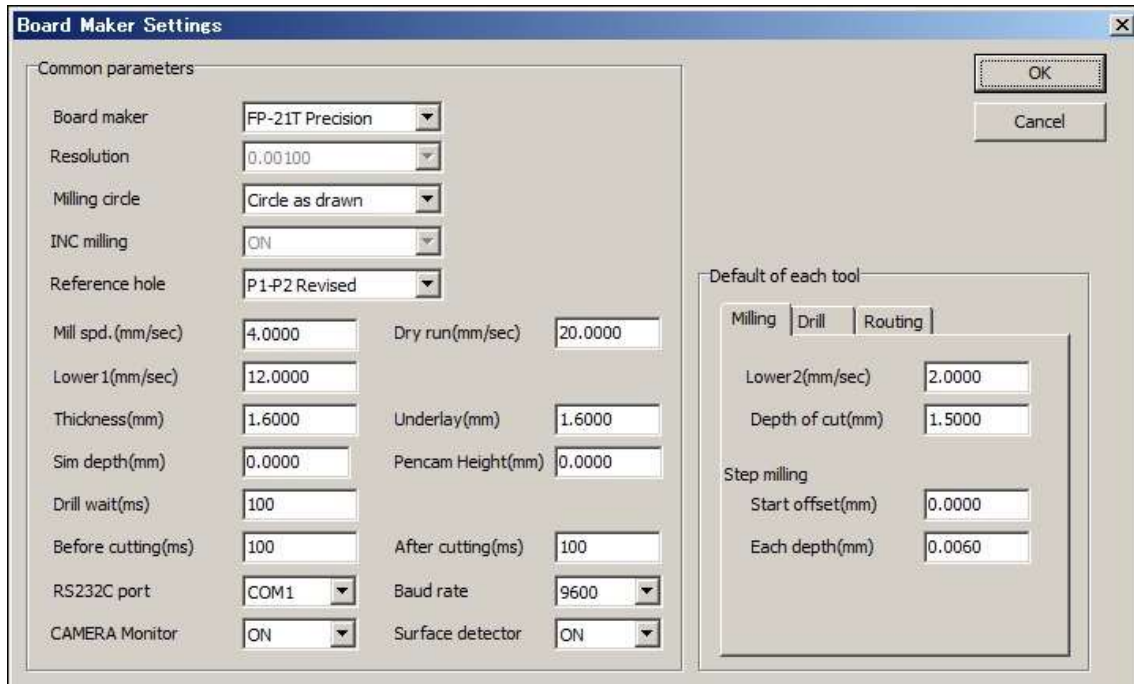You can changes the origin/home point to the clicked point on the screen

Note: Changing origin/home point will be used in CAD Home method. Please refer to page for more details.

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┌─────────────────────────────────────────────────────────────────────┐
│                                                                       │
│    ・CAM Prefs.                                                        │
│                                                                       │
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```

In this section, we will be explaining about each function under CAM Pref.

<u>Board Maker</u>

<u>Board maker</u>

Indicates the prototyping machine the CAM is valid for.

<u>Resolution</u>

Prototyping Machine resolution.

<u>Milling circle</u>

Indicates the milling type of circle and arc data; **Circle as drawn** mills circle as it is and **Octagon** will mill the data in octagon. <u>Select **Circle as drawn** for normal work. (default)</u>

<u>INC milling</u>

Fixed at ON.

Reference hole

Indicates reference holes settings for the operation.

P1-P2 Revised (Default) – Uses P1 and P2 points to set where on the substrate to prototype.

CAD Home – Uses origin of the design as a fiducial hole to prototype.

Mill spd.

Indicates travel speed during milling operation.

Recommended value: 2~6 mm/sec (HF Milling Bit)

                                    12~18 mm/sec (Milling Bit)

Dry run

Indicates travel speed of X, Y directions in "UP" position.

Recommended Value: 20 ~ 30 mm/sec

Lower 1

Indicates travel speed of Z direction until 5 mm above the substrate.

Recommended value: 12 ~ 15 mm/sec.

Thickness

Indicates the thickness of the substrate.

Underlay

Indicates the thickness of the bakelite underlay.

Sim depth

Set up depth during simulation.

Pencam Height

Height of the camera from the surface of the board

Drill wait

Indicates spindle head wait time or the duration for the down position before going up after drilling a hole

Before cutting

Indicates time which spindle head starts moving in X or Y direction after going into "Down" position

After cutting

Indicates time which spindle head starts moving in X, Y direction after going back to "Up" position

RS232C port

Indicates the communication port between the prototyping machines; select appropriate port with your communication cable.
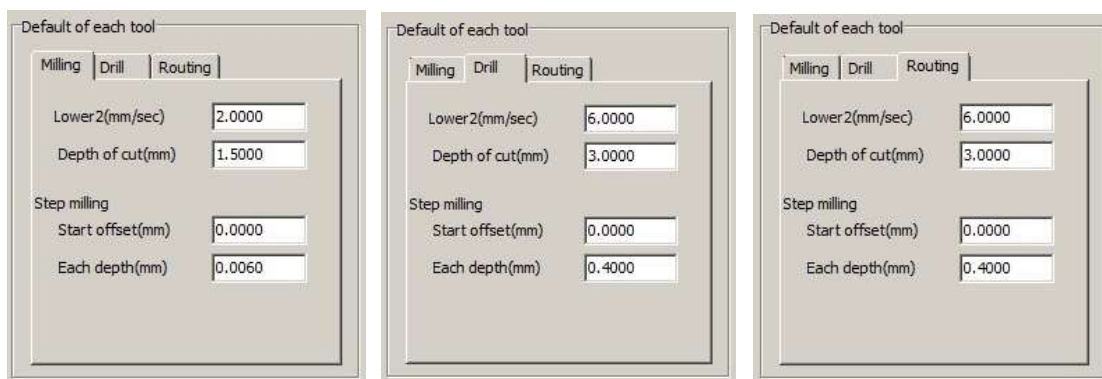
Baud rate

Select 9600 (default)

CAMERA Monitor

Indicates if the camera function is on or off. Select On.

Surface detector

Turns on the surface detecting function. Select On.

Lower 2

Indicates the down speed of the spindle head from 5 mm above the substrate to the substrate surface.

Recommended value: 1 ~ 2 mm/sec.

Depth of cut

Depth of cut from the surface of the board
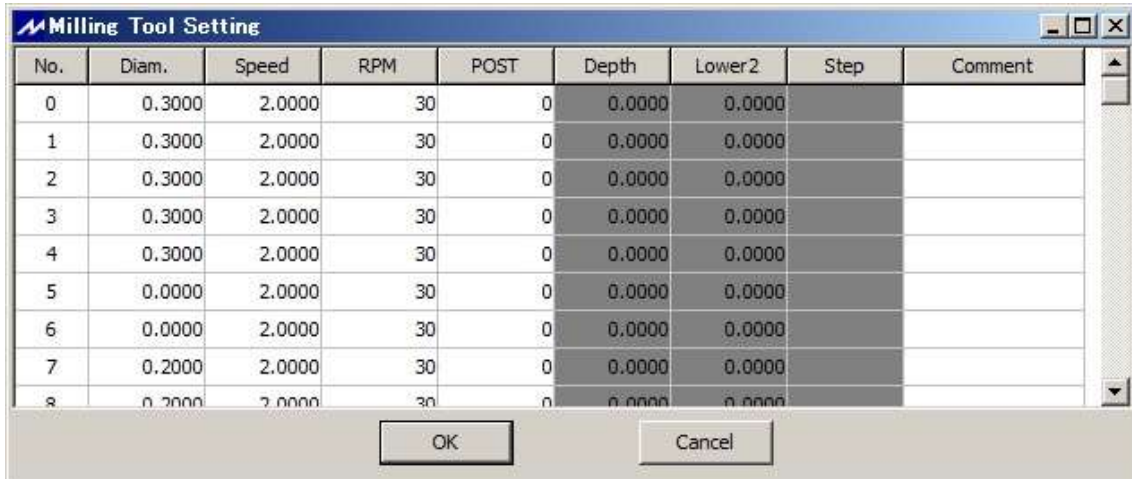
Start offset

The offset position from the substrate surface in step milling

Each depth

Cutting depth for each milling in step milling

Milling / Drill / Routing

No.	Diam.	Speed	RPM	POST	Depth	Lower2	Step	Comment
0	0.3000	2.0000	30	0	0.0000	0.0000		
1	0.3000	2.0000	30	0	0.0000	0.0000		
2	0.3000	2.0000	30	0	0.0000	0.0000		
3	0.3000	2.0000	30	0	0.0000	0.0000		
4	0.3000	2.0000	30	0	0.0000	0.0000		
5	0.0000	2.0000	30	0	0.0000	0.0000		
6	0.0000	2.0000	30	0	0.0000	0.0000		
7	0.2000	2.0000	30	0	0.0000	0.0000		
8	0.2000	2.0000	30	0	0.0000	0.0000		

No. – Tool Number

Diam. – Diameter of the tool in mm

Speed – Speed of milling in mm/sec

RPM – RPM of the tool in 1000 RPM

POST – Post number of the tool (Applicable on Automatic Tool Change machine only)

Depth – Displayed in gray as a default and default value for each prototyping will be applied

Lower 2 – Displayed in gray as a default and default value for each prototyping will be applied

Step – Indicates if step milling is on/off (double click to turn on/off step milling)

┌───┐
│   │
│   ・Trip Meter   │
│   │
└───┘

In this section, we will be explaining about each function under Trip Meter.

Trip Meter
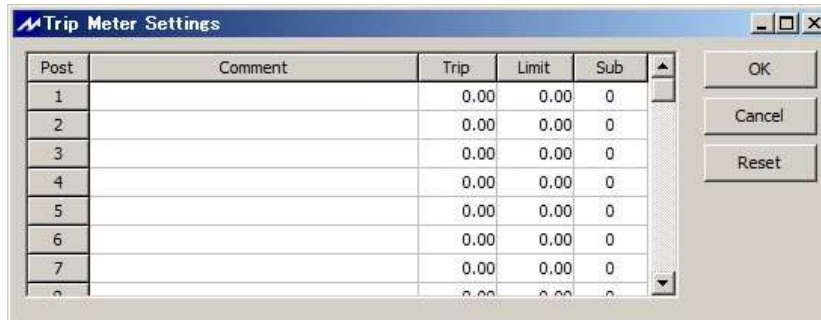
Trip Meter is a function to measure the distance which the tools traveled.

Posts: Post number of the tool (Applicable on Automatic Tool Change machine only)

Comment: Adds comment to the tool

Trip: Displays the total distance during the prototyping

Limit: Sets tool life by distance and once it reaches its limit, message will appear during prototyping

Load Trip Meter

Loads saved trip meter data

Save Trip Meter

Saves current trip meter data

┌───┐
╎ ・Help   ╎
└───┘

In this section, we will be explaining about each function under Help.

