MILFORD INSTRUMENTS Ltd

3-Axis Machine
Part # 5-300/301

Contents

For use with PTH PCB
10/7/02

Introduction

Thank you for purchasing our 3-Axis machine - we hope you enjoy building and using it.

The 3-Axis machine was designed to provide a suitable entry-level mechanism for experimentation with 3-axis machining and CAD/CAMM systems. It has not been designed to replace existing, higher end machines such as those produced by Roland et alia. The emphasis is on accessibility - the machine as supplied uses a Microchip PIC to control the 3 stepper motors and communicate with the PC. The board also allows the standard controller chip to be replaced with our School Stamp2. This is based on the Parallax Basic Stamp2 and allows the user to completely modify the in-built firmware on the machine. The PBasic code required if using the School Stamp 2 is included on the diskette- the standard controller chip uses a compiled version of this.

Whilst the 3-Axis machine is primarily for development purposes, it is always nice if it will achieve some useful purpose immediately when built. To this end we have included several Windows programmes:

PCBDrill allows the 3-Axis machine to be used to drill Printed Circuit Boards,
Replay allows a series of moves to be scripted using the keyboard
Plotter allows the machine to import simple HPGL files (eg for light engraving).

If you wish to experiment further- the VBasic source code for these applications is available for download from our web site (www.milinst.com). Please note that we cannot support code that has been modified.

We suggest you assemble the machine in the order covered in this booklet. If you have any problems or find any section totally unintelligible, please call and let us know.
We would also be very pleased to talk to you if you do develop some nice applications and software.

Electronics Board

The electronics board is supplied completely built and tested. However, we suggest you perform the following initial tests before proceeding further:

Preliminary Testing

Temporarily connect the 3 stepper motors to the terminal blocks - red to R, white to W etc.
On the power connector terminal block, connect a shorting wire between the two inner (STOP) connections.

Connect a 12vDC supply (capable of delivering 1.5Amps) to the power connector. Switch on.
The Z-axis stepper should immediately begin to rotate - *if not switch off* immediately and check all connections before proceeding further.
If the stepper appears to be juddering without precessing - one of the 2 pairs of coils is not being fully energised - check connections.

Assuming the Z-axis motor is turning, use a screw-driver to temporarily short between the S2 pins (to simulate closure of the limit stop micro-switch).
The Z-axis motor should stop turning and the X-Axis motor begin - again if not, then switch off and check the circuit components (particularly the X-Axis driver chip).
Temporarily short the S3 pins. The X-axis stepper should stop rotating and the Y-Axis motor start.

Temporarily short the S6 pins. The Y-axis stepper should stop.
The piezo transducer will briefly sound before the steppers attempt to drive the machine to its origin point.

The board is now complete and tested.
Disconnect the power supply and stepper motors and put safely to one side while the frame is assembled.

Assembling the Frame

As with most kits, the end result reflects the amount of care taken during assembly. We have tried to design out and minimise tolerance problems. The crucial actions are the alignment of the bearing runners - these must be as parallel as possible otherwise they will bind, the stepper will slip and you will obtain strange, unpredictable drilling patterns. If the axes can move freely without any binding at the ends of the travel then all will be OK. If not then we suggest you re-adjust the runner alignment.

Essentially, each axis of the machine runs on two modified drawer runners and is powered by a single stepper motor. The drive to the axis is by means of a special tension cord wrapped twice round the stepper motor shaft. The OD of the shaft is 1/4 " and since the stepper is 200 steps per revolution, this gives a typical resolution of 0.1mm (4 thou). The tension cord has been carefully chosen from a number available on the market (in fact we buy this particular cord from the US) to give a very small degree of stretch and high flexibility and longevity. The cords on the prototype machine ran in excess of 175,000 operations with no visible degradation of the cord.

Identify the various components from the enclosed packing sheet.

Modify the Drawer Runners

The 6 drawer runners require slight modification to ensure they run smoothly from one end stop to the other (at the moment there is an inbuilt braking action towards one end which is not wanted).


Figure 1- Modifying the Runners
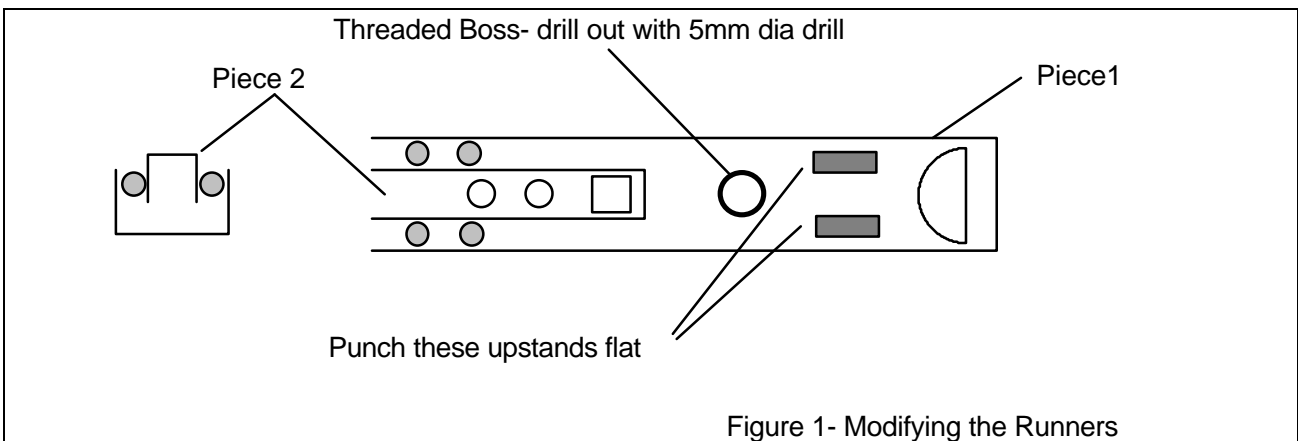
For each of the 6 runners, referring to Figure 1, locate the threaded boss on the larger of the two runner pieces, piece 1, and drill this out with a 5mm dia drill.
Using a punch, carefully flatten the two raised sections near to the boss.
Carefully remove any swarf from the runner and check it now travels freely from one end stop to the other.

