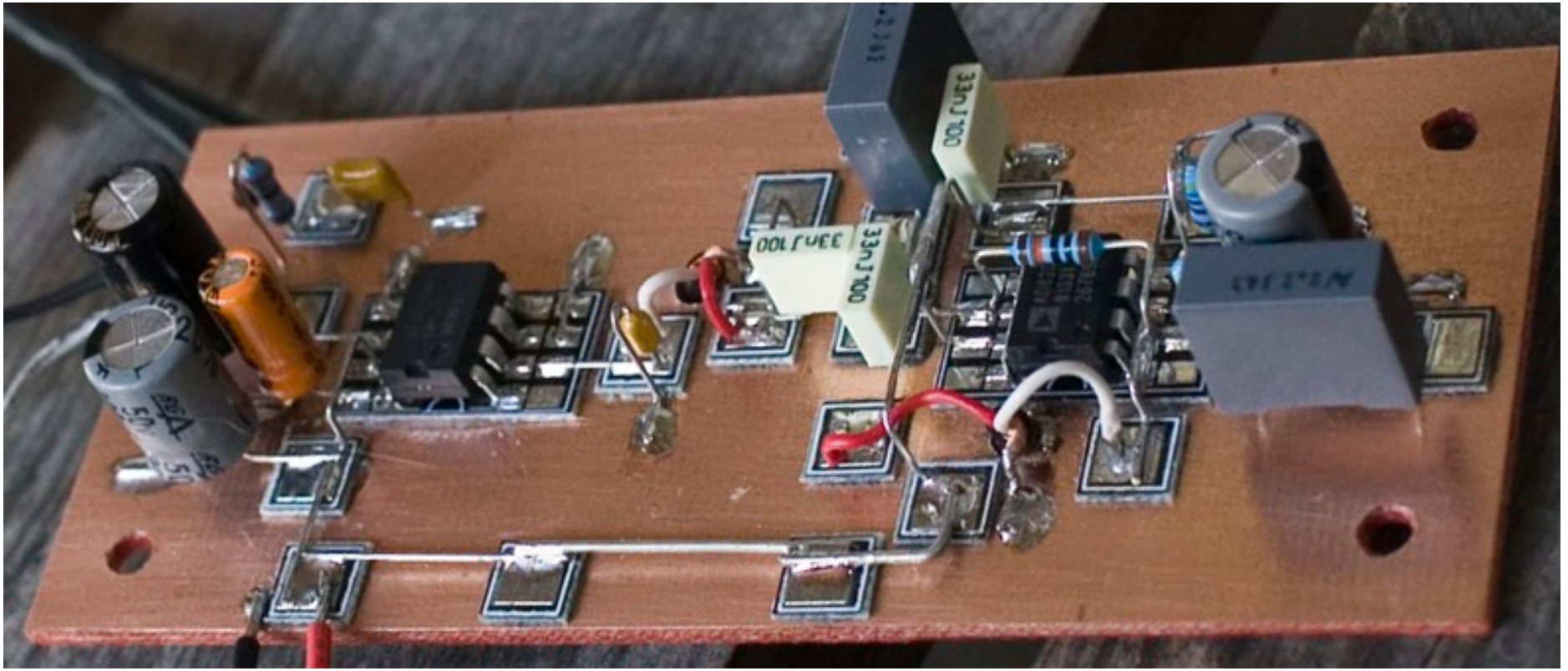
Manhattan

Stripboard Without the Disadvantages



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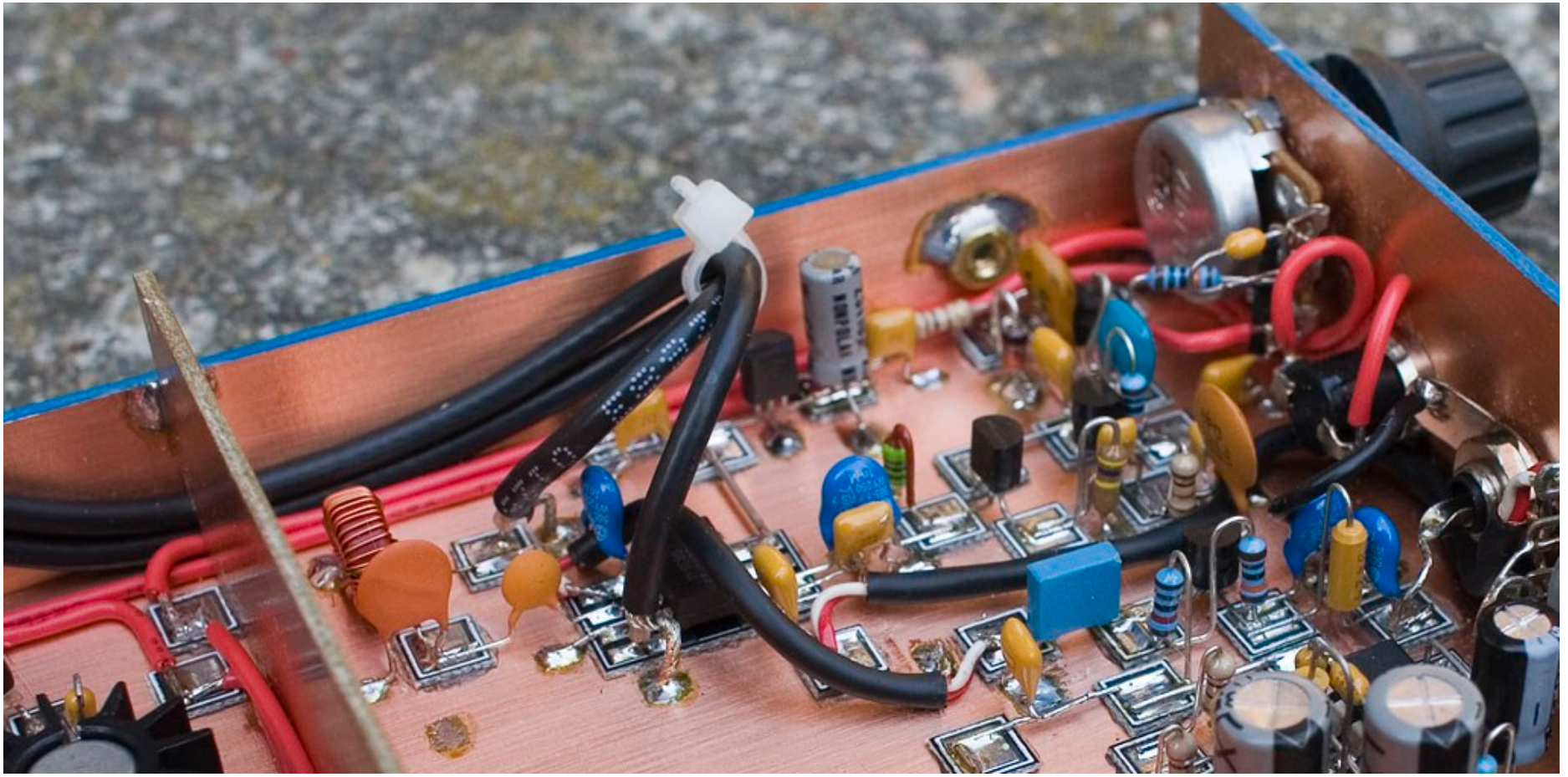
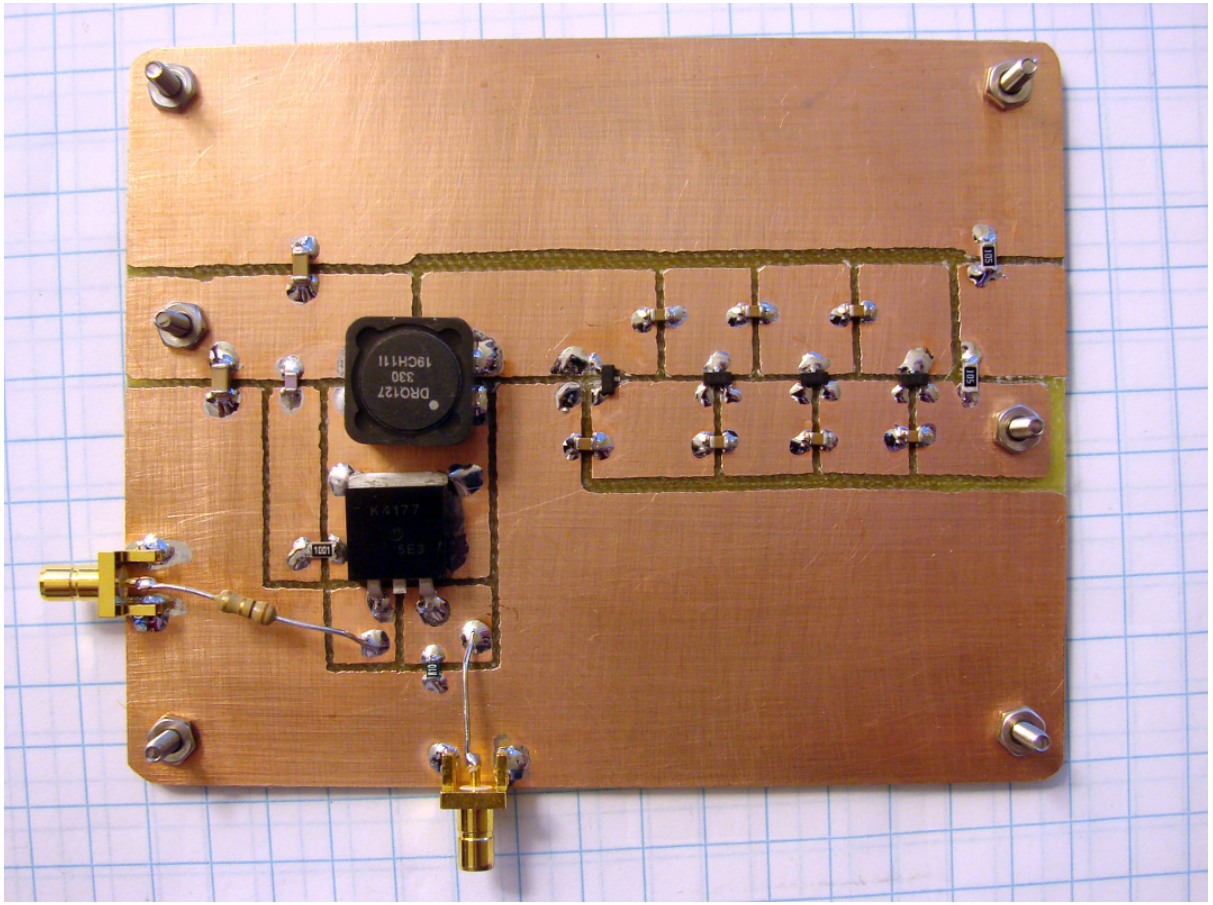


