

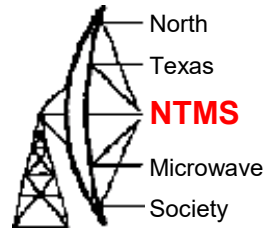
Using microwave filters

North Texas Microwave Society

Jim McMasters KM5PO

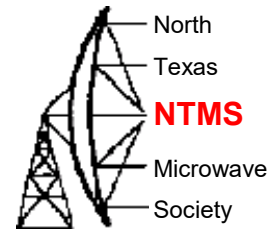
km5po@arrl.net

Types of filter to discuss



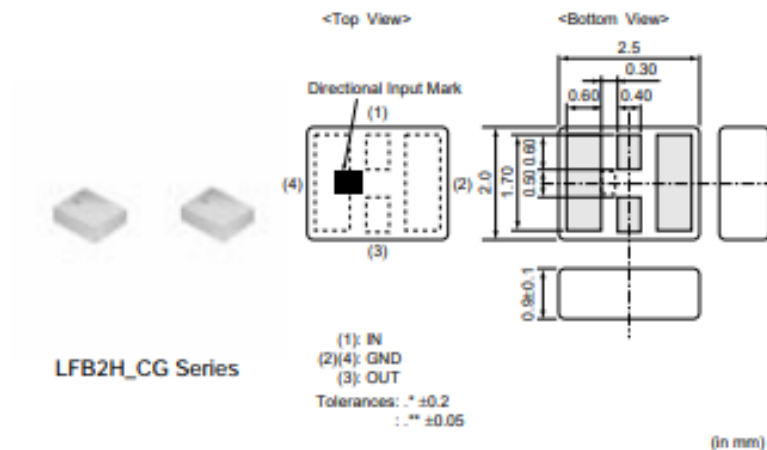
- **Component SMD**
- **Stripline**
- **Hairpin**
- **Waveguide**
- **Pipecap**

Component SMD

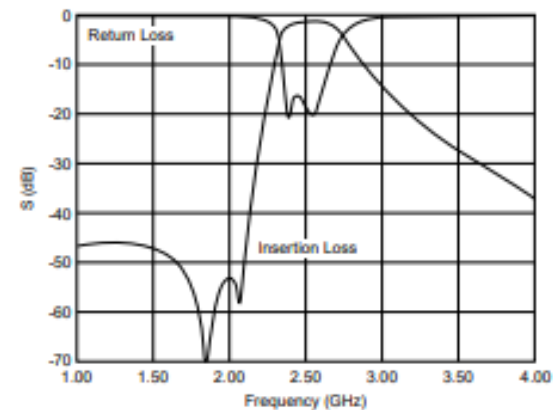


The Wavelab control board has a Murata LFB2H2G45SG7C093

● LFB2H(1008)_CG Series

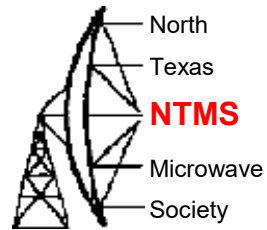


Frequency Characteristics

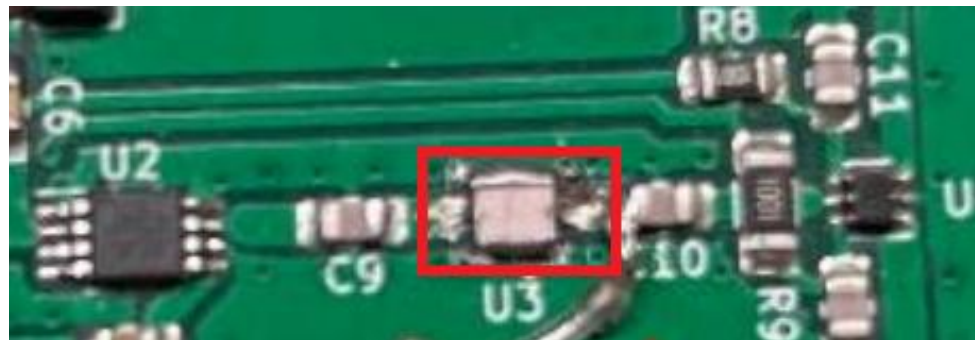
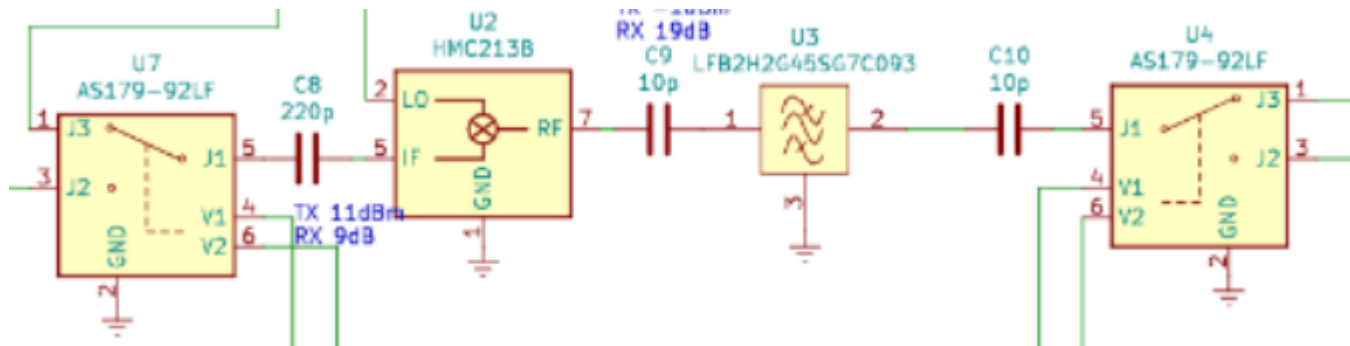


Part Number	Nominal Center Frequency (fo) (MHz)	Bandwidth (BW) (MHz)	Insertion Loss in BW (dB)	Attenuation (Absolute Value) I) (dB)	Attenuation (Absolute Value) II) (dB)	Application
LFB2H2G45CG1C026	2450.00	fo $\pm$ 50.00	2.10 max. (at 25°C)	43 min. at 806-849MHz	43 min. at 1920-1990MHz	WLAN/BT

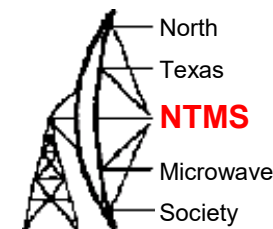
Component SMD



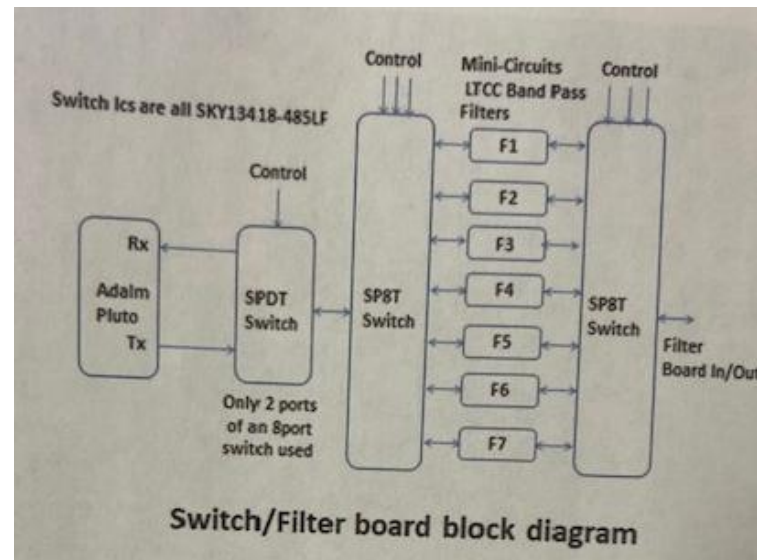
Wavelab U3 Murata LFB2H2G45SG7C093 filter both TX & RX



Component SMD



From MUD Vancouver – multi band filter for Pluto SDR



Mini-Circuits Filters used:

1296 band BFCN-152-75 5 dB Ins Loss

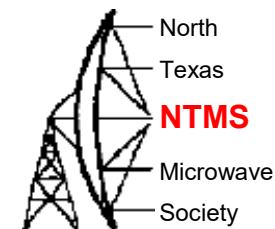
2304 band BFCN-2275+ 5 dB Ins Loss

3446 band BFCN-3600+ 7 dB Ins Loss

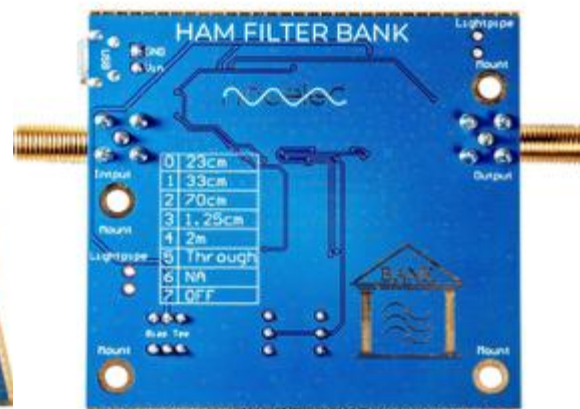
5.7 GHz band BFCN-5750+ 15 dB Ins Loss

10 GHz band BFCN-1052+ 20+ dB Ins Loss

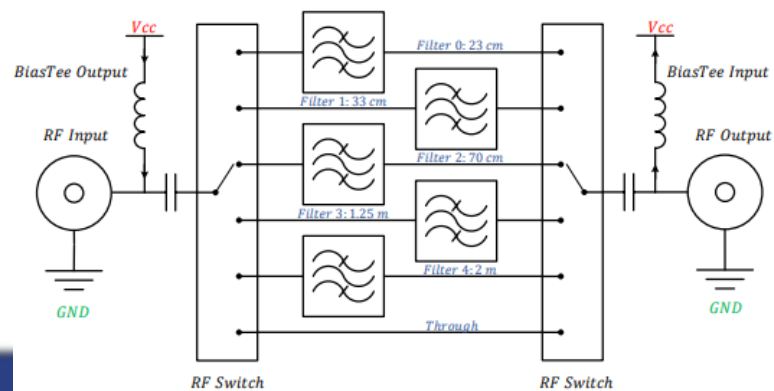
Component SMD



Amazon "Nooelec" Filter. \$59.95. 2m, 1.25m, 70cm, 33cm, 23cm.



[Nooelect Amazon datasheet](#)



Stripline

DEMI stated (Central States 2025) they are using Stripline filters in a new design. Marki Microwave Stripline designer tool was mentioned.

