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DB6NT Mixer for 122 GHz the 2.5mm Band (122.25 to 123 GHz)

W5LUA

May 2, 2020

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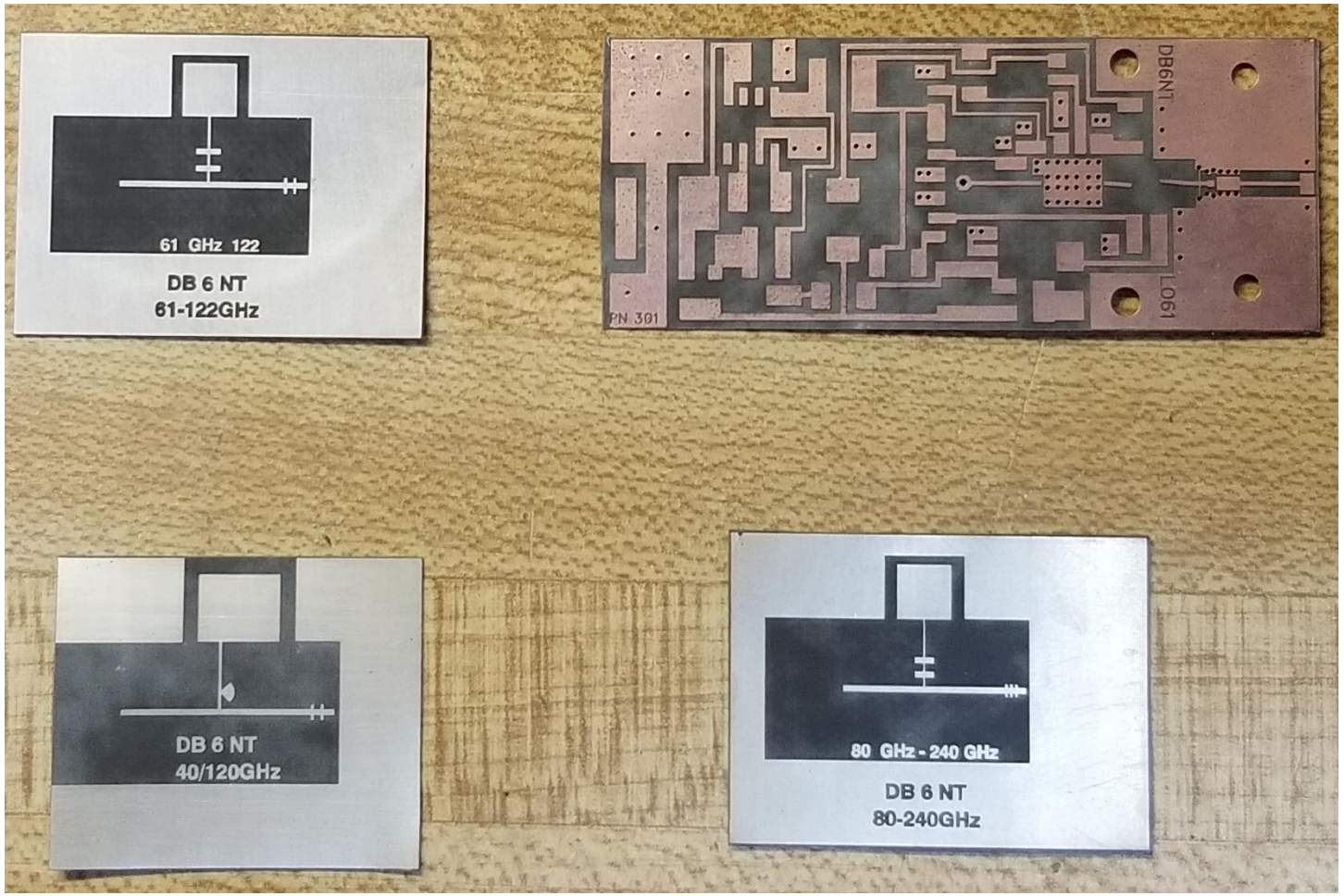
Various DB6NT PCBs



Drilling Housing for WR-12 and WR-06 Waveguide Flanges

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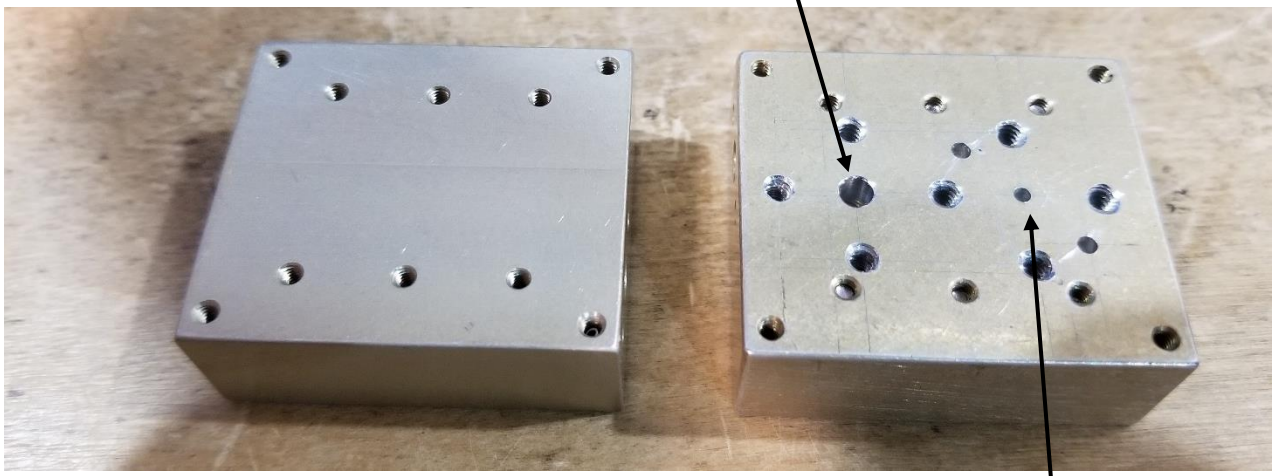
I had several pre-machined housings (left) that I decided to modify (right) for use with the 120 GHz DB6NT mixer boards

