

# **LinkMotion iTest Motion for 1 through 4 Axis:**

The LinkMotion driver comes with a small application that resides in the System Tray. The System Tray is the lower right bar of the Windows screen. **Double click on the LinkMotion icon** to bring up the application. Based on the selection, the Control Pad will show up in English, Spanish, or symbols. Control Pad can be designed easily into any of the languages of the world.

**Your computer should have Windows XP operating system with Service Pak 2 (SP 2) installed, and one parallel port.**

**Do not use Keyboard and mouse connected with USB or wireless connections. Use PS2 connections only.**

**Install LinkMotion with the instruction that you received.**

## **Warning for Control Pad:**

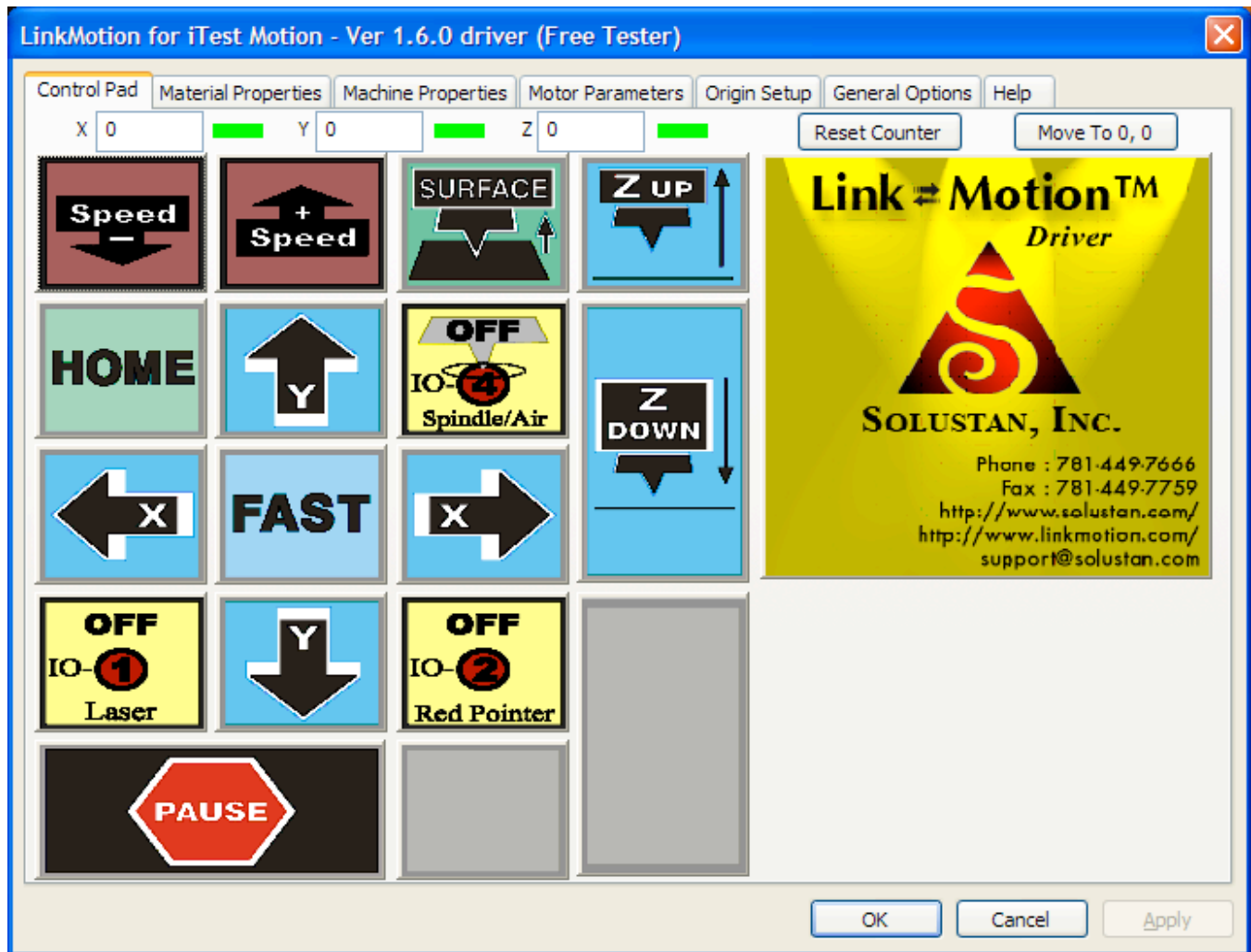
**Use the 'Zero' or the 'Space Bar' key on your keypad to Pause. When jogging the machine do not press any three keys together, it may cause undesirable results. Some times pressing two keys together for both X and Y movements can cause machine to continue moving in one direction even if you are no longer pressing the key. Pressing the same key again or the opposite direction key should stop this unnecessary movements.**

**Do not use the arrow keys elsewhere on the keyboard in place of the Control Pad keys.**

**You will not be able to test some of the functions that relate to sending the actual output on a machine from this iTest motion product. However, We have included the explanation for all the available functions as seen on the screens of each menus from the LinkMotion virtual controller driver for 1 through 4 axis machines.**

**Please refer to the last two pages for the explanation of hardware connection with Parallel port.**

## Control Pad in English:



The Control Pad is operated using the numeric keypad, the right side of the extended PC keyboard.

Click on the Apply button after any changes you make on any of the Tabs (Menus). Changes are effective only when you click on these buttons.

**Home switches** show up at the top of the Control Pad for each axis. If switches are present and properly configured, it will show **green** color when not tripped. Move the table in any one of the axis until the switch is tripped, the green color will change to **red**. Settings for the switches are in the Origin Setup menu. Changing the signal polarity by checking or un-checking the box for high or low will change the signal from green to red or red to green. Green will confirm the correct polarity of your limit switches.