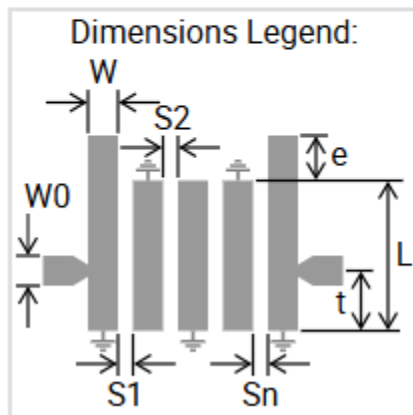


5th Order Chebyshev Bandpass

Lower Cutoff Freq. = 1.900 GHz; Upper Cutoff Freq. = 2.100 GHz

Passband Ripple = 0.1 dB

Substrate: $\epsilon_r = 4.200$, Height = 254.0 μm , Thickness = 10.00 μm



$W_0 = 491.4 \mu\text{m}$

$W = 491.4 \mu\text{m}$

$L = 20.95 \text{ mm}$

$t = 3.728 \text{ mm}$

$e = 477.3 \mu\text{m}$

$S_1 = 461.3 \mu\text{m}$

$S_2 = 564.8 \mu\text{m}$

$S_3 = 564.8 \mu\text{m}$

$S_4 = 461.3 \mu\text{m}$

Stripline



calculate the precise layout dimensions.

Waveguide Connectorized Surface Mount Bare Die Space & Hi-Rel Technical Resources

Filter Properties

Response Type
Bandpass Chebyshev

Topology Order
Interdigital 5

Lower Cutoff Frequency Upper Cutoff Frequency
1900 MH 2100 MH

Passband
Ripple (dB)
0.10

Input \ Output
Impedance (Ω)
50

Resonator
Impedance (Ω)
50

Substrate Parameters

Dielectric Constant, ϵ_r
4.20

Dielectric Height Conductor Thickness
254.00 um 10.00 um

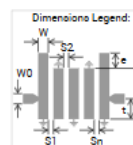
Compute

Reset



5th Order Chebyshev Bandpass

Lower Cutoff Freq. = 1.900 GHz; Upper Cutoff Freq. = 2.100 GHz
Passband Ripple = 0.1 dB
Substrate: ϵ_r = 4.200, Height = 254.0 um, Thickness = 10.00 um



Dimensions Legend:
W0 = 491.4 um
W = 491.4 um
L = 20.95 mm
t = 3.728 mm
e = 477.3 um
S1 = 461.3 um
S2 = 564.8 um
S3 = 564.8 um
S4 = 461.3 um

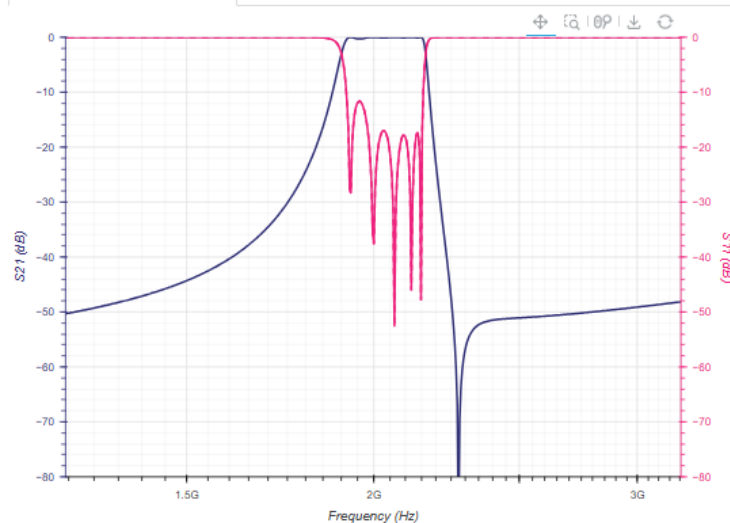


markimicrowave.com | Dec 12, 2025

Insertion Loss and Return Loss

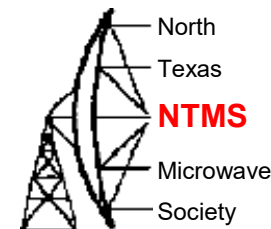
Phase and Group Delay

S-Parameters

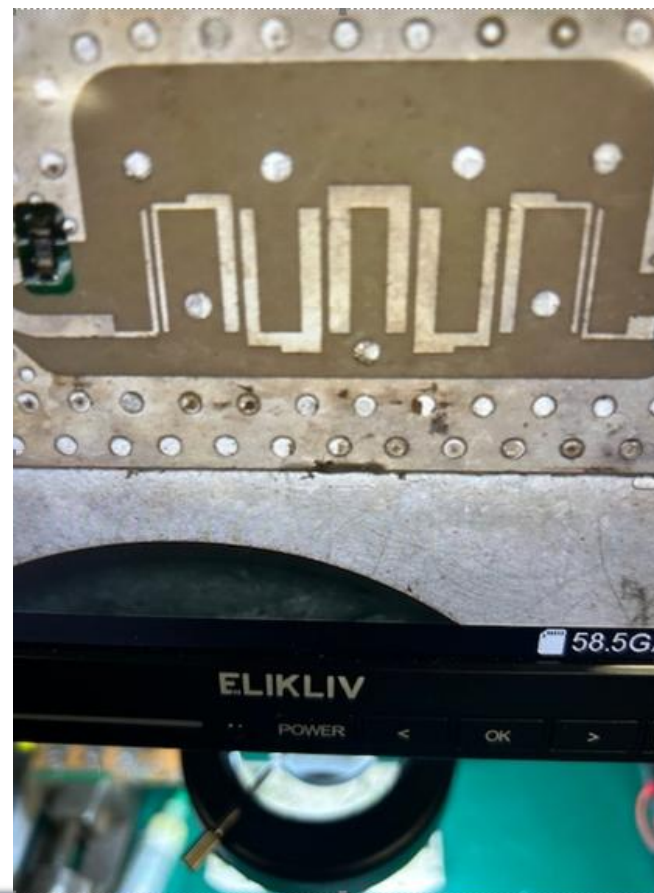


markimicrowave.com | Dec 12, 2025

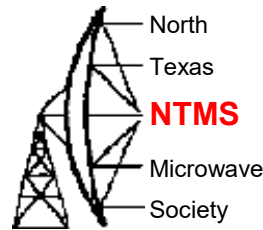
Hairpin (Wavelab module)



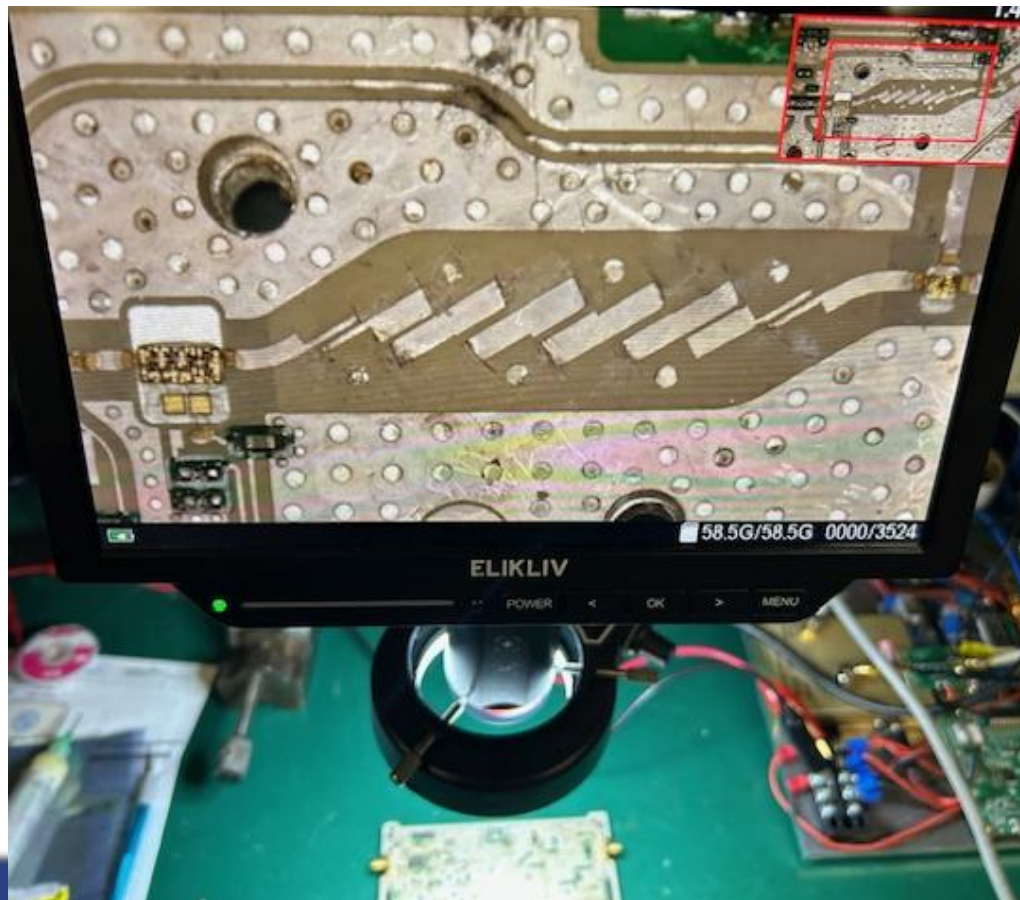
Left: 13mm high (3.6 GHz BPF) Right: 4.5mm high (10.9 GHz BPF)