61 GHz LO input waveguide



122 GHz RF port
Fc = 115 GHz

Using Granite Surface Plate and Digital Height Gage to scribe lines

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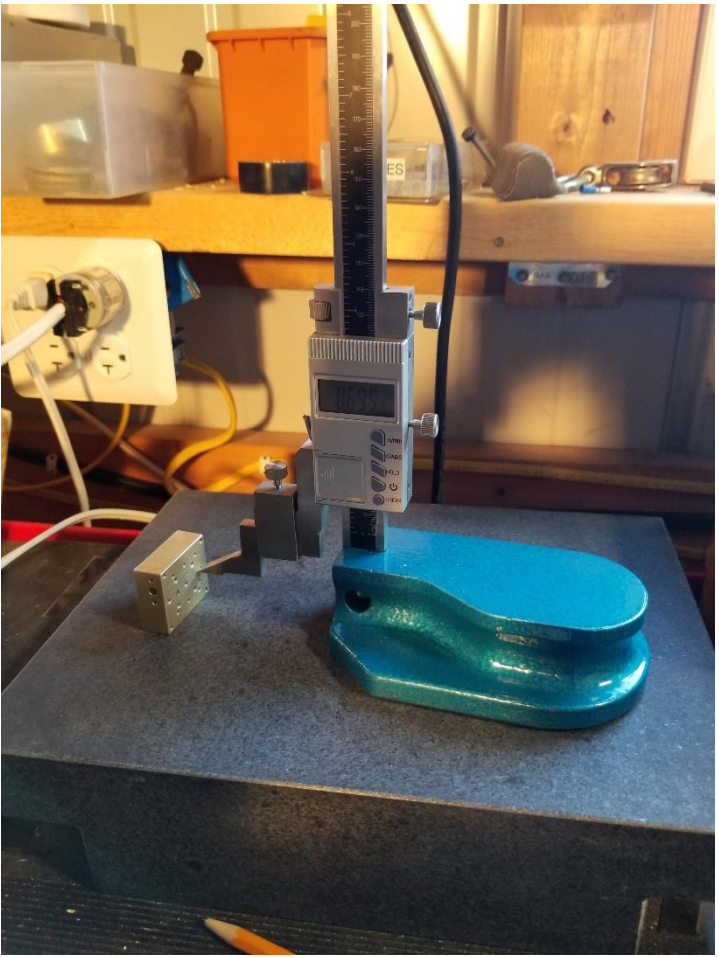
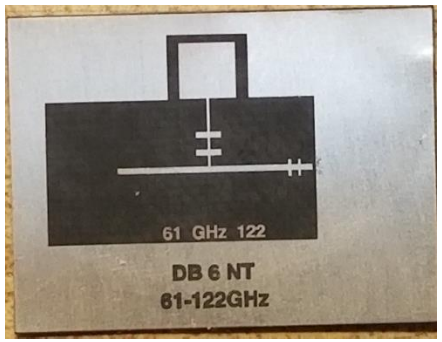
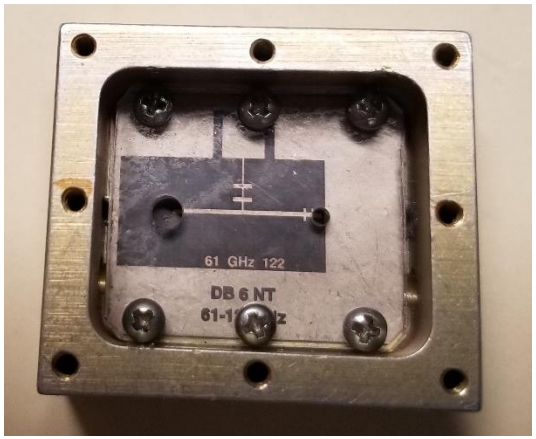


https://www.grizzly.com

DB6NT 122 GHz Mixer PCB



PCB #40



Piece of acrylic plastic drilled to match holes in housing.

Provides a drilling template for pcb and will be used to apply pressure on board when silver epoxying board into place.

Shining a flashlight into the RF and LO ports gives a good indication of alignment with pcb.

Next step is to make back shorts for LO and RF ports

LO and RF Back Shorts

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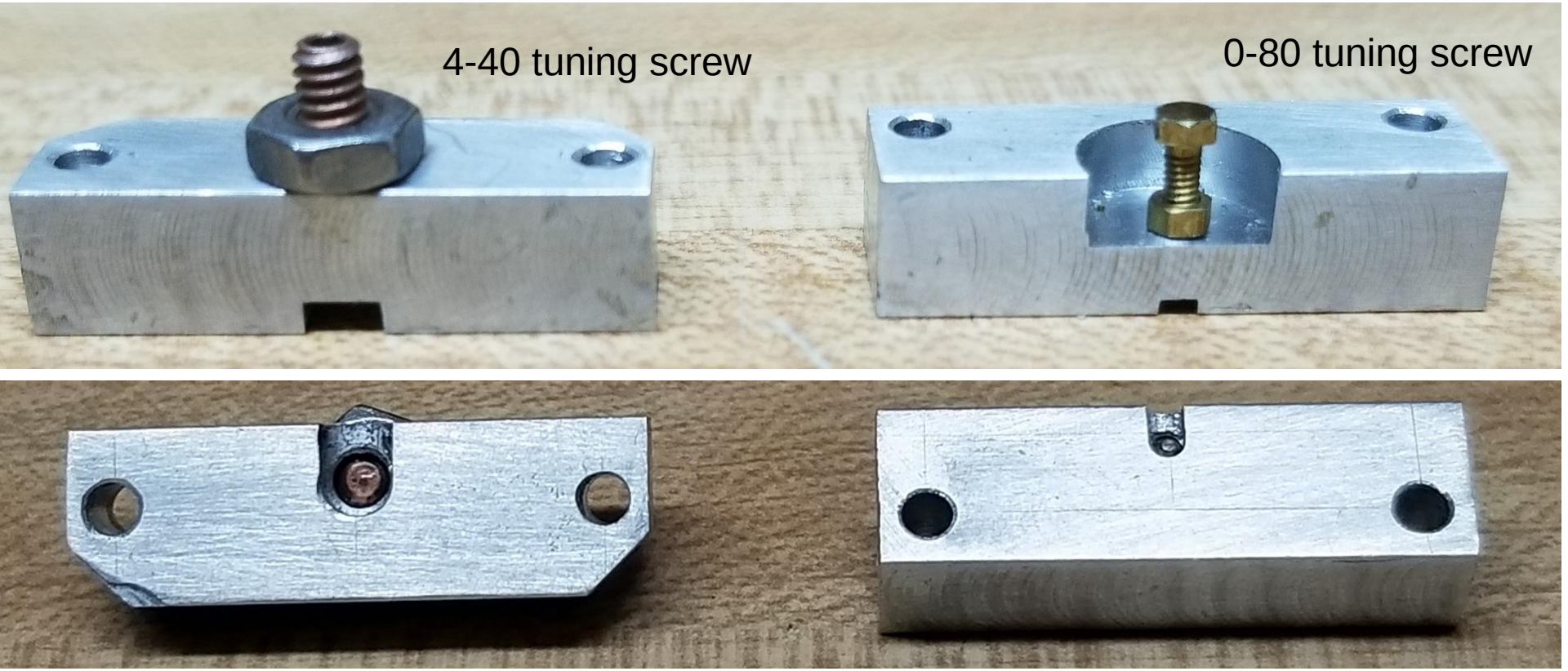
61 GHz LO Back short