Assembling the Base Platform

Take piece C: file an additional small cut-out into the Stepper motor mounting hole to allow passage of the motor wires - Figure 2:

Figure 2
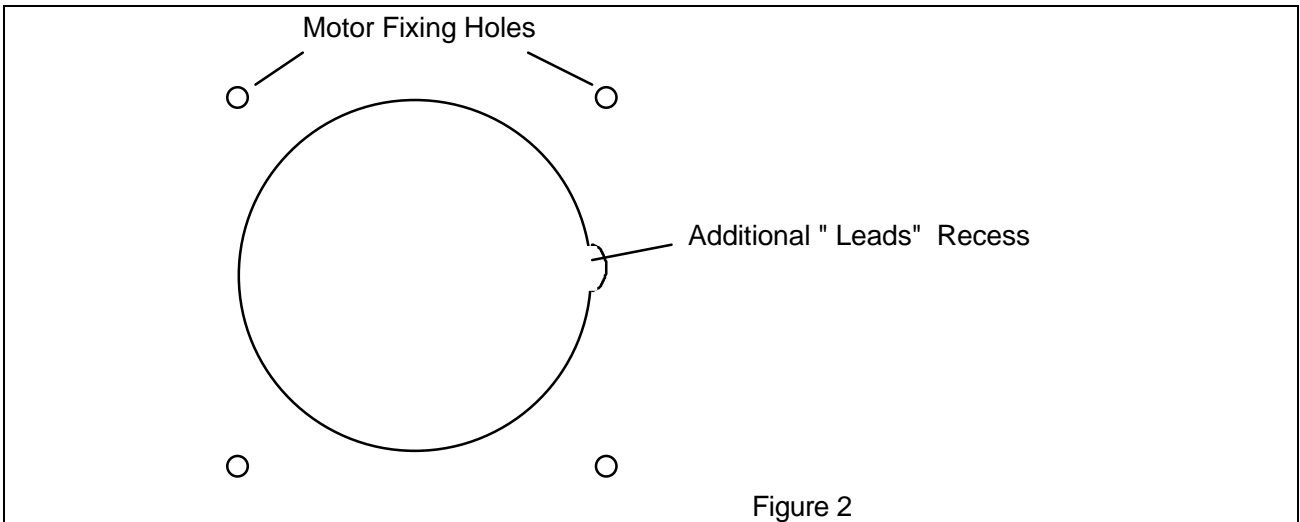
Insert the motor into the hole from the upper face (ie the motor mounting boss should be sitting on the upper surface of piece C), mark-out and pre-drill the mounting holes with a 2mm drill. Fit one of the stepper motors using 4 6x15mm long screws - this will be the Y-axis motor.

Trial assemble pieces A, B and C. They should fit snugly together to form the base as per figure 3. Check the overall width of the base - it should be 290 +/- 1mm to ensure a good fit with the Bridge Assembly later.
Remove and re-assemble but this time use a small amount of wood-working glue in the grooves and 8 7x20mm long screws. Note that the motor mounting hole is not central - during final assembly the base should be orientated so that the motor is nearest the front of the machine.
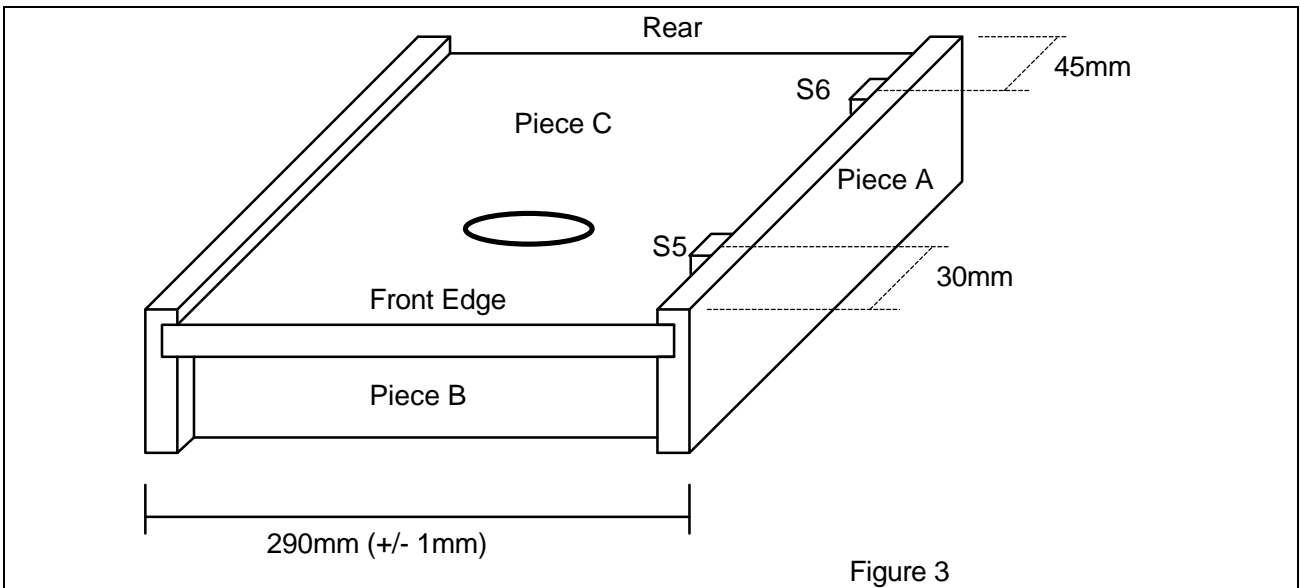
Figure 3

Fitting the X-Y platen; Piece D

Take 2 long (250mm) runners and mount them on what will become the under surface of the platen - (Figure 4) using 4 6x15mm long screws. Face 1 of each runner should be fixed to piece D. Ensure they are as parallel as possible (+/- 0.25mm is OK)
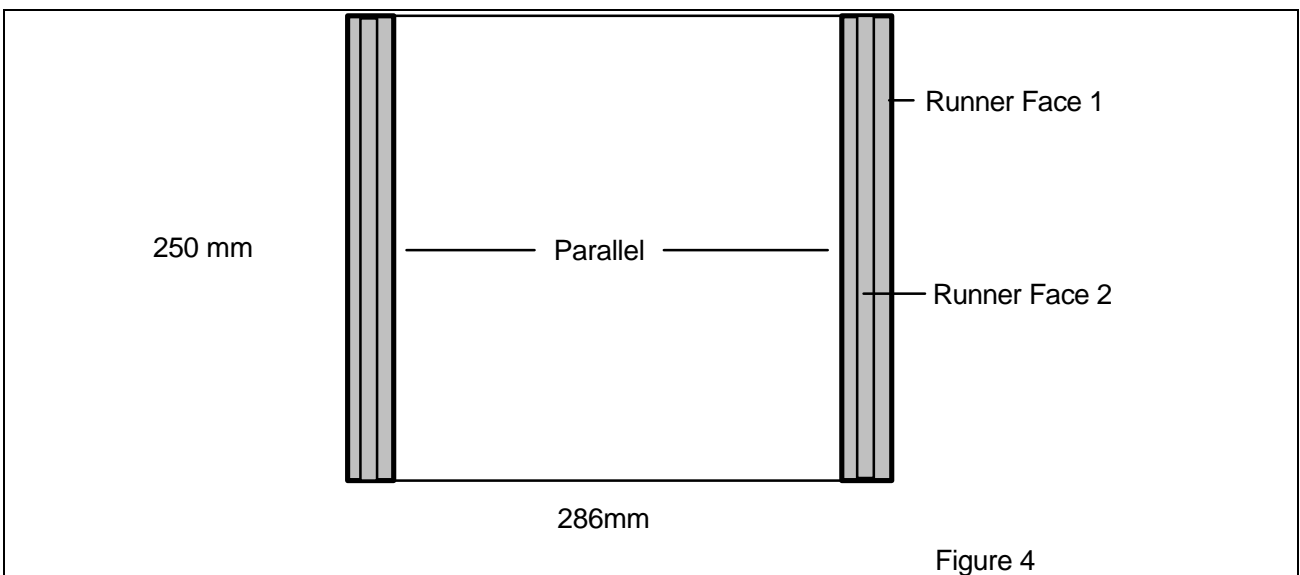
Figure 4