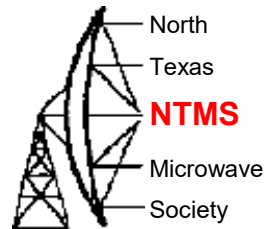
Stripline



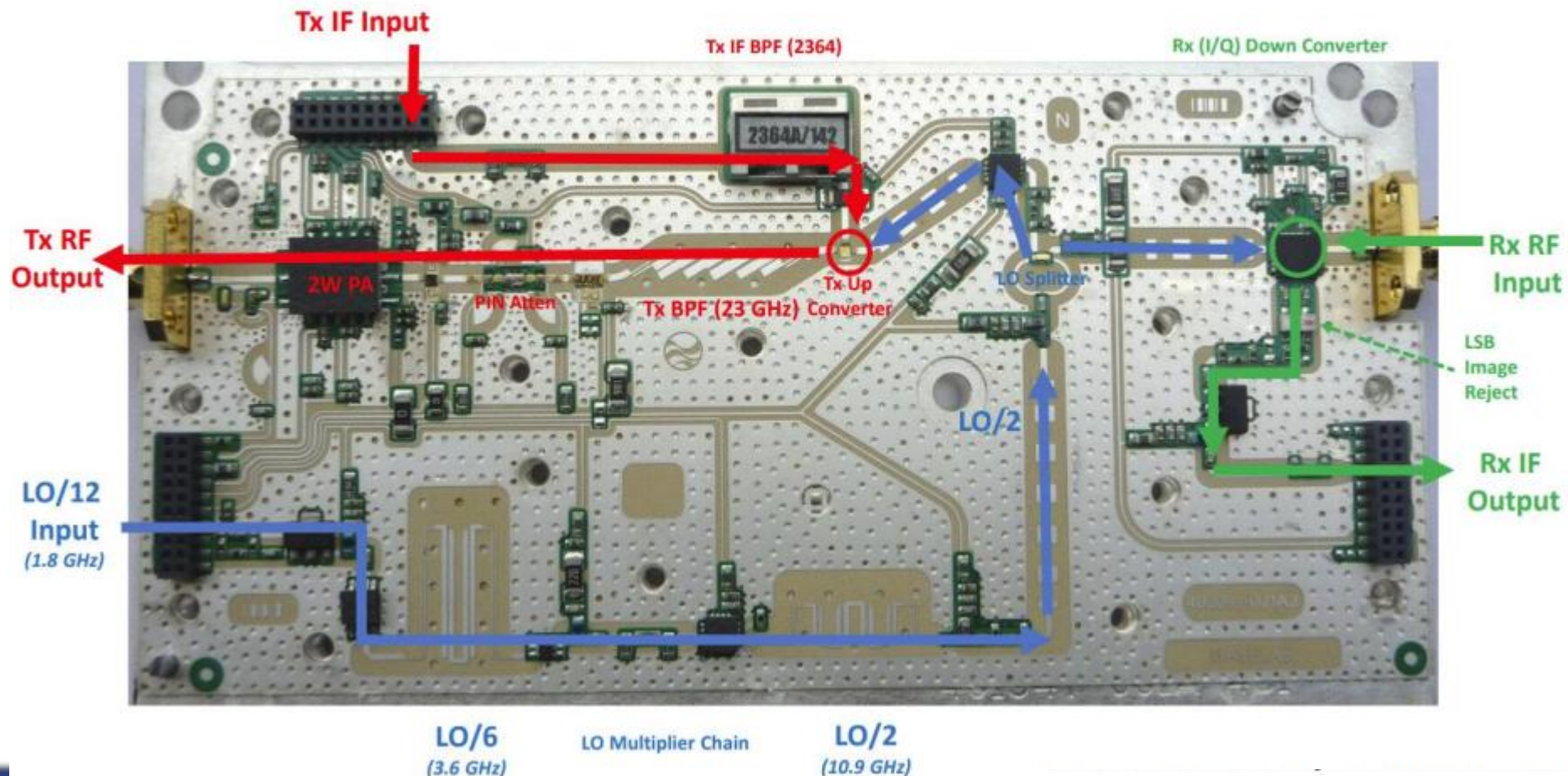
Transmit chain final BPF before PA – 23 GHz BPF (modified to 24 GHz)
Elements are 3.6mm x 1mm in size. Substrate is .34mm thickness



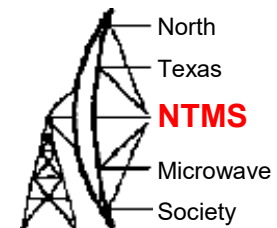
Inside the Wavelab module



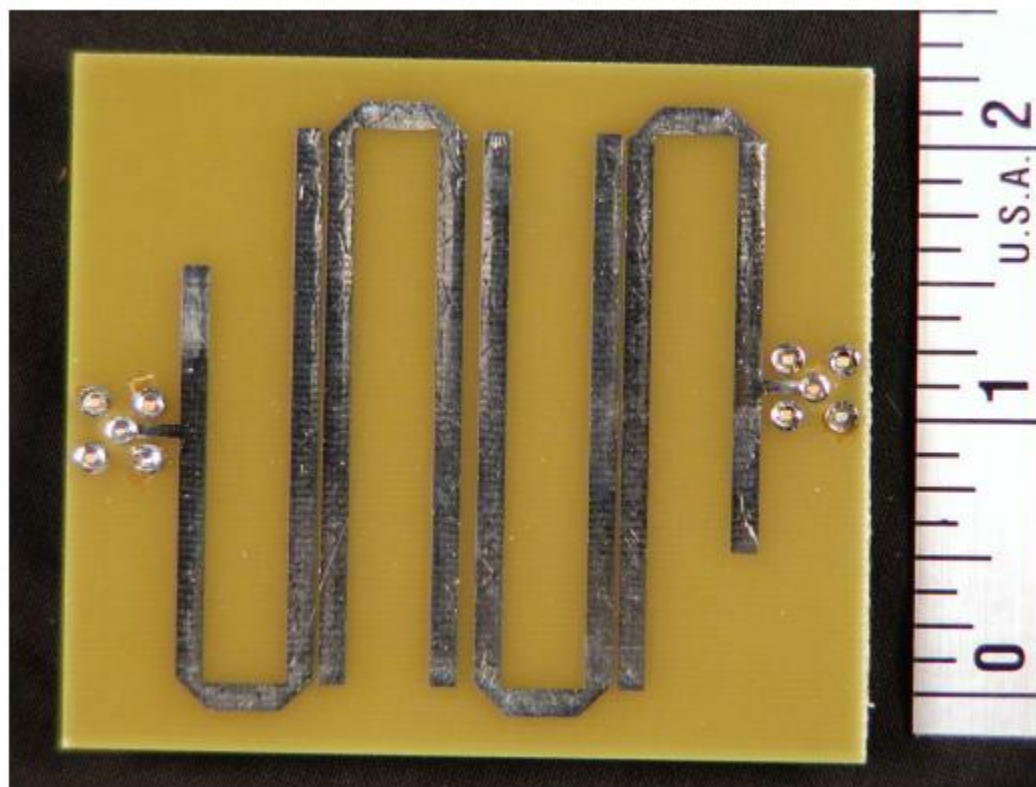
Signal Flow & Components Inside the Wavelab Module



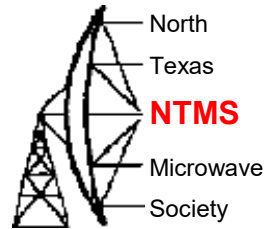
Hairpin



[W1GHZ published information on Hairpin filters](#)

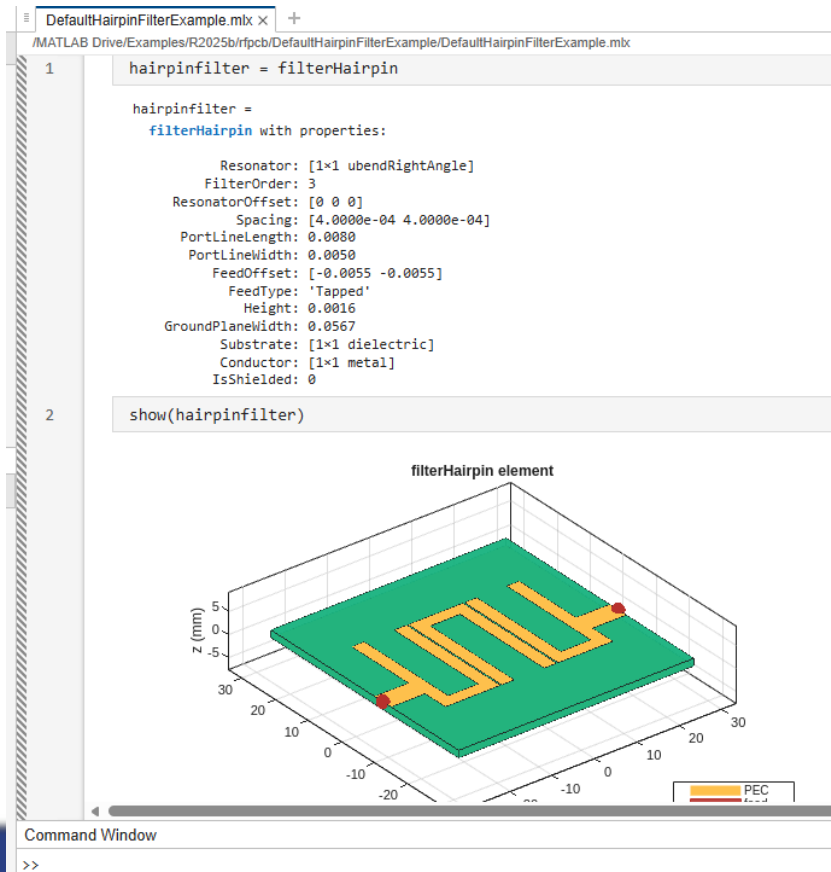


Hairpin



MATLAB designer is free.. but has a learning curve

MATLAB Hairpin design information



Hairpin

Charles' Labs Hairpin filter designer

The microstrip hairpin filter generator

Enter your desired elements length in the following form to generate an SVG or Kicad file. Use the form under to compute the element length for any given frequency.

Preview:



Elements length (mm)

 GENERATE KICAD FOOTPRINT

 GENERATE SVG FILE

This hairpin must be printed on one side of a standard **double sided 1.6 mm thick** PCB. The back side must stay **copper coated** and be connect to the ground. Remove the solder mask on top of the filter.

On the SVG file, the horizontal line at the bottom of the page is 150 mm, to check scaling after printing/importing.

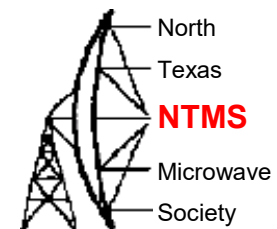
The generated topologies are designed to be used with standard female 50 Ω SMA board-edge connectors. Solder the connector center signal pins to the hairpin feeder tracks and the ground pins to the bottom side.

Center frequency (MHz)

Hairpin elements length (mm)

This tool is under MIT license.

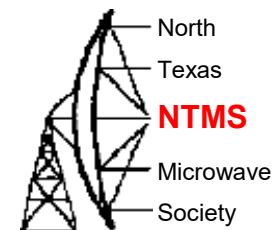
Comblines – Cavity ?



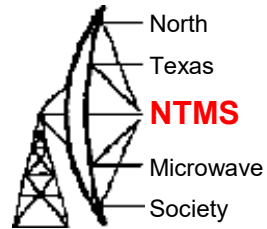
5.7 to 5.9?