Help

It will open Help window.

About

It will open version information of Design Pro.

License Information

It will open License Information window.
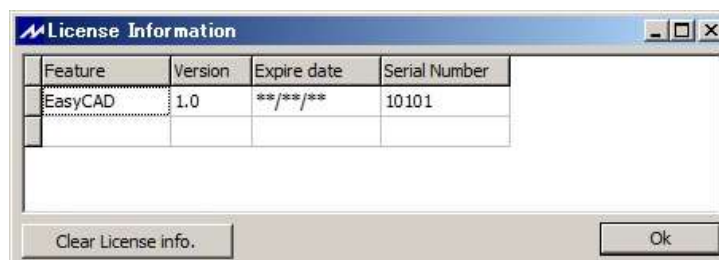
In this section, we will be explaining about P1, P2, P3 and P0.

On MITS Design Pro, there are 4 points involving prototyping the PCB; P1, P2, P3 and P0. You will only be controlling P1 and P2, however you could also change P3 and P0 as well.

P1, P2
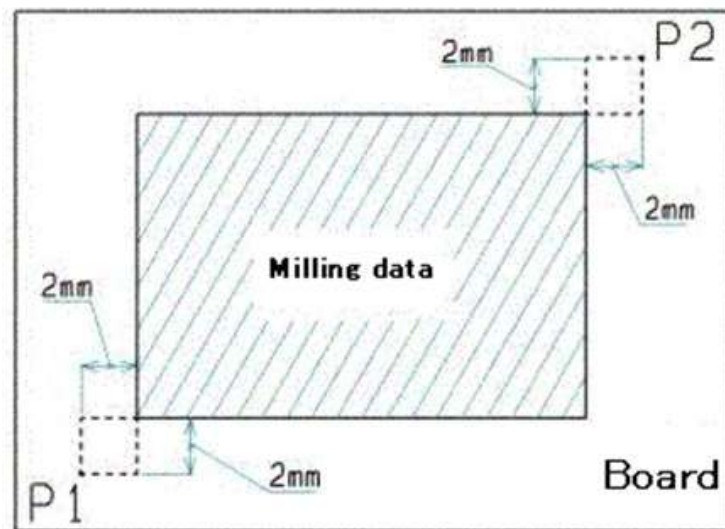
P1 and P2 are the points used to determine the actual working area on the substrate during the prototyping. As shown in the picture above, P1 is a point located 2mm to the left and down from the front left corner of the milling data and P2 is 2mm right and up from back right corner of the milling data. During prototyping, P1 position is manually set on the substrate and P2 is automatically calculated and derived.

P3

P3 point is a point in the center axis of the working area. It is located in the front side and approximately in the middle of the working table.

P0

P0 point is also know and standby point. It is a position where the machine will move into before moving in to P1 point after clicking Start Job and after completing the job. It is set in the back of the machine as a default.

```
┌─────────────────────────────────────────────┐
│                                             │
│  ・Manual Operation                         │
│                                             │
└─────────────────────────────────────────────┘
```

In this section, we will be explaining about each buttons and parameters on manual operation window.
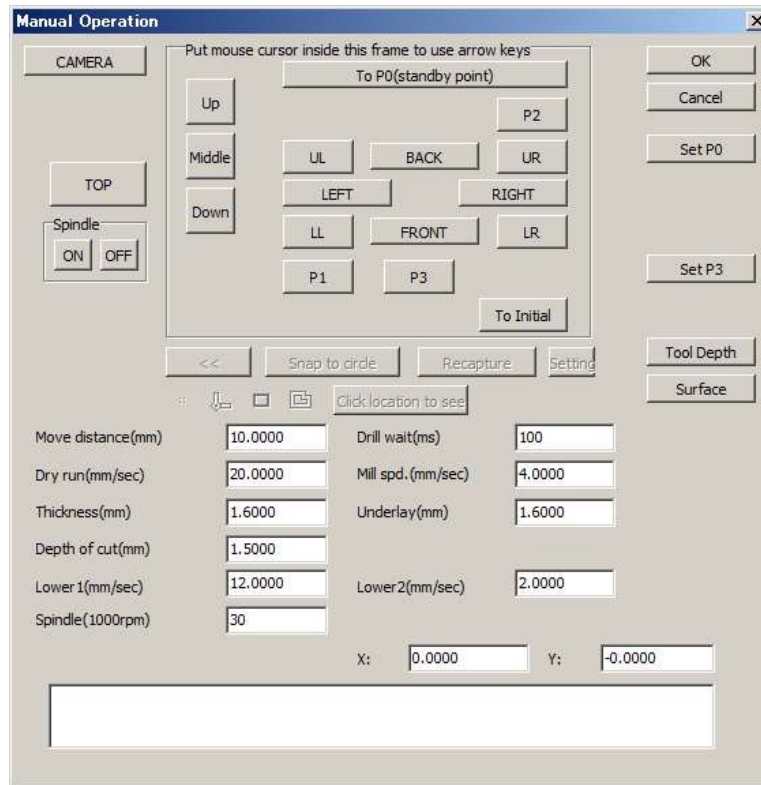
<u>FRONT, BACK, RIGHT, LEFT, UR, UL, LR, LL</u>
Moves the spindle head to the clicked direction by distance on Move distance
*UR, UL, LR, LL are Upper Right, Upper Left, Lower Right, Lower Left

<u>P1, P2, P3, To P0 (standby point)</u>
Moves the spindle head to clicked position/point

<u>To Initial</u>
Moves the spindle head to the initial position, which is the upper left corner

<u>Up, Middle, Down</u>
Moves the spindle head in Z-axis direction
*Middle position is 5mm above the surface of the substrate
** In order go into Down position, the spindle motor needs to be turned on.

ON, OFF

Turns the spindle motor on/off

TOP/BOTTOM

Shows whether you are looking from top side or bottom side and click to change

CAMERA

Spindle head will move to camera position and go into camera mode

*Launch Design View to display image from camera

Move distance (mm)

Movement distance per click

Drill wait (ms)

Wait time when the machine is in the down position while drilling

Dry run (mm/sec)

Travel speed in X, Y direction when the spindle motor is in "Up" position

Mill spd (mm/sec)

Travel speed in X,Y direction when the spindle motor is on or "Down" position

Thickness (mm)

Thickness of the substrate

Underlay (mm)

Thickness of the underlay/bakelite board

Depth of cut (mm)

Z-axis movement moving down from the substrate surface

*Note that this is not the actual depth of the cut

Lower 1 (mm/sec)

Travel speed in Z direction till 5mm above the substrate surface

Lower 2 (mm/sec)

Travel speed in Z direction from 5mm above the substrate to the substrate surface

Spindle (1000rpm)
Rotating speed of spindle motor

X, Y:
Current position of spindle head in X and Y coordinates
*P1 position is 0, 0.

Set P0
Current spindle head position will be set as P0 position

Set P3
Current spindle head position will be set as P3 position

Tool Depth
Measures the depth of cut by using the tool protrusion equipment

Surface
Measures the thickness of the substrate by using surface detecting device

Camera Mode
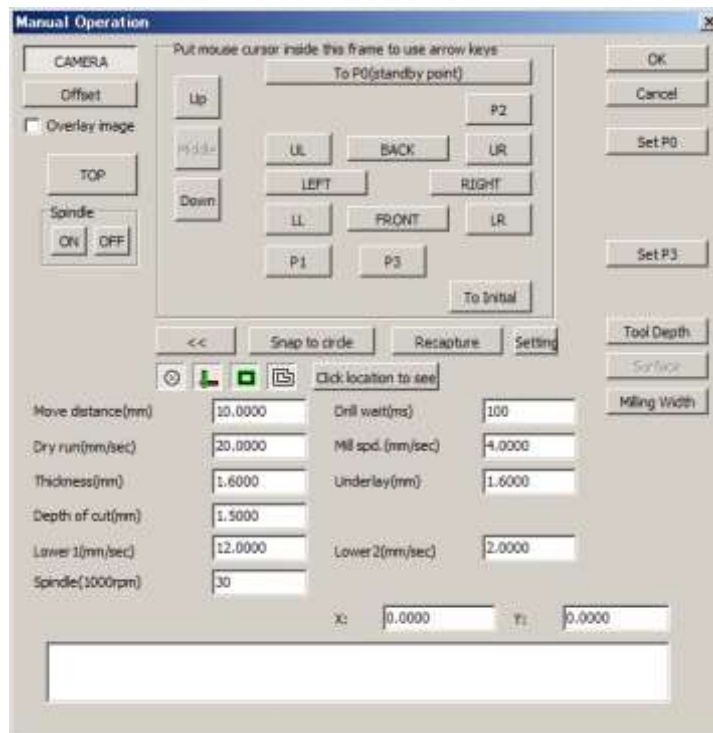
Offset
Opens Camera Offset Setting window to set offset

Overlay image

Camera will capture the image and match will design on the screen and overlay the image

Snap to circle

Spindle head will automatically move to circle/hole on the screen using the camera

Recapture

Refreshes and recaptures the image

Setting

Opens Capture Setting window
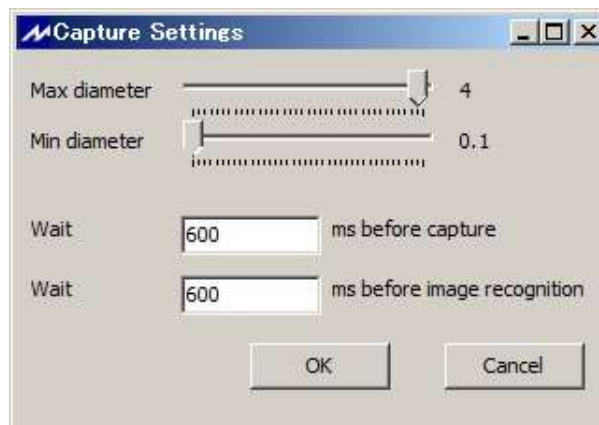
Max diameter – Maximum diameter that camera will capture

Min diameter – Minimum diameter that camera will capture

Wait ___ ms before capture – Time which the camera captures the image

Wait ___ ms before image recognition – Time which the camera begins image recognition

You may change the value for the capture and image recognition time above when Snap to Circle is not working or instable.

Click location to see

Click on the screen and camera will move to the clicked position and captures the image

Milling Width

Opens Check Milling Width window to measure the milling width with camera

Go – Marks the substrate and checks milling width

Test cut – Mills the substrate for 5 mm for test cut

As for Milling Width setting, refer to Page 50 for more details.

・Tool Change

In this section, we will be explaining about tool change for FP-21T Precision.

FP-21T Precision is a manual tool change machine and the tool change will be done using the tweezer provided as accessory.