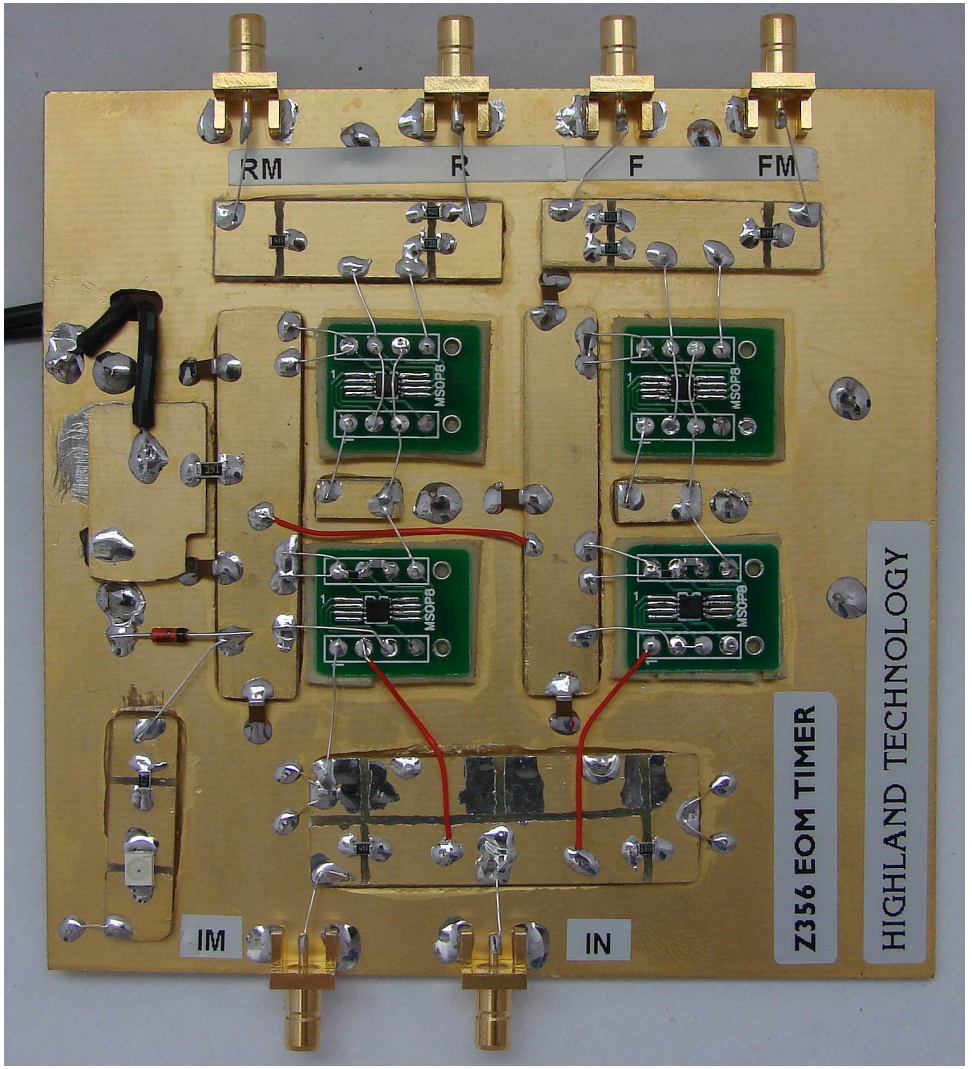
Manhattan

- SMD, cut PCB not adhesive islands
- can scratch/cut, better to dremel, preferably with a dental burr