Comblines

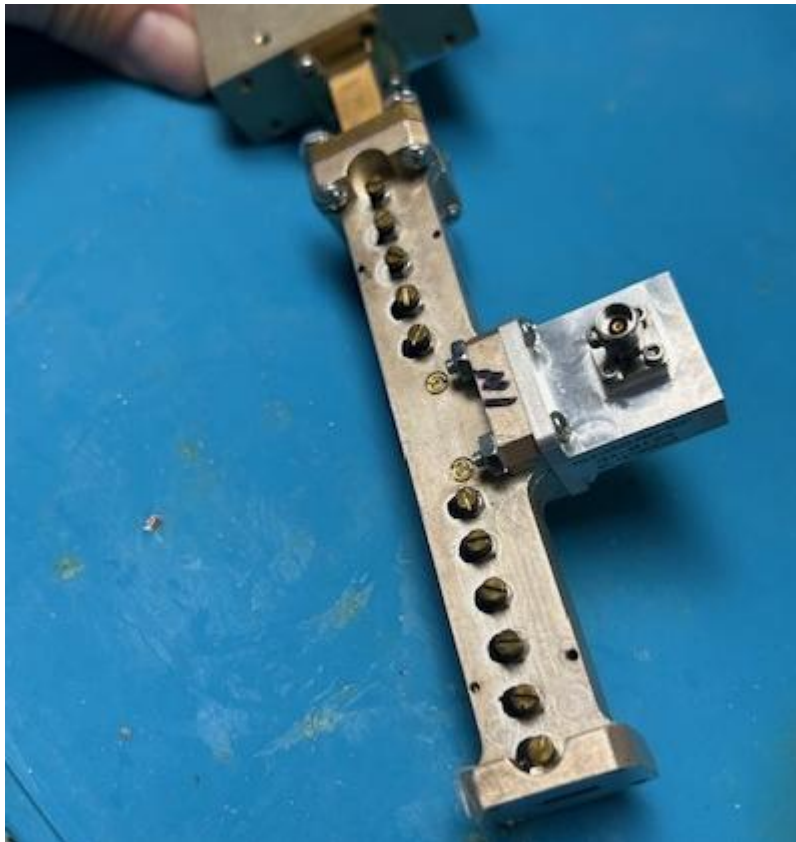


Waveguide

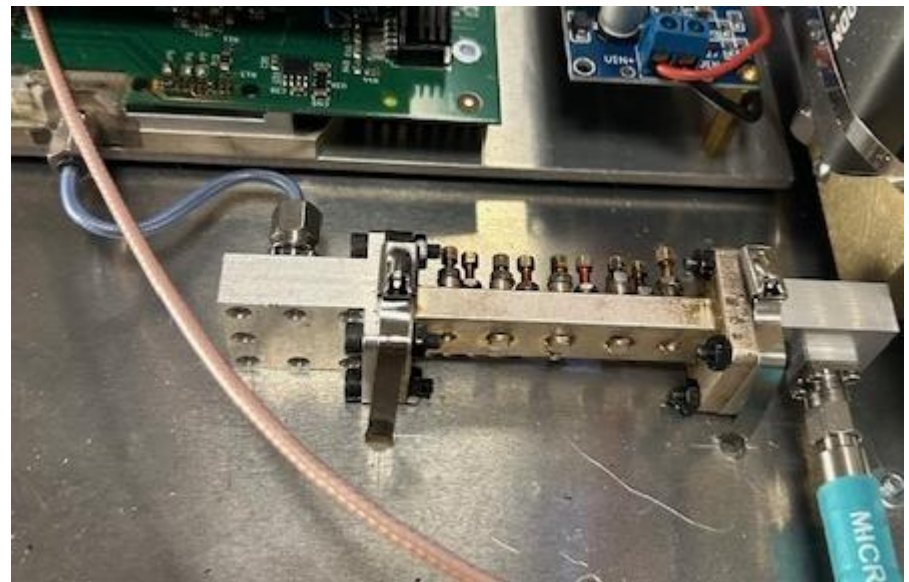


Mats KD5FZX tuned these filters to 24192 MHz.

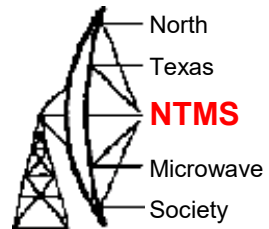
Left (3 ports) – initial 24 GHz Sectoral Horn tests on NTMS beacon



Right filter is on RF output port of Wavelab in 23 GHz NTMS beacon



Pipecap



Early designs from Kent WA5VJB.

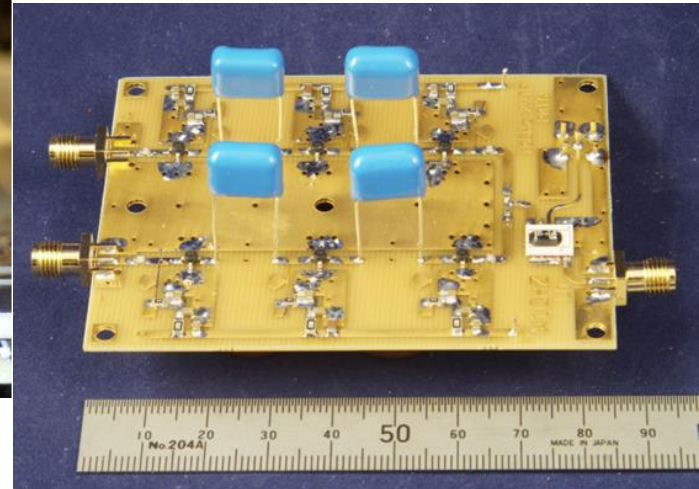
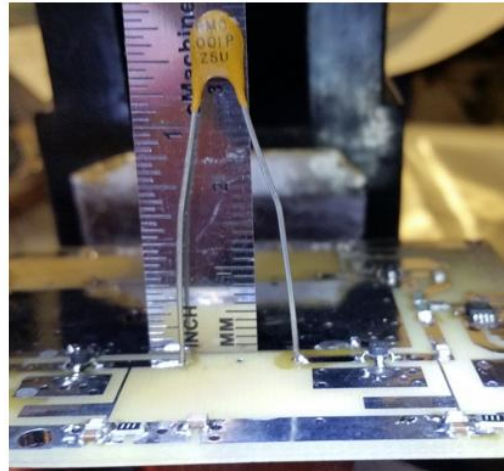
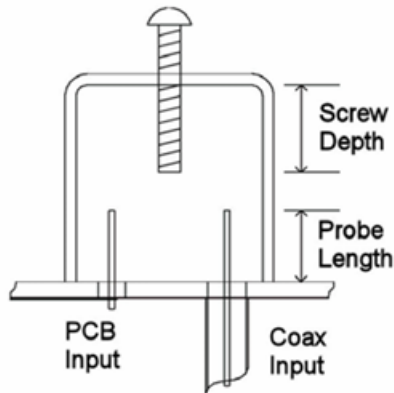
[WA5VJB Cheap Microwave Filters](#)



Pipecap

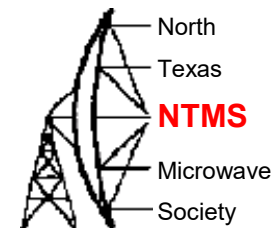
https://www.w1ghz.org/filter/Pipe-cap_Filters_Revisited.pdf

https://www.w1ghz.org/xvtr/Personal_Beacon_Update_2023.pdf



Good theory papers and suggestions on using bits of wire for pipe cap filter probes.

3.456 GHz in – 10.368 GHz out



W1GHZ 10 GHz personal beacon and LO Multiplier

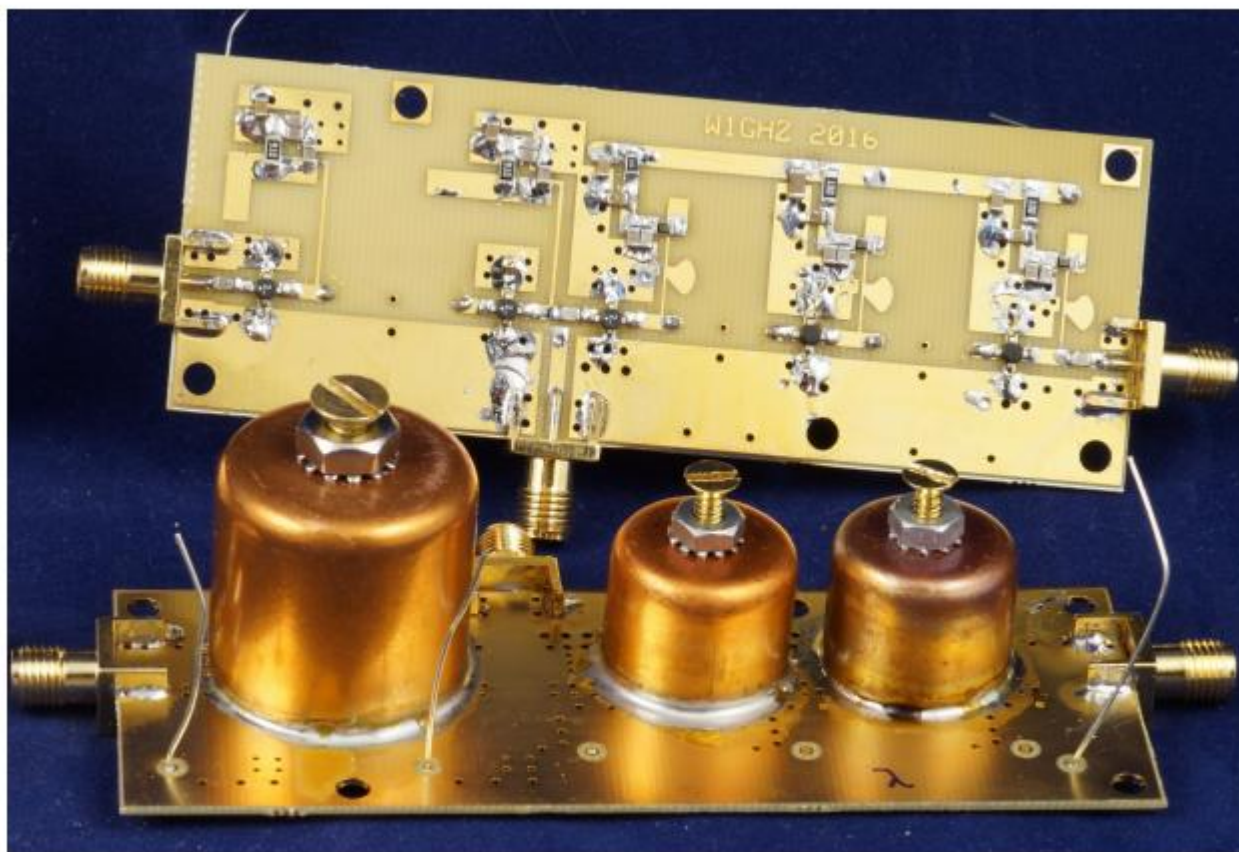
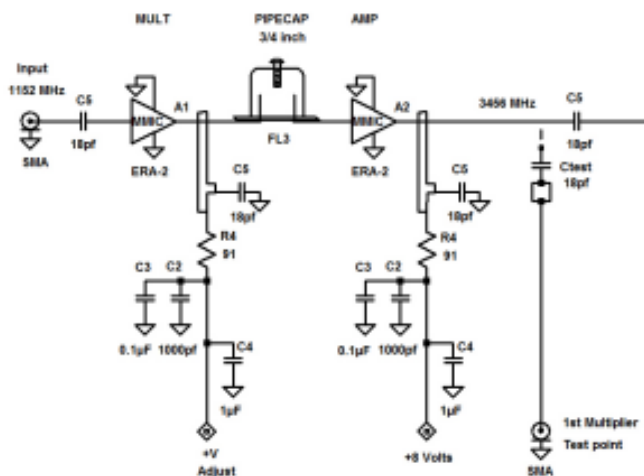