Use the tweezer to hold the tool and turn the tool change lever to the right.
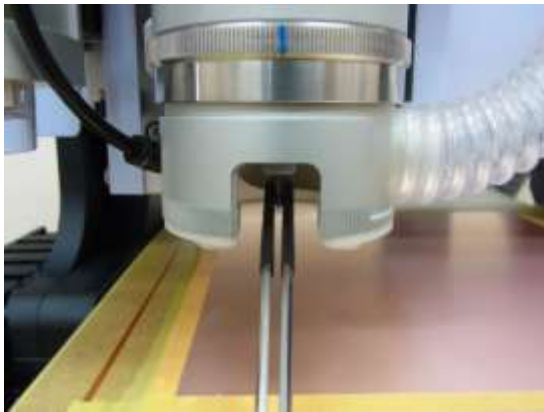
Pull the tool out and insert the new tool in the spindle motor.
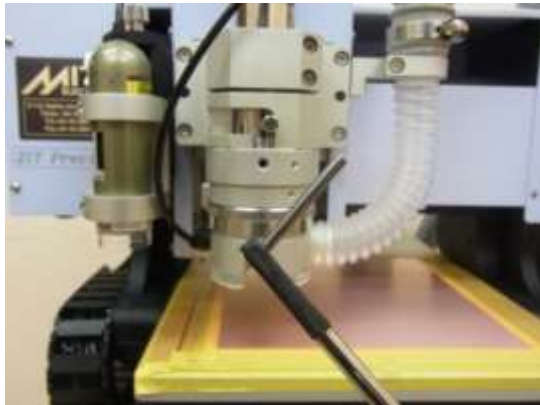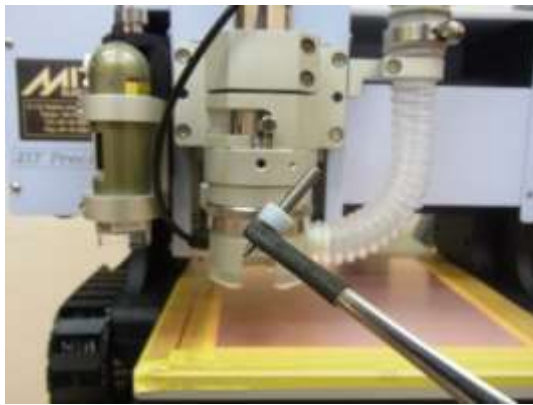
Be sure to insert the tool all the way in and turn the tool change lever to the left.
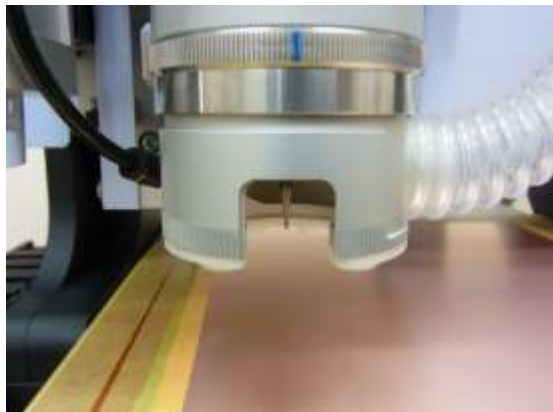
・Design View

In this section, we will be explaining about Design View.
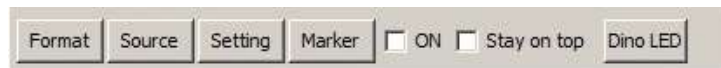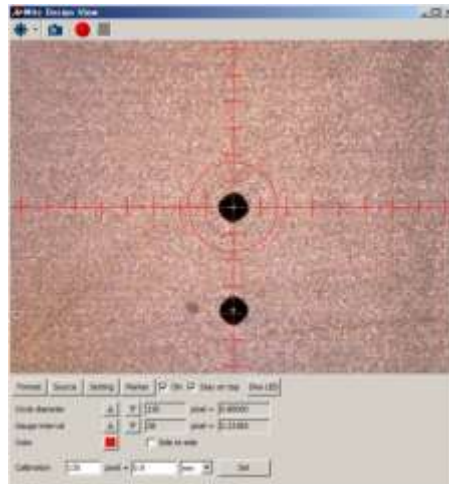
Format – Select the window size of Design View

Source – Select the source of the camera

Setting – Opens the setting window

Marker – Opens the marker menu below

On – Turns the marker on

Stay on top – Keeps Design View stay on top on the screen

Dino LED – Turns the LED light on or off
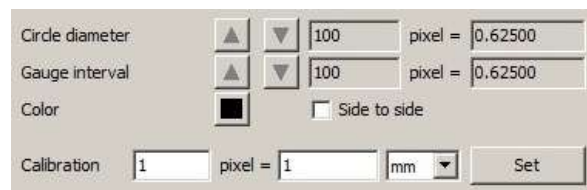
Circle diameter – Indicates the circle marker diameter and control it with the up and down button

Gauge interval - Indicates the gauge interval distance and control it with the up and down button

Color – Changes the color of the marker

Side to side – Changes the gauge interval to side to side mode

Calibration – Indicates the pixel to mm/inch conversion

*Enter **130 pixel to 0.8mm** and click set

```
┌──────────────────────────────────────────────────────────────┐
│                                                              │
│    ・Camera Offset                                            │
│                                                              │
└──────────────────────────────────────────────────────────────┘
```

In this section, we will be explaining about camera offset during camera mode in Manual Operation.

In order to use the camera correctly, it is important to set the offset of it before prototyping. If the offset is incorrect, the alignment of top and bottom will be off and milling width measurement will also be off.
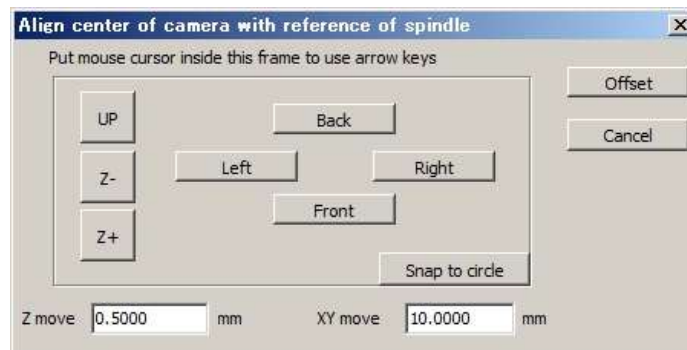
Front, Back, Right, Left – Moves the spindle head to the clicked direction by distance on XY move

UP – Moves the spindle head back up to the up position

Z- - Moves the spindle head up by distance on Z move

Z+ - Moves the spindle head down by distance on Z move

Snap to circle – Spindle head will automatically move to circle/hole on the screen using the camera

Z move – Movement distance per click for Z direction (Z-, Z)

XY move – Movement distance per click for X and Y direction (Front, Back, Right, Left)

Offset – Design Pro will set the offset to current spindle head position

Offset Setting Procedure

Offset is set by marking the substrate and aligning with the center of the camera with center of the marking after clicking Offset button.

Offset setting is done in the Manual Operation mode. Click on Manual Operation icon .

Change the tool to Milling Bit or Drill Bit. Click spindle motor **ON** and move the spindle head **Down**.
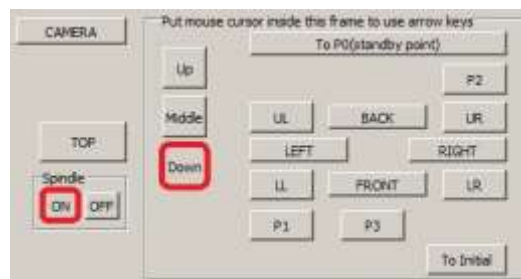
Bring the spindle head back **UP** and turn the spindle motor **Off**. Make sure there is a marking or a hole on the substrate.
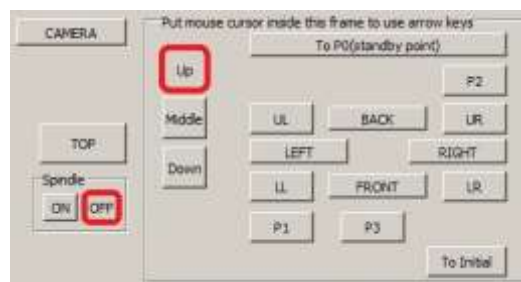
Launch Design View and click **CAMERA**. Spindle head will move to camera position. Check if the center of the marking or the hole is aligned with the center of the Design View.
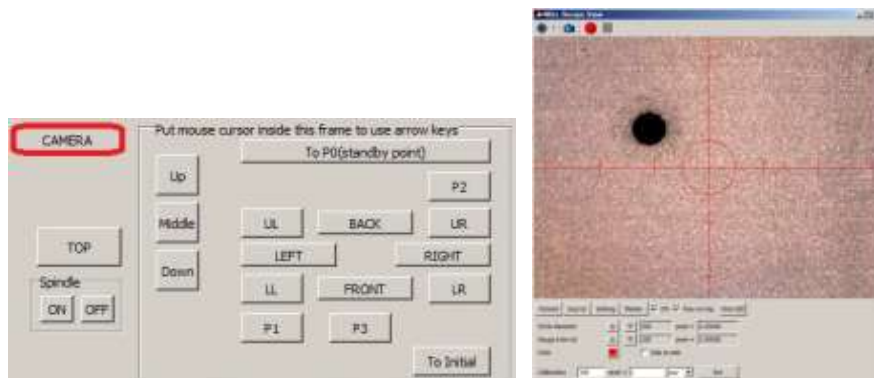
Click **Offset** and align center of camera with reference of spindle window will appear.
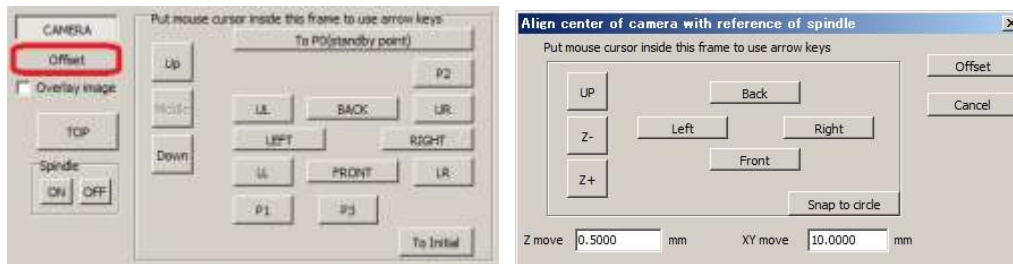
Click **Snap to circle** and camera will automatically move to the marking or the hole on the screen. Adjust by entering move distance in XY move and using the movement button if necessary.

Click **Offset** to complete the offset setting.

・Prototyping Work Flow

In this section, we will be explaining basic work flow for prototyping using FP-21T Precision.