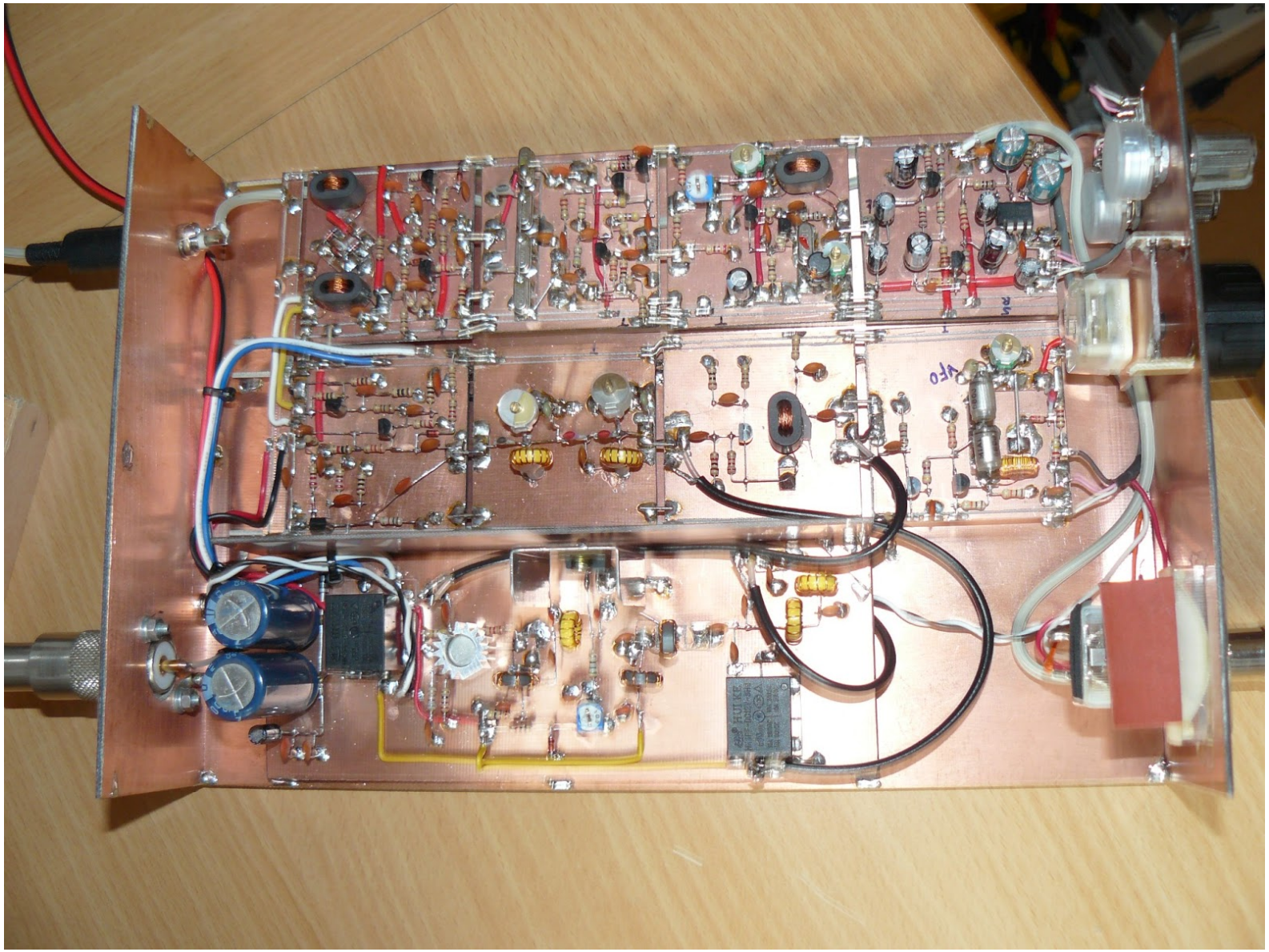


Manhattan

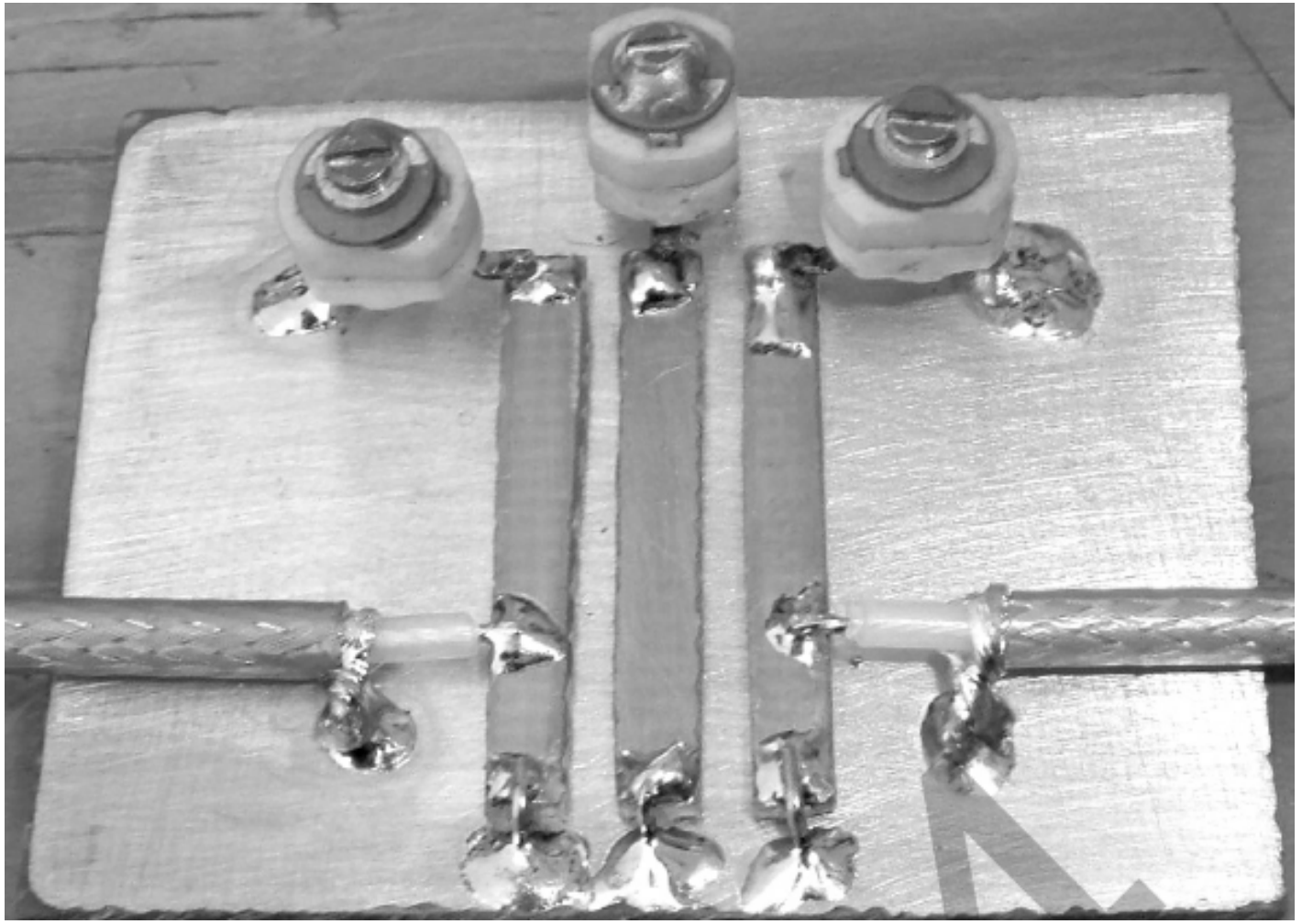
- product shipped to customer
- variety of techniques...
- solid groundplane
- SMD & connectors
- power wire strain relief
- breakout boards
- double wires for power
- stuck-on PCB islands
- dremelled PCB island subassemblies
- power rail “busbar” & power rail decoupling



Manhattan, Incremental



Standard RF/Microwave



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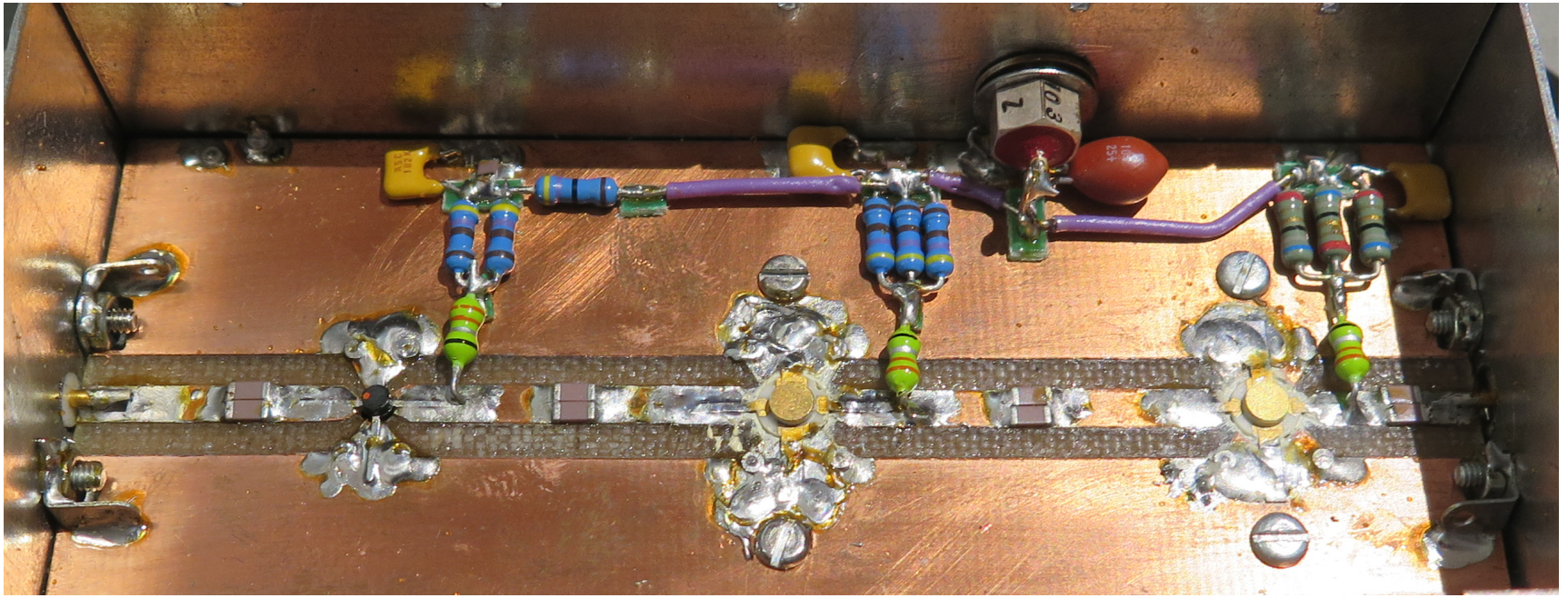

Copper Foil

- copper foil strips on insulating substrate, e.g. single sided PCB
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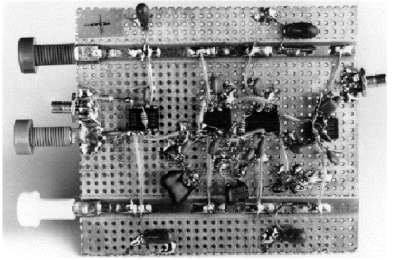
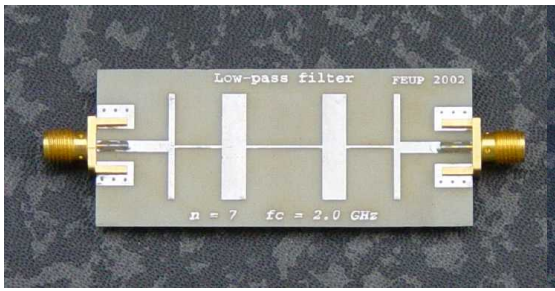
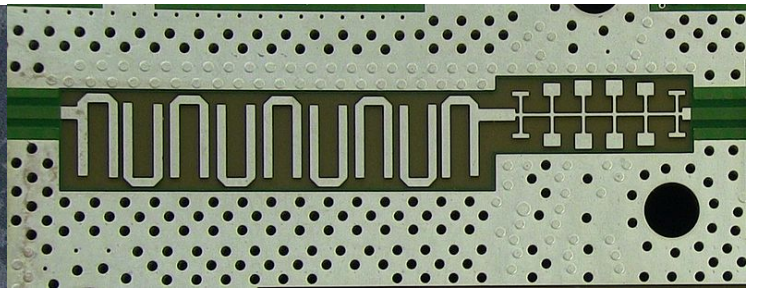
  - *could* achieve controlled impedance with correct width foil (used to be able to buy such strips)
  - often adhesive is conductive for an EMI/EMC “gasket”, so *don't* use on a conductive substrate and *do* solder joins
  - ordinary prototypes