122 GHz RF Back short



DB6NT 122 GHz Mixer

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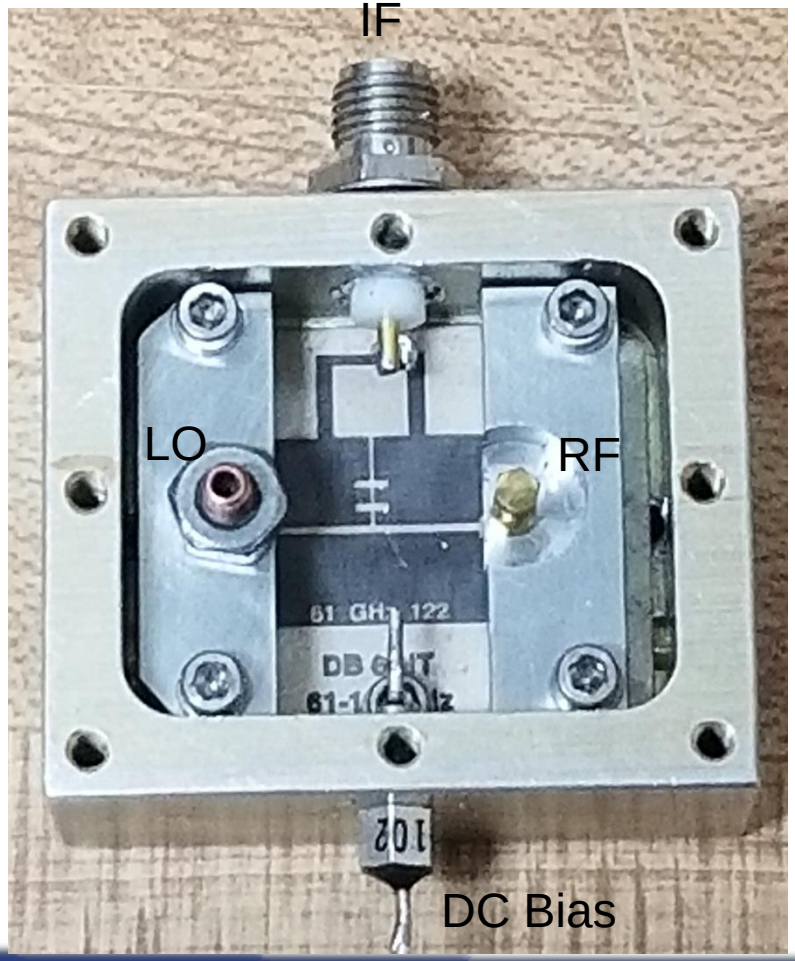
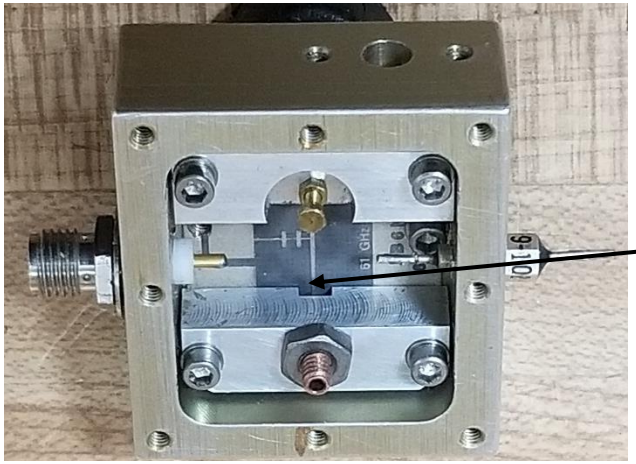
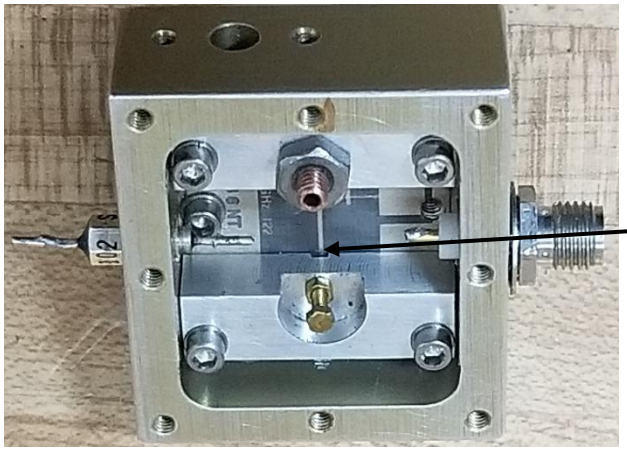
Completed mechanical assembly





Looking down towards 61 GHz LO input



Looking down towards 122 GHz RF port

Next Step

- Silver epoxy PCB into housing (or not)
- Wire IF port and dc port
- Install Diodes
- Test

MA4E1318 Anti-Parallel Flip Chip Diode Pair

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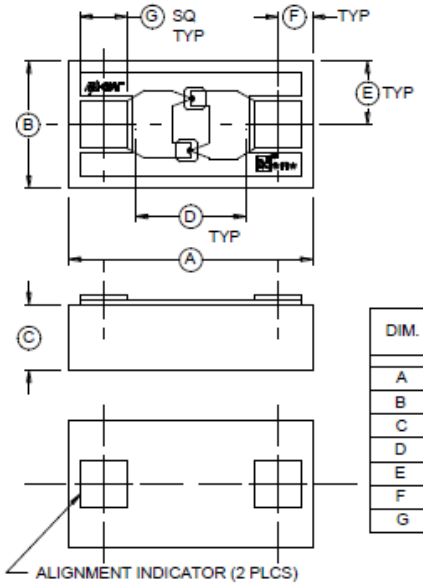
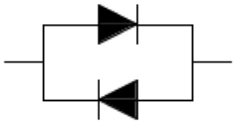


MA4E1318
Case Style 1197



DIM.	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	.025	.027	.64	.69
B	.012	.015	.32	.37
C	.006	.008	.15	.20
D	.018	.020	.45	.50
E	.0075	.0085	.190	.216
F	.003	.005	.08	.13
G	.004	.006	.10	.15

MA4Exxxx Series

MACOM

GaAs Flip Chip
Schottky Barrier Diodes
Rev. V12

Electrical Specifications @ +25°C

Parameters and Test Conditions	Symbol	Units	MA4E1317			MA4E1318		
			Min.	Typ.	Max.	Min.	Typ.	Max.
Junction Capacitance @ 0 V, 1 MHz	C_J	pF	-	.020	-	-	.020[3]	-
Total Capacitance @ 0 V, 1 MHz[1]	C_T	pF	.030	.045	.060	.030[3]	.045[3]	.060[3]
Junction Capacitance Difference	DC_J	pF	-	-	-	-	-	-
Series Resistance @ +10 mA[2]	R_S	Ω	-	4	7	-	4	7
Forward Voltage @+1 mA	V_F1	V	.60	.70	.80	.60	.70	.80
Forward Voltage Difference @ +1 mA	DV_F	V	-	-	-	-	.005	.010
Reverse Breakdown Voltage @ -10 µA	V_{BR}	V	4.5	7	-	-	-	-
SSB Noise Figure	NF	dB	-	6.5[4]	-	-	6.5[4]	-