Position platen D over the base platform so that the runners (face 2) sit squarely on the two uppermost edges of the platform and with no overhang beyond the sides of the base (otherwise it will foul the bridge piece when fitted later on). Carefully slide the platen forward to reveal the end fixing holes in runner piece 2. Position the platen so these are symmetrical to the base platform, mark and pre-drill (2mm dia) and fix with a 6x15mm screw - Figure 5

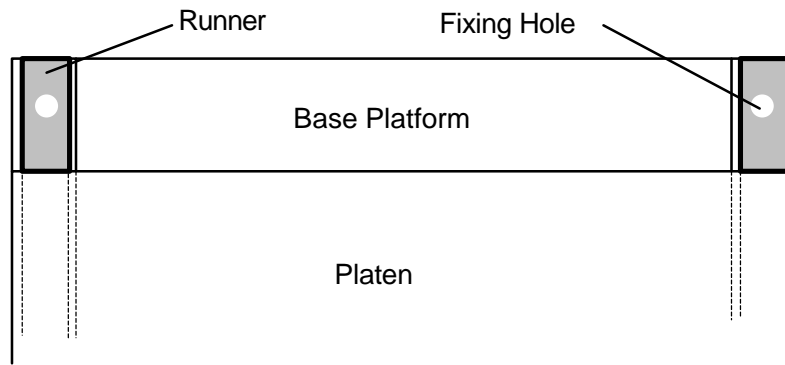Figure 5- Plan view of assembly

Slide the platen over the screws just installed to reveal the runner fixing holes at the opposite end. Align the edge of the platen to be parallel with the edge of the platform base, mark and pre-drill the fixing holes and insert a 6x15mm screw.

Check the platen moves smoothly and parallel to the edge of the platform base. If not, adjust the assembly before proceeding.

Marking-out for the Tension Cord Brackets

Slide the platen until the front edge is over the spindle of the stepper motor (or as near as possible). Mark the RIGHT-HAND edge of the spindle onto the end of the platen when viewing from the front of the machine. This mark identifies the centre-point for the tension cord fixing bracket. (Ref. Figure 6)

Position the bracket on the platen end, mark the fixing holes, pre-drill and fix using 2 6x15mm screws.

Repeat for the rear fixing bracket. - **Note** that if you now view the platen from the rear face, the fixing bracket centre-mark will now align with the LEFT-HAND edge of the motor spindle.
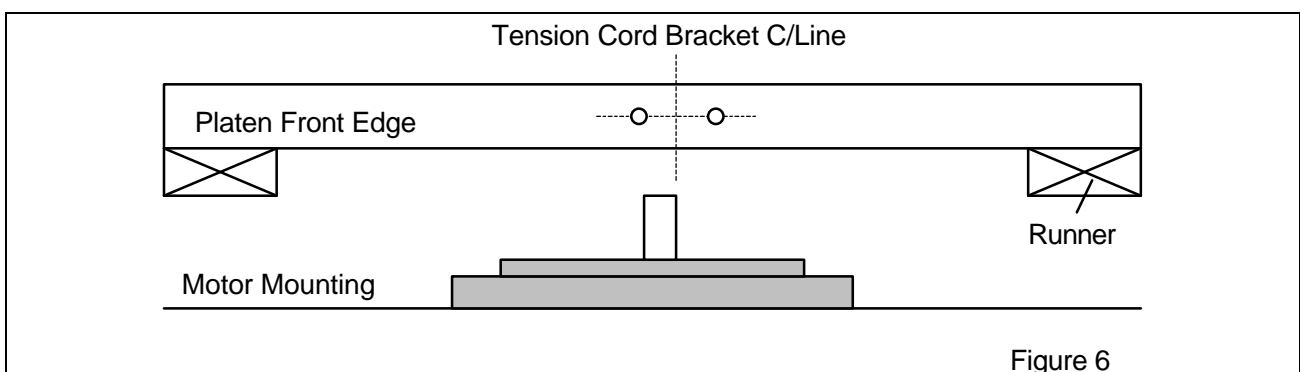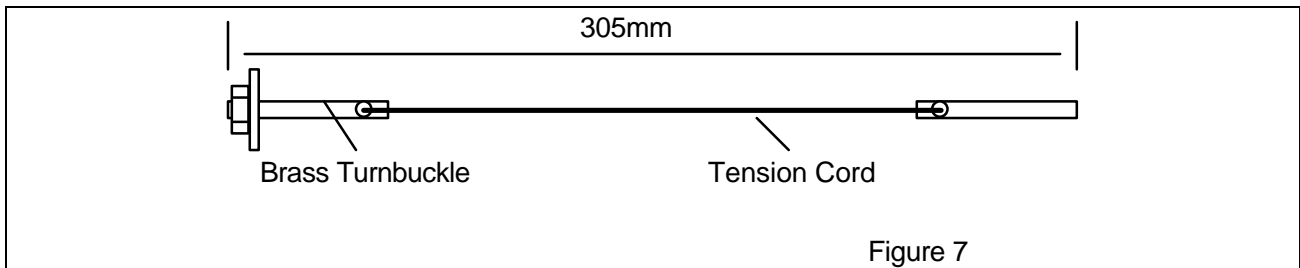

Figure 6

Tension Cord Assembly

Using the six brass turnbuckles, make up 3 tension cord assemblies as shown in Figure 7.

Figure 7

Take one assembly, slip a 3mm washer on one turnbuckle followed by an M3 nut - leave the nut on the end of the thread to aid installation. Pass the cord through the hole in one of the tension brackets, wrap twice round the motor spindle and through the hole in the second fixing bracket. Fit the remaining washer and nut and tension the cord by hand. The tension in the cord should be adjusted until the motor spindle turns reliably when the platen is gently pushed by hand.

The base platform sub-assembly is now complete.

Assembling the Drill Slide

Take piece K and scribe a line to represent the centreline of the drill. Mark-out and pre-drill two 2mm dia holes for the drill holding bracket. (Figure 8).