**Reset Counter** – Basic function of this is to **Reset Counter to 0 the value** for each X, Y and Z axis positions. If you move the tool any where on the table, the X, Y and Z the counter will display the actual position of the tool. If you then click on the **Reset Counter** it will make all the display values to 0, 0, 0.

Machines without the Home switches or selecting a new starting position on any machines are some of the useful functions of **Reset Counter** button.

**Move To 0,0** – Clicking on this button will make your machine **move your X and Y position to 0, 0 location if the counters show values other than 0, 0**. This is a useful function for resetting back to the start position for the machines without the Home switches.

Clicking on the Solustan logo will take you to Solustan web site, if the computer is online and connected to Internet.

All the blue colored keys are designed to move X, Y, and Z axis with respective directions. Following are the keys for each axis X left (4), X Right (6), Y Up (8), Y Down (2), Z Up (-), Z Down (+) and Move Fast (5).

**Move Fast Key (5)** is pressed along with X or Y key movement to make it move faster. For faster movement you also need to have faster speed in the Move section of the materials menu. Move value is responsible for two functions. One function is **fast jog speed** and second function is **tool up speed** (also known as traversing or rapid movement) when it lifts up between the shape while doing a job.

**Z Ref key (\*)** is clicked when the tool is just touching the top of the material. LinkMotion will remember the reference surface for the job. It will use the Z reference to calculate the moves in the Z axis for the depth and lift as it processes the job. If **your machine has the home switch** for Z axis and if it is activated in LinkMotion, **Z Reference value is automatically calculated**. If **your machine does not have the home switch** then you can declare the Z Reference value in the **Origin setup in the Z offset for Start Position** and it will go up by that distance with the **Z Reference Key**. **If your Z stroke is 3 inches or more and you do not care to travel the full stroke while seeking the home switch during homing operation, you could declare Z home switch not enabled and declare your own Z-up stroke in the Z-offset in start position of Origin setup menu.**

**HOME key (7)** will move the machine to its Home position, if the machine is equipped with home switches. Machines may have home switches in X and Y axis or all the three axis.

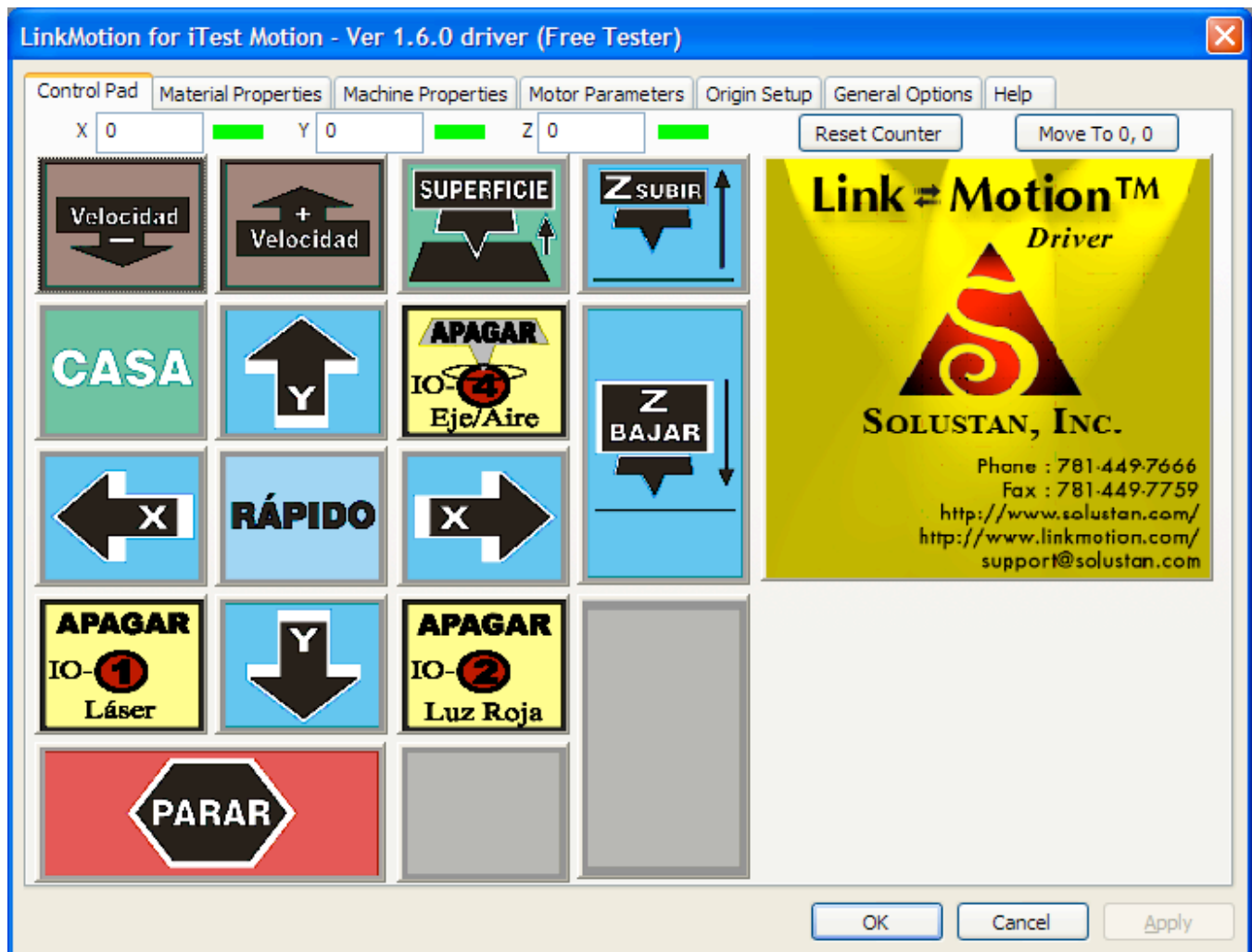
**I/O Keys (1), (3), (. or Del) and (9)** are available for I/O 1, I/O 2, I/O 3 and I/O4 controls. These could be used to control Z axis movement in case Z axis is not motorized but it is solenoid and is controlled by air valve, for example. Can also be used for lubrication of tools, vacuum control, laser control, red diode, air, water etc. Each click of the keys can toggle the I/O position. User can set to make the action momentary or toggle by way of settings in the LinkMotion .INI file.