Cost per diode only $2.17 from Mouser but you must buy in 100 quantity

MG Chemicals 9400 Electrically Conductive Adhesive

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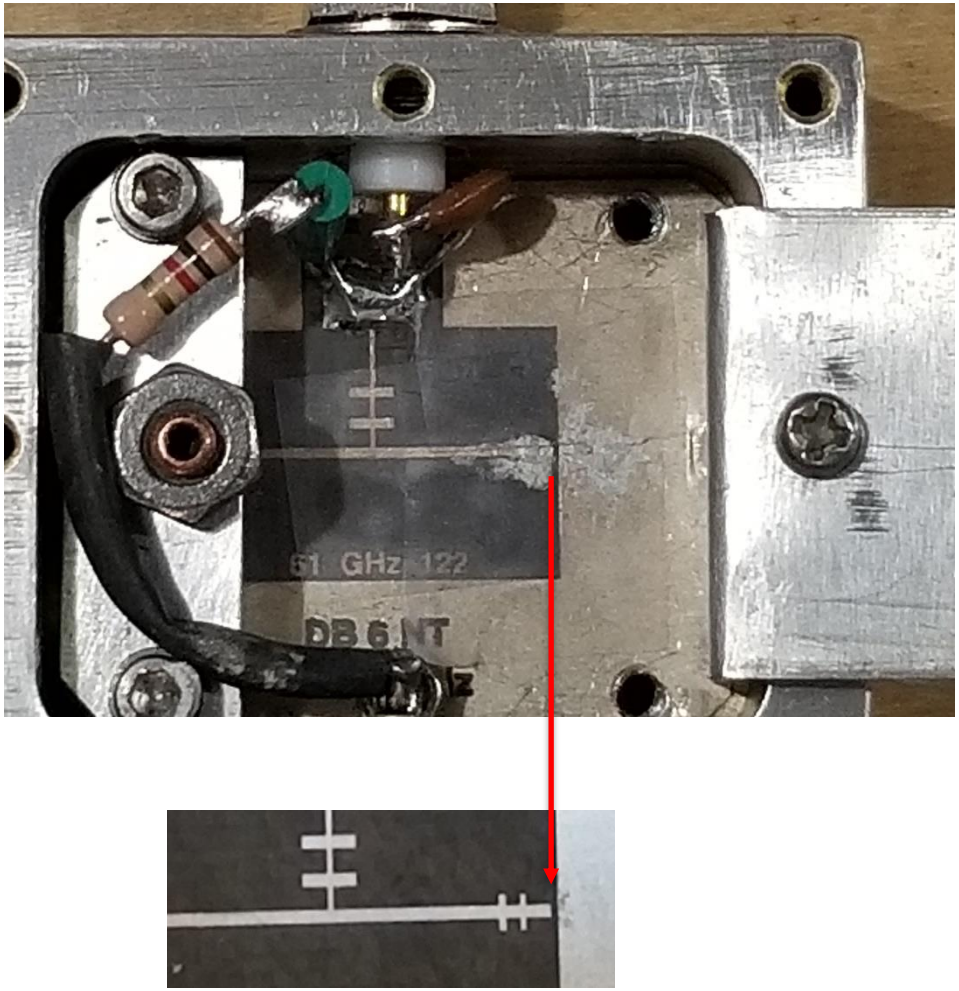
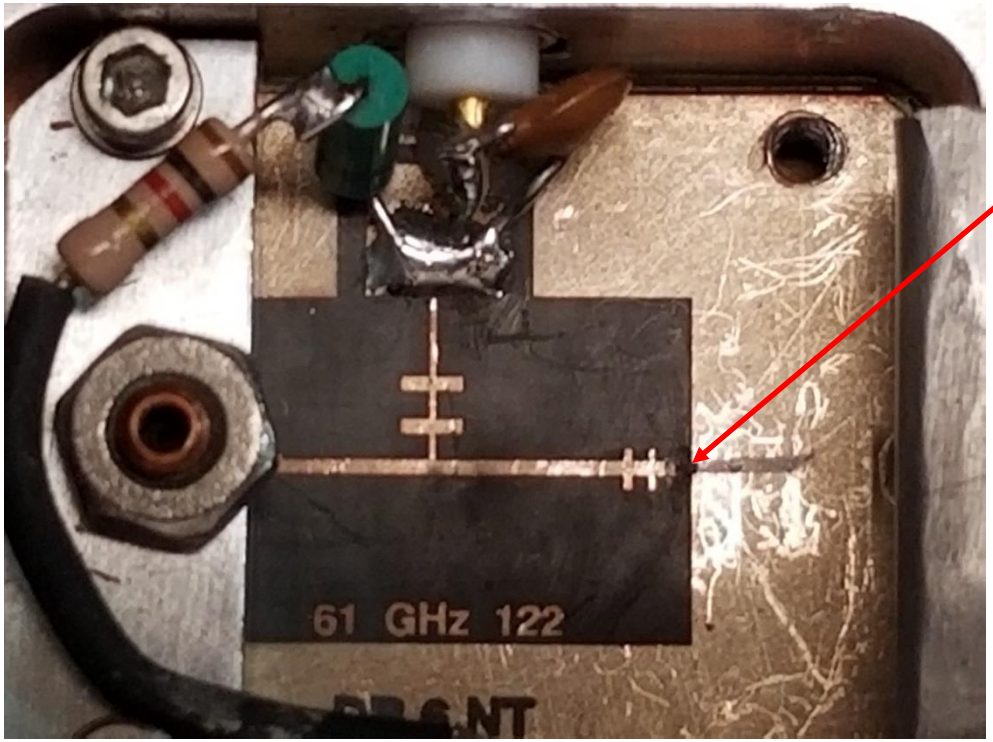
- One-part Epoxy
- Recommended for semiconductor attachment.
- Unlimited working life
- Store in freezer
- Heat Cure 70C (158F) for 2 hours.
- Now for the fun……not

Installing the Diode



I decided NOT to epoxy the pcb in place.
I will rely on the LO and RF back shorts to keep the pcb in intimate contact with the housing.
I built a bracket to keep pcb in close contact with the housing when the RF back short is removed.
I had tremendous difficulty in keeping the epoxy away from the LPF.
I decided to use regular clear tape to mask off area where I did not want to have epoxy, then remove tape and put diode in place.

Diode Pair Installed

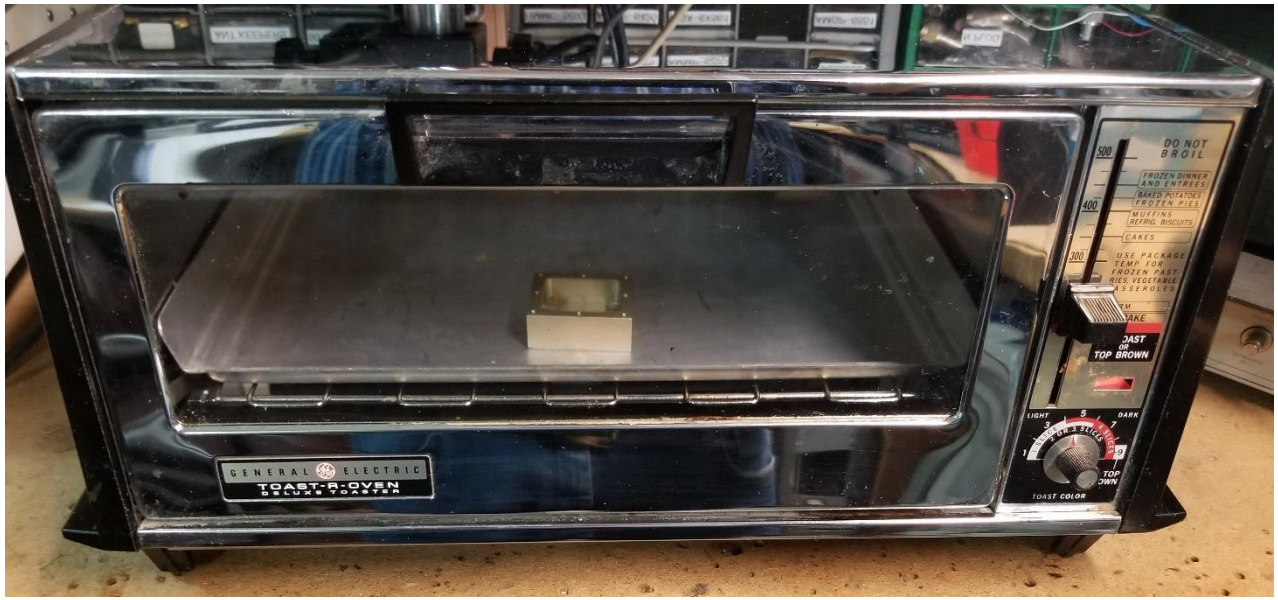


Diode installed

Only ruined or lost 5 diodes!

