Building your own PCB Router

Part 1 (Introduction)

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For many months I've tried methods of building plotter like machines with various levels of success. I've browsed the Internet for many an hour to gather information on how these machines work. The most important was to be able to get a stepper motor to turn in one direction and in the reverse direction too. Stepper motors are quite simple really and their controllers can either be very complex or they can be simple too. If we look at the cost of parts needed to build a PCB Router it can become way too expensive to even think of building one , but fortunately the computer eras change constantly leaving outdated equipment available for use by homebrewers!

The stepper motors used on the machines I have experimented with and built came from ex CITOH printers. The older types of printers are more likely to have more suitable and available mechanical parts than their newer counterparts. From now on keep your eyes open for anything that may be useful in building a plotter , engraver or PCB Router. That includes slides , shafts , carriages , bearings , bushes and definitely good stepper motors! You may have to use your imagination and see possibilites for every mechanical item you lay your eyes on.

Buying motors is prohibitively expensive and the motors needed to provide the power and torque to control your machine can cost you R1000 per motor and more! It is amazing what gets thrown onto the scrap heap ……. OM John ZS6HK found this heap of scrap metal for me at a scrap yard in Benoni after seeing my first attempts at building a machine after sending these pictures via SSTV on HF to him with my B25. This has become the basis of my latest machine which works beautifully!

Converting rotational motion to linear motion can be done in many ways. I have used the "Lead screw" methods on all my machines I have experimented with so far. If you are fortunate enough to get hold of similar mechanical wonders , hang on to them for this will reduce the cost in building YOUR machine considerably.

You will also need an old IBM compatible PC too , preferably a 486 DX 100 or higher. These can be sourced from just about anywhere nowadays! There is a lot of software available to control your machine. I have tried many , even written my own controlling programs in Visual Basic with various levels of success but it is like reinventing the wheel. The control of your machine will be done via the printer port. A standard mono screen is sufficient for the controlling PC.

The software I will base my discussions on goes by the name of "TurboCNC" which is perfectly useable and the author Dave Kowalzyk from DAK Engineering in the USA charges an equivalent of R150-00 for the program if it is to be used on a permanent basis. One would have to really look carefully to find a more professional program for the price and it works under DOS. Many programs are commercially available that can work under Windows too , but we are trying here to keep our costs to an absolute minimum. PCB Software that we can use to produce printed circuit boards and that is freely available goes by the name of "EasyTrax" and it has third party conversion programs to convert the output of EasyTrax to be compatible with "TurboCNC" which is in the form of G-Code.

Stepper motor concepts

Stepper motors come in two types. Unipolar and bipolar. Bipolar motors normally have 4 wires and theoretically speaking , two coils. Both coils are active at all times but the polarity is reversed in a planned sequence thus causing the motor to step clockwise or anticlockwise. Unipolar motors usually have 5 or 6 wires and internally have two centre tapped windings.

Stepper motor electronics

The Internet is an invaluable source of imformation concerning hobby CNC and this is where I have accumulated most of my knowledge on this fascinating subject , but it takes many hours of reading and experimentation mechanically and electronically! More on this in Part 2.