**Spindle Control for CNC type application or Air Control for Laser type application - Key (9) I/O 4** is used to control spindle motor or air in case of laser application. Each click of the keys will toggle the I/O position.

**The big 0 (zero) or Space bar key is available to stop when going home and you have a need to stop.**

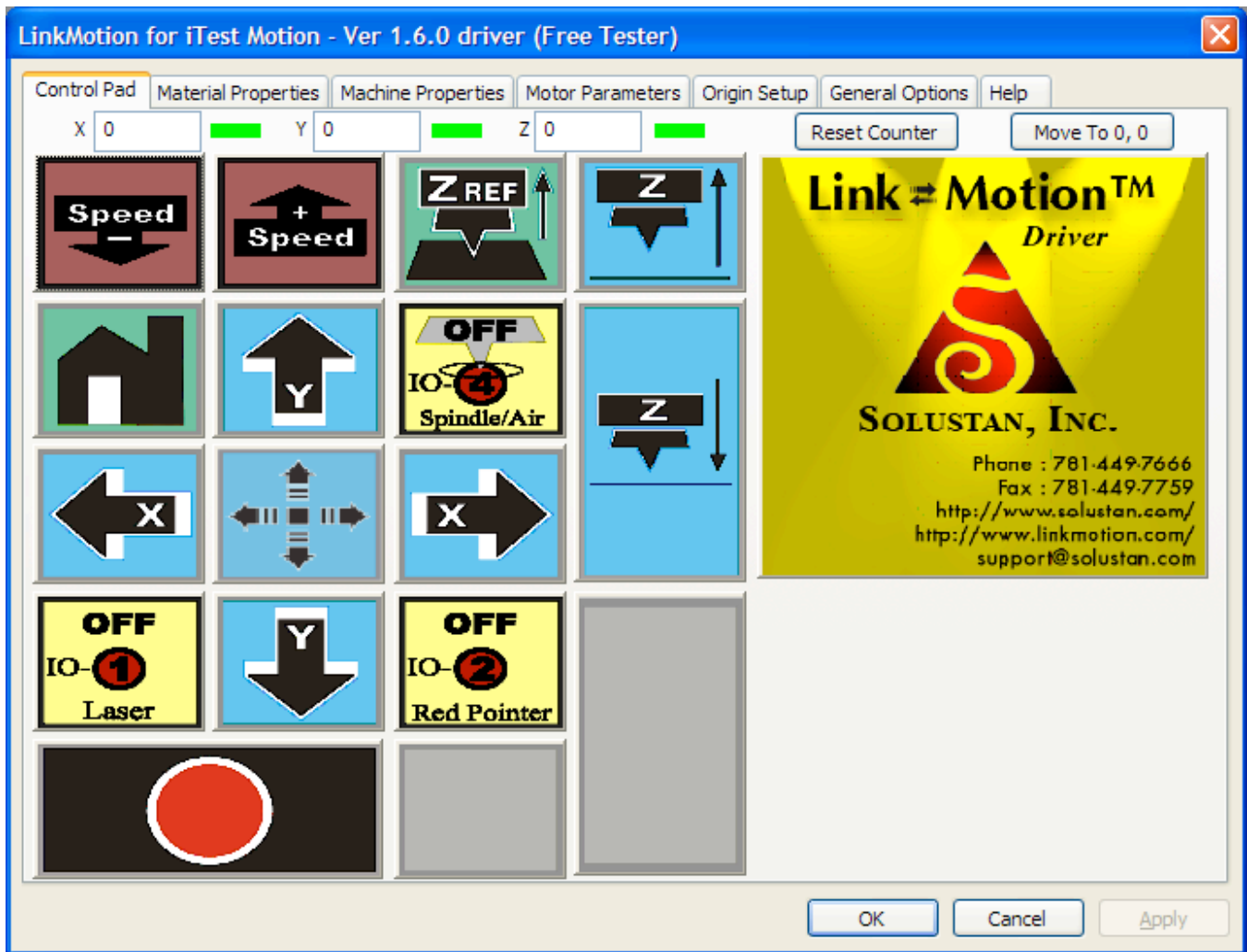
**Num Lock and \ keys are available only when machine is in motion doing a job.**