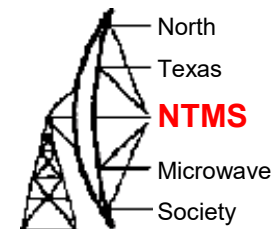
Figure 3 – Completed 10 GHz Personal Beacon board

Piecap

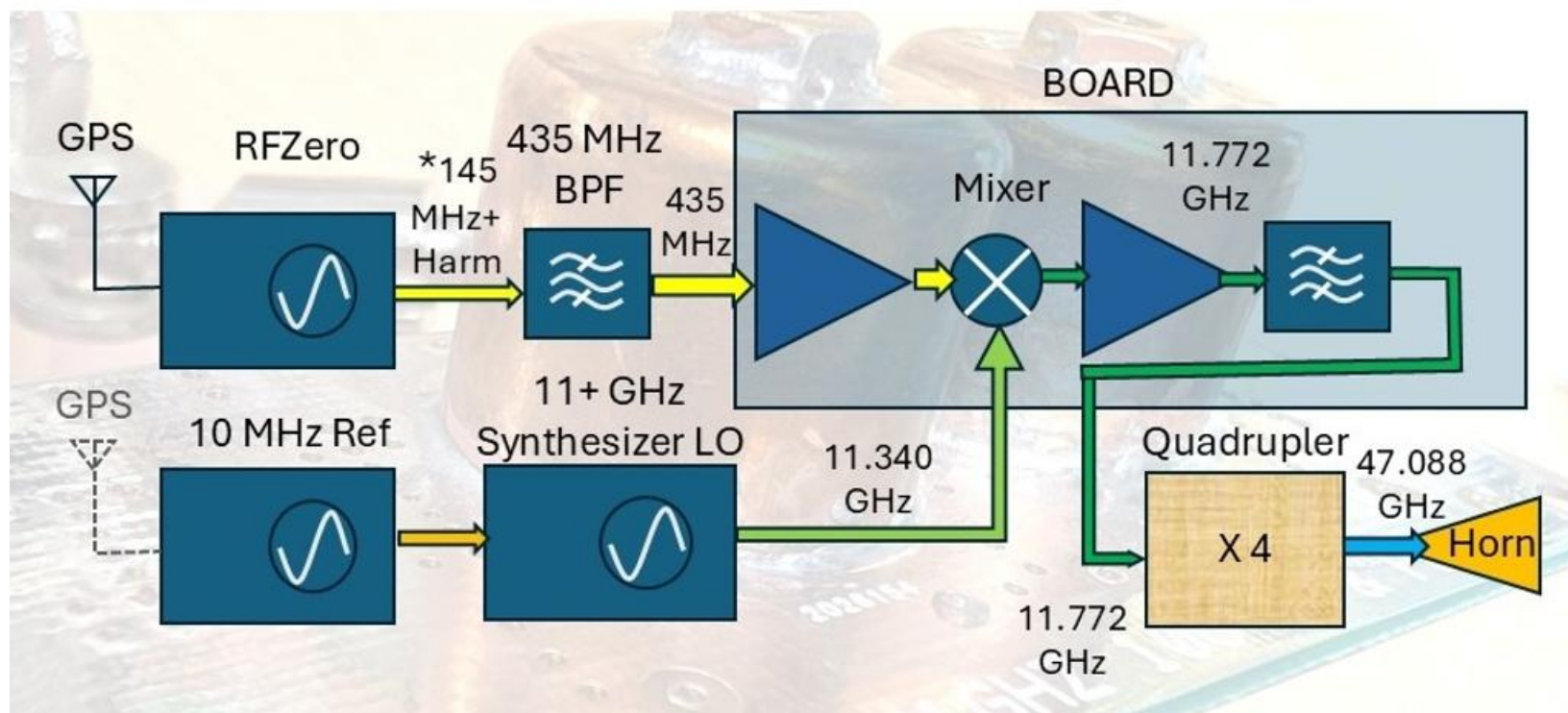
Using first stage of W1GHZ “Personal Beacon” as a 3.5 GHz filter – 1” OD pipe cap. SMA I/O. (10 GHz NTMS beacon)



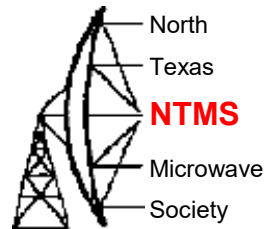
WA1MBA 11 GHz board



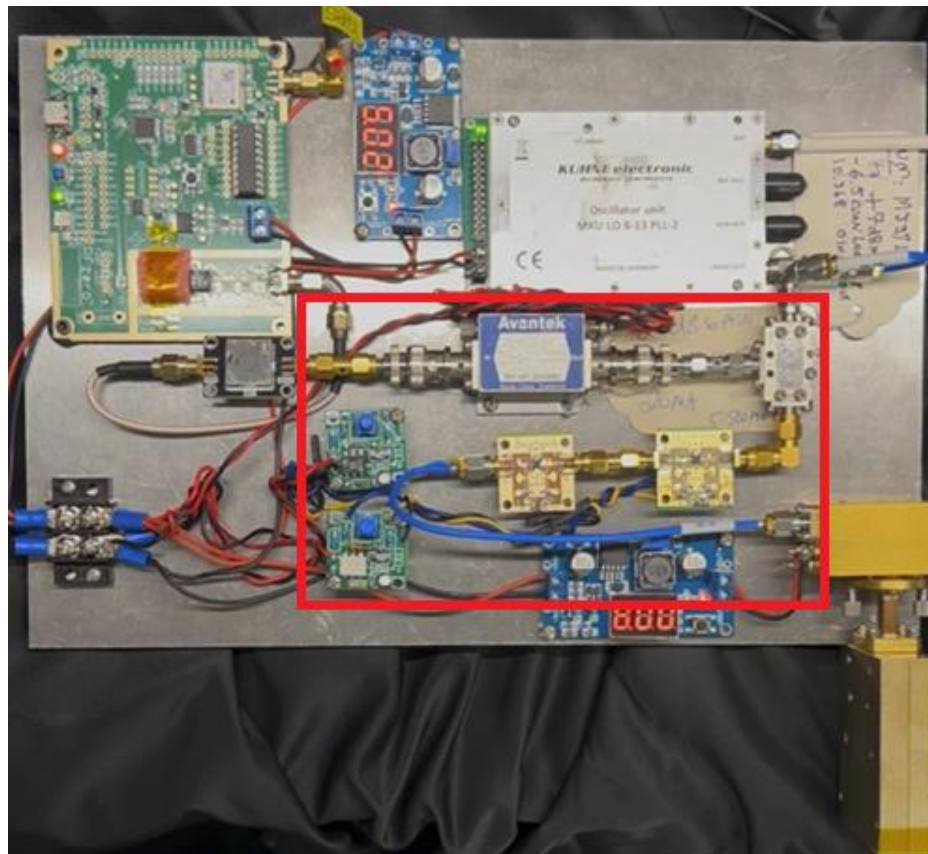
Provides 11.772 GHz filter for 47 GHz beacon. the undesirable image at $LO-435 = 10902 \text{ MHz} \times 4 = 43608 \text{ MHz}$ ie. Well outside the Amateur allocation of 47-47.2 GHz



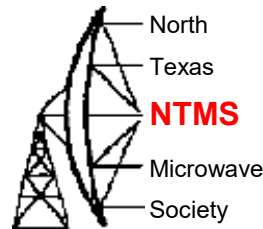
NTMS 47 GHz beacon



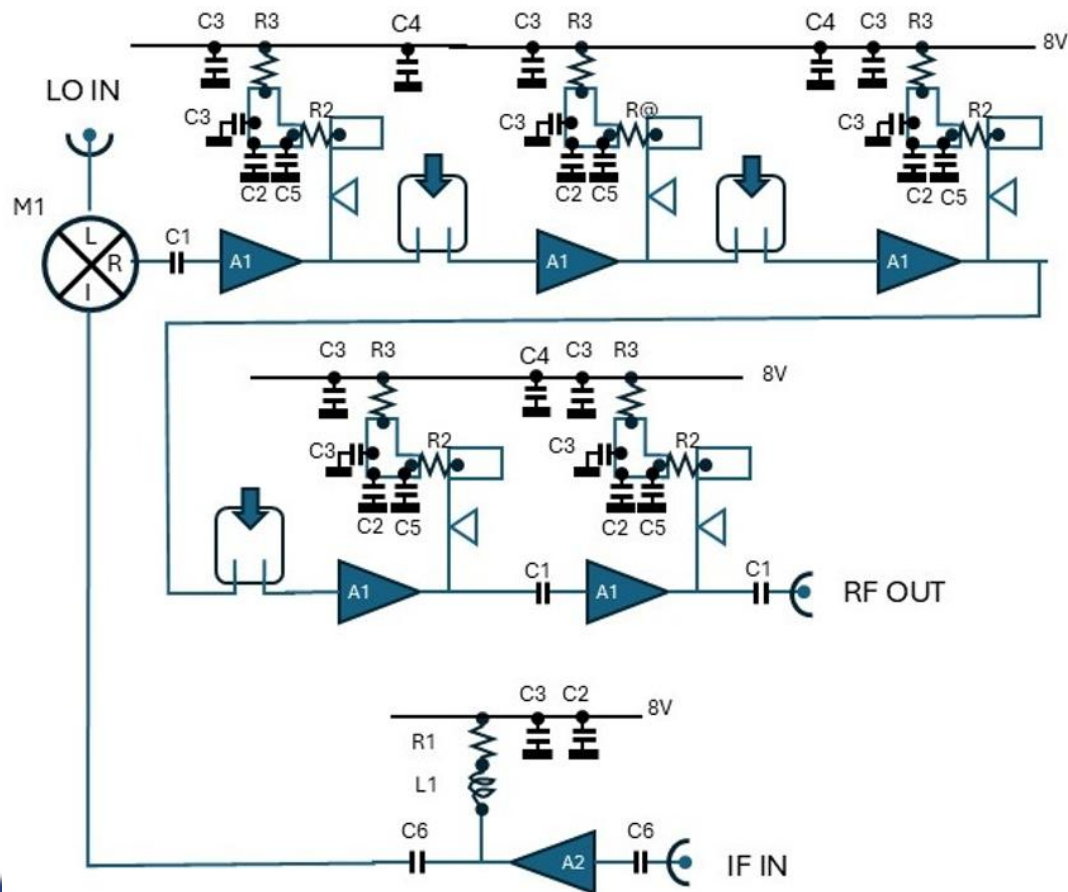
Genesis for MBA board need. Same IF and LO frequencies.
Good POC beacon but not sufficiently filtered.