Toaster Oven for Curing Epoxy

July 7, 1973 Wedding Present



Heat Cure 70C (158F) for 2 hours.

Testing the Mixer

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- I have no test equipment for 122 GHz, so in the true ham spirit, I must improvise.
- Most importantly, I need a signal source at 122 GHz.
- Need to accurately measure receive dBs so I can tune for the last dB.. I use NaP3 Power SDR software with my K3 & DEMI 2m XVTR.
- Now back to making a signal at 122 GHz..

Potential Weak Signal Sources for 122 GHz

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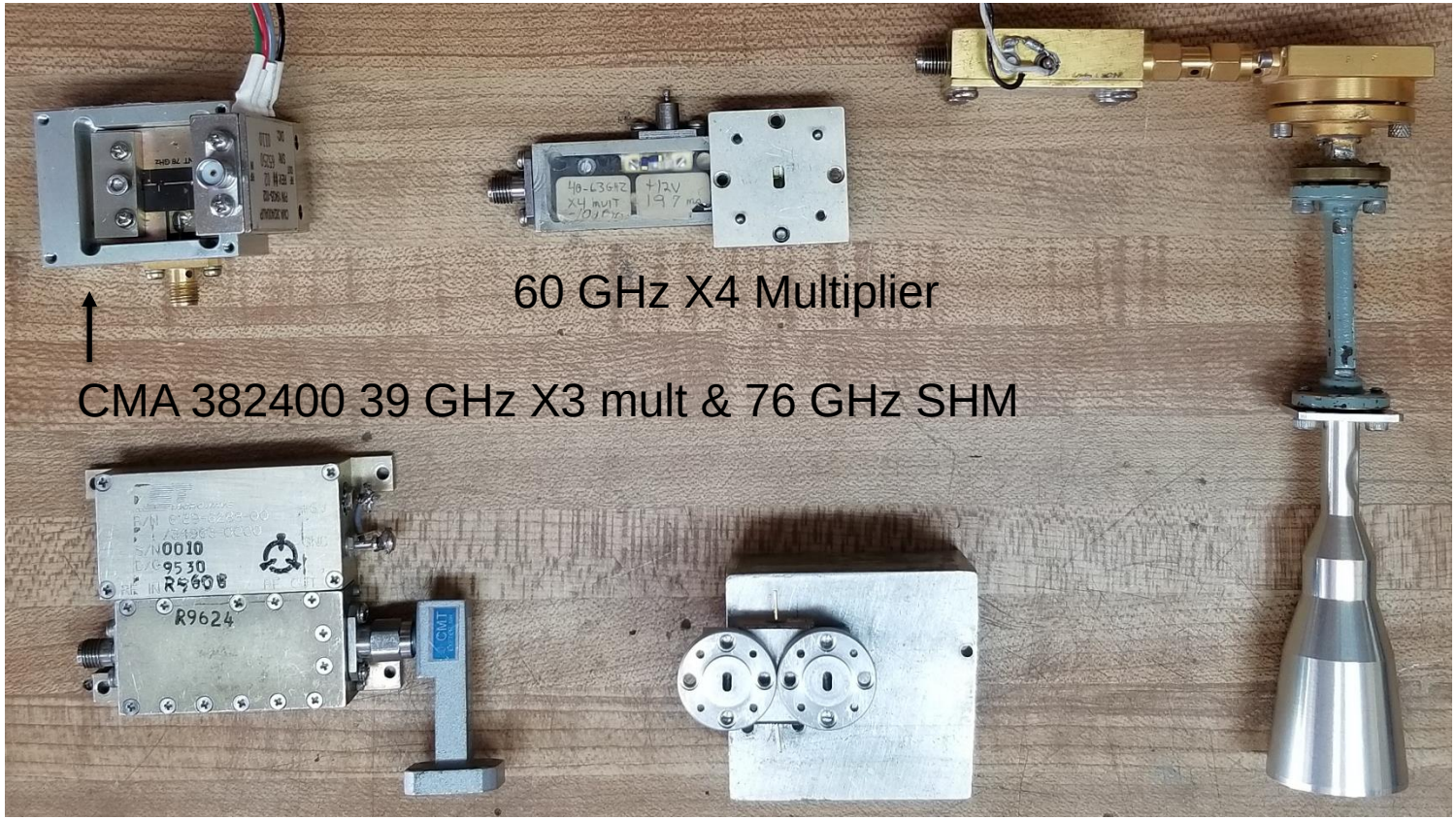

Wiltron 13 to 20 GHz Amplifier & Spacek X3 (U-3X) with WR-22 output. Converted WR-22 to WR-15 & WR-15 Horn supplied by K9JHK, Thanks Karl!

ST Microwave Amplifier/Multiplier heard on 47/76 GHz

60 GHz WR-15 Amplifier

122 GHz LO & IF Sections

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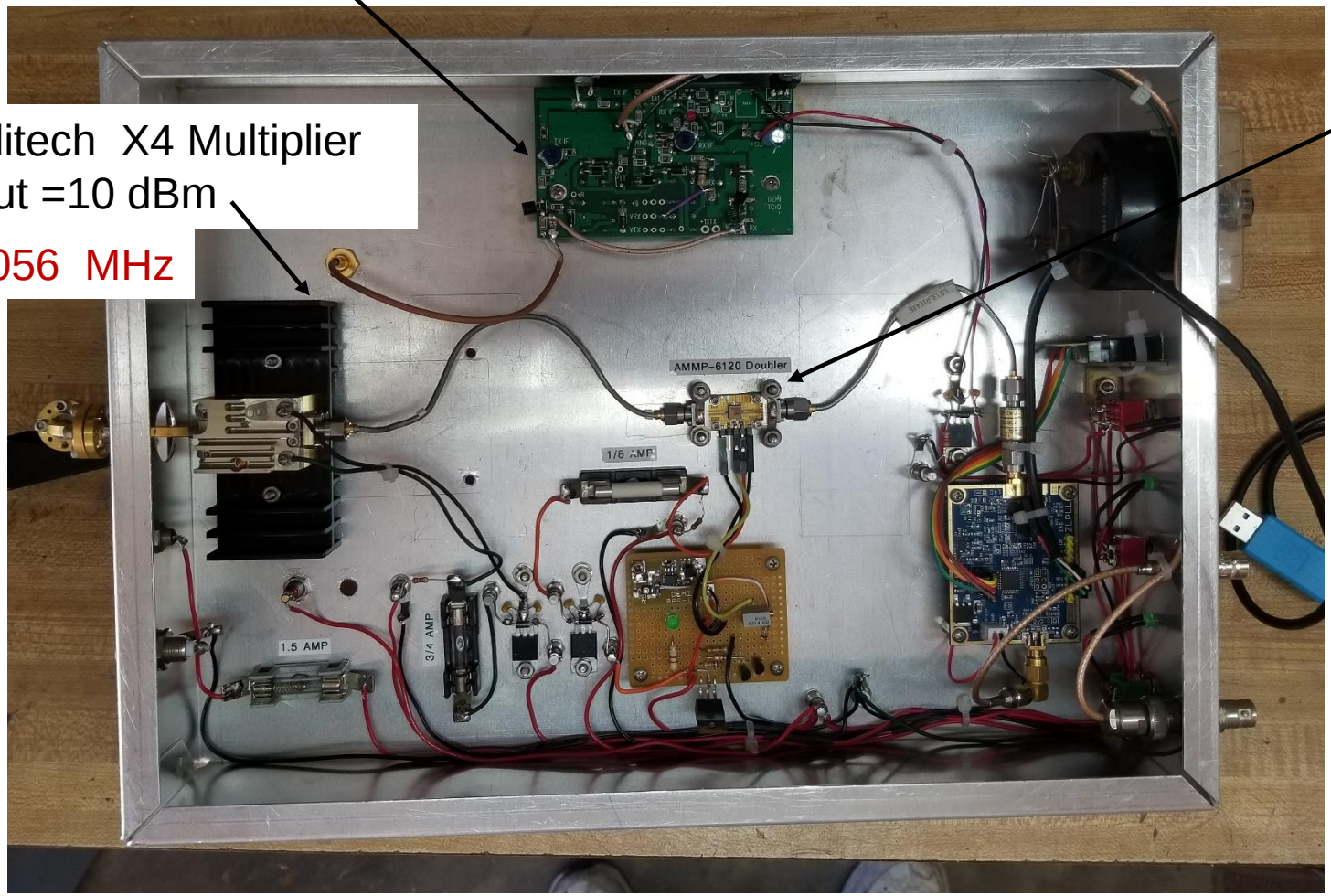
DEMI TC IF Interface with PGA-103 LNA (less than 1 dB NF)