## Control Pad in Spanish language:



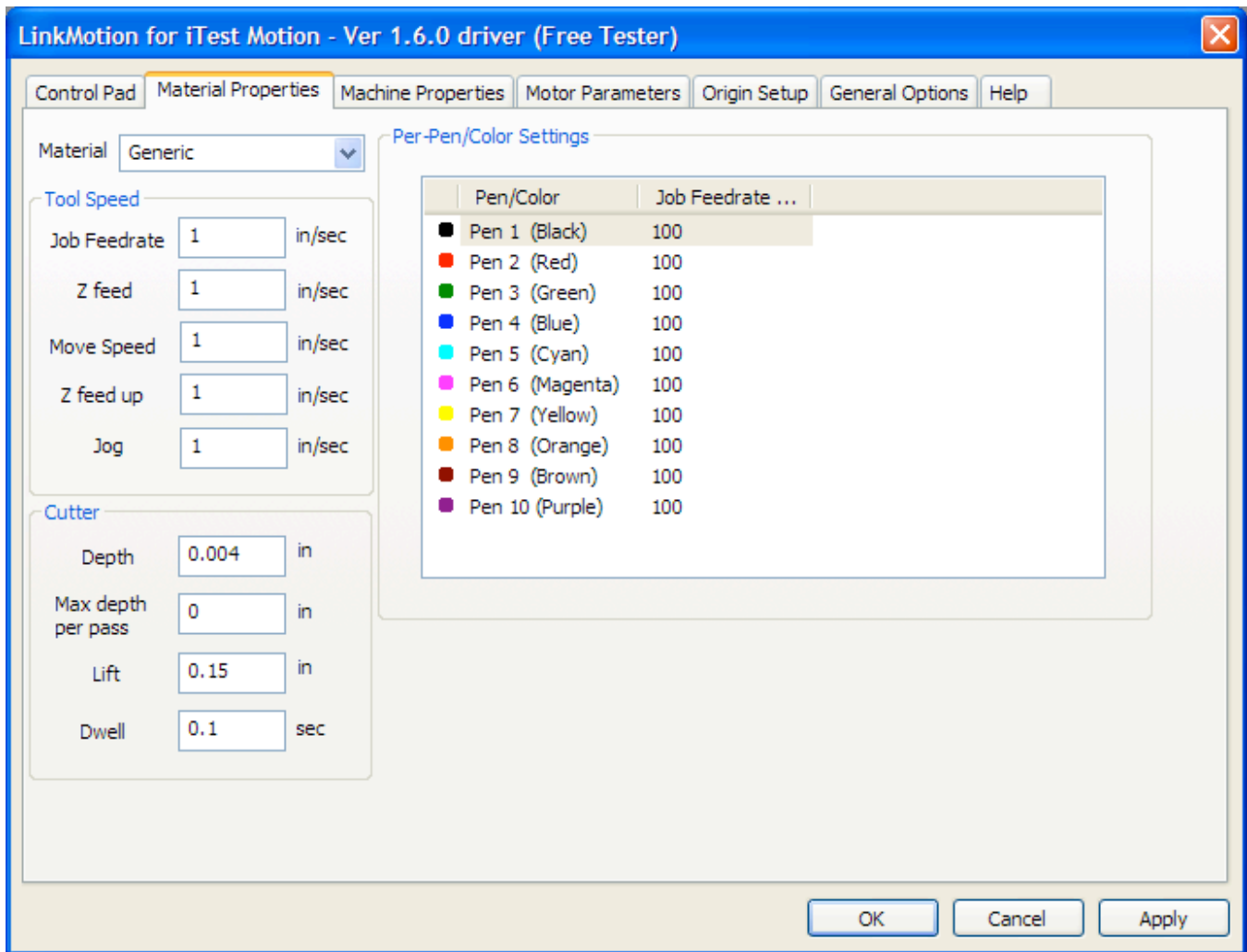
Go into **General Options** menu. Look at **Control Pad Labels**. Arrow to the right will show you the choices you have. Here select the **Spanish** Control pad and click on Apply button. Now you will see the **Spanish control pad**.

## Control Pad with Symbols:



Go into **General Options** menu. Look at **Control Pad Labels**. Arrow to the right will show you the choices you have. Here select the **Symbol** Control pad and click on **Apply** button. Now you will see the **Symbol** control pad.

## Materials Properties Menu:



Pull down the **Material Properties menu** to observe a selection of various materials. Pre-select the values of speed and tool positions for each of the materials. The default values are simply that. LinkMotion can be employed to work with many different types of machines. Hence, there is no single value appropriate for all different machines. User's experience will dictate the values for his/her machines.

The values can be inches per second or millimeters per second or centimeters per second. General Options menu allows you to make your selection for this measure of units.

Jobs can be designed in color and job feed rate speeds can be defined as percentage of declared values for each of the color. One of the applications of this feature is to design the same job in different colors on different layers and sequence the layers appropriately.

Following are the color/pen values for the LinkMotion printer driver. RGB values are given in percent.

Pen number	Color	R	G	B
1	Black	0	0	0
2	Red	255	0	0
3	Green	0	255	0
4	Blue	0	0	255
5	Cyan	0	255	255
6	Magenta	255	0	255
7	Yellow	255	255	0
8	Orange	0	128	255
9	Brown	128	0	0
10	Purple	128	0	128

If you did not create a color palette with the above RGB values, our understanding of the way GDI handles this is that GDI will convert the object's color to an RGB value using whatever color correction model is in effect, then will do a least-squares fit to the 10-color palette (whichever of the 10 colors is closest to the color of the object on a least-squares bases will be the color that is sent to the printer driver).

**Job feed rate** is the speed when the tool is engaged into material and working. Bringing your arrow on the number that shows Job Feedrate (100%) for each pen and Double clicking on the number should open a box that will allow you to change this number. If your job federate in tool speed is 2in/sec and you make the red pen to give output at 50% then job should run at 1in/sec.

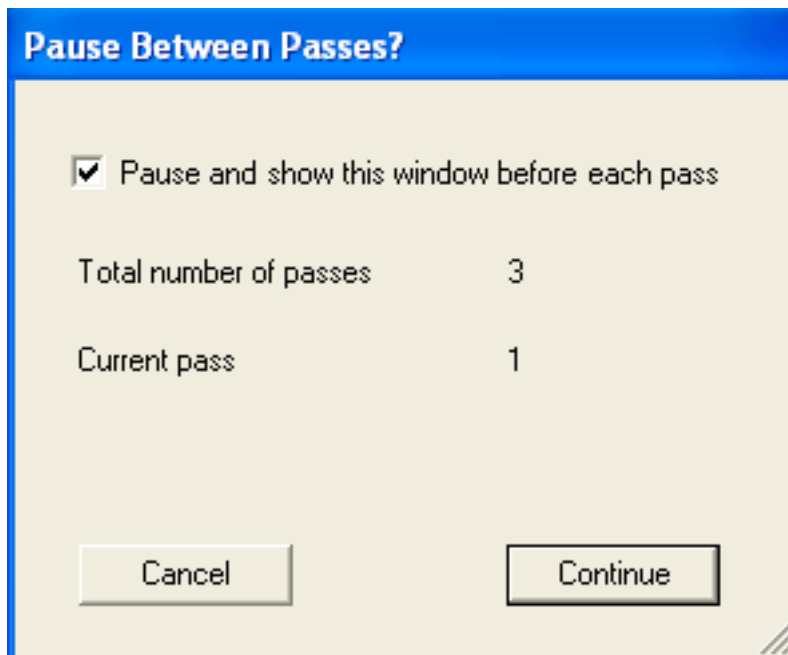
**Jog speed** is when the user is jogging the machine with the help of Control Pad.