Double-Sided Board
↓
Milling Sequence Setting
↓
Adjust
・Set P1 P2
・Set Milling Width
・Drill P1 P2
↓
Drill Top
↓
Mill Top
↓
Bottom Side Adjust
・Align P1 P2
↓
Mill Bottom
↓
Route Bottom

Single-Sided Board
↓
Milling Sequence Setting
↓
Adjust
・Set P1 P2
・Set Milling Width
・Drill P1 P2
↓
Drill Top
↓
Mill Top
↓
Route Top
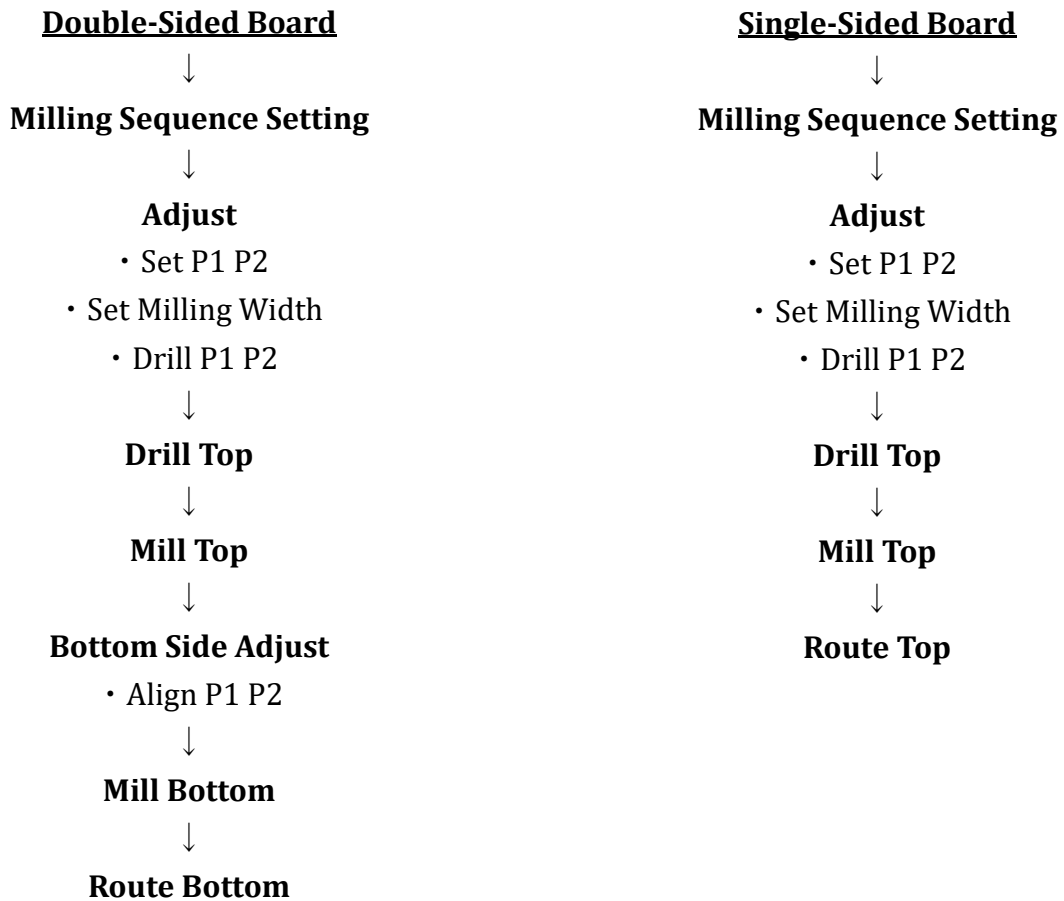
In this section, we will be explaining milling sequence setting window.

Click on Start Job icon 🔨 and Milling Sequence Settings Window will appear.
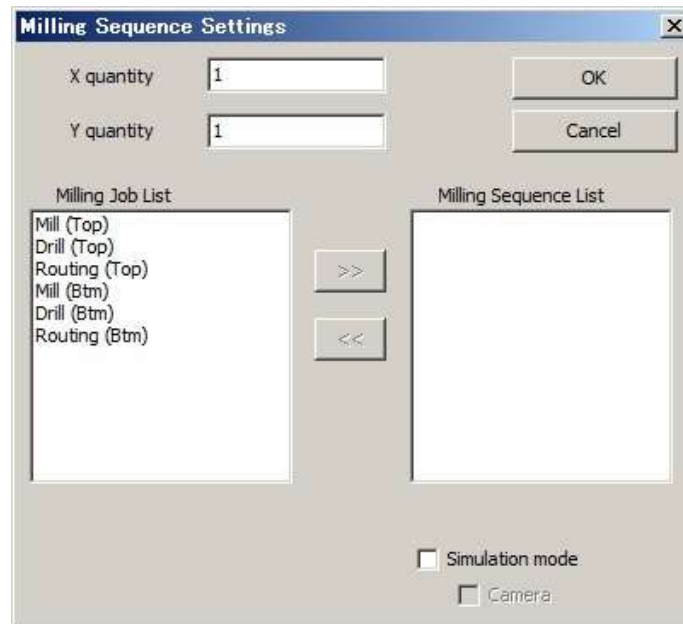
X quantity – Number of the design to be prototyped in X axis

Y quantity – Number of the design to be prototyped in Y axis

Milling Job List – List of jobs for the prototyping

Milling Sequence List – List of jobs which will be implemented in order of top to bottom

Timer – Opens Tool List window to show estimate time of the jobs

Simulation mode – Machine will simulate the prototyping by keeping the spindle head up and move only in X and Y axis

Camera – Machine will be in camera position during simulation mode

X quantity/Y quantity

X and Y quantity can be used to when you are prototyping multiple boards with same design. This will allow you to be efficient with the prototyping,

X quantity is the number of the board which will be prototyped in the X axis or the horizontal axis and Y quantity is the Y axis or the vertical axis. The P1 and P2 point will always be on the corner of the milling data.

X quantity: 1   X quantity: 3
Y quantity: 1   Y quantity: 2
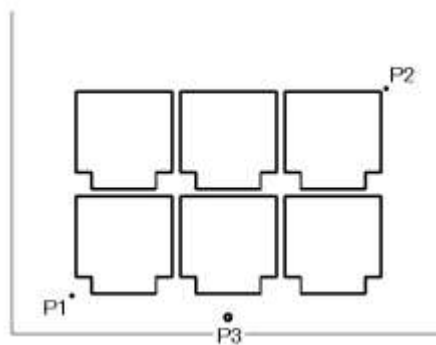
Milling Sequence Setting Procedure

PCB prototyping machine will operate in the sequence of Milling Sequence List. The ordinary PCB prototyping for double-sided board is as below.

Drill (Top)
Mill (Top)
Mill (Btm)
Routing (Btm)

Double-click on **Drill(Top)** to move from Milling Job List to Milling Sequence List.
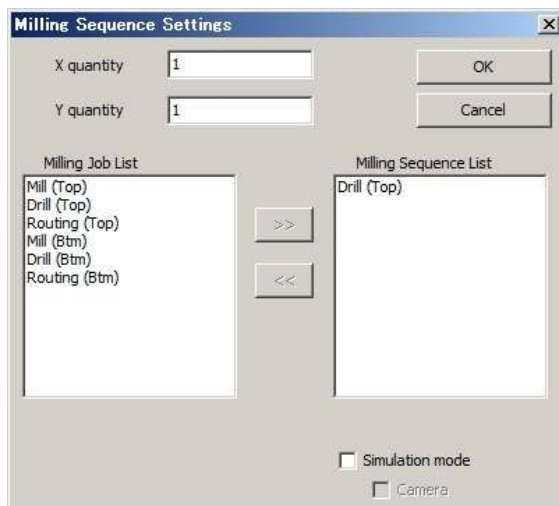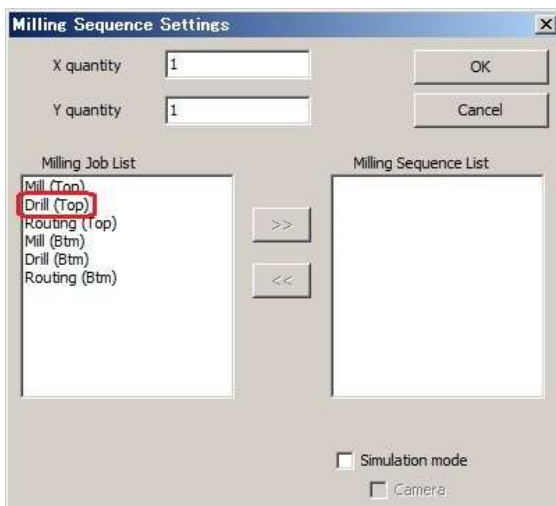
Repeat the process to move the jobs on Milling Job List to Milling Sequence List as the order below.
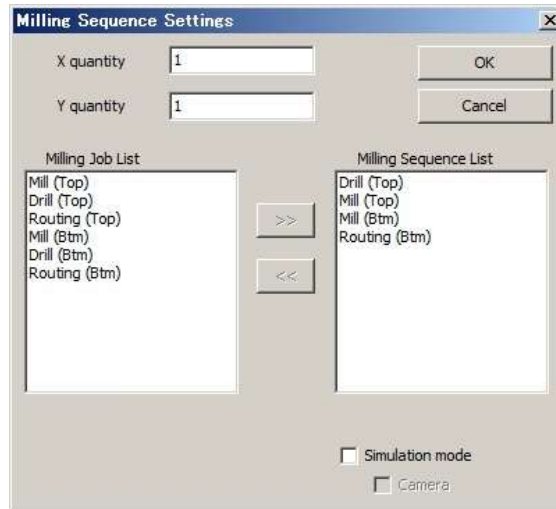
As for the single-sided board, set the Milling Sequence List as below.

Drill (Top)
Mill (Top)
Routing (Top)

Click continue to proceed. Time Estimated window will appear.
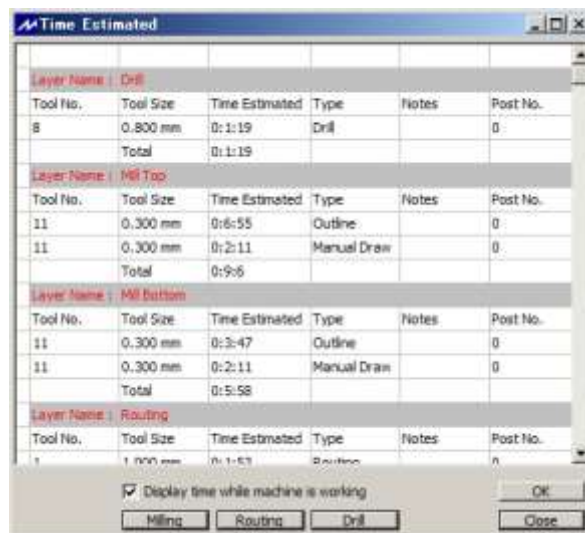
Check the prototyping time and click OK to continue.