  - *possibly* make RF black magic components





Proprietary Products

- there are *many* “build a better mousetrap / apple-peeler” products
- forced to choose IC/transistor pitch/pins
- tradeoff between
  - small pads
    - more SMD component positions, iff pitch right
    - easier to melt glue holding pad to substrate
  - large pads
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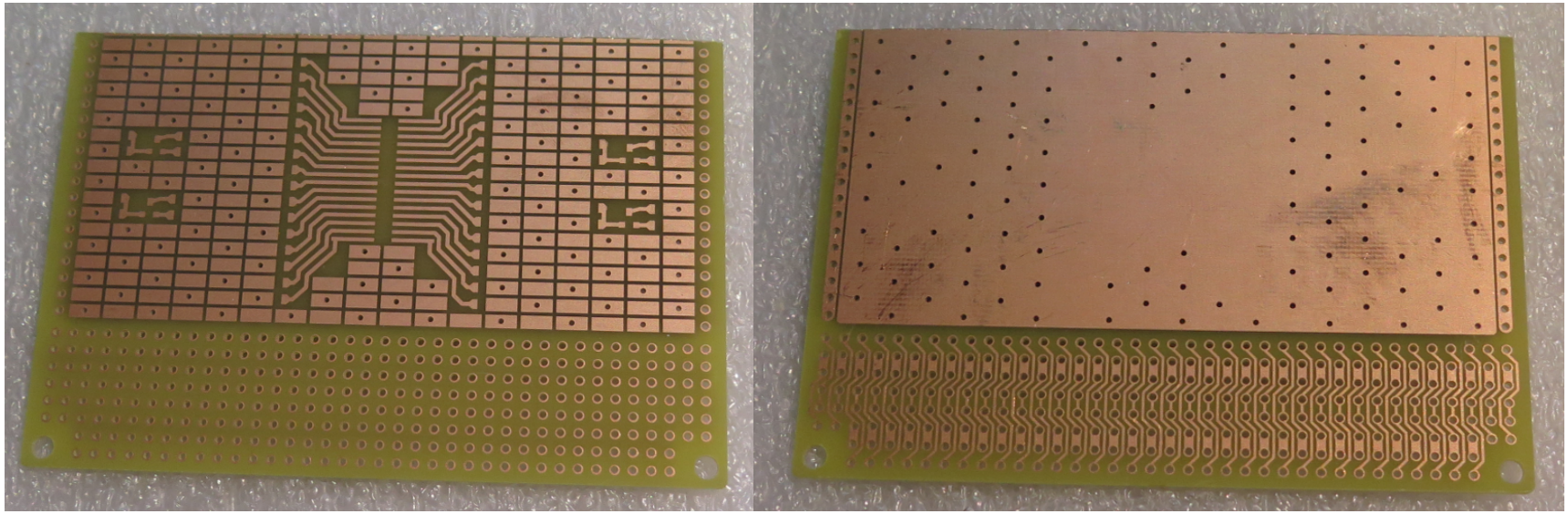
    - may need dedicated IC and SMD pads/breakouts

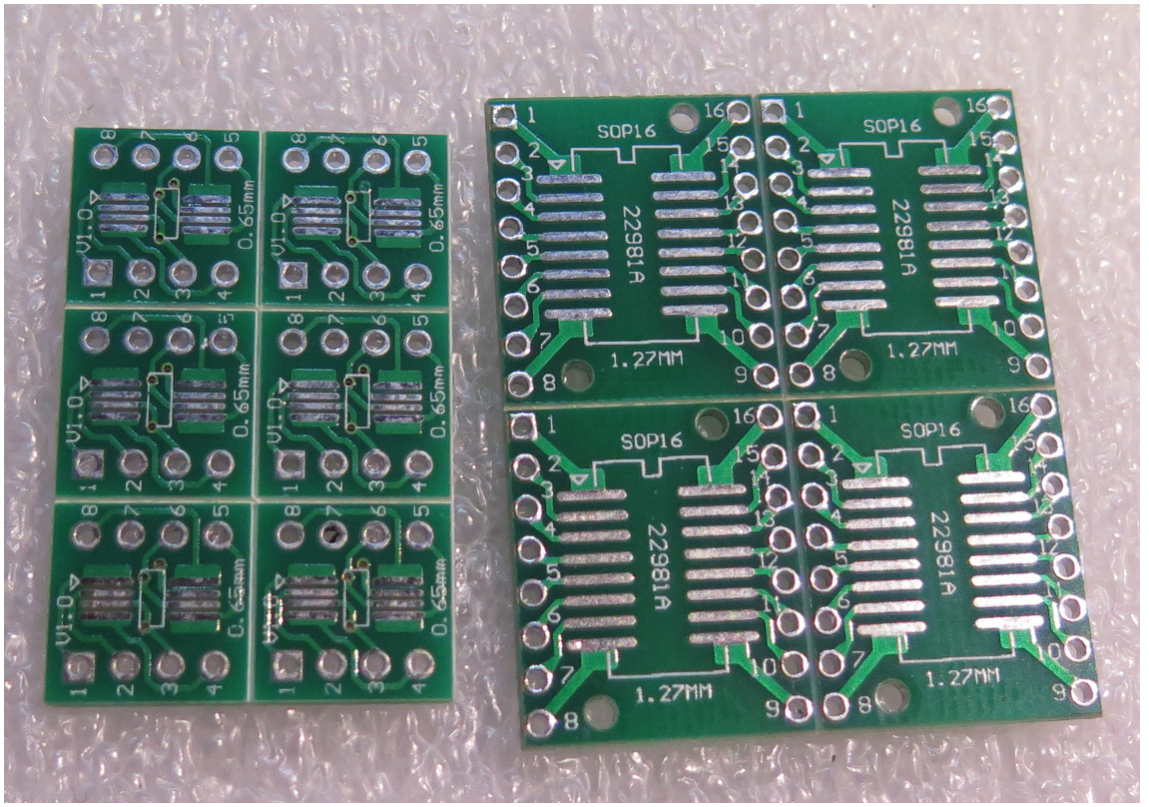
Proprietary Products

- “uncommitted manhattan”; pads *not* connected to full ground plane (BusBoard)



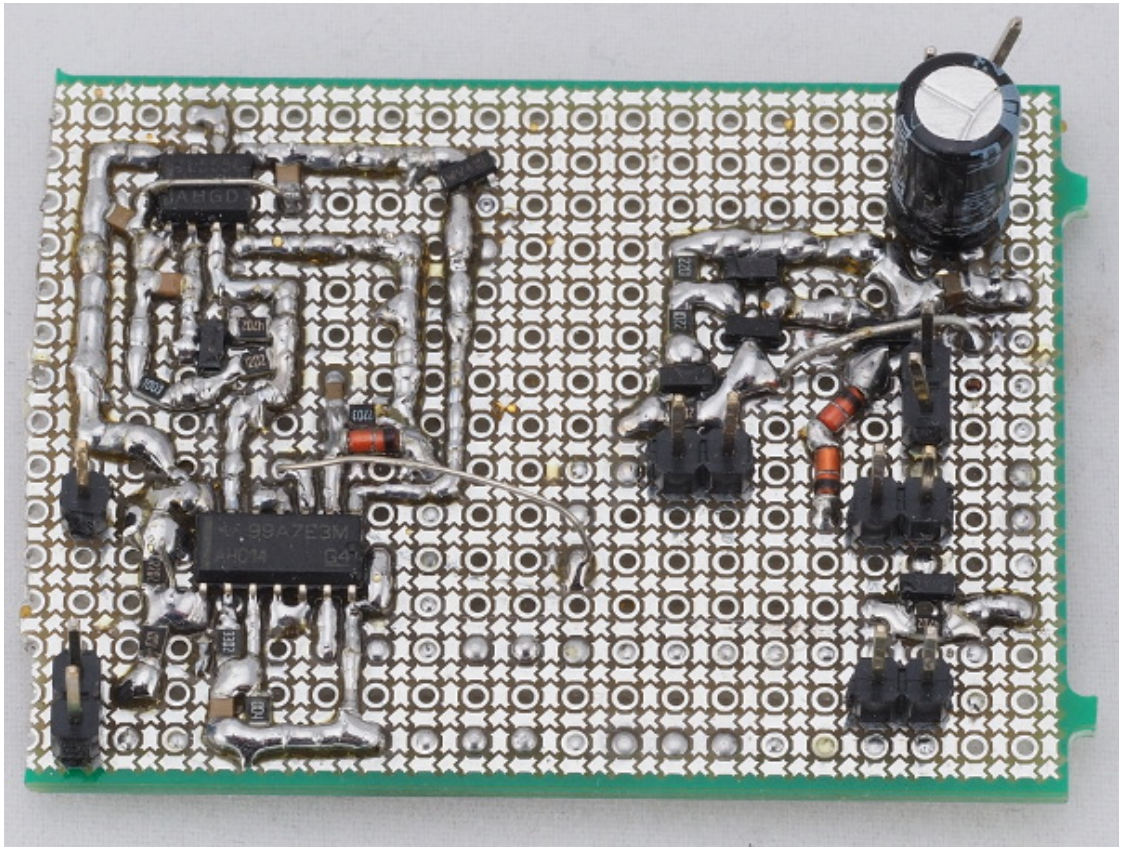
Proprietary Products

- standard breakout, many varieties, different pattern on each side (fleabay)