**Move speed has two functions**, it is the speed when the tool is retracted and the **machine is moving to the next shape** after finishing the previous one and it is also used for **fast jogging** (holding down fast key while keeping the directional key pressed).

User can set up separate speeds for **Z feed up** and **Z feed down**.

**Depth** is the value declared for tool to travel in the material. Once the top of the material surface is determined, **depth** value controls the movement of the tool in the vertical axis.

**Maximum depth per pass** is the value declared if you wish to do your job in multiple passes. For example if you have selected 0.15 in to be your Depth value and you want to do your job in three passes you can declare 0.05 in value for Maximum depth per pass and your job will be done in three passes. When you send the job you should see the dialog box for **Pause Between passes**. User can select to pause between the passes or continue without the pause in the dialog box when doing the job with multiple passes as shown on the screen below. Your tool will always return to 0, 0 for X, Y position (Regardless of whether you have checked or unchecked in the origin setup for Return to 0,0 after job) and then do the next path. If you declare 0 value in multiple pass it will always do the job in one pass.



**Lift** is the value for tool to lift between the shapes to do the job. If you have several inches of travel available for Z axis then it saves time to plug in the lift value where it does not travel all the way up for Z axis between the shapes and instead it travels only by the Lift value and saves time.

**Dwell** is the amount of time in seconds and fraction of seconds the tool will stay at the same position in the material before making X, Y move and after finishing the shape to cut the material.

## Machine properties:

The screenshot shows the 'Machine Properties' tab of the 'LinkMotion for iTest Motion - Ver 1.6.0 driver (Free Tester)' software. The dialog box has a blue title bar and a standard Windows-style interface with a close button (X) in the top right corner. The main content area is divided into several sections:

- Control Panel:** Contains tabs for 'Control Pad', 'Material Properties', 'Machine Properties' (selected), 'Motor Parameters', 'Origin Setup', 'General Options', and 'Help'.
- Enable Output 1:** A checked checkbox.
- Enable Output 2:** A checked checkbox.
- Z axis is Solenoid (Not Motorized):** An unchecked checkbox.
- Enable Spindle:** A checked checkbox.
- Spindle Delay:** A text input field containing the value '1', followed by the unit 'Sec'.
- Reverse X direction:** An unchecked checkbox.
- Reverse Y direction:** An unchecked checkbox.
- Reverse Z direction:** A checked checkbox.
- Cylindrical Axis support:** A section containing:
  - Enable Cylindrical Support:** An unchecked checkbox.
  - No Limit Switch:** A checked checkbox.
  - Reverse Direction:** An unchecked checkbox.
  - Cylindrical Axis:** A sub-section with two radio buttons: 'X Axis' (unchecked) and 'Y Axis' (checked).
- Maximum Travel:** A section containing three text input fields: 'X axis' (12 in), 'Y axis' (13 in), and 'Z axis' (2 in). Below these is the text 'Table size 12.00 x 13.00 in'.
- Linear Travel per revolution:** A section containing three text input fields: 'X axis' (0.1 in), 'Y axis' (0.1 in), and 'Z axis' (0.1 in).
- Motor Gear Ratio:** A text input field containing the value '50'.
- Job Piece Diameter:** A text input field containing the value '1.591', followed by the unit 'in'.

At the bottom right of the dialog box, there are three buttons: 'OK', 'Cancel', and 'Apply'.

If **Enable I/O control 1** is checked, it will turn the I/O 1 **ON** while cutting/engraving a shape during a job and turn itself **OFF** at the end of completing the shape. The I/O will stay **OFF** during the traverse/Move motion to the beginning of the next shape. You can test the operation of the I/O by either clicking on the **Key 1** button with a mouse or depressing the key on the Control Pad.

If **Enable I/O control 2** is checked, it will turn the I/O 2 **ON** while cutting/engraving a shape during a job and turn itself **OFF** at the end of completing the shape. The I/O will stay **OFF** during the traverse/Move motion to the beginning of the next shape. You can test the operation of the I/O by either clicking on the **Key 3** button with a mouse or depressing the key on the Control Pad.

**Z axis can be selected as solenoid or air controlled.** It may be attached to I/O 1 or I/O 2.

If **Enable I/O control 3** is checked, it will turn on and off with the job execution. You can check by clicking **Key Del (.)** on the Control Pad.

If **Enable I/O control 4 (Spindle)** is checked, it will turn on and off with the job execution. You can check by clicking **Key 9** on the Control Pad. The value of delay can be entered in **seconds and fraction of seconds in the Spindle Delay area**. This delay value will allow the spindle motor to reach its speed before the tool plunges into the material.

## Logic levels of the I/O's

Microsoft Windows sets all the active lines of the parallel port as logic High when the PC and the Windows are launched. To comply with that, LinkMotion uses Logic Low to activate any of the I/O's. We set up a line in the INI file called,

**Control Port Default=4** (This makes logic High) or

**Control Port Default=11** (This makes logic Low)

If you need to invert any of the I/O lines, you could do that by declaring different values for the above setting. Following values will give you the following results:

<b>Control Port Default=</b>	<b>1</b>	<b>2</b>	<b><u>4</u></b>	<b>7</b>	<b>8</b>	<b>11</b>	<b>15</b>
I/O1 (Pin14)	L	H	<u>H</u>	L	H	L	L
I/O2 (Pin1)	H	L	<u>H</u>	L	H	L	L
I/O3 (Pin17)	H	H	<u>H</u>	H	L	L	L
I/O4 (Pin16)	L	L	<u>H</u>	H	L	L	H

## Safety, Limit, and Emergency controls

Pin 15 on the parallel port is available for connecting safety, limit, and emergency switches.