Figure 8
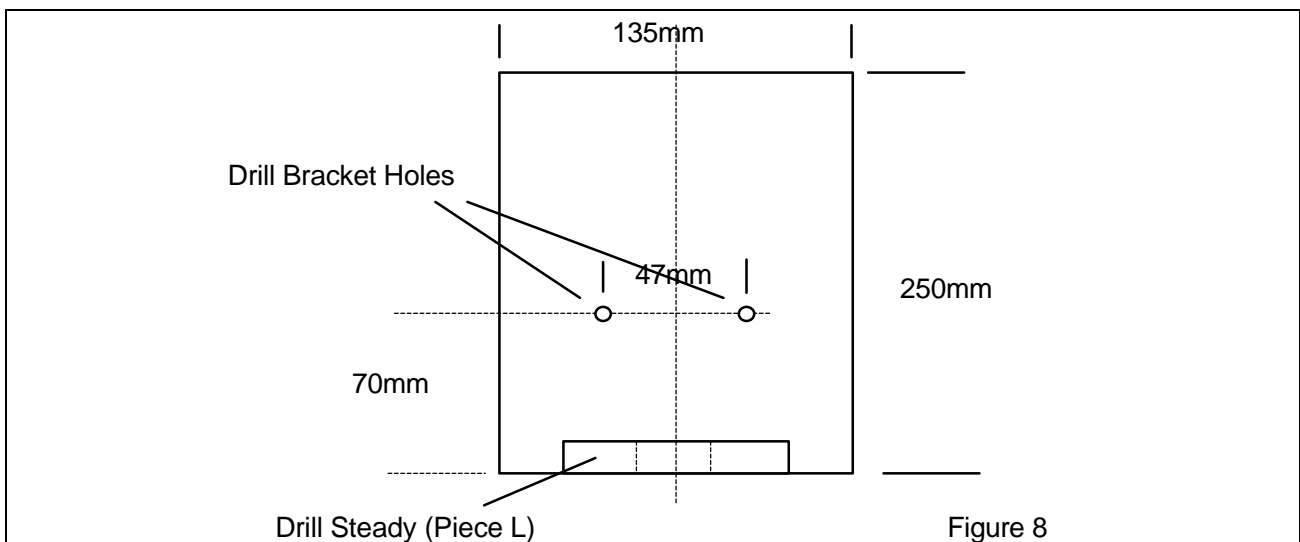
Fix the drill bracket with 7x10mm screws.
Find the centre of the through hole on the drill steady (piece L) and transfer this to the rear edge.
Fix the drill steady in place with 7x20mm screws using the holes in the drill slide.

Assembling the X-Slide

Locate the X-slide carrier, piece J. Prepare the motor mounting hole and fix the stepper motor as per the base platform motor. The motor boss should be on the surface with the twin 15mm wide slots and the motor should be orientated in the hole so that when assembled, the winding leads will be towards the bottom of the motor. - Figure 9
Locate and fit the runner slips, pieces H, into the slots in piece J using a small amount of glue and 4 7x20mm screws.

Figure 9, X-slide carrier- Front View
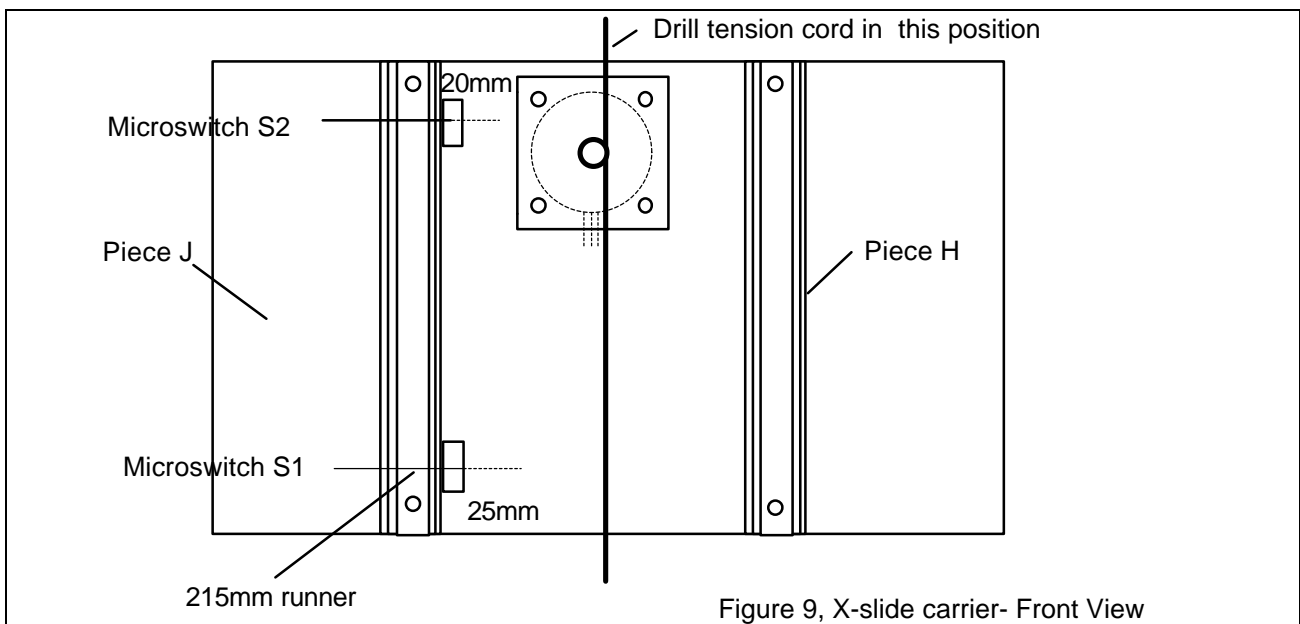
Using 6x15mm screws, fix the two 215mm runners to the top edge of pieces H - face 1 of the runners should be in contact with piece H. When fixing, ensure the runners are exactly parallel to one another and to the edge of piece H.

Position the drill plate on the runners fixed to the X-slide carrier. Mark out the upper fixing holes and fasten using 6x15mm screws as with the Y-axis runners. Adjust the drill slide so that it is parallel with the edge of the X-slide, mark out the lower holes and fasten. Check the drill slide moves freely from one stop to the other without binding.

Mark out the tension cord fixing brackets as per the Y-axis. Note the position of the tension cord is to be as in Figure 9 (if reversed, then the logical "true" motor drive direction will be incorrect). Fit a tension cord assembly and tighten. The drill-slide assembly is now complete.

Bridge Assembly

Locate piece F and modify to take the motor winding leads as per piece C.
Locate and trial assemble pieces E, F and G (5 pieces in total) - Figure 10.
the front face of piece F should be flush with the front edge of the side pieces E (and therefore the front edge of pieces G should protrude by approx 16mm).

Figure 10-Side view of Bridge
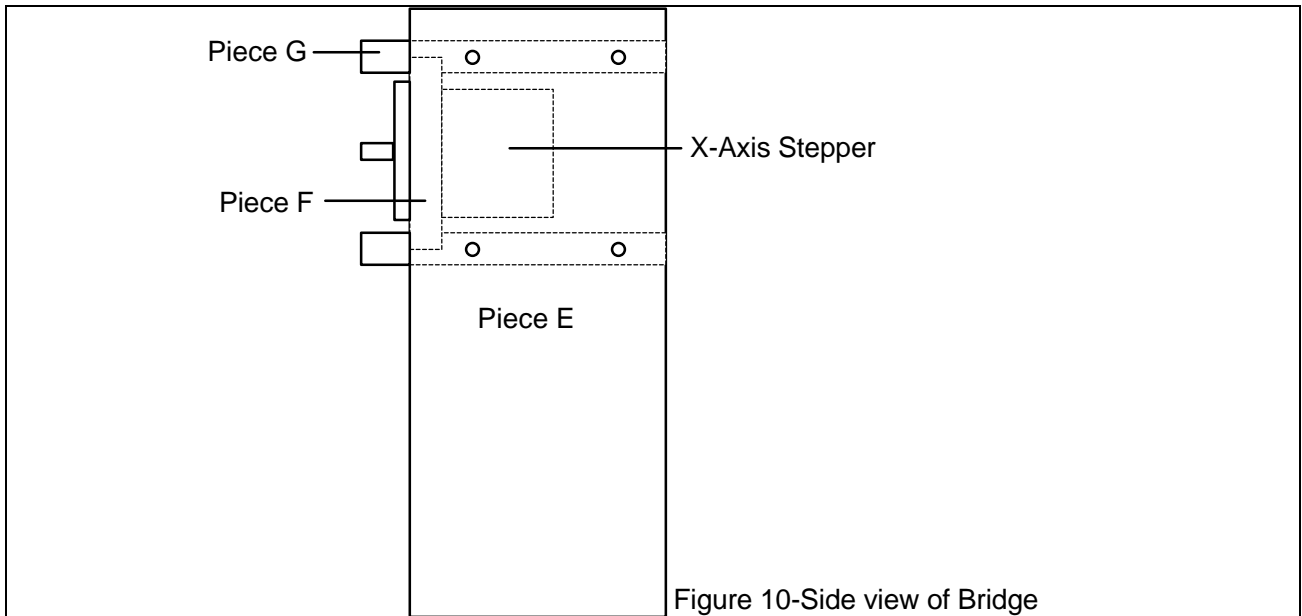
Check the opening size between the inner faces of pieces E - it should be 290mm and should agree (to within +/- 1mm) with the width of the base platform. (Figure 11)
When this is correct re-assemble the bridge using a small amount of glue and the 8 7x20mm screws.

