

Hello Roger,

Thanks for incorporating the G Code generator in VeeCad as promised.

I now have my Woodpecker mini CNC and over the past couple of months I have got to grips with manufacturing small PCBs from blank copper clad stock.

The Woodpecker is Arduino based (although a proprietary board) and runs under GRBL 0.9 to control the CNC motors. To complement this I use Candle V 1.0.11 to process the G Code which I develop from KiCad generated Gerber and Drill files in Flatcam.

Milling PCBs I found to have quite a steep learning curve (especially as I was also moving from Tincad / FreePCB to KiCad at the same time!). The biggest pitfall was that it seemed almost impossible to combine lack of board flatness with the need to make very fine shallow cuts with a conical cutter to achieve close track spacing. However, after some research and a small modification to the machine (adding a height measuring probe) it became possible to use a feature of the Candle software to create a height map of the blank PCB and then have it modify the "Z" parameters of the G Code to produce consistent cutting results.

Having had that experience I approached the task of evaluating the G Code generated by VeeCad with some confidence that I could give you some sensible feedback.

I used a small board that I had made some years ago as my test piece (one that I also used in my KiCad / milled PCB exercise too).

It was fairly obvious that unlike a piece of blank PCB stock, stripboard stock needs to be aligned accurately with the X and Y axes of the Woodpecker. This was reasonably easy for me as I'd carried out a bed flattening run on the piece of sacrificial wood that I'd mounted on top of the machine bed (very necessary in view of my many mistakes early on in the PCB trials!) and there was a ridge running along the X axis that I could place the bottom (flat edge) of the board against.

Initially I loaded the VeeCad generated G Code into GRBL and not quite sure what cutter to use I continued with the conical cutter used in my PCB trials. I then set the XY co-ordinates as the "home" position as advised in the VeeCad help; similarly I zeroed the Z co-ordinate but this time using the Probe command in GRBL to get a very accurate Z home position.

The first run immediately produced two errors, namely that G50 and T1 commands are not supported in version 9 of GRBL. So I just edited them out and continued the run. Everything now worked OK but the run took just over 12 minutes, which I thought was excessive, and it was obvious that the conical cutter was really too fine for this job.

I examined the G Code and to speed things up I made the following changes that reduced the run time to under two minutes – a more acceptable figure I felt :-

- 1) The fast move clearance height reduced from 20mm to 5mm
- 2) The spindle lowering speed increased from 6.4 to 85mm / second (could probably be even faster)
- 3) The cutting speed increased from 12.7 to 100mm / second.

Other changes I made were to increase the cut depth from 0.03mm to 0.06mm to allow for a certain amount of board unevenness and I reduced the spindle speed to 700rpm as my machine gets a bit of vibration above that speed.

I also changed to conical cutter to a 1mm end mill.

In the end I had a very workable set up that should save lots of time and hard work in the future.

Some more general comments :-

I tend to use the two sizes of the stripboard sold by Futurlec as STPBRD1 and 2 (similar boards are sold by others) and on small machines such as the Woodpecker the STPBRD1 will only fit the bed in landscape rather than portrait mode, therefore if these size boards are to be accommodated then it will be necessary to be able to select East-West or North-South G Code generation.

The necessity to align the board as accurately as possible to the machine's XY axes is vital if the cuts are to be placed accurately. To state the rather obvious, the further away a cut is made from the XY home position the more pronounced any error becomes due to XY misalignment.

A possible future enhancement – a selectable board cut out feature. Say three circuits at an incremental 0.55mm cut depth using the 1mm end mill along the edges of the board as drawn.