**LinkMotion expects Logic 0 on pin 15 for the machine to operate normally. When we see logic 1 on pin 15, the job will be aborted or will not start.** Once job is aborted, it cannot be recovered. It has to be restarted.

**Directions for X, Y and Z** can be set properly here by checking or un-checking the direction button.

If the axis movements are opposite to the intended directions, the direction or directions can be reversed without changing the wiring.

The **maximum travel distances of the machine in X, Y and Z axis is shown here**. The maximum travel numbers (in other words the size of the table) should match the Design applications you are using like Corel Draw or Auto Cad for the job to appear in the expected place on the machine.

**Linear travel per revolution (lead screw pitch)** is shown here and you can change this if necessary. There are unknowns in a system from time to time. These are the pitch of the screw (2 turns per inch, 5 turns per inch, etc.), full step angle of a step motor (200 full steps for 360 degree turn, etc.), and micro stepping of the driver. If you know any two of the three, the third one can be determined using nudging feature of the Control Pad. Typically, most of the Control Pad is activated using physical keys of the

keyboard and using them with fingers. The nudge feature is activated using a single click of the mouse on the appropriate key on the screen. Nudge a distance by declaring the distance in the General Options. Next, measure the actual distance moved by the machine. Make the necessary correction of the value for the unknown parameter until you get the desired distance by nudging.

Cylindrical axis choices will be offered if the machine is equipped with it. **It is very important to quit and Re-launch LinkMotion applet after you make this selection.** Maximum Travel size of the table in X or Y will change when you Enable Cylindrical Axis Support. You do not need to enter this new size in Maximum Travel area in LinkMotion applet. However, it is very important to remember the dimensions and create that Table size in your design applications like Corel or Cad. Selecting X or Y whichever is the cylindrical axis for your machine. Motor Gear Ratio and Job Piece Diameter is entered for your job in the bottom section.

## Motor Parameters:

The screenshot shows the 'Motor Parameters' dialog box in the LinkMotion software. The dialog has a title bar 'LinkMotion for iTest Motion - Ver 1.6.0 driver (Free Tester)' and a close button. It contains four sections of input fields for X, Y, and Z axes:

- Full Steps per Revolution:** X axis: 200, Y axis: 200, Z axis: 200
- Toolhead Maximum Acceleration:** X axis: 15.00 in/sec<sup>2</sup>, Y axis: 15.00 in/sec<sup>2</sup>, Z axis: 15.00 in/sec<sup>2</sup>
- Microsteps per Full Step:** X axis: 10, Y axis: 10, Z axis: 10
- Maximum Motor RPM:** X axis: 1500, Y axis: 1500, Z axis: 1500

At the bottom right, there are three buttons: 'OK', 'Cancel', and 'Apply'.

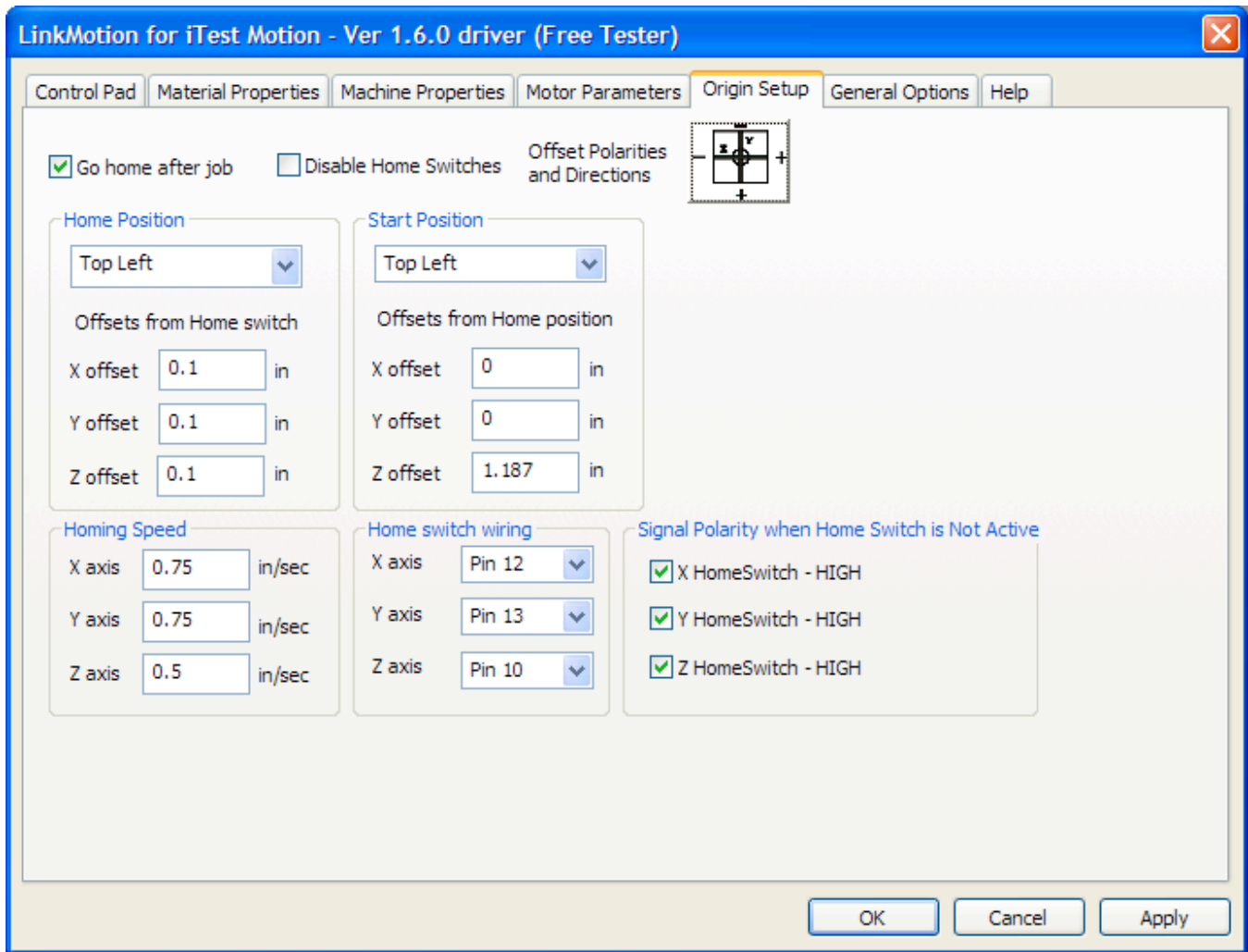
Above values are determined by the motor manufacturer. Enter **Full steps per revolution** values for each axis depending upon the motor and the lead screw size specifications.