Millitech X4 Multiplier
Pout =10 dBm

61056 MHz



Avago AMMP-6120 8-24 GHz X2 Multiplier

15264 MHz

ZL2BKC 14 GHz PLL

7632 MHz

Front Panel of 122-134-241 GHz Transverter

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Test Bench for tuning up mixer

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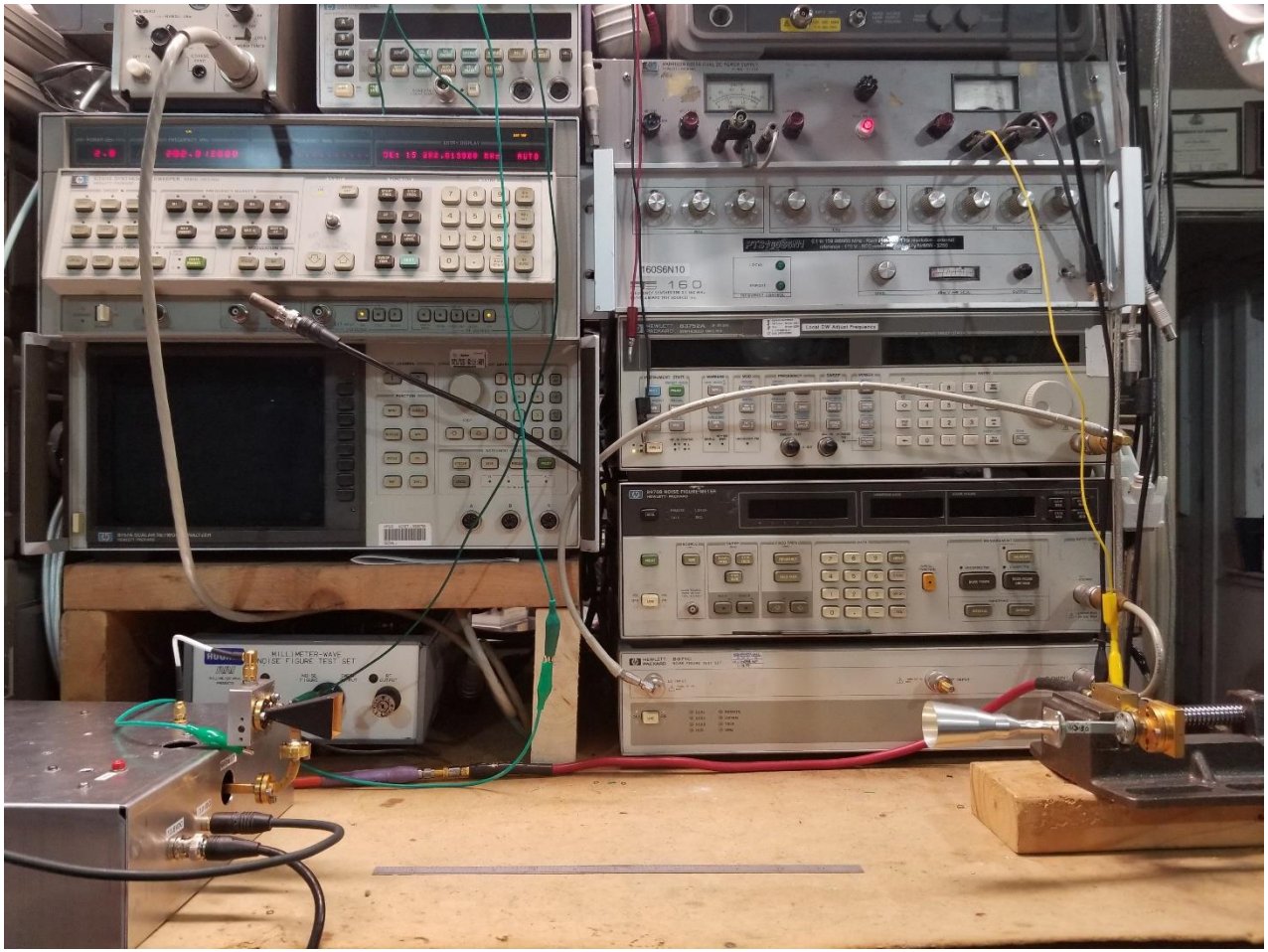