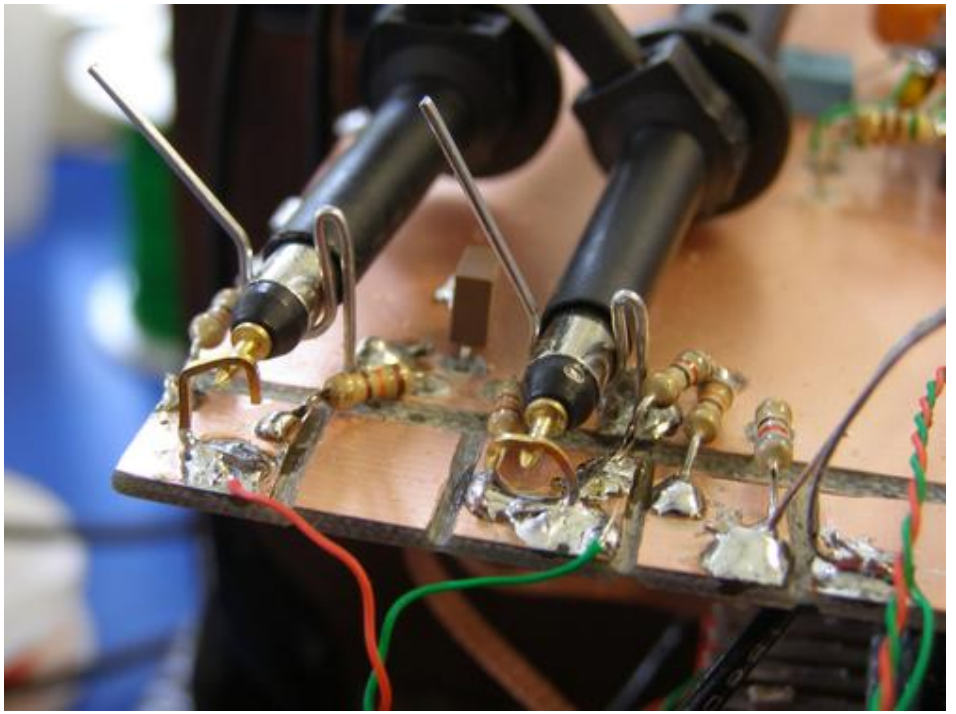
Proprietary Products

- 1.27mm/0.05” pitch, DIY from KiCad/gerber files (electroniceel)



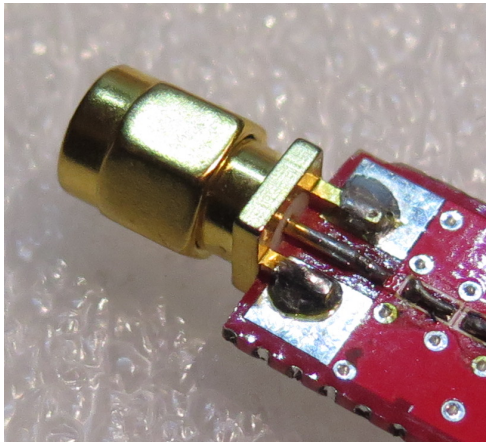
Tips and Tricks

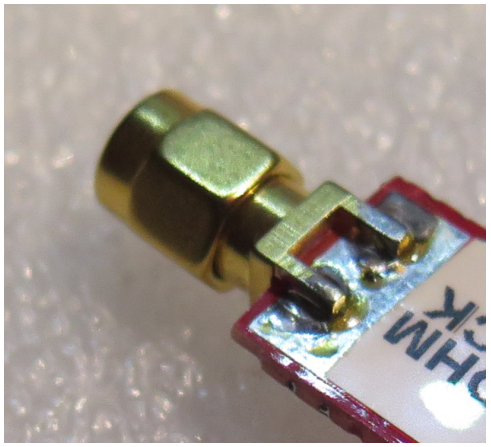
- high performance probe connections

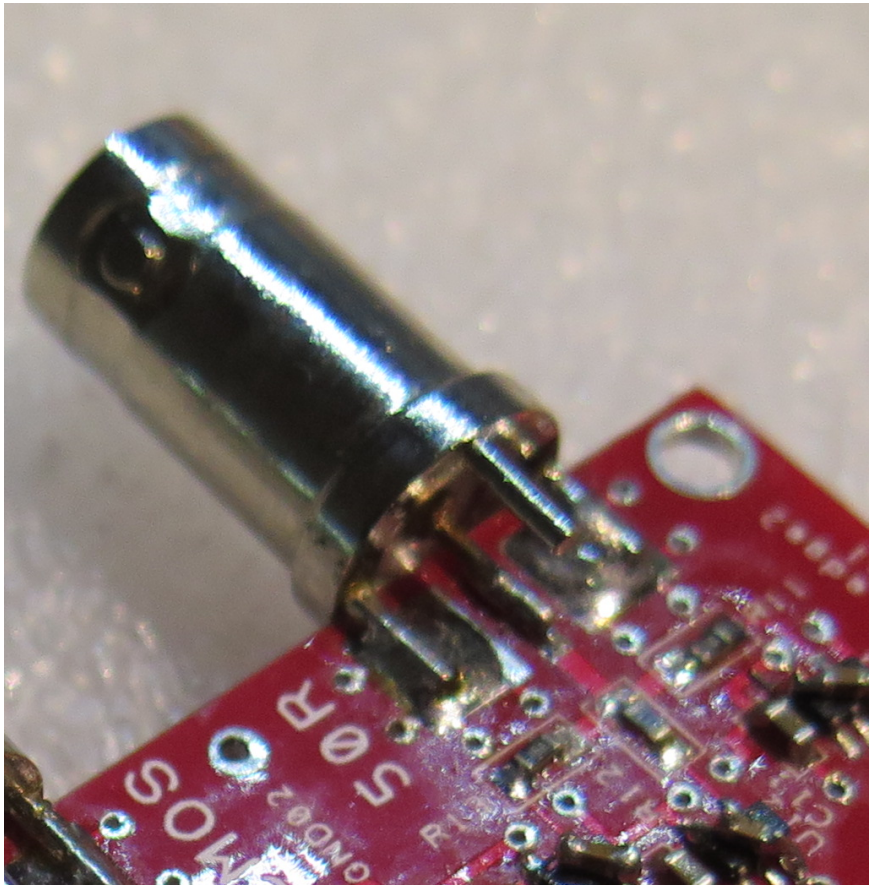


Tips and Tricks

- edge mounted coax connectors







Tips and Tricks

- write pin numbers on groundplane with an alcohol based pen
- ditto connections and testpoints
- add wire loops for witches' hat probe grabbers
- already noted:
  - strain relief
  - enclosures
- copper foil for PSU connections
- mix and match techniques as convenient
- make your own prototype PCBs for whatever technique you like (DirtyPCBs 5cm*5cm, double sided, PTH, 10 off, £10)

Review

- some of the techniques are:
  - used effectively by professionals and experienced amateurs (esp. hams)
  - useful for prototypes
  - used in production equipment, since they have very good performance
- techniques can be mixed and matched wherever convenient
- I prefer manhattan and dead bug/breakout, but use others
- *use whichever techniques you like*, provided you:
  - always have a solid groundplane
  - stop using solderless breadboards!