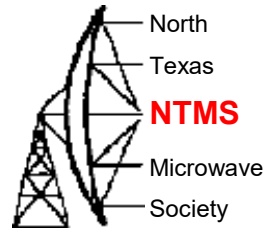
WA1MBA 11 GHz board



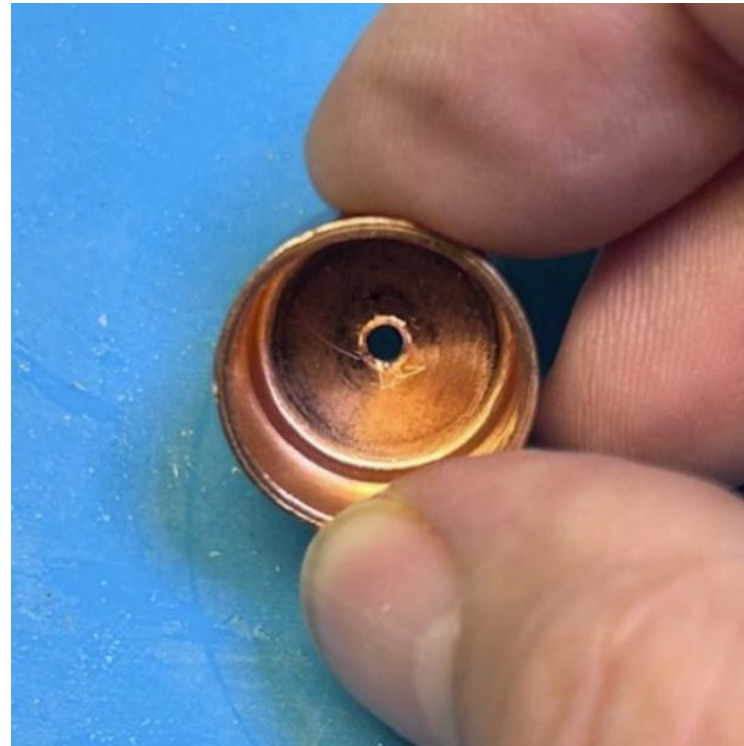
Replacing several individual components and providing 11 GHz filtration and amplification. Requires 3 ea .5" pipe caps.



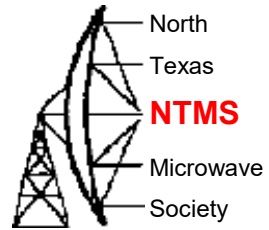
Pipe cap filter assembly many ways to do this



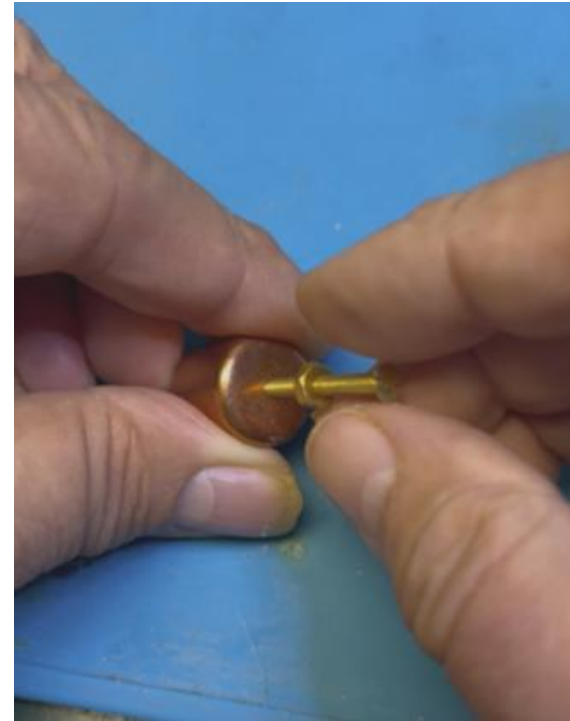
Pipe cap center hole is drilled, tapped, deburred.



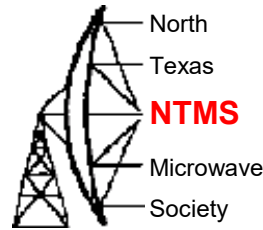
A wood block is used as a fixture with a captured nut



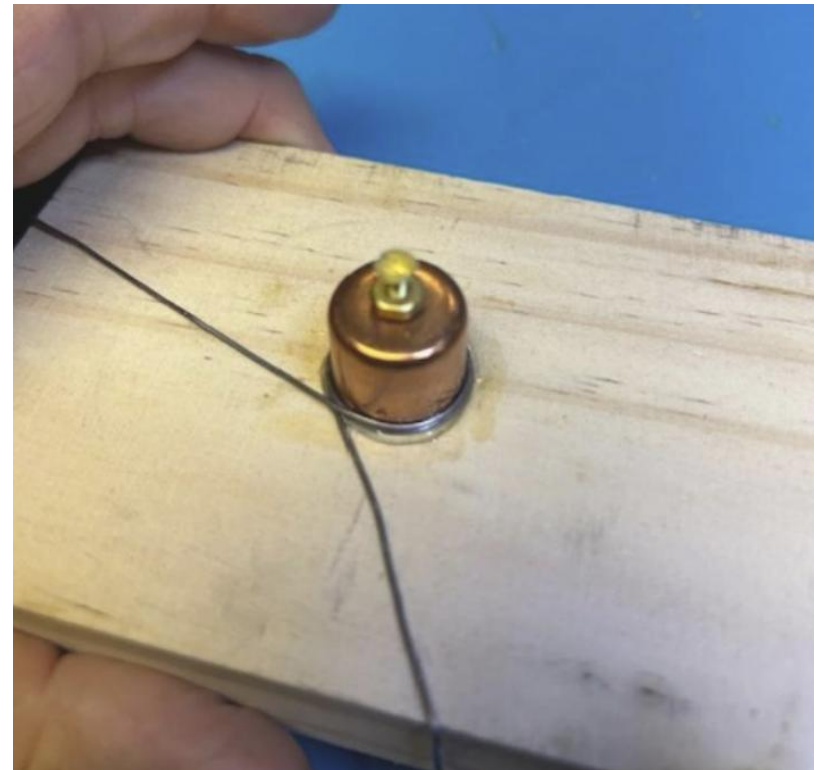
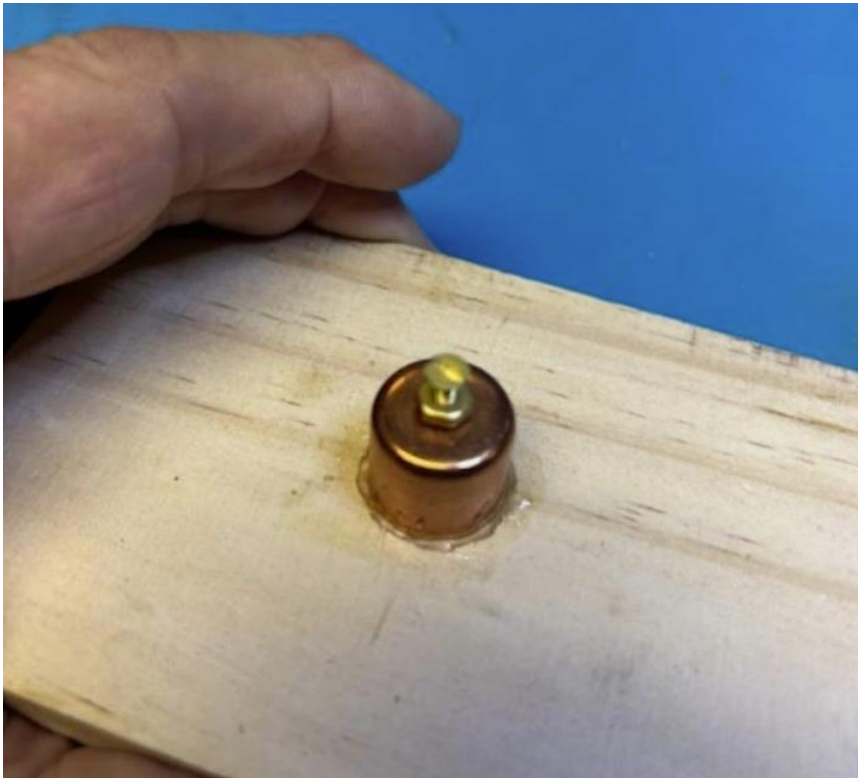
This will hold the pipe cap and bolt assembly.



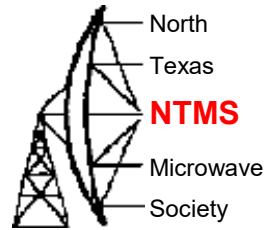
Prepare the assembly for heat



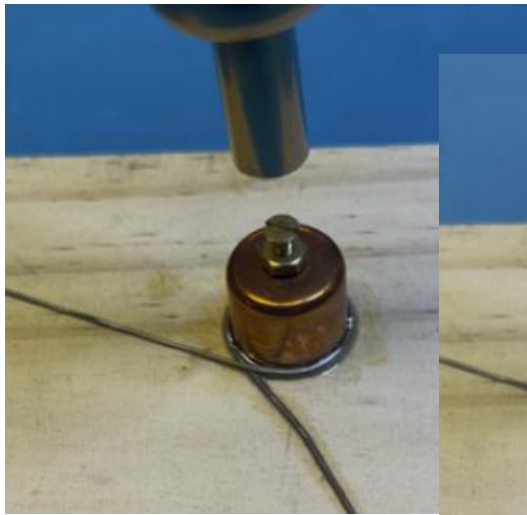
Screw down the assembly on wood fixture, add flux and lasso with two loops of solder. Tap down the solder into the flux.