Discovered accidently that the diodes like to be biased, about .4 mA

LO power of +10 dBm needs to be increased in future

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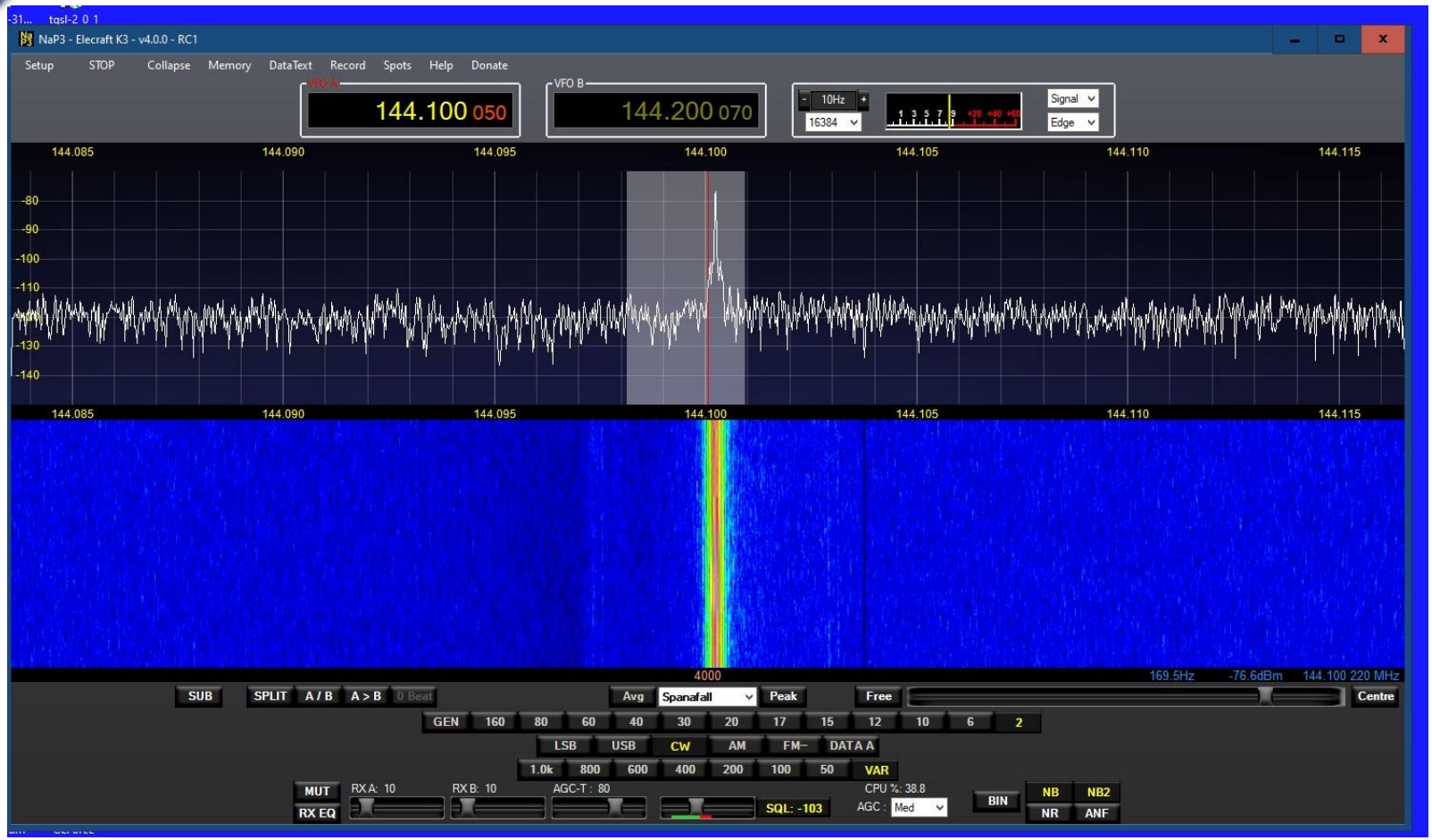
122,256.1 MHz



Near-in spurs are -25dBc, still sounds T8+

Most phase noise is due to multiplying the HP8340A 15282.0125 MHz signal X8

Completed 122 GHz System

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12” Cassegrain Fed Dish on 122 GHz

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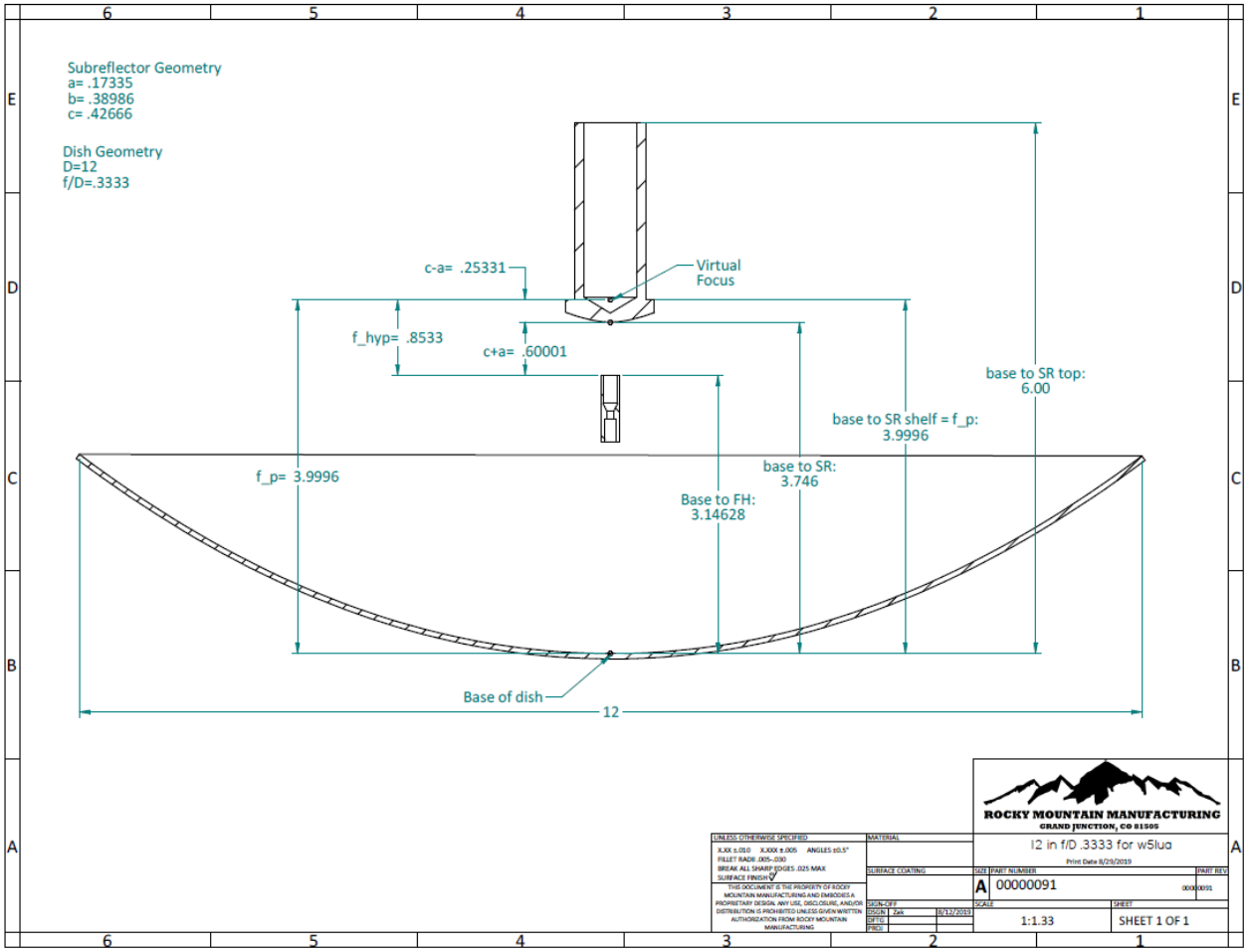

Mark N0IO used the W1GHZ Cassegrain Calculator to find the optimum feed and sub reflector for my 39 GHz dish. Mark machined both pieces. A big thank you Mark!