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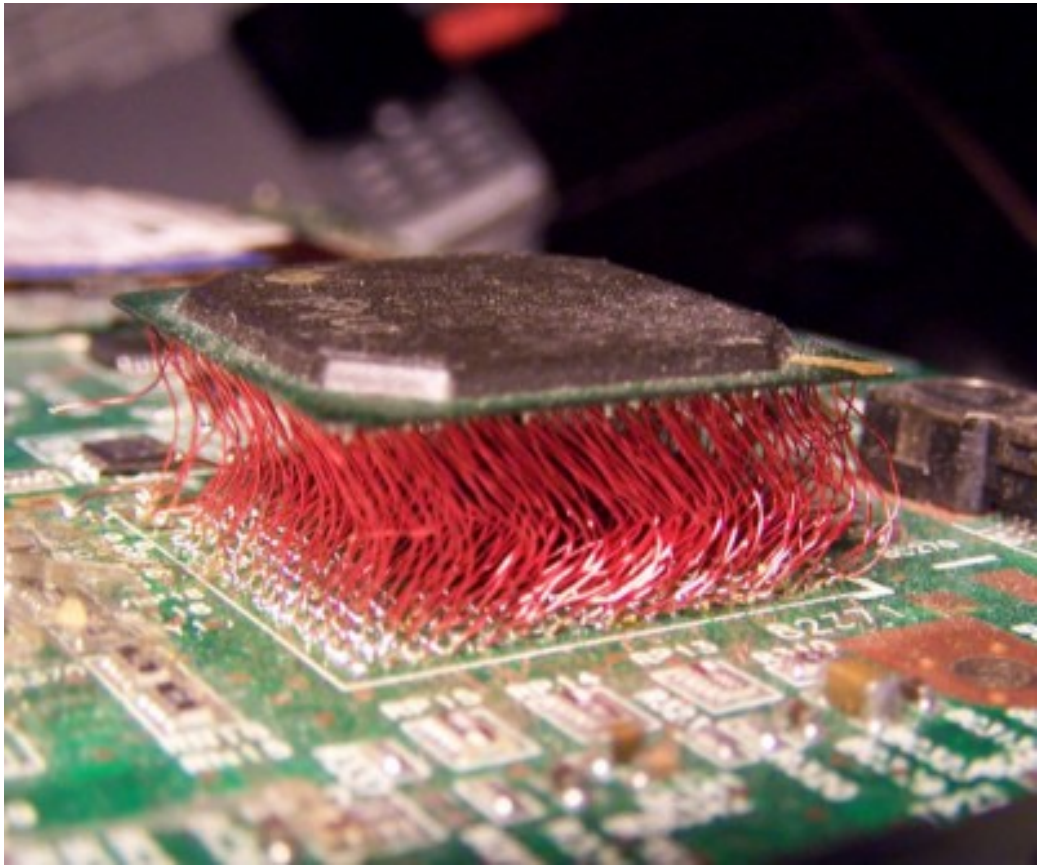
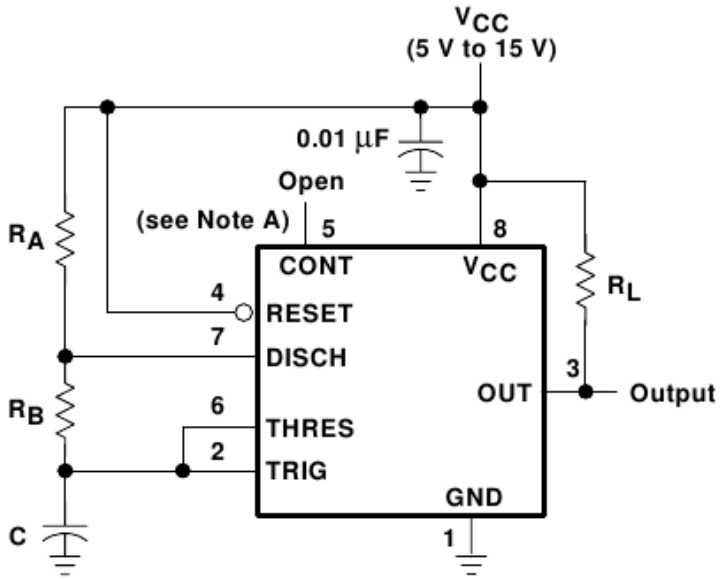
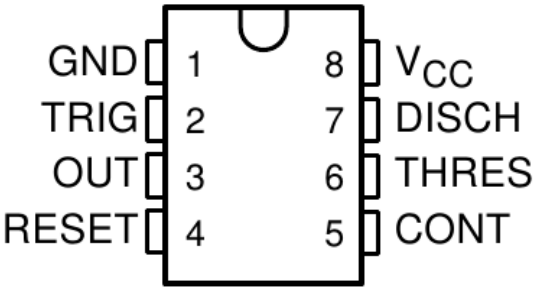
- example products
  - matrix and breakout boards http://www.talkingelectronics.com/EM/Matrix%20Boards/MatrixBoards.html
  - BusBoard SMD etc etc boards http://www.busboard.com/surfacemountpcbs
  - 1.27mm pitch DIY from gerbers https://github.com/electroniceel/protoboard
- methods
  - http://www.dartmouth.edu/~sullivan/prototyping.pdf
  - radio amateurs have many useful techniques; search for ARRL handbook
  - Robert Pease “Troubleshooting Analog Circuits”
  - Paul Harden’s (NA5N) guide to Manhattan http://www.aoc.nrao.edu/~pharden/hobby/HG-MANHAT2.pdf

Heroic Fun



Practical: 555 Astable Oscillator





$$t_H = 0.693\ (R_A + R_B)\ C$$

$$t_L = 0.693\ (R_B)\ C$$

Other useful relationships are shown below.

$$\text{period} = t_H + t_L = 0.693\ (R_A + 2R_B)\ C$$

$$\text{frequency} \approx \frac{1.44}{(R_A + 2R_B)\ C}$$

$$\text{Output driver duty cycle} = \frac{t_L}{t_H + t_L} = \frac{R_B}{R_A + 2R_B}$$

$$\text{Output waveform duty cycle} = \frac{t_H}{t_H + t_L} = 1 - \frac{R_B}{R_A + 2R_B}$$

$$\text{Low-to-high ratio} = \frac{t_L}{t_H} = \frac{R_B}{R_A + R_B}$$

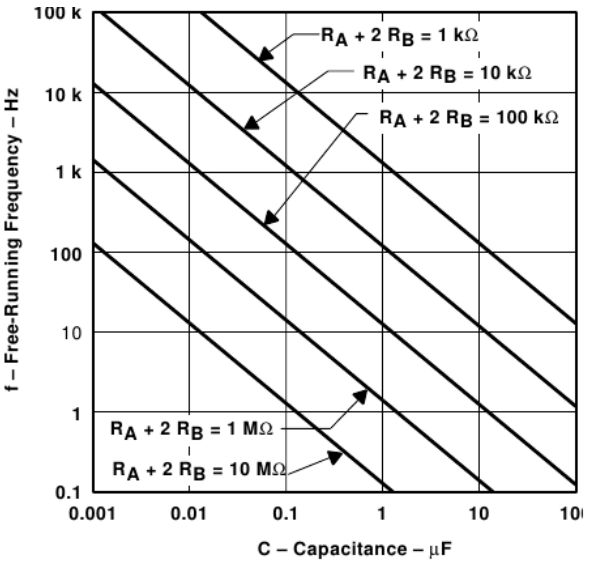


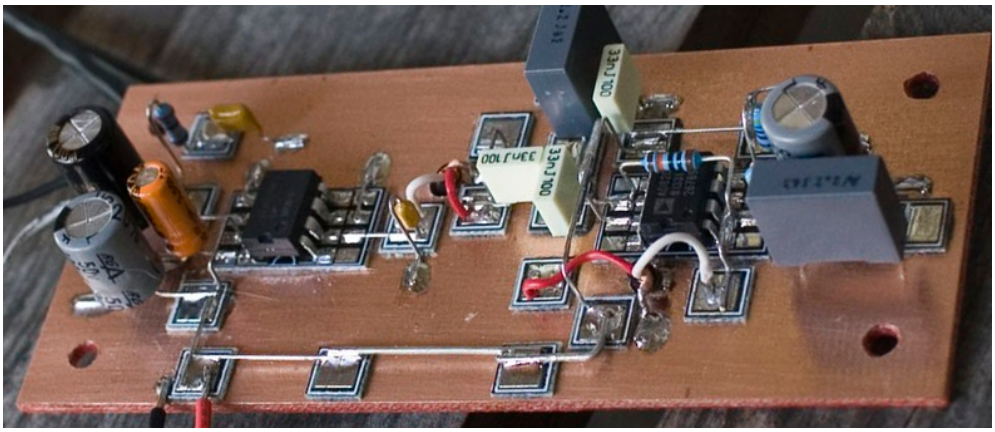
Figure 14. Free-Running Frequency

Practical: Planning and Tricks

- planning
  - dead bug, live bug, SMD+breakout?
  - build/test all at once, or in stages?
  - which nodes must/might be probed?
  - which nodes need to be short, or low capacitance, low leakage?
  - which nodes need strong or permanent external connections?
  - which components are going to be tweaked?
  - how will power be attached?
- tricks
  - use groundplane!
  - place ICs
  - write pin 1 and/or corner pins
  - place power connections
  - place PSU decoupling caps
  - place critical components/nodes
  - place other components