Figure 11
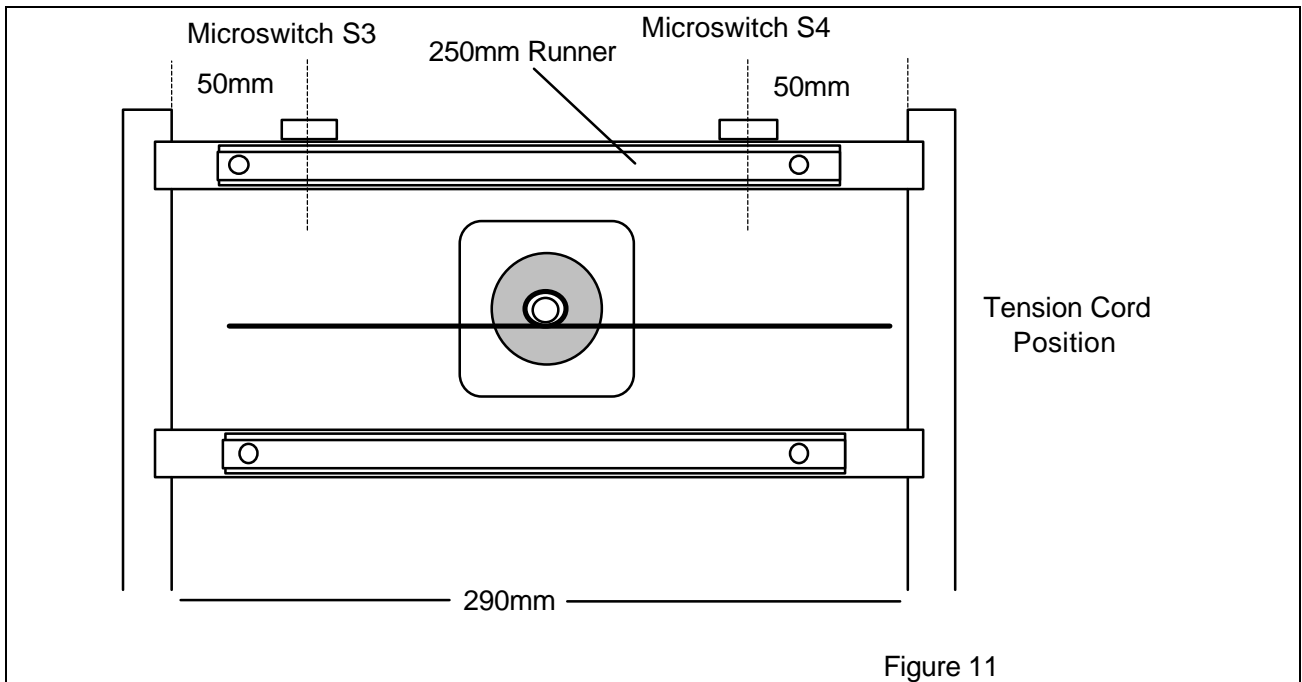
Locate the remaining pair of long runners midway along the front edge of piece G (with face 1 against piece G). Mark out and fix to G using 6x15mm screws ensuring the runners are parallel. Position the X-slide carrier on face 2 of the runners and align such that the lower edge of the X-slide carrier is flush with the lower face of the lower piece G. Fix to the runners in a similar manner to the drill-slide runners and Y-slide runners.

Check the X-slide moves smoothly between the end stops. Adjust if necessary.

Mark out and install the X-axis tension cord noting its position around the X-axis stepper motor as detailed in Figure 11.

The Bridge assembly is complete.

Final Assembly

Offer the Bridge assembly to the Base Platform assembly. The Base platform should just fit between the inner faces of the Bridge cheeks. Locate the Bridge at the extreme rear edge of the Base, check that it is perpendicular to the Base and secure in place with 8 7x20mm screws. Check all the 3 motions of the machine move smoothly from end stop to end stop.

Fitting the Limit Stops

The limit stops consist of 6 microswitches. The switches should be positioned, two per axis, such that they signal the Stamp2 to stop the relevant axis stepper motor before the brass turnbuckle becomes entangled in the motor spindle- Figure 12.

Recommended minimum

—20mm —
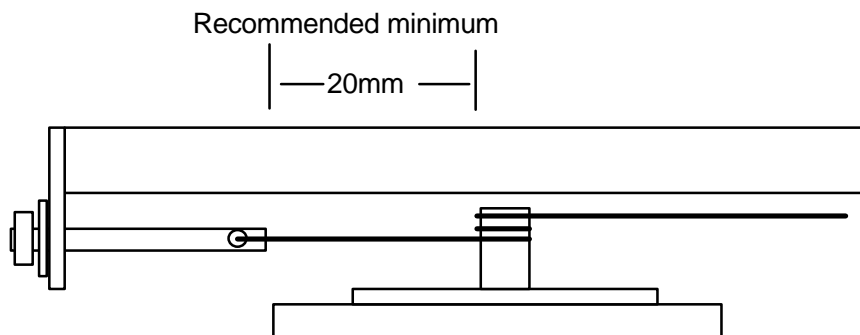
Figure 12

Separate the supplied ribbon cable into 6 separate twin tails and solder to the microswitches as shown in Figure 13.

Figure 13
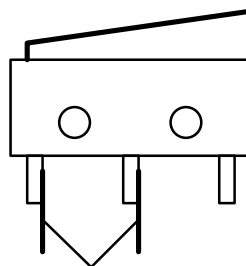
Connect to these connections

Fix the microswitches as indicated in Figures 3, 9 and 11 using the sticky pads. The measurements given are approximate and may need to be modified depending on final construction. The lever arms should point away from the centre of slide travel. Fix a 6x15 screw into each of the slides for the actuator pin - adjust the height for reliable operation of the

microswitches but with the ability for the actuator screw to pass over the microswitch. Refer to Figure 14.