Closeup of mixer & transition to circular waveguide to dish feed

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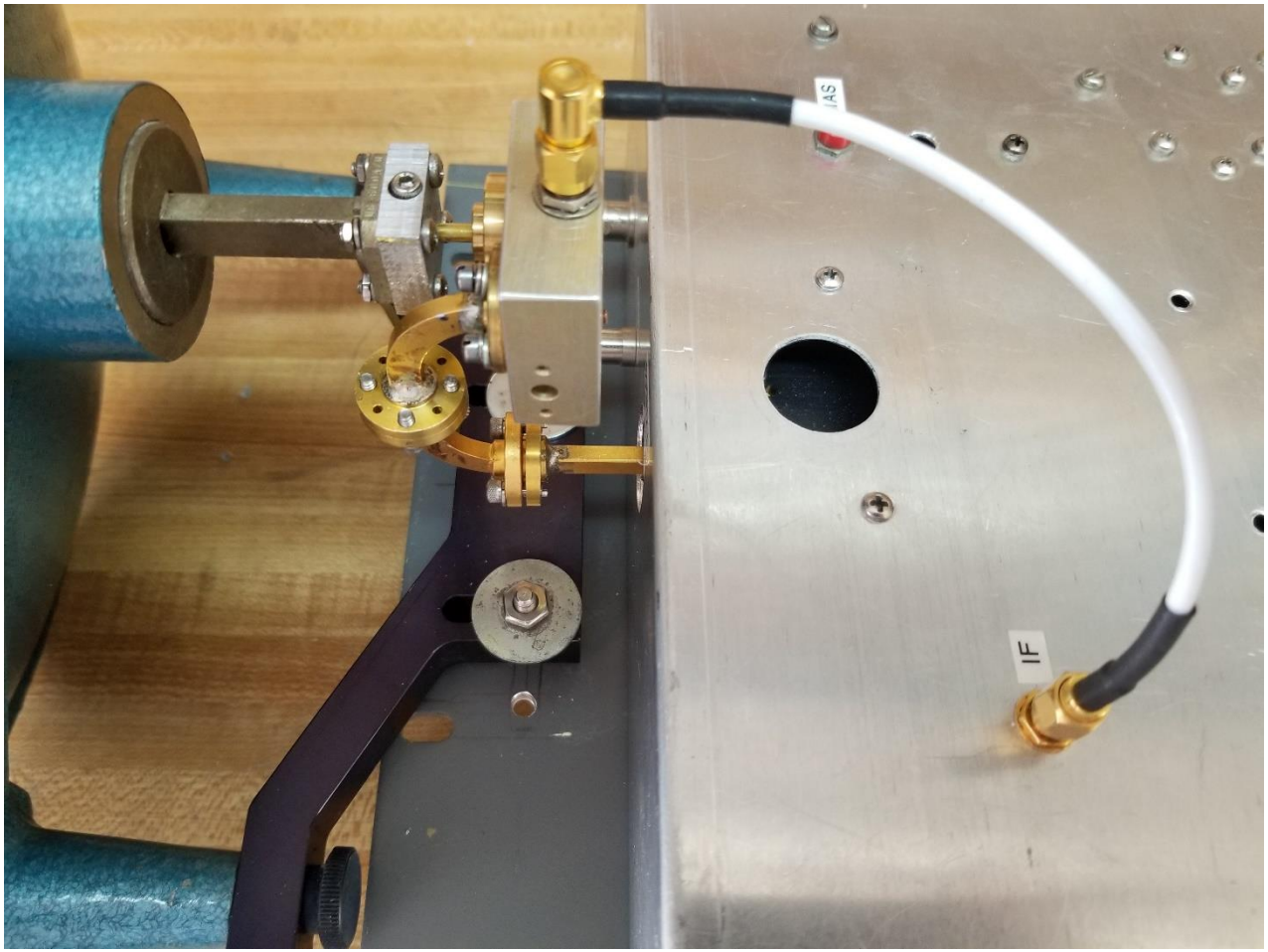

W2IMU Feed & Cassegrain Reflector

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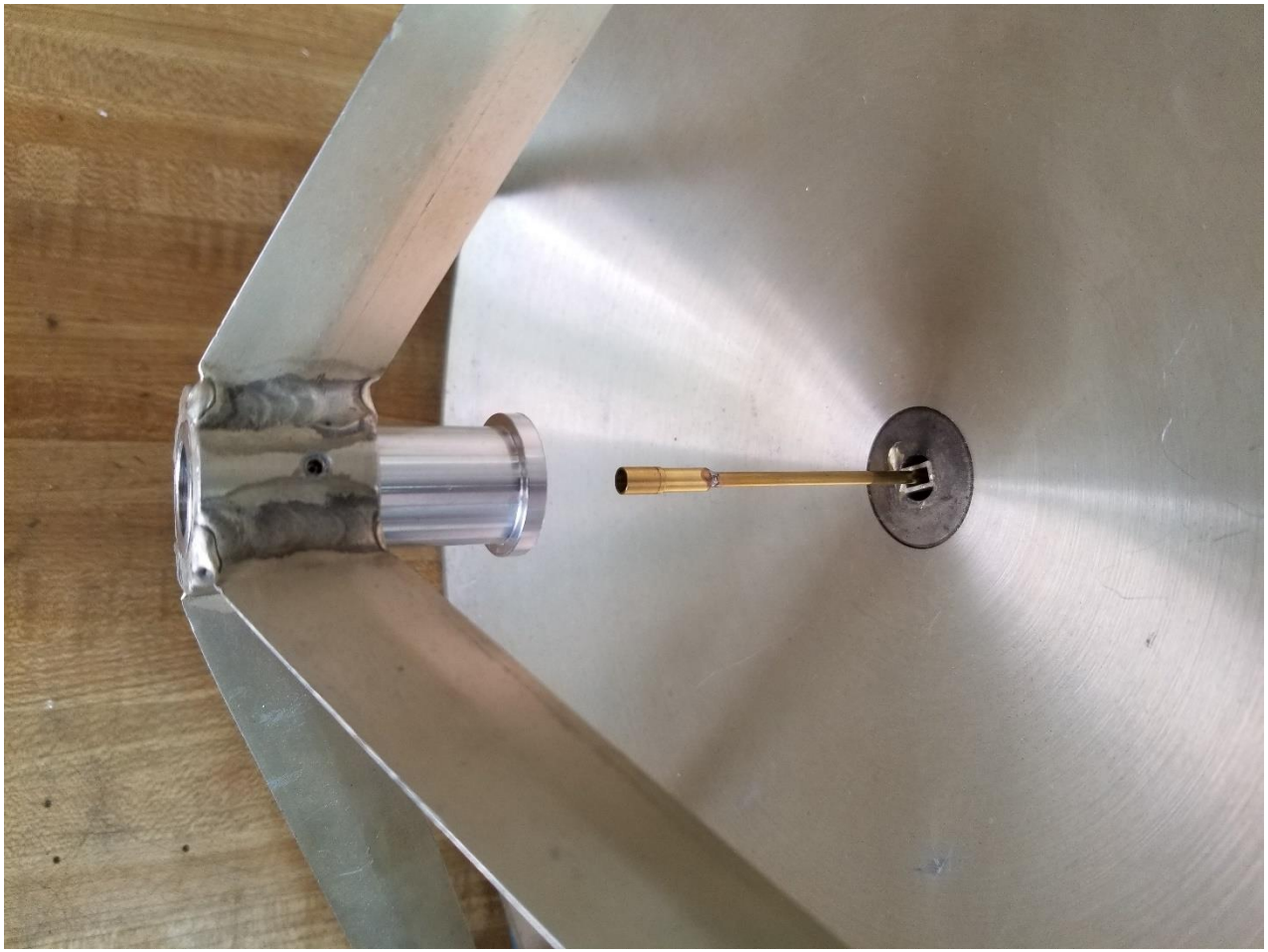

What is next?

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- Original horn has a gain about 25 dBi
- Changing over to a 12 inch dish with nearly 49 dBi gain (and a 3 degree beamwidth of .6 deg) should provide a 24 dB improvement in S/N ratio
- Try to increase 61 GHz LO power from +10 dBm to +15 dBm
- Build DB6NT PCB #47 that uses a 40 GHz LO and works on the 3rd harmonic and compare the two mixers on the weak signal source
- Find a better conductive epoxy – VE4MA is sending me some EPO-TEK H20E

Summary

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- Hope to work you on 122,256.1 MHz
- Any questions?