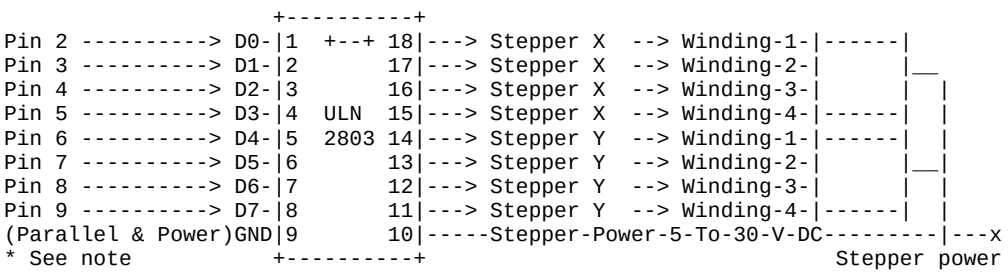
Connections to the printer port

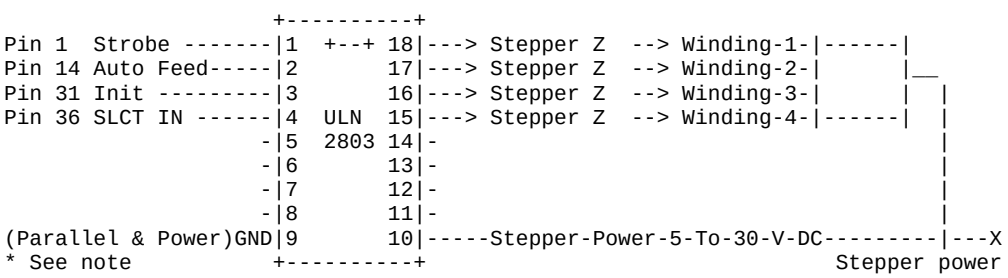
The circuit below works fine but if higher currents are needed , then you may have to build something more eloborate. I used the ULN2803'as drivers for higher power darlington transistors pulled of old mainframe tape units. Keep your eyes open at flea markets for anything resembling high power electronic devices , you will probably need heatsinks to dissipate the heat. Typically a stepper motor coil would draw 1.5 amps and in many cases to produce higher torque , two coils will have to be energised at a time.

My present machine draws approximately 9 amps continuously so a good stable DC power supply anything from say 6 volts upward will come in very handy. I use an old “Farnell” 10 volt DC power supply capable of supplying in excess of 20 amps and this supply works like a dream! You don’t want your stepper motors missing a step at a critical point because your motors were under powered it is not worth the frustration!

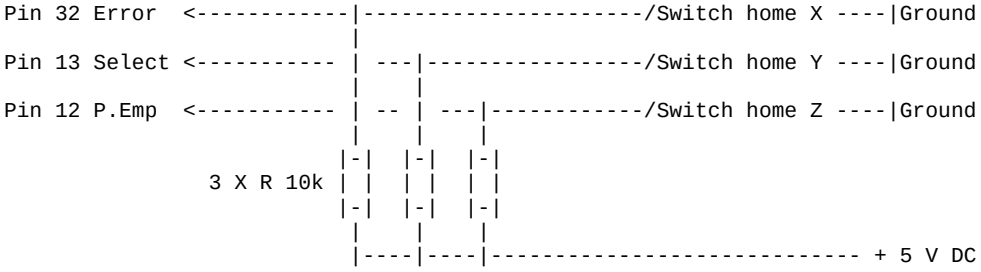
ULN2803 NPN Darlington driver I.C.’s (8-bit 50V 500mA TTL-input)

Centronics Port (Printer side of parallel port cable)





Home Switches



* Parallel Ground Pin numbers 16,19,20,21,22,23,24,25,26,27,28,29,30,33

For a view at my *first* attempts take a look at www.geocities.com/edleighton_za/agea4/

Converting rotational motion to linear motion

This is a simple method I have used to convert the rotational motion of the stepper motor to linear motion in order , in this case , to raise or lower a Dremell drill. I used a length of threaded rod running through a nut soldered to a piece of angle iron which is bolted to a slide removed from an old tape drive unit.

The threaded rod is fixed to the stepper motor shaft by means of a 6mm x 20mm length of stengthened plastic tubing and held onto the shaft and threaded rod by two hose clamps.

The slide is simply a length of aluminium stock sliding lengthwise within another length of aluminium channeling seperated by a row of ball bearings on either side running in a groove. The ball bearings being held in place by a strip of aluminium with holes drilled slightly larger than the bearings themselves and spaced by aproximately one bearing apart. Improvise using what you can get your hands on!

What can we do with our homebrew machine?

The picture below which I downloaded from the Internet should give you a good idea!