Figure 14
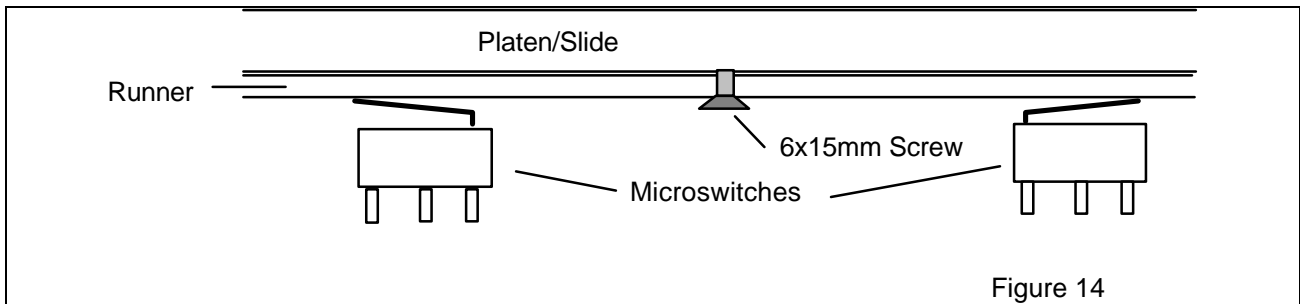
Solder the 4-core extension wire to the Y-axis Stepper motor and protect each of the joints with a length of heat shrink tubing. Drill two 5mm dia holes, one through the left-hand side of the base where it is fastened to the left-hand upright of the bridge and the second through the left-hand bridge upright into the bridge cross-over assembly. Thread the extended motor cable from the base into the rear of the bridge cross-over assembly.

Fix the electronics board to the rear edges of the bridge cross-over assembly; at the extreme right-hand end so that the D-9 socket projects beyond the upright. Use the 6 spacers and 6 6x15mm screws to provide a 5mm stand-off to the board.

Connect the stepper motors to the relevant terminal block. Route the microswitch cables to the pin header on the electronics board, trim as necessary (leave some slack for minor adjustments), fit a two pole connector and push into place.

Testing

Check the shorting wire is still in place between the "Stop" connection on the power terminal block.
Connect a 12v DC supply to the power connections.
Switch on.
The drill slide (Z-axis) should immediately start to rise - if it starts to lower, either the stepper motor connections are back-to-front or the tension cord has been fitted the wrong way round. The drill-slide will continue to rise until the upper microswitch is triggered - adjust the microswitch if this doesn't occur or check that the upper and lower z microswitches are not interchanged.
Once the drill-slide is at its maximum height, the X-slide will begin to move to the left (decreasing X) and continue until the left-hand microswitch is depressed. Adjust the position of

the microswitch and actuator screw as necessary.

Finally the Y-axis motor will start and move the platen to the rear until the rear microswitch is depressed.

The machine has now determined its absolute position in relation to the frame- the machine always performs this routine after power up and after certain commands once running.

After a few seconds the machine will move off the limit switches in the positive X and Y direction by 250 and drop to the +500 point - this point is referenced as 0,0,+500 and all subsequent movements are referenced to this position.

The drop distance of the Z axis is determined by the value in the parameters file. The drop distance is the distance from the upper micro-switch limit position to the 0-0 X-Y plane. If this is set to 2 (the default value at time of shipping) then the drill will assume that the 0,0,0 point is 2000 below the upper Z micro-switch position so will drop a distance of 2000-500 in the above routine.

Check and adjust the tension cords as necessary - too tight and the fixing brackets will start to bend! Too slack and cord will slip round the motor shaft.

Enclosure

The 3-Axis machine, although designed for experimentation purposes, could trap fingers etc during operation.
Once the machine has been built YOU will need to decide whether the machine requires enclosing to prevent injury to persons.
The machine can be housed in a very simple wooden case with transparent plastic hood - a microswitch and Emergency Stop button should be included so that opening the hood or pressing the Stop button cuts all power to the machine and drill. The "Stop" contacts on the terminal block are provided for this purpose.

The 3-Axis machine is now complete.

Installing the Drill

If you intend to use the 3-axis machine for drilling purposes, we recommend the Minicraft MB150. The following instructions relate to the MB150 and may require modification if using a drill from another manufacturer.

Push the drill through the plastic restraining clamp and into the drill steady bracket. For most purposes, this arrangement will be sufficient to firmly hold the drill. In addition you may wish to add a small amount of hot-melt glue to the drill/steady connection or loop a large rubber-band round the drill-steady for additional restraint. The rubber-band method is preferable as it will still allow the drill to move upwards if it is accidentally driven into the platen.

Inspect the drill connector and ascertain the +ve lead. Remove the plug and connect the drill to the connector beneath relay marked DRILL. If you are powering the drill from the same supply as the stepper motors, connect the +ve drill lead to the NO contact and the -ve lead to the GN contact. You will also need to ensure the jumper just above the Drill relay is set to the +ve position.

If you are powering the drill from a separate supply, ensure the jumper above the drill relay is removed completely, connect the drill -ve lead to the -ve of that supply, the +ve drill lead to the NO contact and the +ve supply lead to the Com contact. The drill will now be under software control.

To protect the X-Y platen, we recommend the use of a sacrificial piece of MDF type board. This can be easily stuck down onto the platen with double sided tape and allows the drill bit to fully penetrate the material being drilled and yet not damage the X-Y platen.

Supplied Windows Software

The 3-Axis machine is supplied with a suite of 3 programmes, Drill, Replay and Plotter
The software is based on 32-Bit VBasic and will run happily under Windows '9X operating
systems. Run the individual Setup programmes to load them onto your machine.

Our web site includes all the VBasic source code associated with these applications in case you
wish to customise them further. Please note we cannot support any customer modifications to the
supplied software.

PCB Drilling Software

Click the drill icon to open the programme.
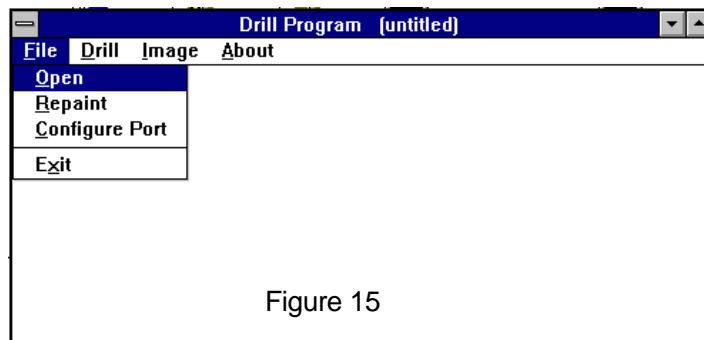
Figure 15

The drill programme opening screen is shown in Figure 15
File Menu
Open
Opens an existing Excellon type drill file (eg the file 1_477-D.001on the supplied diskette). The
default file format is XXXXXX-d.001 where X is an unspecified alpha-numeric character. Chose a
suitable file and load. The hole layout for the board will be displayed with varying colours
representing differing hole sizes. (Figure 16)

Figure 16

Repaint

Use to refresh the screen representation of the board following any changes.