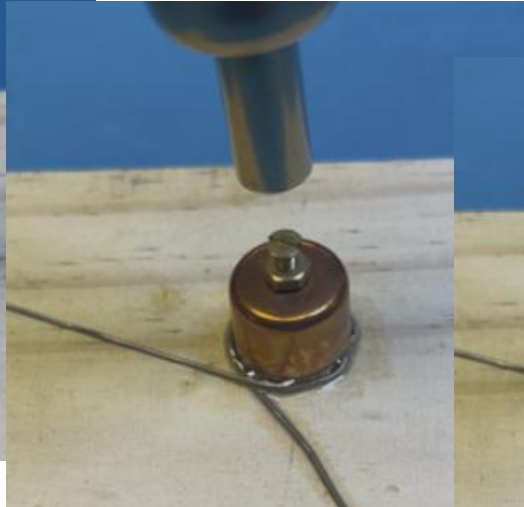
Apply heat at 850 F



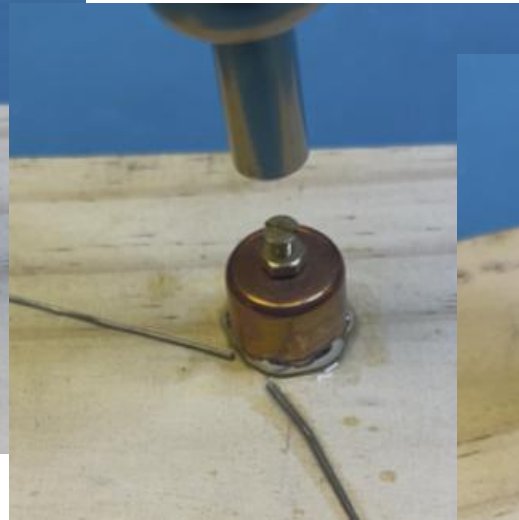
32 sec



36 sec



45 sec

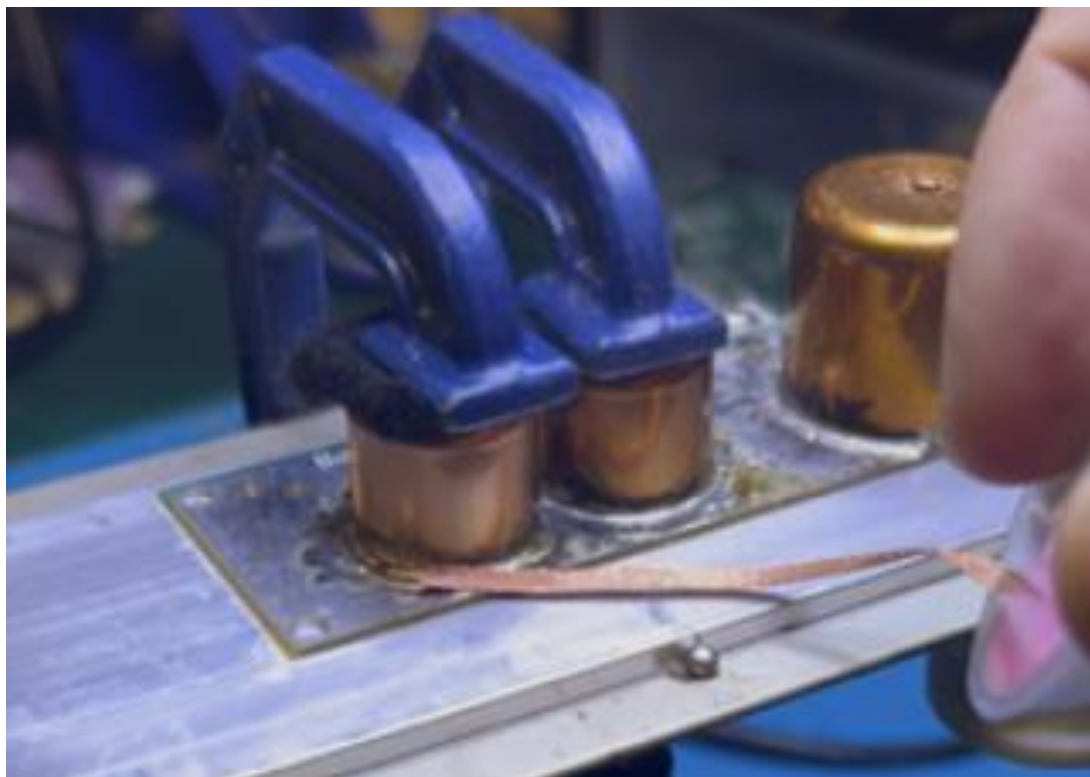
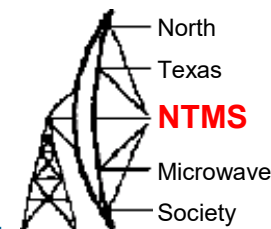


touchup



Solder pipe cap to PCB

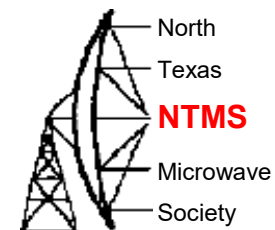
W1GHz board. Filters are C-clamped to PCB board, 1/8" sheet aluminum and hot plate – all supported by a vise.



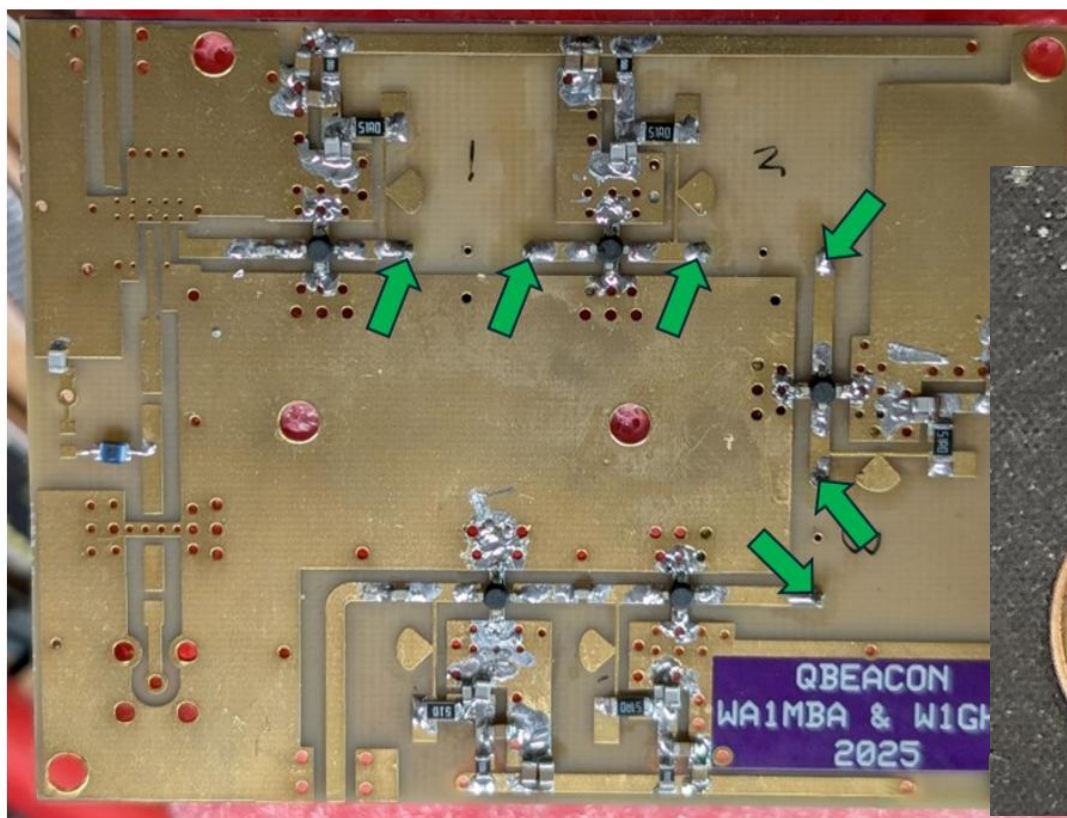
MBA board with filters



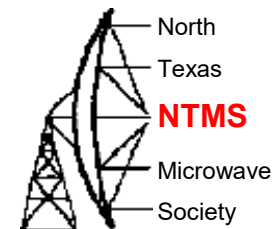
WA1MBA 11 GHz board



Pipe cap probe pins are soldered from the underside of the PCB. For 11 GHz, the probe length is critical. Mouser 575-5068000150000000