Declare **Toolhead Maximum Acceleration** values for the motors in each of the axis in in/sec<sup>2</sup>. You may need to adjust this numbers to get proper acceleration constants for smooth motion. Check with your machine manufacturer for the correct numbers required for the machine. In absence of that, you should start with a number between 25 and 100 as a safe starting point.

Set the **Microsteps per every full Step** for your system for each of the axis. This is necessary only if you are using step motors in your system. This number is derived from the Amplifier driver used for your motors. In case of servo motors, you need to make sure that the multiplication of numbers in this area as well as in the number of full steps per revolution of the motor in the Motor parameters match your encoder number for the feedback. Generally, it would be a good idea to declare number 1 as the number in microsteps per every full step and the encoder resolution number in the number of full steps per revolution in the motor parameters location.

**Maximum Motor RPM** number should be selected by the specifications given by your motor manufacturer.

## Origin Setup:



**Return to 0, 0 after job (Go Home After Job) – If you have not checked this box** then after finishing the job it goes up for Z axis and stops at the position where it finished the last shape. It does not move its X and Y position. It does not go to the start position. Checking this box **makes your tool go back to the starting position (parking position) for X, Y and Z axis.** If your machine has the limit switches and limit switches are enabled it will sense those switches and park the tool to its home position.

**Disable Home Switch – Checking this box disables the limit switches. Un checking the box activates the limit switches.** If **limit switches** are present, **pin numbers** need to be assigned in **home switch wiring** section where the switches are connected to the computer. It is also important to declare the logic level of the switch in normal conditions high or low.

### **Home Switch Position:**

This is the parking position of the tool of your machine. **Bottom Left and Top Left** are the choices.

Top Right and Bottom Right are not available at present.

It is important to understand the setting of the origin for the machine. If the machine has home switches, it will have a defined **Home position**. It should be selected. The offsets from the home switch sensing serve two purposes:

- A. It is advisable to get off the switch once sensed. The **offset value** will allow the machine to move back by the declared distance after reaching the switch.
- B. The offset values can be adjusted to get to a specific position such as the very corner of the table where the user may want to start every job.
- C. This position shall be recalibrated every six months or anytime the sensor is replaced.

The **Homing speed** for finding and going Home is different than the jogging or move speed.

LinkMotion forces the machine to go Home twice when asked to go Home. **The Home key is key 7 on the Control Pad**. The first time the machine travels at a higher speed. Once reaching Home the first time, the machine travels back into the working area of the table and hunts for Home again at a slower speed. This will allow the table to get to the exact Home position every time.

### **Start Position:**

**Bottom Center, Bottom Left, Bottom Right, Center, Top Center, Top Left and Top Right** are the choices.

**If your Home Position and Start Positions are the same following are the selection necessary:**

<b>Home Position Selection</b>	<b>Start Position Selection</b>
Bottom Left	Bottom Left
Top Left	Top Left

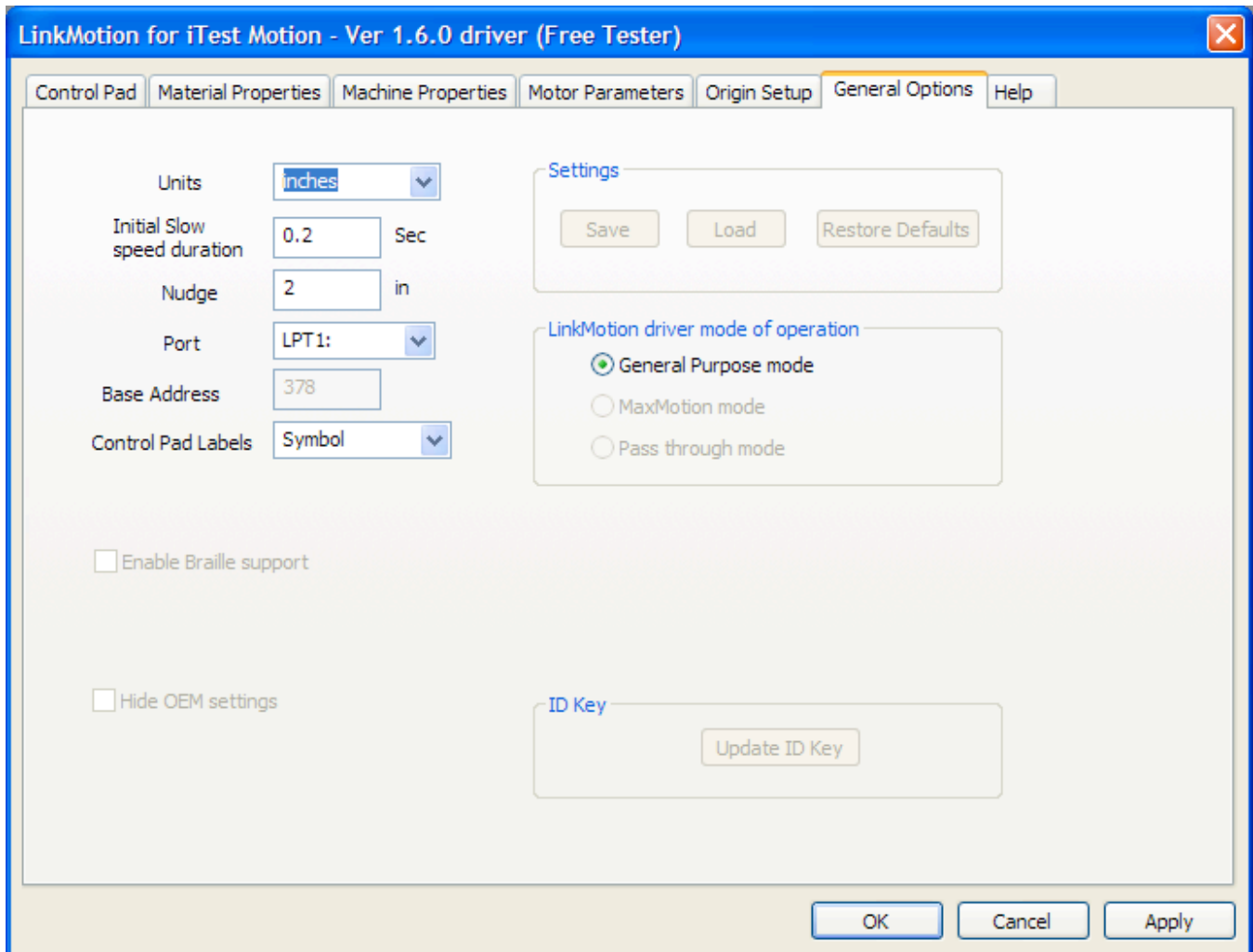
**Job start position can be different than the Home position. Job start position may be,**