Configure Port

Select between comms port 1 or 2.

Drill Menu

Click on the Drill Menu to reveal the Drill options:

Figure 17

Parameters

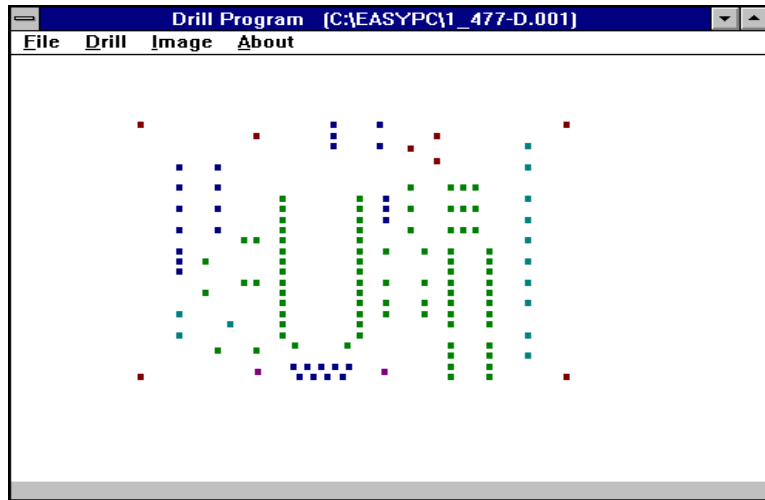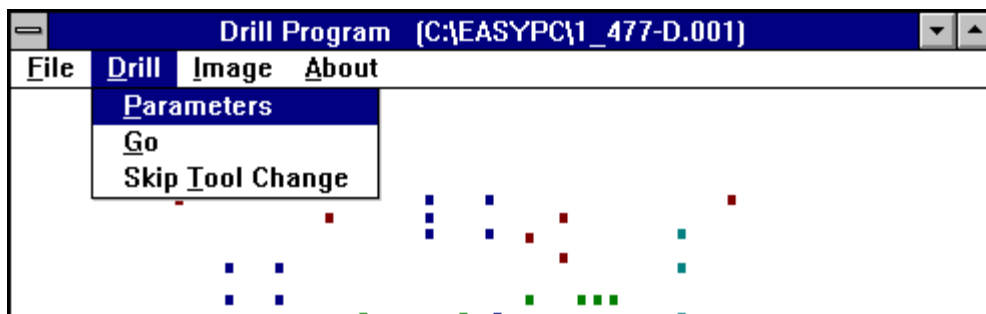| Drill Parameters				
Drill Depth (inches)	.01	Upper X limit (inches)	6
Displayed Hole Size (pixels)	2	Lower X limit (inches)	0
Small Alignment Increment (inches)	.01	Upper Y limit (inches)	6
Large Alignment Increment (inches)	.2	Lower Y limit (inches)	0
Comms timeout time (secs)	25	Upper Z limit (inches)	4
Lift of drill between movements (")	.15	Lower Z limit (inches)	0
Feed depth (inches)	.05	Hold position X (inches)	0
Stretch factor	.8200683	Hold position Y (inches)	0
Z Origin Drop Distance (inches)	2	Hold position Z (inches)	1

Enter   Cancel

Drill Depth
Drilling depth from datum point set up during the drill set-up sequence - usually from just above the pcb. Distance in inches.
Displayed Hole Size
Screen size of holes - in pixels.
Alignment Increments
Set the number of steps moved per key click during set-up adjustments - coarse and fine.
Key for fine movements; CTRL+Key for coarse movements.
Lift of Drill
Lift of drill between holes - set to clear any obstacles on the board - in inches.

Drill Feed
Feed rate of drill - inches per step.
Stretch Factor
Factor calculated during set-up; relates to the difference between the computer world and the real world. No user adjustment necessary.
Z Drop Distance
The distance between the upper Z micro-switch and the 0,0,0 plane. Please see the Testing section for more information
Upper/Lower X,Y,Z Limits
Software set limits for each axis. Note that the physical limits defined by the microswitches cannot be over-ruled. Distances in inches.

Hold Point X,Y,Z

If "Hold for tool changes" is requested, the drill will park at this position to facilitate tool changes. Distance in inches.

Image Menu
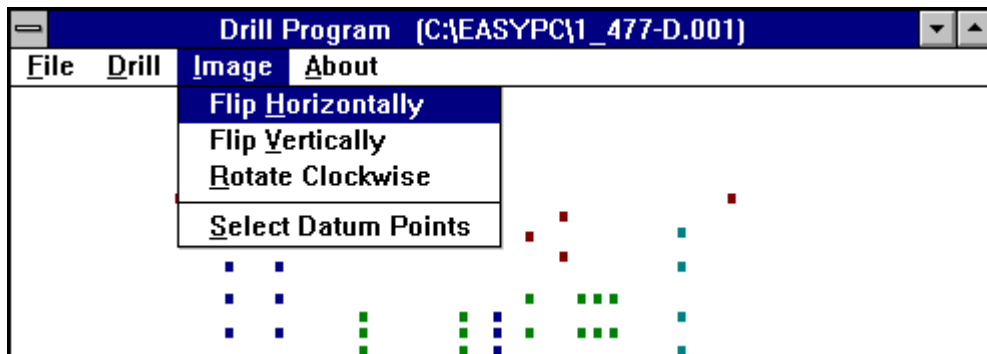
Figure 19

Flip /Rotate

Flip and Rotate the screen image to correspond to the preferred drilling orientation.

Select Datum Points

The pcb to be drilled should be positioned centrally on the X-Y platen, preferably with its principle axes aligned (roughly) with the machine axes. Tape the pcb in place to prevent it from moving during drilling.

The computer must be told the position and orientation of the board. This is achieved by selecting two (diagonally) opposite hole positions and moving the drill bit over each hole in turn. Once this is completed the computer will correctly drill all the holes without any elaborate setting of the pcb.

Click on the 2 hole positions to select these as the datum points.

Go (Drill Menu)

The drill will move to where it believes the first datum point should be. Carefully move the drill manually using the keyboard to make the final alignment. Press enter.

The drill will now move to where it believes the second datum point should be. Carefully complete the alignment using the keyboard.

The drill will now begin the drilling the holes in the sequence stored in the Excellon file (this may not appear to be the most logical sequence!).

If "Hold for Tool Changes " has been selected, the drill will move to the requested parking position and stop awaiting a new size of drill bit. You are given the option of performing a position re-calibration at this point if required.

Replay Software

The Replay Software has been developed to allow the user to script a number of machine moves without the need for detailed programming.

Install the software from the diskette using the setup file.

The drill is moved to the required position either by using the standard keyboard or by entering exact co-ordinates into the X, Y and Z boxes.
Pressing the Record button will record the current position and it will appear in the right-hand windowpane.
It is not necessary to enter all 3 co-ordinate points- the programme assumes the last noted position if none is specified.
Repeat the procedure to record a fixed path for the head.
The software supports diagonal movement in the x-y plane but not the z-plane. The speed of traverse between points may be changed by clicking the Fast, Medium or Slow buttons- the currently selected speed will appear in the recorded path pane. The actual values associated with these buttons may be changed from within the parameter file.