If the Display time while machine is working is checked off, Design Pro will not display the time while prototyping and Time Estimated window will not be shown after Milling Sequence setting.

・Board Change/Adjust

In this section, we will be explaining about Board Top/Bottom Change window and Adjust mode.

Milling Job – Indicates the job which will be implemented

Continue – Continues the job

Redo – Redo the job

Skip – Skips the job

Adjust – Opens Manual Operation window

Suspend – Suspends the prototyping

Adjust

By clicking Adjust button, it will open Manual Operation window. In the Adjust mode, you will set P1P2, milling width and drill P1P2 holes for fiducial holes. Make sure to set camera offset in the Adjust mode if you haven't done so.
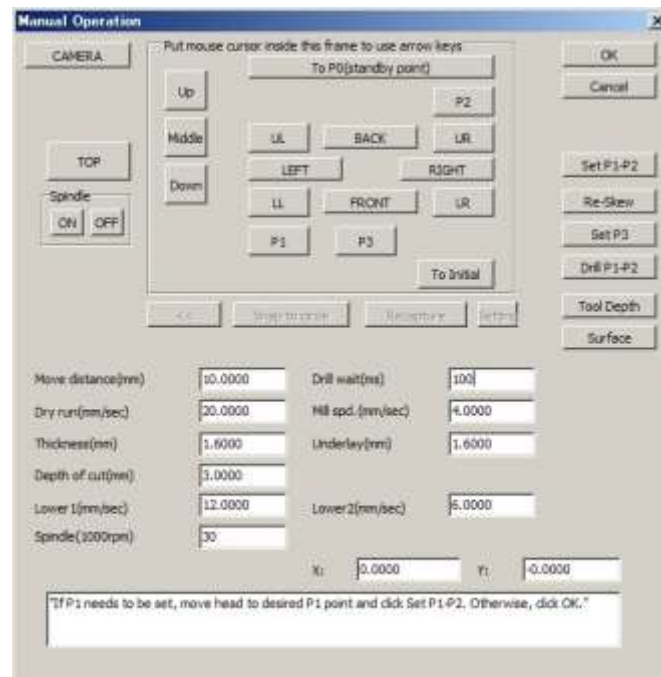
Set P1-P2 – It will set the spindle head position as the P1 point and the P2 point is derived automatically.

Set P3 – It will set the spindle head position as the P3 point.

Drill P1-P2 – It will drill P1 and P2 point automatically. Make sure to change the tool to drill bit.

Set P1-P2 Procedure

Move the spindle head using the movement button to the point where you would like to set the P1 point. Lower the spindle head to the **Middle** position to check if the pressure foot is not set on top of P1 point.
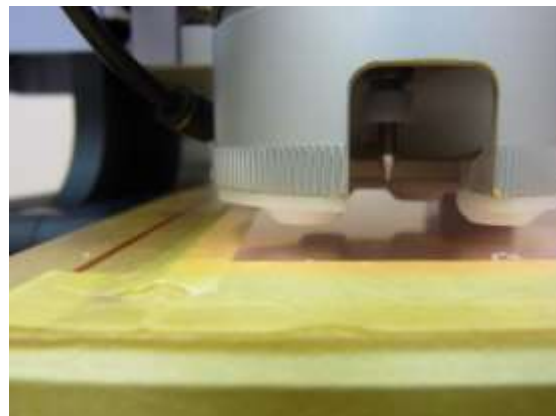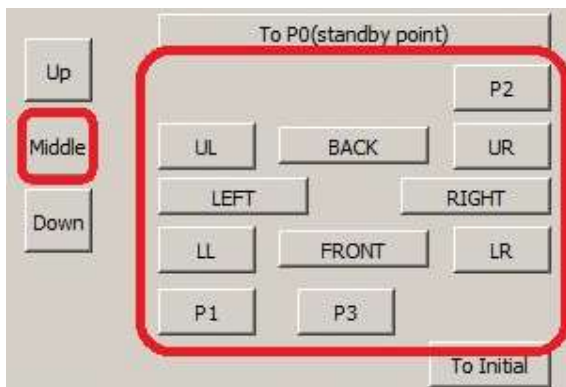
Click **Set P1-P2**. Confirm P2 window will appear.
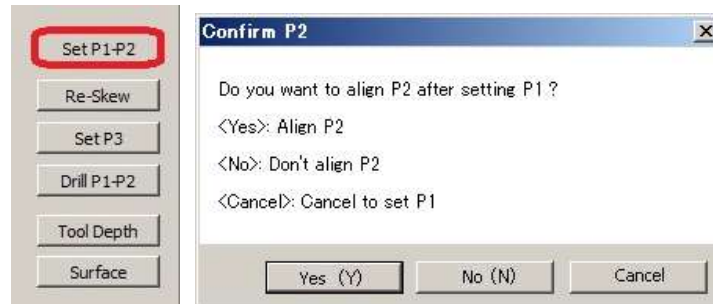
-Single-Sided Board
Click **No** since P2 point does not need to be adjusted.

-Double-Sided Board
Click **No** if you are working on the top side since angle alignment is not necessary at this point.

Please refer to Pg. 50 for bottom side alignment.

P1 P2 setting is completed. Click P1 and P2 button to check the two points are inside the substrate and the pressure foot it not on the tape.

Milling Width Setting

Go to **P1** and click on **CAMERA** and go into camera mode.
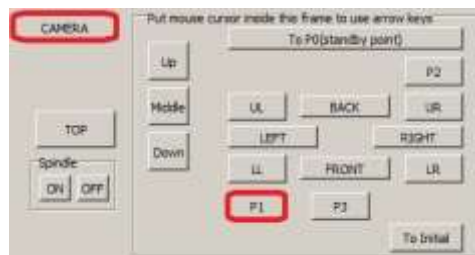
Move 3 mm to the left from P1 in order to avoid milling width setting inside the working area. Click Milling Width button.

Click **Go** to begin milling width setting. The prototyping machine will automatically turn on the spindle motor and move down to mark on the substrate.

Design View will scan the mark and measures the width. If the result is above the desired milling width, turn the depth adjustment screw to the counter-clockwise and if it's below, turn in clockwise. If there is no marking, turn the depth adjustment screw clockwise since the tool is not projecting from the pressure foot.
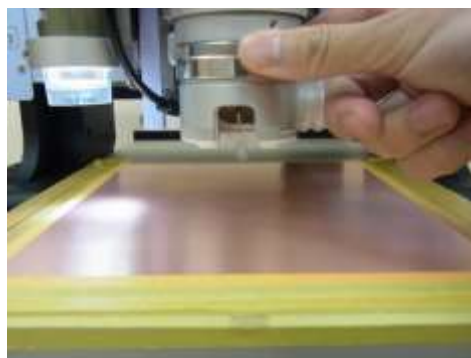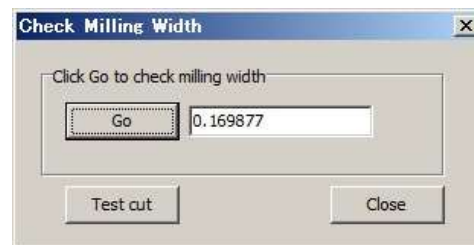
Click Go again after turning the depth adjustment screw. Prototyping machine will move back 1mm and mark the substrate. Check the result and turn the depth adjustment screw if necessary for further adjustment. Repeat until the result matches the desired milling width.

After milling width has been set, click Test cut. The machine will cut 5mm backwards. Move the camera to align with the right edge of the cut and move the desired width to check if it would align with left edge of the cut.

Lastly, use the loupe/magnifier to check the milling width. Move the spindle head back enough for that you can place the loupe/magnifier and look inside.
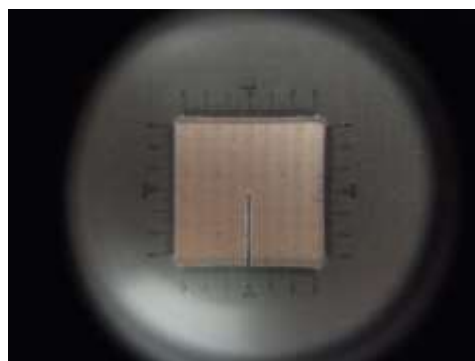
Note: Make sure to have the calibration on the Design View has been set.

Drill P1-P2 Procedure

Change the tool to 0.8mm drill bit and click **Drill P1-P2** button. Spindle head will move to P2 point and confirmation window will appear. Click **Yes**.
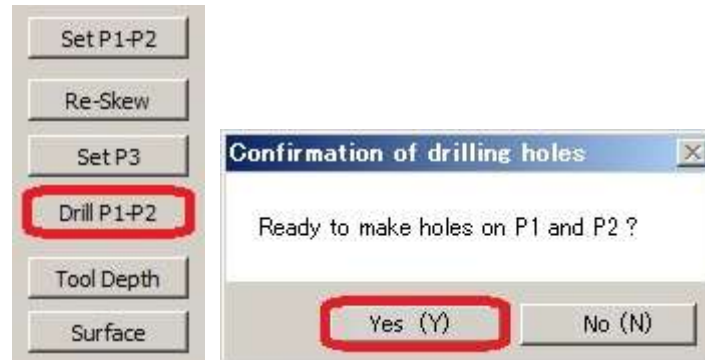
The machine will drill P1 and P2 point.
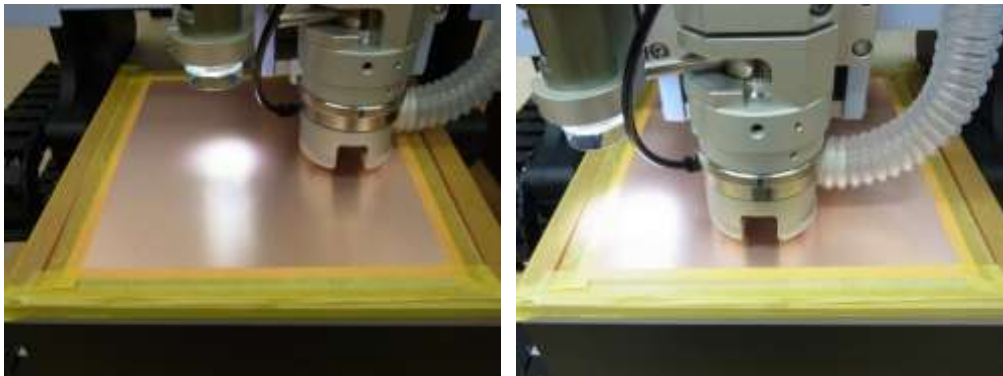
Tip: Click on CAMERA to check if the camera offset is correct. The center of the camera should align with center of the hole. Check also if the calibration is correct by matching the circle marker with the drill hole.