- Where the jig is positioned (Home Position)
- **Center of a machine in case of a vise type machine** with offset values in X and Y where both jaws move
- **Top center of a machine** with offset value in X only in case of a machine where only bottom jaw moves

In above situations and others, it is necessary to select **Start Position** and declare offset values for X and Y appropriately.

If you suspect that there is a problem with one or more limit switches and it is hindering your production, check the **Disable home switch box at the top**. This will allow the operation of the machine while the limit switches are being investigated.

## General Options:



There are just a few things in the General Options screen. **Units of choice can be selected from inch, mm, or cm.**

LinkMotion is designed to provide a **slow speed move** for a declared amount of time, when jogging. After that, the tool will move at the declared speed of jogging in materials property screen. This allows the user to position the tool or the laser red indicator diode at a precise position quickly.

The **Nudge** will allow the axis to move a fix distance when any axis is moved with a **single mouse click** on the keys that move the X, Y and Z axis when Control Pad tab is open or selected.

**Port:** LinkMotion will send the jobs to the **selected port**. If it is used for Virtual Controller applications where machine is connected to parallel port. You can specify the port's **Base address**.

**Control Pad Labels:** Arrow to the right will show you the choices you have. Here select the **English, or Spanish or Symbol** and click on the **Apply button**. Now you should see the control pad you have selected.

**This product should allow you to test complete motion of your equipments.**

## **Description of the parallel port configuration for machine control:**

It is amazing what parallel port (AKA Printer port) allows us to achieve in the world of motion control.

Pins 2, 3, 4, 5, 6 and 7 are used for the three step motors for the three axis.

Pins 1, 14, 16, and 17 are output lines. Microsoft Windows prefer to set all the bits on the parallel port to logic high when Windows is invoked. To be compatible and to avoid any surprise turning on of the I/O lines, we recommend that the logic be setup to invoke the I/O's when you receive logic low from the parallel port.

It is always a good Idea and a good practice to turn on the PC first and your driver module after the Windows is loaded. In the same manner, It is always a good Idea to turn off the PC last when you switch off the system.

The procedure will be that the X and Y motors will move to a position. The speed of the move will be determined by the pre-selected speed in the software. The customer will also pre-select the number of micro steps required.

Pins 10, 12 and 13 along with one of the ground lines (18 through 25) will be used for the Home switches, if necessary.

It is important to note that the gates on the parallel ports may not be able to source 4 mA to 5 mA and may not be able to sink much more current. Some of the newer parallel port boards may use lower power circuits (instead of 5 V TTL, it may be a 3.3 VDC level). Some parallel ports may be able to drive the gates of the step motor drivers. Others may not be able to. Additionally, if you plan to use solid state relays to control I/O's, the relays may require more current. For all these reasons, it is advisable to use a breakout board that may have a couple of high current drivers IC's to Interface to the parallel port (you need two of such IC's and may cost around 25 cents each) to do the trick. We build simple breakout boards and make them available to simplify the system builder's job.

It is important to note that the Home switch feed back shall be TTL levels only, if you use our breakout board. This means that the high output level shall not exceed 5 VDC or it may damage

your parallel port card.

### **Standard configuration of Parallel Port of a PC for LinkMotion Multi-Axis Virtual Controller**

Parallel port on the back of a PC has a 25 pin female connector. Most computers may have only one parallel port. However, a PC can be configured with as many as 3 parallel ports. You can use any one of them to connect to the XYZ table. Following is the pin configuration:

<b>DB-25 pins</b>	<b>Signals</b>
1	I/O (2) output switch (I/O signal, turns on and off with the job)
2	X - Step
3	X - Direction
4	Y - Step
5	Y - Direction
6	Z - Step
7	Z - Direction
8	Switching between cylindrical and flat axis (TTL level change)
9	
10	Home switch Input to parallel port- Z axis
11	Future use
12	Home switch Input to parallel port - X axis
13	Home switch Input to parallel port - Y axis
14	I/O (1) output switch (I/O signal, turns on and off with the job)
15	Emergency switch Input to parallel port
16	I/O 4, Spindle motor enable (Programmable delay available before plunging)
17	I/O 3 output switch
18 - 25	Ground lines

This is the standard configuration.