If traversing large distances at slow speeds, it may be necessary to re-set the comms time-out parameter to (say) 60secs otherwise Replay will time-out before the 3-axis machine completes its present task.

At each point it is also possible to select the status of Relay 1 and 2 and to insert pauses between moves -the duration of the pause may be changed within the parameter screen.

To execute a continuous loop- insert the LOOP command at the end of the tasks.
If you wish to re-establish the datum position of the head at any time during the scheduled tasks- insert the CHECK LIMITS command.

HOLD will suspend operation of the machine until instructed to proceed- ie until a new work piece has been inserted.

The on-board buzzer will sound whenever a Buzz command is reached.

One a task sequence has been scripted, it may be edited by changing the various values in the right-hand pane.

Use the Replay, Resume and Step commands to scroll through the tasks

Plotter Software

The Plot-It software allows the use of standard HPGL files with the 3-Axis machine either for plotting or LIGHT milling duty. The software does not accept the HPGL circular interpolation codes.

Installation
Run the set-up file from the diskette to load both the execution files and the Windows system files.

Software
File-Open:
Select an HPGL format file- either .txt or plt endings are common for this type of file. A sample file (sample.txt) is supplied on the diskette. Press Enter to load the file.
The HPGL drawing will now be displayed on the screen- the calculated tool paths for both with the tool up and tool down are shown (in inches) on the lower edge of the screen.

File-Configure:
Select the appropriate Comms port (1) or (2).

Plotter-Parameters:
Ensure the Stretch Factor is set to 1. This controls the relationship between machine units and real-world units and should always be 1 when using Plot-It.
Select the Slow speed option.
The "Lift of Plotter between movements" represents the difference between the pen up and pen down positions (in .001 inches).
The Upper and Lower Limits represent the maximum software allowed travel area and should be left as is for the present time.
The Hold position co-ordinates determine the rest position for tool changes (if any) and again should be left as is for the present time.

Image- Select Datum points
Click on two diagonally opposite portions of the drawing to create two Datum marks. These are used to help position the working area.

Plotter- Go
Select GO. The plotter first initialises the 3-axis machine by driving it to its limit switch positions, then moves the tool to where it believes the first datum point should lie.
Use the keyboard the make final adjustments to the required position of the datum point and press Enter. At the second point simply accept it by pressing enter. If you move the second datum point, you will change the stretch factor and machine and real-world units will differ.

The machine will begin to traverse the displayed path. Progress is shown by the colour change on the display (blue to red).

Plotting may be suspended at any time by pressing the Stop button. After this you have the

choice of either
- exiting completely,
- continuing form the present position,
- backing up a number of points (useful if you have broken and replaced a tool/pen),
- go to the hold position for a tool/pen change,
- re-align the machine (after a tool change).

It is possible with very long paths and slow plot rates that the software will indicate a comms time-out. If you find this occurring, simply increase the comms time-out factor (in seconds) in the Parameters section.

Runtime Errors
The most common errors are as follows:

Communications error: the machine is busy for a period exceeding the comms time-out parameter as set in the Parameter file. Try increasing the time-out period.

Drill Exceed Limits:
 You are trying to drive the machine outside its limits. This may occur in one of two ways:
1) If you try to drive the machine into a negative region relative to its start-up position or
2) You are trying to drive it to a positive position greater than that allowed by the upper micro-switches.

Machine Firmware
The command set for the 3-Axis Machine is as follows:

All commands are sent at 9600 baud, 8-bit, No parity bit and 1 stop bit (8-N-1).
There is no handshaking.
A 4-byte string is sent to the machine, $<C1><C2><C3><C4>$

Byte C1 contains the control code and the command is checked in the following order:
If C1=

%00011111	Reset Machine
%00001111	Pulse the buzzer for 300msecs
%XX1XXXXX	Set the delay between steps to C3 msecs (min 5 msecs, max 127msecs)
%1XXXXX01	Move to X position C2*256 +C3 steps as part of X-Y move
%1XXXXX10	Move to Y Position C2*256 +C3 steps as part of X-Y move
	(Note that the X coordinate must be sent first for paired moves)
%000XX001	Move to X position C2*256 +C3 steps
%000XX010	Move to Y position C2*256 +C3 steps

%000XX100	Move to Z position C2*256 + C3 steps	
%00001XXX	Switch the drill relay ON	
%00010XXX	Switch the second Relay ON	

C2 is the high byte of the number of steps
C3 is the low byte of the number of steps

C4 is the CRC check sum byte- it is calculated as $C1 \wedge C2 \wedge C3$ ie it is the bitwise XOR performed on a byte by byte basis:

eg C1=%10000001, C2=%00001000, C3=%00000100

C1	%10000001	
C2	%00001000	
$C1 \wedge C2$	%10001001	
C3	%00000100	
$C1 \wedge C2 \wedge C3$	%10001101	=C4

Going Further

The 3-Axis machine was designed to act as a starter platform for experimentation with NC drilling and CAD/CAMM systems.

The 3-Axis should be treated as a very light-duty machine - drilling in PCBs/plastics/wood etc. should present no problems.
If it is wished to develop milling capabilities, please bear in mind the forces in the runners and steppers and keep the feed speeds low. If you are experiencing significant stepper motor slip then we suggest you try increasing the time between steps (the Delay constant in the programmes). Stepper torque depends on the steps/second rate; reduce the rate and the torque increases. With the motors supplied, torque does not increase significantly with step delays greater than 20msecs.

The machine firmware may also be customized as the control board uses a discrete chip-set version of the Parallax BASIC Stamp2.
The supplied CD-ROM includes the code supplied with the machine plus Parallax manual and editor software.
Please note that we cannot support Customer modifications to the supplied firmware.

Technical Specifications

Maximum Machine Travel:	X-Axis	185mm
	Y-Axis	185mm
	Z-Axis	160mm
PCB Drilling Rate: (typical)		20/minute
Maximum Resolution: (any axis)		0.1mm
Maximum Traverse rate: (any axis)		10mm/sec
Stepper Motors:		
	Resolution	200 steps/rev
	Operating Voltage	18V DC Max
Power Requirements: (excluding drill)		2A @ 12-15v DC
Driver Relays:		5A @ 24vDC
Serial Connection:		D-9 Modem lead
Recommended Drill:		Minicraft MB150
Embedded Processor:		Parallax BS2-IC

Parts List:

Electronics**:**

PCB..1
Microswitch.. 6
1x2 Pin connector housing 6
Pin connectors... 12
Board Standoffs 6
Microswitch 12 way multi-core 1m
Y-Stepper extension cable 0.5m
Heatshrink sleeve 100mm

Motors: 200 steps/rev 3
Runners: 215mm long.. 2
250mm long.. 4
Frame: (5-300 only) One set Pieces A through L............. 1
Hardware: Tension Cord 1m
Tension turnbuckle c/w nut/washers 6
Tension Cord Brackets 6
Drill Bracket 1
Hole Buttons 30
Microswitch Fixing pads 6
Screws: 7x25... 38
6x15... 54

Assembly Manual 1
Software Diskette) 1