Refer to Camera Offset section for more details regarding camera offset.

・Milling/Drilling/Routing (Top)

In this section, we will be explaining about Milling/Drilling/Routing after adjusting in the previous section.

After clicking Continue in Board Top/Bottom Change window, CAM-TP will display Tool Change window.
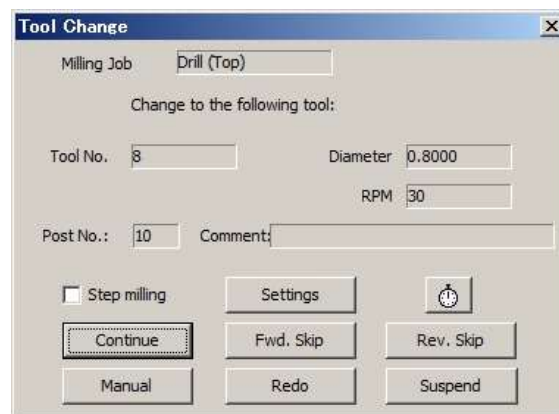
Milling Job – Indicates the type of the job which will be executed

Tool No. – Tool number of the job

Diameter – Diameter of the tool

RPM – Spindle motor rotation speed in (Unit: 1000 RPM)

Post No. – Post number in automatic tool change machine (you may disregard in FP-21T Precision)

Comment –

Step milling – Indicates if the step milling is on or off

Settings – Opens step milling setting window

Continue – Continues specified Milling Job

Fwd. Skip – Skips the job and proceeds to the next job

Rev. Skip – Skips the job and return to the previous job

Manual – Opens Manual Operation window

Redo – Machine will redo from the selected data

Suspend – Suspends and closes the prototyping

Change the tool to the tool specified in the window and click Continue to begin prototyping.
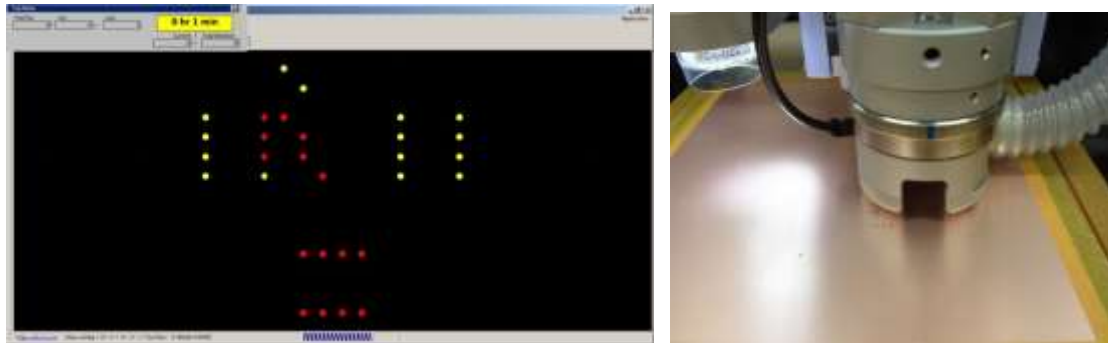
Prototyping will begin. The data in yellow are data which will be prototyped and red are data which have been transmitted to the machine already. The trip meter and timer is displayed on the window on the upper right corner.

ESC Key: Pause prototyping

To pause prototyping, press **ESC** key on the keyboard. The machine will pause from prototyping after completing the red data which has been transmitted.
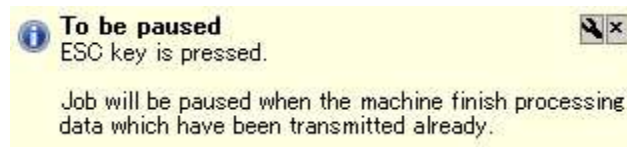
It will pause with opening Tool Change window. You may change the setting by changing parameters in manual operation window if necessary. Click Continue to resume prototyping.
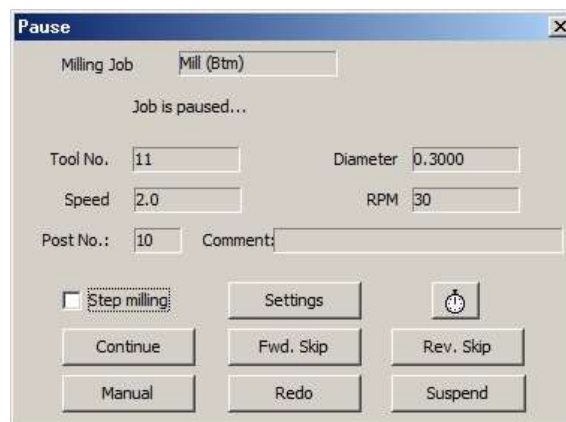
Emergency Stop

For emergency stop, turn the power switch off and press **Shift + ESC** to force quit the communication between prototyping machine and computer. Turn the power switch back on and machine will move to the initial position.

After the job is completed, Board Top/Bottom Change window will appear. Check the Milling Job to see if the order is correct. Click Continue.

Tool Change window will appear. Change the tool to tool specified in Milling Job and continue prototyping.

In this section, we will be explaining about aligning bottom side using the camera and Milling/Drilling/Routing.

<u>Align Bottom Side</u>

Before prototyping the bottom side, you will need to align using the P1 P2 holes and the camera.

When the top side is completed, the machine will move to P0 position and Board Top/Bottom Change window will appear. Check the Milling Job to see if the following job is for the bottom side.


Remove the masking tape off from the substrate. Turn the board over to the bottom side with having P1 on the right hand corner and P2 on the left hand corner. Fix the board with the masking tape.
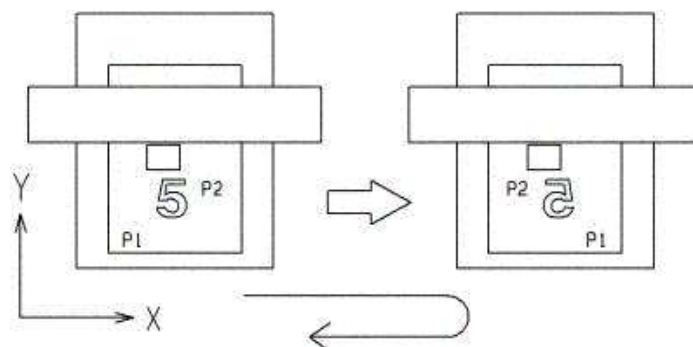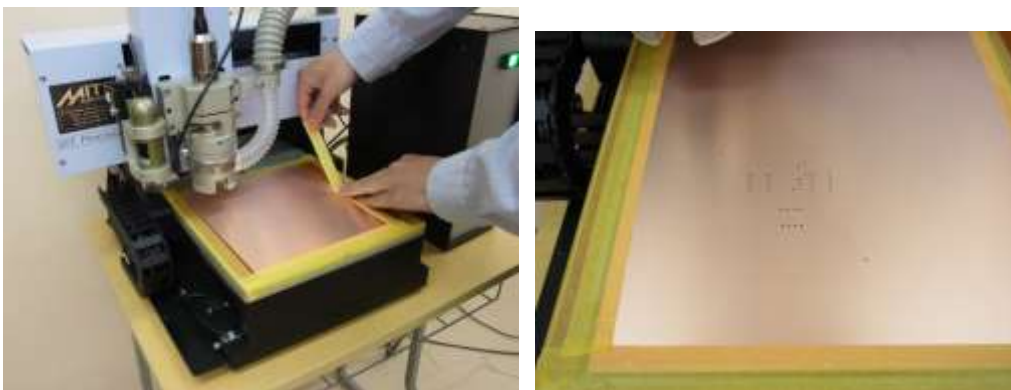
Click **Adjust** and open Manual Operation window. Click **P1** to move the P1 position.
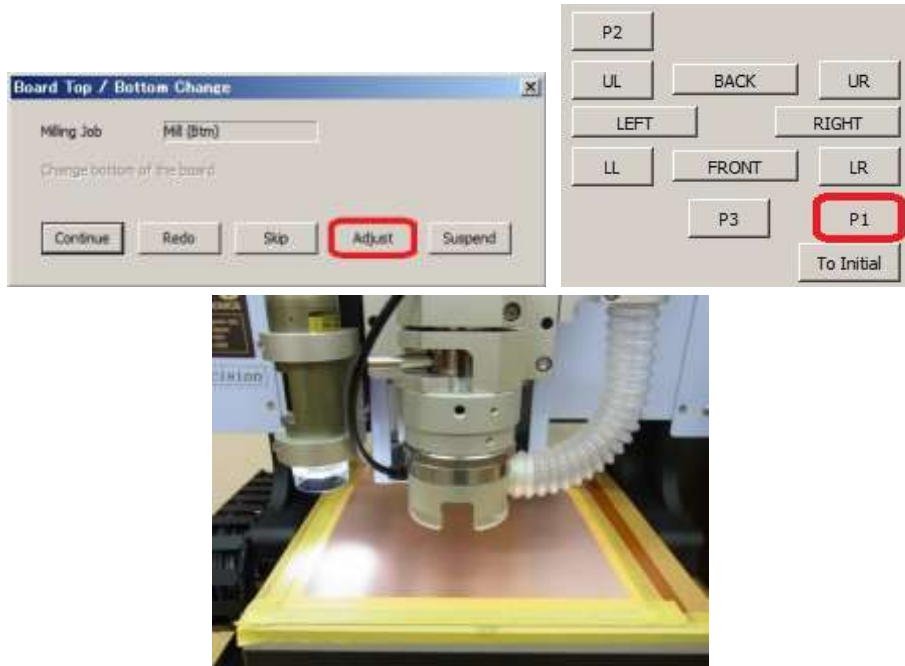
Open Design View and click **CAMERA**. Move the camera to a position where P1 point is shown on the Design View.
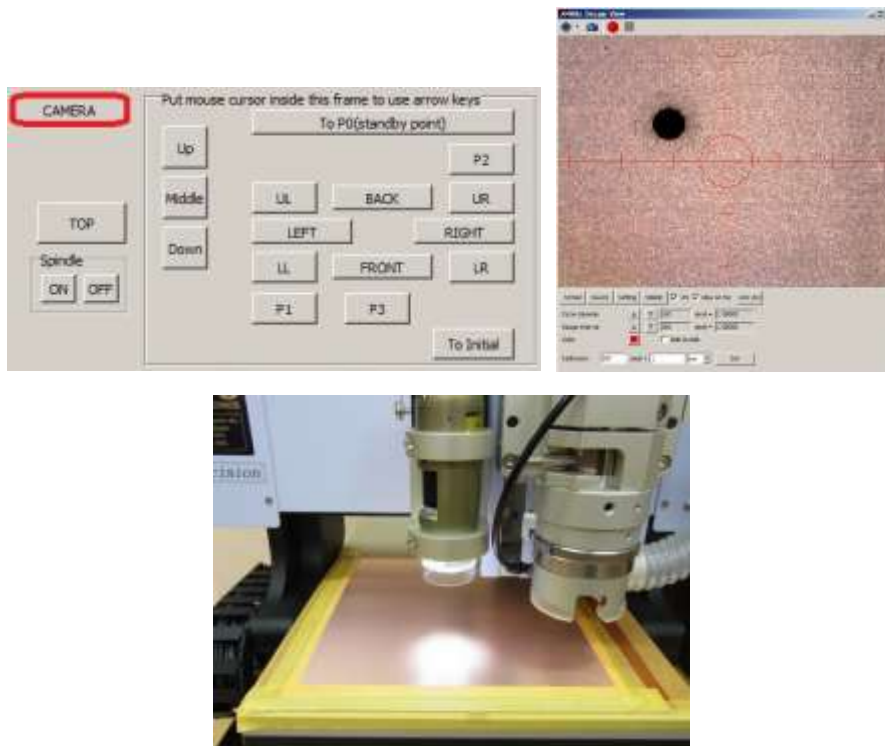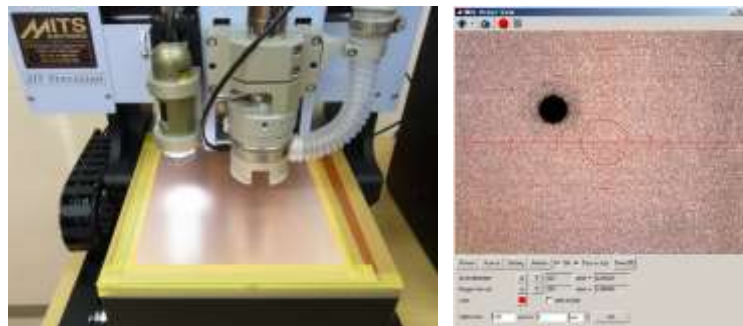
Click **Snap to circle** when the P1 point is shown on Design View. The machine will automatically move to P1 point and align. Use the movement icon if adjustments are needed.