Manhattan

Stripboard Without the Disadvantages

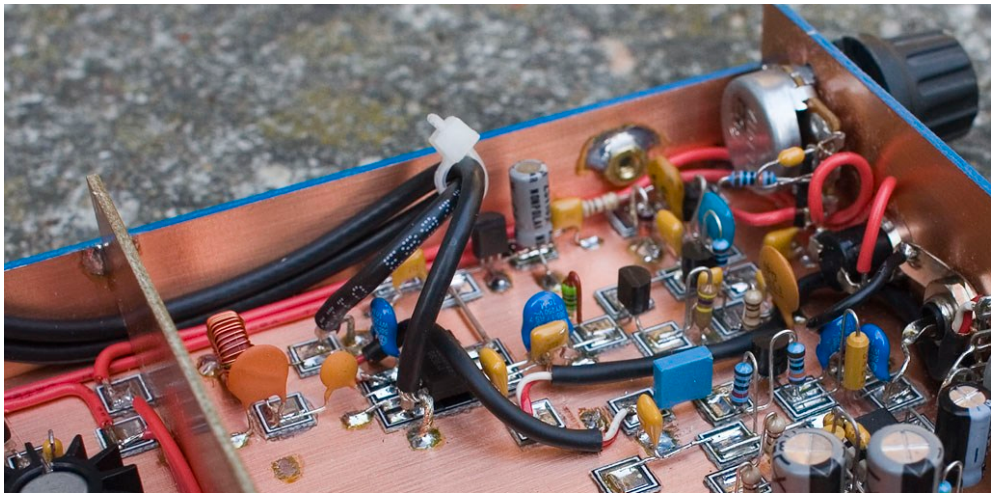


My personal favourite technique

A more disciplined and robust dead/live bug technique

Easy, high speed, low noise, robust, cheap, incremental

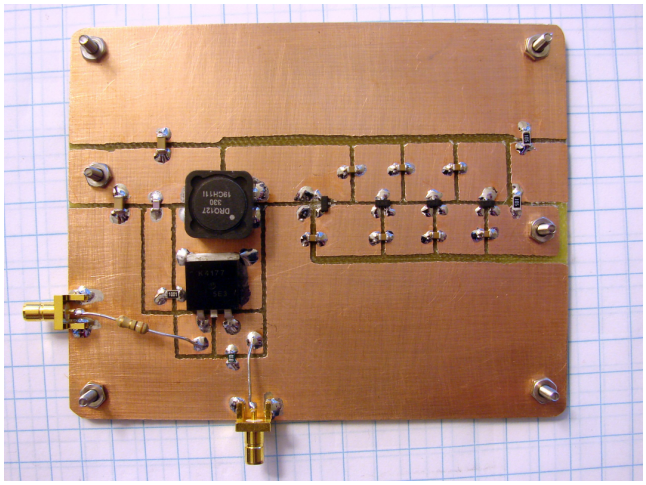
Manhattan



Can also build the enclosure this way.
Could make a PCB for the front panel; silkscreen the legend

Manhattan

- SMD, cut PCB not adhesive islands
- can scratch/cut, better to dremel, preferably with a dental burr



I think this is an SMPS to turn +-12V into +-14V
SMD and/or PTH
Rare to have such an easy layout without wire jumpers

Manhattan

- product shipped to customer
- variety of techniques...
- solid groundplane
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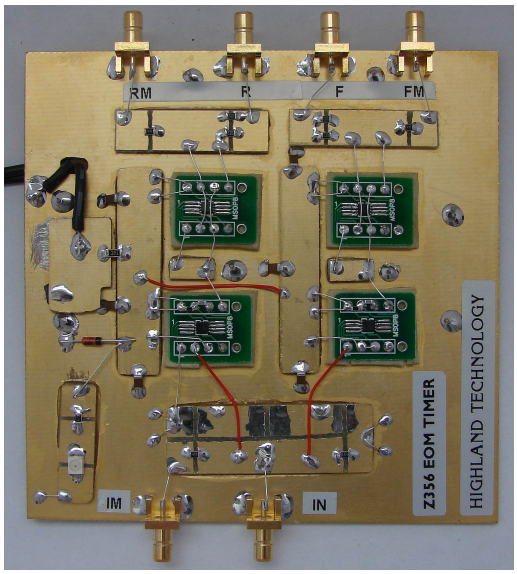

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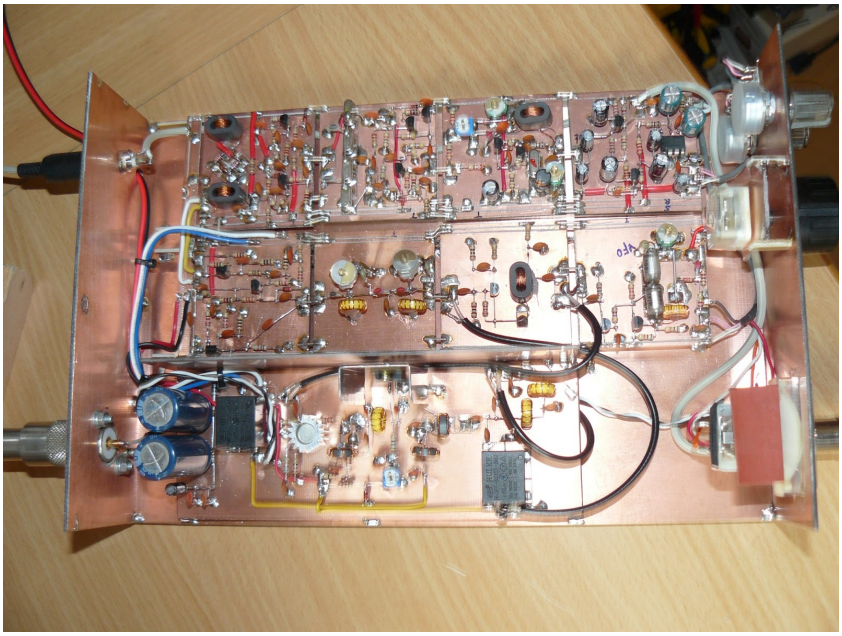
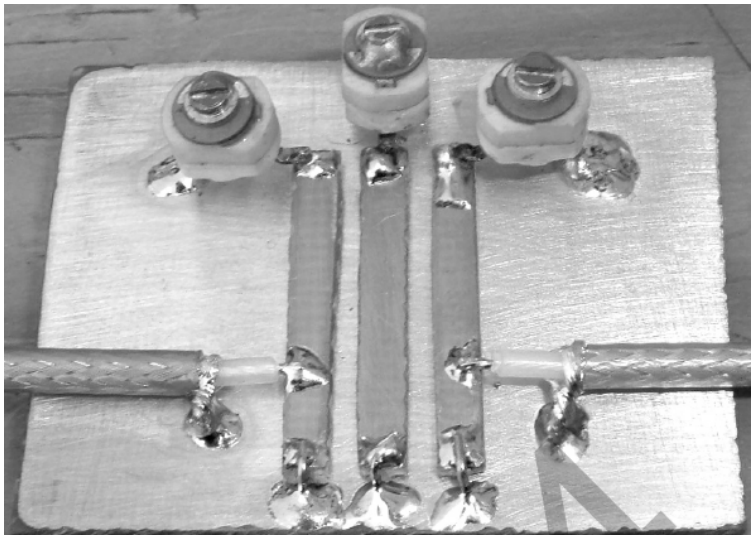


Build a bit at a time, can remove and replace

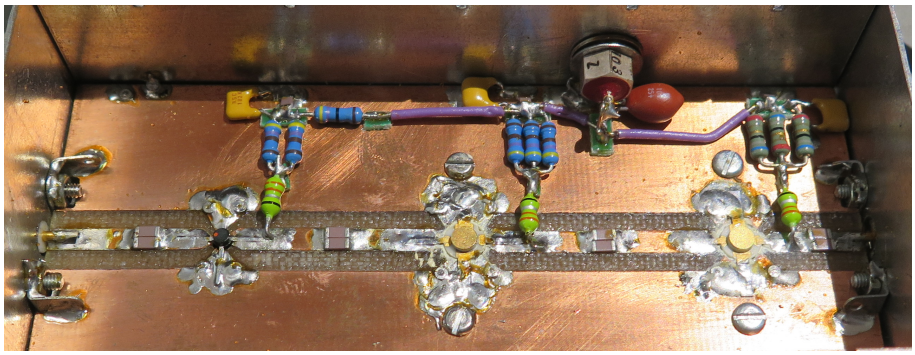
Standard RF/Microwave



RF filter (10MHz-10GHz) made from strips of PCB glued to groundplane; dimensions are critical, and determine the frequency response

Good for high frequency/speed: leads short and solid groundplane

Standard RF/Microwave



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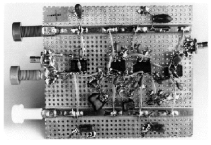
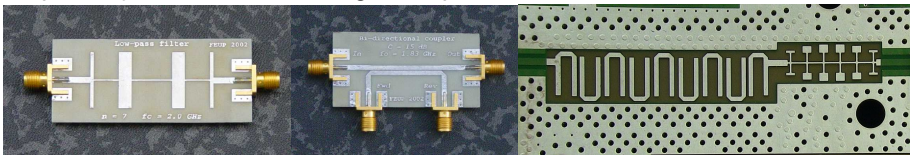
Copper Foil

- copper foil strips on insulating substrate, e.g. single sided PCB
  - *possibly* artistic or for absolute beginners
  - *could* achieve controlled impedance with correct width foil (used to be able to buy such strips)
  - often adhesive is conductive for an EMI/EMC “gasket”, so *don't* use on a conductive substrate and *do* solder joins
  - ordinary prototypes