Precision filter probes

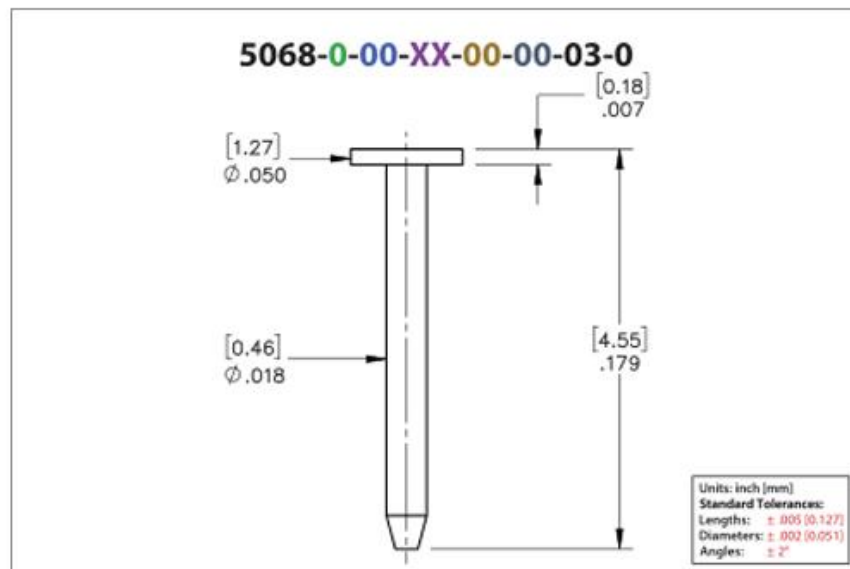


“Nail head” length=.179” diameter=0.018” – fits 0.022” PCB hole

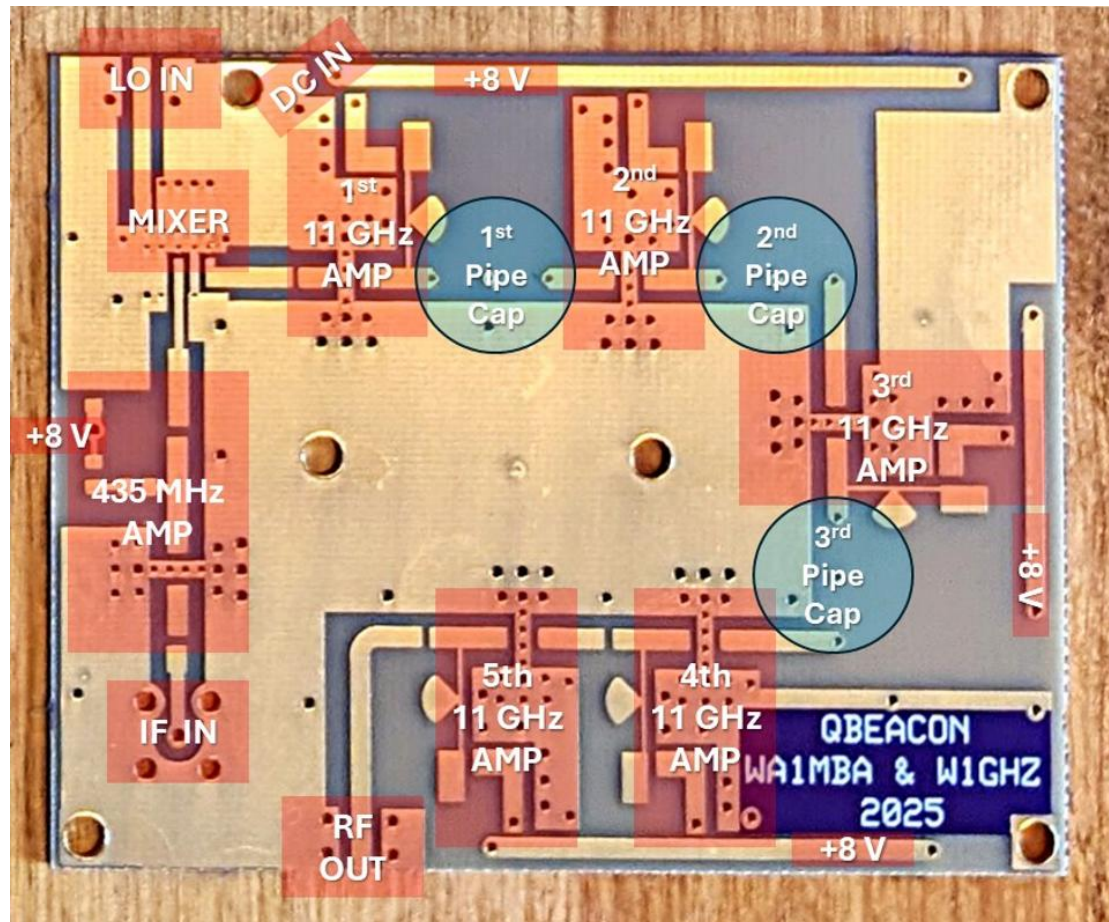
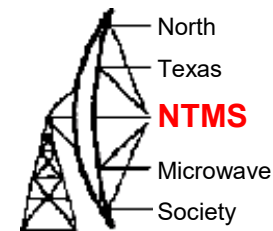


PRODUCT NUMBER: 5068-0-00-15-00-00-03-0

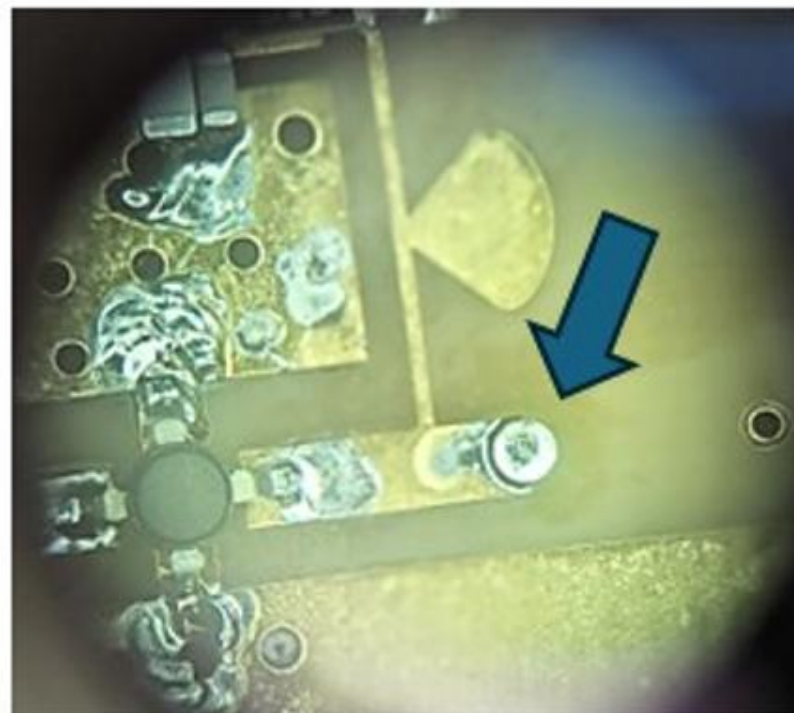
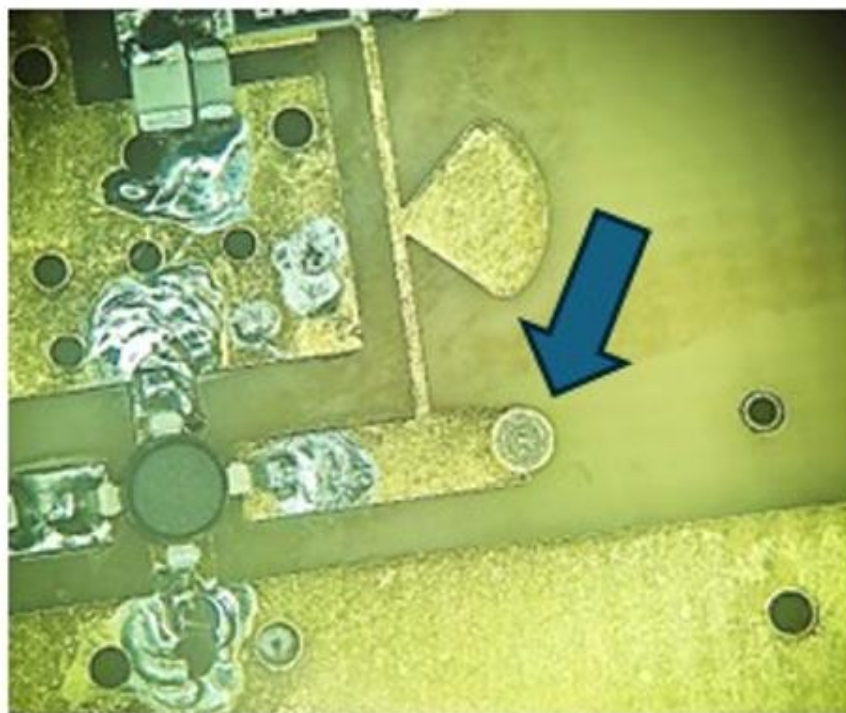
www.mill-max.com
DATA SHEET



MBA board pipe cap filter locations

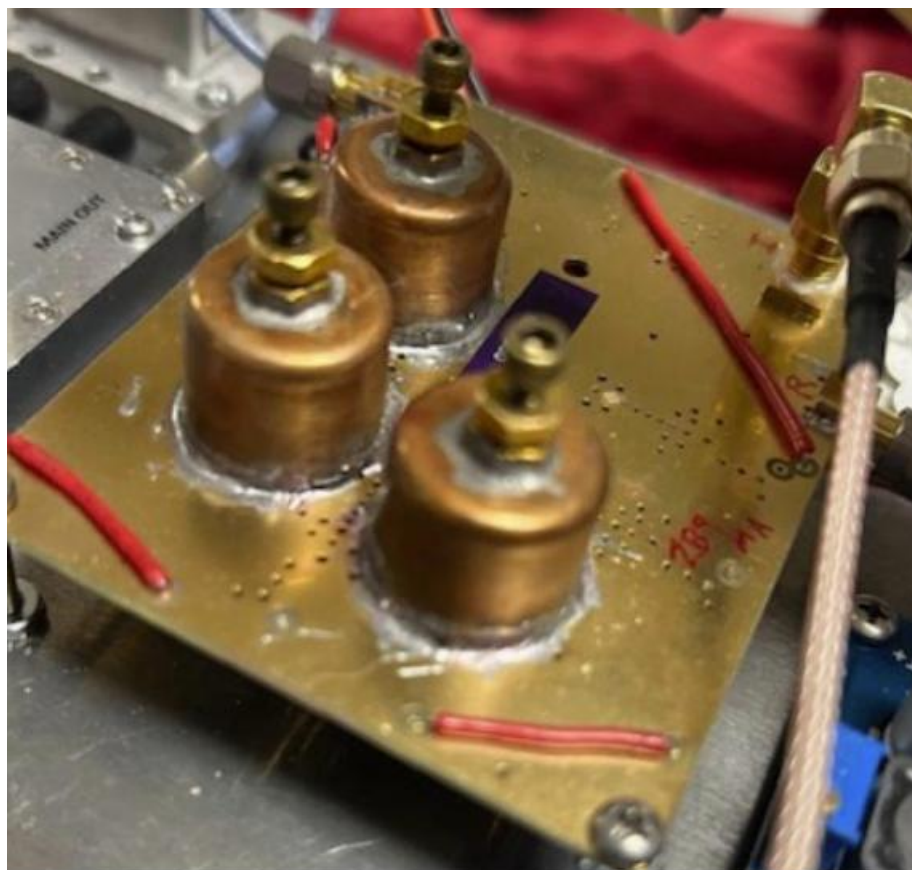
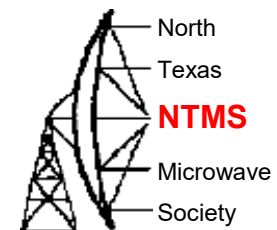


Probe placement and soldering

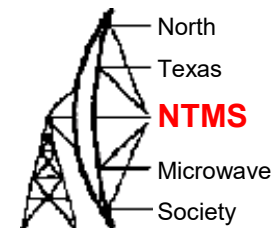


On the left is a pin inserted but not soldered yet. On the right the pin has been soldered.

Completed MBA board in NTMS Beacon



References



[Marki Microwave Stripline filter designer](#)

[W1GHZ 10 GHz personal beacon and LO Multiplier](#)

[MATLAB Hairpin design information](#)

[Charles' Labs Hairpin filter designer](#)

https://www.w1ghz.org/filter/Pipe-cap_Filters_Revisited.pdf

https://www.w1ghz.org/xvtr/Personal_Beacon_Update_2023.pdf

Questions?