I hope my comments are useful,  
Best regards  
Dave

Links etc. :-

YouTube of milling the holes : <https://youtu.be/La7a928raB4>

GRBL 9 : <https://github.com/grbl/grbl>

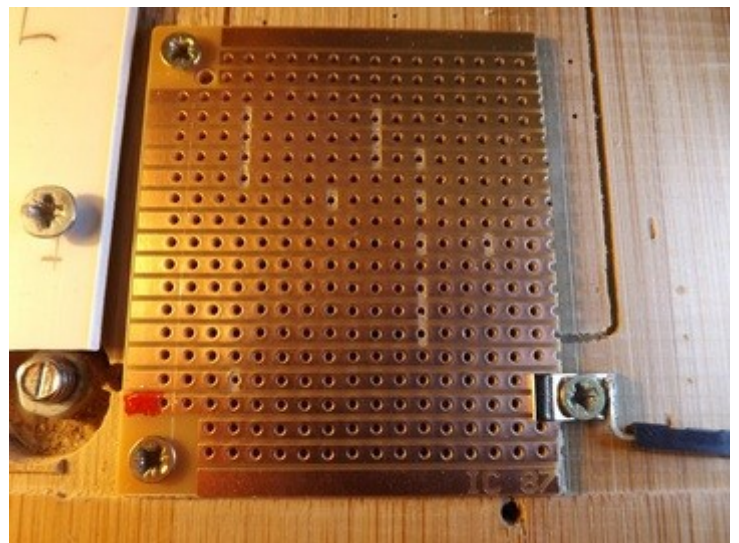
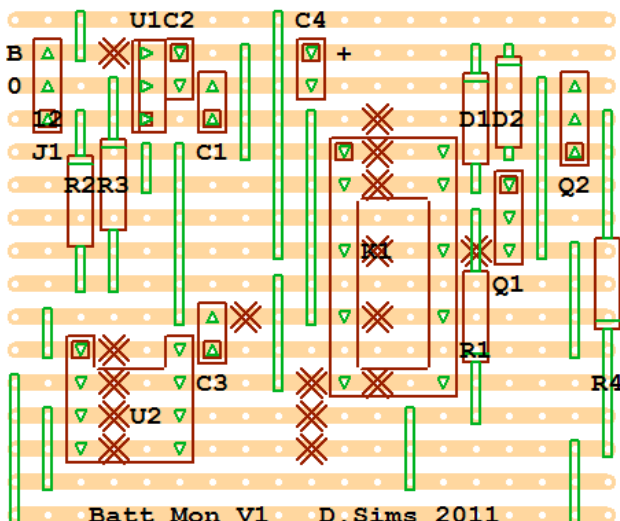
Candle 1.0.11 : <https://github.com/Denvi/Candle> (Down the page a bit; latest version is at the top)

FlatCam : <http://flatcam.org/>

Woodpecker (1610 CNC) : [https://www.aliexpress.com/wholesale?catId=0&initiative\\_id=SB\\_20170729044009&SearchText=CNC1610+GRBL](https://www.aliexpress.com/wholesale?catId=0&initiative_id=SB_20170729044009&SearchText=CNC1610+GRBL)

Suitable 1mm End Mills : [https://www.aliexpress.com/wholesale?catId=100006802&initiative\\_id=AS\\_20170729044011&SearchText=1mm+end+mill](https://www.aliexpress.com/wholesale?catId=100006802&initiative_id=AS_20170729044011&SearchText=1mm+end+mill)

The board :-



## Original VeeCad G Code :-

G17 (set xy plane)  
G90 (absolute mode)  
G40 (cancel cutter radius comp)  
G49 (cancel tool len offset)  
G80 (cancel canned cycle)  
G50 (reset scale 1:1)  
G91.1 (IJ relative arcs)  
G21 (metric mode)  
(set reference pcb point - bottom left hole)  
M05 (stop spindle)  
M06 T1 (tool change)  
M03 S1000 (spindle on)  
G00 Z20.0000  
G00 X0.0 Y0.0  
G00 X6.35 Y3.44  
G00 Z2.0000  
G01 Z-.0300 F6.4  
G01 X6.35 Y1.64 F12.7  
G00 Z20.0000  
G00 X6.35 Y26.3  
G00 Z2.0000  
G01 Z-.0300 F6.4  
G01 X6.35 Y24.5 F12.7  
G00 Z20.0000  
G00 X6.35 Y28.84  
G00 Z2.0000  
G01 Z-.0300 F6.4  
G01 X6.35 Y27.04 F12.7  
G00 Z20.0000  
G00 X6.35 Y31.38  
G00 Z2.0000  
G01 Z-.0300 F6.4  
G01 X6.35 Y29.58 F12.7  
G00 Z20.0000  
G00 X6.35 Y33.92  
G00 Z2.0000  
G01 Z-.0300 F6.4  
G01 X6.35 Y32.12 F12.7  
G00 Z20.0000  
G00 X16.51 Y23.76  
G00 Z2.0000  
G01 Z-.0300 F6.4  
G01 X16.51 Y21.96 F12.7  
G00 Z20.0000  
G00 X21.59 Y28.84  
G00 Z2.0000  
G01 Z-.0300 F6.4  
G01 X21.59 Y27.04 F12.7  
G00 Z20.0000  
G00 X21.59 Y31.38  
G00 Z2.0000  
G01 Z-.0300 F6.4  
G01 X21.59 Y29.58 F12.7  
G00 Z20.0000  
G00 X21.59 Y33.92