Click **Set P1-P2**. Confirm P2 window will appear. Click **Yes** to align the P2 point.
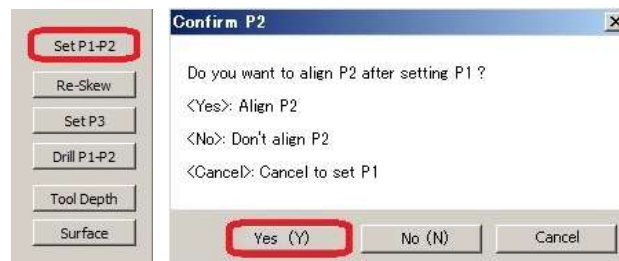
The machine will move to estimated P2 position. Move the camera to a position where P2 point is shown on the Design Pro.

Click **Snap to circle** to align to P2 point and use the movement icon if adjustments are needed.

Click **Set P1-P2** to complete the bottom side alignment. Click on P1 and P2 button to make sure that both points are aligned.
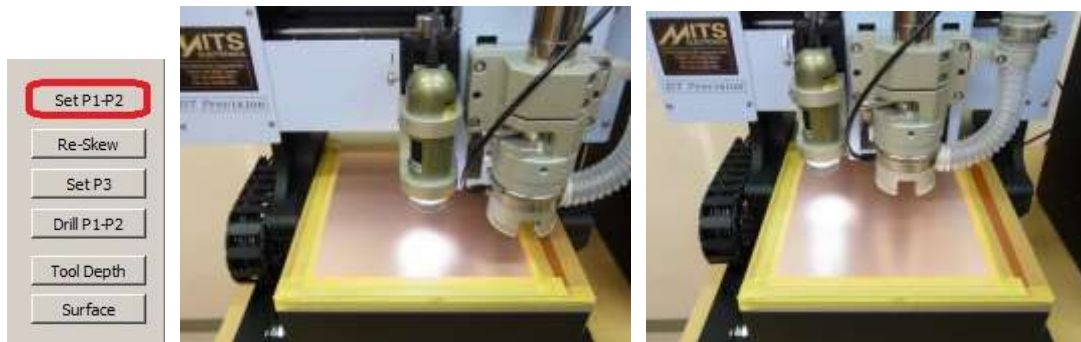
Click OK and finish Adjust/Manual Operation mode. Click Continue on Board Top/Bottom Change window and continue prototyping.

In this section, we will be explaining about procedure after completing prototyping.

After all jobs on Milling Sequence list is completed, closing Confirmation window will appear.

Restart – Restarts the prototyping from the beginning

Redo – Redo the select data

Manual – Opens Manual Operation window

Close – Closes the window and finishes prototyping

Remove the masking tape and use the brush to scrub the PCB.

Use cutter knife or nipper to separate the finished PCB from the blank PCB.

Change the tool back to dummy tool.
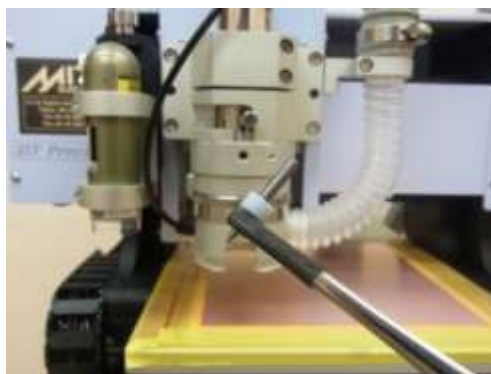
WARNING: Make sure to change back to dummy tool. The spindle motor needs to hold a tool at all time to maintain the retentive power.

Turn the power switch off.

All operation is completed.

・Step Milling

In this section, we will be explaining about step milling and its setting.

To acquire 100um or 50um milling width, you simply cannot mill the copper at once. This is because the tip of the tool is extremely fragile and broken easily.

Tool Protrusion System

Milling RF or microwave pattern requires the cutting edge to be sharp and keeping the milling of the insulation layer below the copper minimum. Tool Protrusion System measures and sets the protrusion distance of the tool tip; in other words, it measures milling depth.

First you will set zero point of the too protrusion system. Place the prism on tool tip sensor and hold it down to have the button will be flat with the surface.

Adjust the gauge and set it scale to zero with button being flat. Repeat several times to set the gauge precisely.


Change the tool to HF milling bit. Adjust the tool position by turning the depth adjustment screw counter-clockwise. Make sure that the tool stays inside the pressure foot.


*Be extra careful when handling HF milling bit with diameter below 0.2mm. They are extremely fragile and the tip will break easily.

Open manual operation window. Change the parameter on Lower 2 to 2mm/sec. Since the tool is extremely fragile, the Z-axis moving speed needs to be lowered. Double-check if the tool is inside the pressure foot and click Tool Depth.
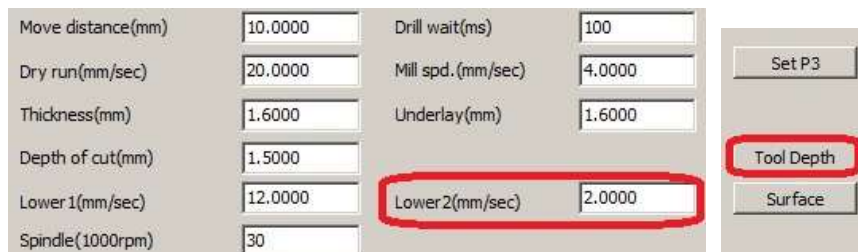
Tool Depth Information window will appear. Click OK and Check Tool Depth window will appear.
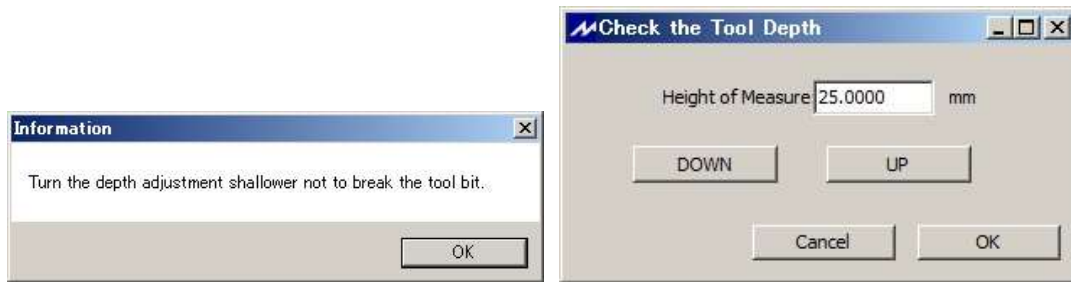
Place the tool protrusion system under the pressure foot.
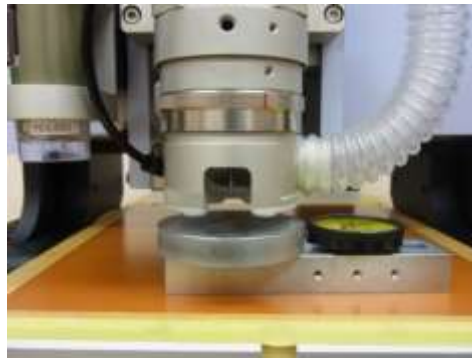
Make sure Height of Measure is set to 25mm and click DOWN. Spindle head will move down and compressed air will shoot out from pressure foot. Note that spindle motor will not turn on.

Set the depth to the thickness of the copper. Use the depth adjustment screw to adjust the depth and check with the gauge on the tool protrusion system.

After setting the milling depth, click UP to bring the spindle head back up.
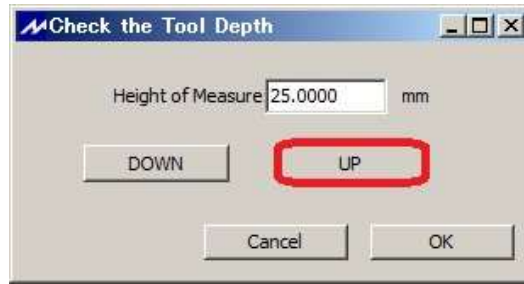
Surface Detection Device

In order to successfully complete ultra-precision milling, it is important to know what the exact thickness of the substrate is. Surface Detection Device is used to measure the distance between surface of the substrate and the bakelite/underlay board. Note: The setting will be done in Manual Operation window.

By using the surface detecting device, the machine will detect when the tip of the tool, attached with Electrode 1, comes in contact with the substrate, with Electrode 2-A or B on top.