  - *possibly* make RF black magic components



Proprietary Products

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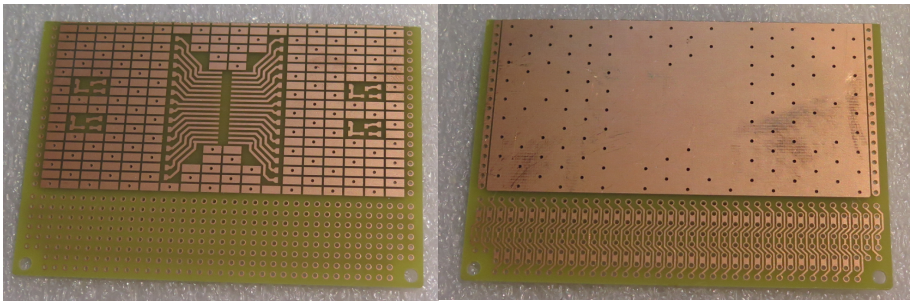
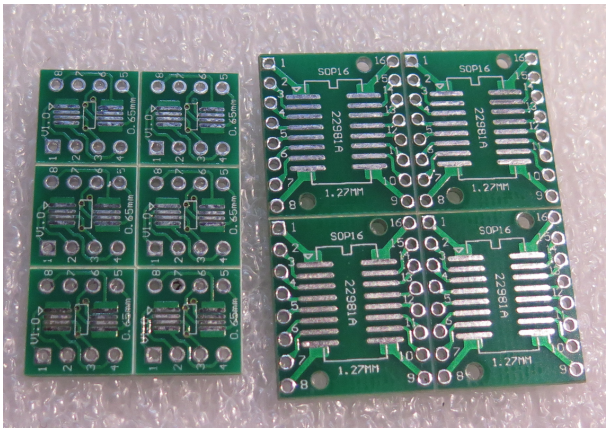


Good but expensive, and you have to choose the pitch.
Plonk components down wherever convenient.
Solid groundplane
Holes not plated, so add your own wire to staple top pad to groundplane

Proprietary Products

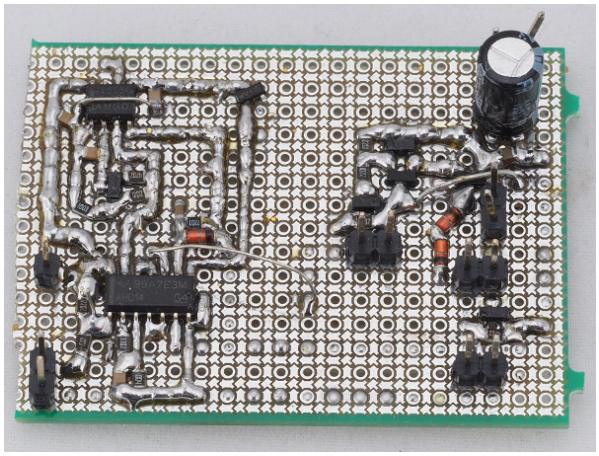
- standard breakout, many varieties, different pattern on each side (fleabay)



Breakout boards are cheap enough to buy many on spec. Just as well, given the number of IC pitches

Proprietary Products

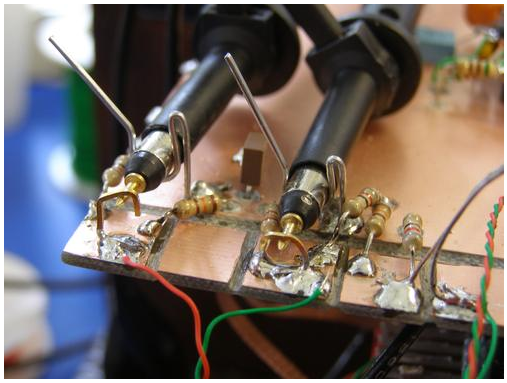
- 1.27mm/0.05” pitch, DIY from KiCad/gerber files (electroniceel)



Small gaps between lands are easily bridged with solder. Best if circuit is preplanned.

Tips and Tricks

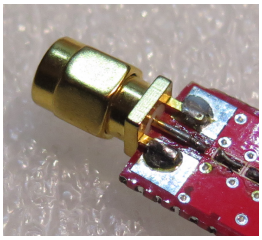
- high performance probe connections

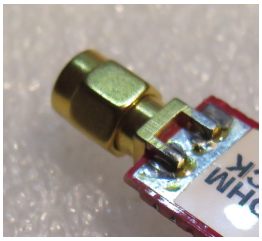


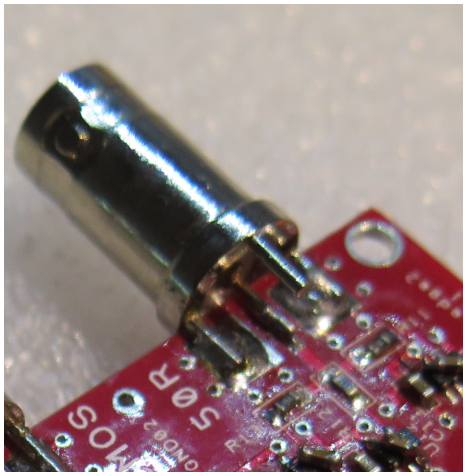
Probe connections from bent wire or paperclips.
Excellent performance since no ground lead.
Can leave probe attached, but still remove it easily

Tips and Tricks

- edge mounted coax connectors







Coax connectors are ideally “edge mount” and the same width as the PCB's thickness (1.6mm, but can bodge it with a 1.2mm PCB). Usefully strong, provided the PCB land is large.

Might work with other connector types.

Tips and Tricks

- write pin numbers on groundplane with an alcohol based pen
- ditto connections and testpoints
- add wire loops for witches' hat probe grabbers
- already noted:
  - strain relief
  - enclosures
- copper foil for PSU connections
- mix and match techniques as convenient
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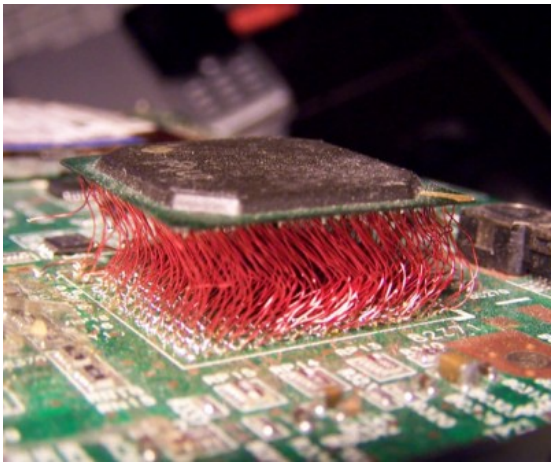
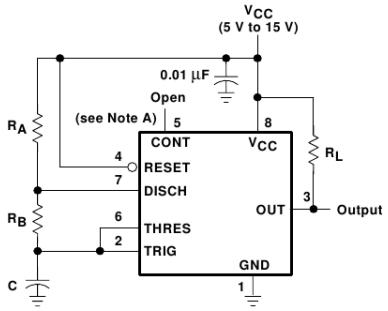
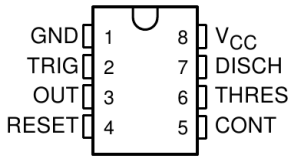
- methods
  - http://www.dartmouth.edu/~sullivan/prototyping.pdf
  - radio amateurs have many useful techniques; search for ARRL handbook
  - Robert Pease “Troubleshooting Analog Circuits”
  - Paul Harden’s (NA5N) guide to Manhattan http://www.aoc.nrao.edu/~pharden/hobby/HG-MANHAT2.pdf

Heroic Fun



Practical: 555 Astable Oscillator





$t_H = 0.693\ (R_A + R_B)\ C$

$t_L = 0.693\ (R_B)\ C$

Other useful relationships are shown below.

period $= t_H + t_L = 0.693\ (R_A + 2R_B)\ C$

frequency $\approx \frac{1.44}{(R_A + 2R_B)\ C}$

Output driver duty cycle $= \frac{t_L}{t_H + t_L} = \frac{R_B}{R_A + 2R_B}$

Output waveform duty cycle

$= \frac{t_H}{t_H + t_L} = 1 - \frac{R_B}{R_A + 2R_B}$

Low-to-high ratio $= \frac{t_L}{t_H} = \frac{R_B}{R_A + R_B}$

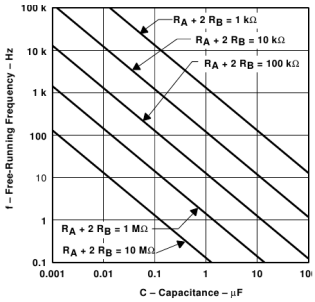


Figure 14. Free-Running Frequency

Practical: Planning and Tricks

- planning
  - dead bug, live bug, SMD+breakout?
  - build/test all at once, or in stages?
  - which nodes must/might be probed?
  - which nodes need to be short, or low capacitance, low leakage?
  - which nodes need strong or permanent external connections?
  - which components are going to be tweaked?
  - how will power be attached?
- tricks
  - use groundplane!
  - place ICs
  - write pin 1 and/or corner pins
  - place power connections
  - place PSU decoupling caps
  - place critical components/nodes
  - place other components