G00 Z2.0000  
G01 Z-.0300 F6.4  
G01 X21.59 Y32.12 F12.7  
G00 Z20.0000  
G00 X26.67 Y8.52  
G00 Z2.0000  
G01 Z-.0300 F6.4  
G01 X26.67 Y6.72 F12.7  
G00 Z20.0000  
G00 X26.67 Y11.06  
G00 Z2.0000  
G01 Z-.0300 F6.4  
G01 X26.67 Y9.26 F12.7  
G00 Z20.0000  
G00 X26.67 Y13.6  
G00 Z2.0000  
G01 Z-.0300 F6.4  
G01 X26.67 Y11.8 F12.7  
G00 Z20.0000  
G00 X26.67 Y18.68  
G00 Z2.0000  
G01 Z-.0300 F6.4  
G01 X26.67 Y16.88 F12.7  
G00 Z20.0000  
G00 X26.67 Y23.76  
G00 Z2.0000  
G01 Z-.0300 F6.4  
G01 X26.67 Y21.96 F12.7  
G00 Z20.0000  
G00 X26.67 Y28.84  
G00 Z2.0000  
G01 Z-.0300 F6.4  
G01 X26.67 Y27.04 F12.7  
G00 Z20.0000  
G00 X34.29 Y18.68  
G00 Z2.0000  
G01 Z-.0300 F6.4  
G01 X34.29 Y16.88 F12.7  
G00 Z20.0000  
M05 (stop spindle)  
M09 (all coolant off)  
G00 X0.0 Y0.0  
M30 (end with rewind)

## My Modified G Code :-

```
G17 (set xy plane)
G90 (absolute mode)
G40 (cancel cutter radius comp)
G49 (cancel tool len offset)
G80 (cancel canned cycle)
G91.1 (IJ relative arcs)
G21 (metric mode)
(set reference pcb point - bottom left hole)
M05 (stop spindle)
M03 S700(spindle on)
G00 Z5.0000
G00 X0.0 Y0.0
G00 X6.35 Y3.44
G00 Z2.0000
G01 Z-.0600 F80
G01 X6.35 Y1.64 F100
G00 Z5.0000
G00 X6.35 Y26.3
G00 Z2.0000
G01 Z-.0600
G01 X6.35 Y24.5 F100
G00 Z5.0000
G00 X6.35 Y28.84
G00 Z2.0000
G01 Z-.0600 F80
G01 X6.35 Y27.04 F100
G00 Z5.0000
G00 X6.35 Y31.38
G00 Z2.0000
G01 Z-.0600 F80
G01 X6.35 Y29.58 F100
G00 Z5.0000
G00 X6.35 Y33.92
G00 Z2.0000
G01 Z-.0600 F80
G01 X6.35 Y32.12 F100
G00 Z5.0000
G00 X16.51 Y23.76
G00 Z2.0000
G01 Z-.0600 F80
G01 X16.51 Y21.96 F100
G00 Z5.0000
G00 X21.59 Y28.84
G00 Z2.0000
G01 Z-.0600 F80
G01 X21.59 Y27.04 F100
G00 Z5.0000
G00 X21.59 Y31.38
G00 Z2.0000
G01 Z-.0600 F80
G01 X21.59 Y29.58 F100
G00 Z5.0000
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G00 X21.59 Y33.92
G00 Z2.0000
G01 Z-.0600 F80
G01 X21.59 Y32.12 F100
G00 Z5.0000
G00 X26.67 Y8.52
G00 Z2.0000
G01 Z-.0600 F80
G01 X26.67 Y6.72 F100
G00 Z5.0000
G00 X26.67 Y11.06
G00 Z2.0000
G01 Z-.0600 F80
G01 X26.67 Y9.26 F100
G00 Z5.0000
G00 X26.67 Y13.6
G00 Z2.0000
G01 Z-.0600 F80
G01 X26.67 Y11.8 F100
G00 Z5.0000
G00 X26.67 Y18.68
G00 Z2.0000
G01 Z-.0600 F80
G01 X26.67 Y16.88 F100
G00 Z5.0000
G00 X26.67 Y23.76
G00 Z2.0000
G01 Z-.0600 F80
G01 X26.67 Y21.96 F100
G00 Z5.0000
G00 X26.67 Y28.84
G00 Z2.0000
G01 Z-.0600 F80
G01 X26.67 Y27.04 F100
G00 Z5.0000
G00 X34.29 Y18.68
G00 Z2.0000
G01 Z-.0600 F80
G01 X34.29 Y16.88 F100
G00 Z5.0000
M05 (stop spindle)
M09 (all coolant off)
G00 X0.0 Y0.0
M30 (end with rewind)
```