1 – Connecting Cable
2 – Electrode 1-A
3 – Electrode 1-B
4 – Electrode 2

Note: Make sure to use the surface detection device after using the tool protrusion system.
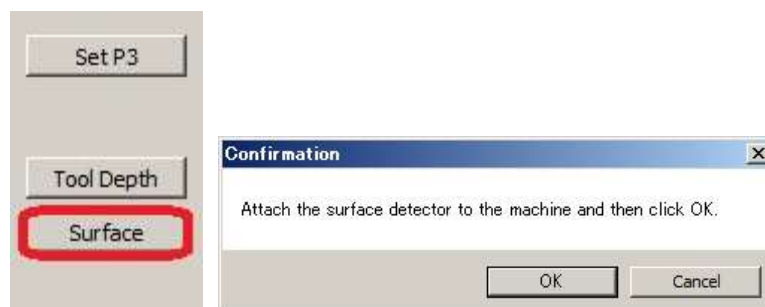
Connect the Electrode 1-A and Electrode 2 to the connecting cable and connect the connecting cable to control box.

Place Electrode 1-A on the substrate and attach Electrode 2 to the tool. Make sure to place Electrode 1-A away from the pressure foot in order to avoid contact.
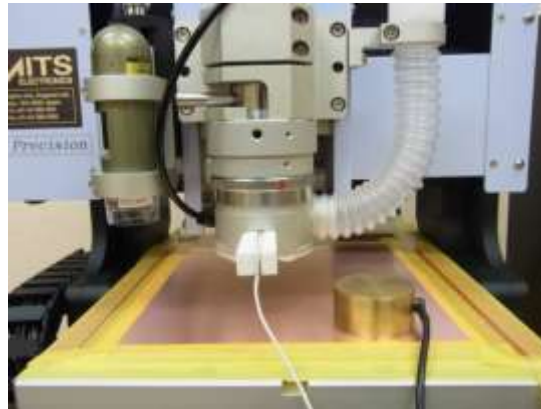
Click Surface on manual operation window. Confirmation Window will appear. Click Ok.

Spindle motor will turn on and spindle head will move down. When the tip of the tool touches the substrate, spindle head will move back up automatically.

The result will appear. Make sure to check several points of the surface since the board is not perfectly flat. Take the average of the result and enter it in Board Thickness.

Step Milling Setting
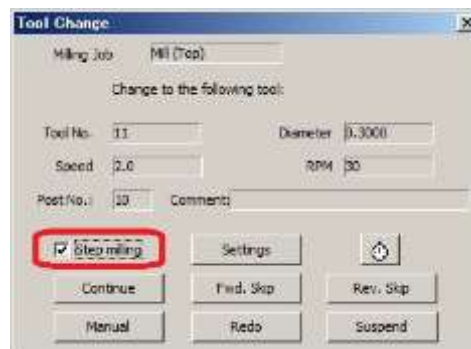
There are 2 ways to set step milling.

CAM Pref.

Go to CAM Pref. and select Milling. Click on the gray box of the tool to enable step milling.
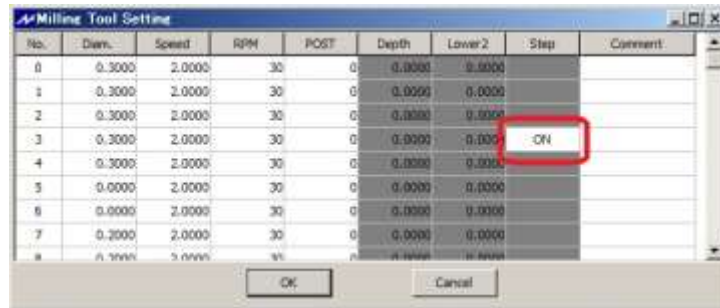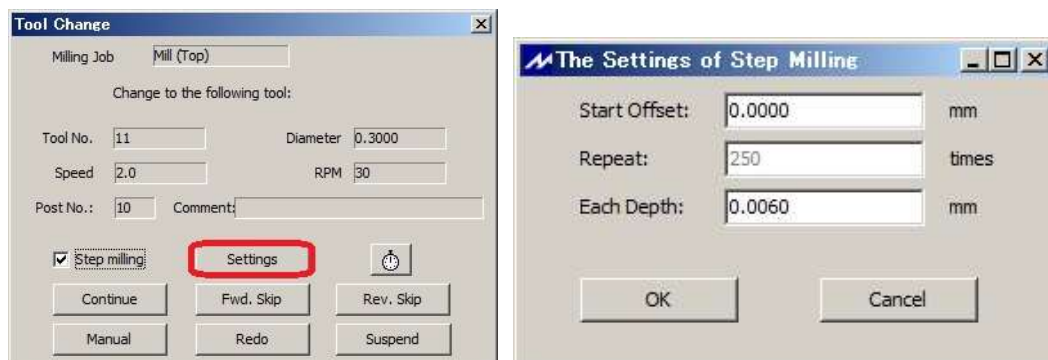

Tool Change window

Click on the step milling checkbox on the Tool Change window.

Click on Settings on Tool Change window to set milling depth for each step milling.

Start Offset – Point where the offset is started from surface of the substrate

Repeat – Number of times milling will be done (calculated automatically)

Each Depth – Milling depth of each time

Enter the appropriate value for each depth depending on the diameter of the HF milling bit and change the milling speed on Manual Operation window to suitable speed as a reference.

| Milling Width	Milling depth for each step	Milling Speed
0.05mm	0.005~6mm	1 or 2mm/sec
0.1mm	0.008~0.009mm	2mm/sec
0.15mm	0.01mm	3~5mm/sec
0.2mm	0.01~0.02mm	4~6mm/sec

Make sure to do the test cut first before prototyping and change the milling speed and spindle RPM around to find the most suitable parameters. Since each tool has individual differences, it is highly recommended to test cut deliberately with different parameters. The above parameters are simply for references.

Change the parameter for Lower 2 on Manual Operation window to 2mm/sec. This is to diminish the impact on the tool tip when the tip comes in contact with the surface of the substrate.

Note: Handle the HF milling bit with great care. The tip of the HF milling bit is EXTREMELY fragile.

Click Continue to begin prototyping.
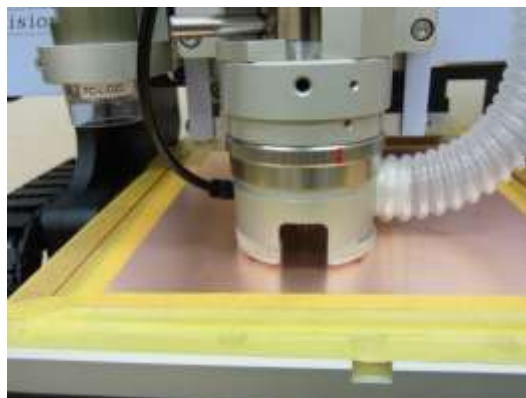
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┌─────────────────────────────────────────────────────────┐
│ ・Trouble Shooting (USB,RS232C Serial Connection)         │
└─────────────────────────────────────────────────────────┘
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１．　　Prototyping Machine does not activate after clicking 🖊Start Job icon

　　Enter SHIFT + ESC on the keyboard. Check the below points:

- Prototyping Machine Switch is On
- RS-232C Serial Cable/USB Cable is not connected

  * For RS-232C Serial Cable, use Straight connection cable.
    Do not use reverse/cross connection.

- If you are using USB, go to WINDOWS Device Manager in Control Panel. Check MITS USB driver is properly installed.

  * If the Prototyping Machine does not activate with properly installed MITS USB driver, go to CAM Prefs.→ Board Maker in Design Pro. Set the RS232C port to USB. Click OK on the Board Maker Setting window and close Design Pro. The setting changed will be applied after the software is closed.

２．　　Port Open Error message appears after clicking 🖊Start Job icon

- Go to CAM Prefs.→ Board Maker and select the port/cable you are using on RS232C port.
- After selecting to the port, close Design Pro. The changes will be applied after the software is closed.

３．　　Prototyping Machine does not activate after clicking 🖊Start Job icon.

　　If the connection does not suspend after entering SHIFT + ESC on the keyboard;

- Turn the Power Switch Off and enter SHIFT + ESC again.
- Go to Control Panel→Device Manager. Change the setting for USB Root Hub. (See next page)

＜USB Root Hub Setting＞

Go to Device Manager. Right click on USB Root Hub and select Properties.
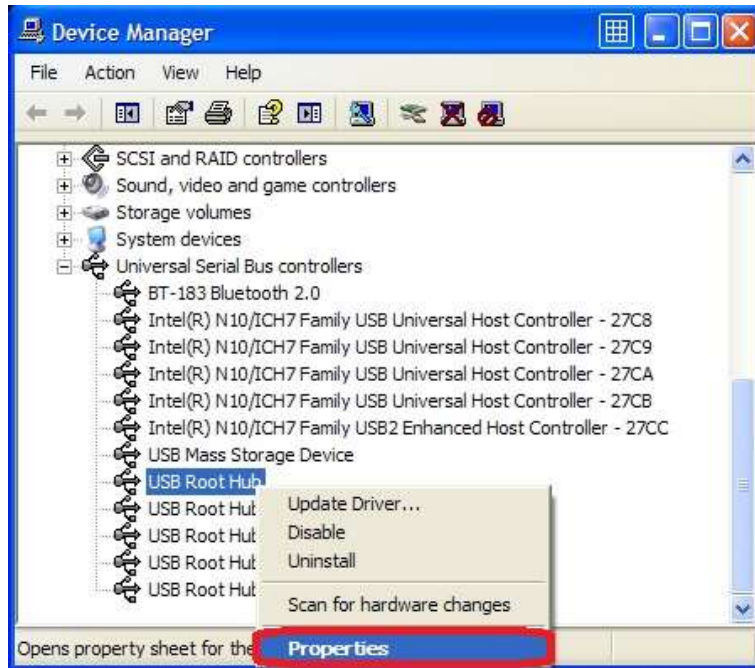
Select Power Management tab and remove the check mark in the box for
Allow the computer to turn off this device to save power.

Repeat the above for all of the USB Root Hub in Device Manager.

After setting has been changed, restart your computer.

If the connection trouble with USB cable does not resolve with the above, please use the USB Serial converter cable. We kindly ask you to source locally.

・Trouble Shooting (Prototyping Machine)

◆ Working Area

When the machine moves out of the working area during processing or manual operation, the error message will appear.

Hardware Limit Error: Recovery (Manual Operation)
Click Initial. The spindle head will move to initial position and recover from hard limit error.

Hardware Limit Error: Recovery (While Processing)
Click Suspend.

If ⧖ is shown and stays, enter SHIFT + ESC on the keyboard.

After doing so, turn the power switch off and back on.

◆ Step-Out

When step-out occurs, the software coordinates and the actual coordinates will be misaligned. Click Initial button in Manual Operation window to move the spindle head to initial position to realign the origin coordinates.

◆ Lubricate Lead Screw

Lubricate the lead screw using the oil when abnormal sounds occur from the X, Y, Z-axis while processing. After coated with the oil, move the spindle head with manual operation to coat evenly.

(Suggested Product： STP OIL TREATMENT)