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Octapak Test Results

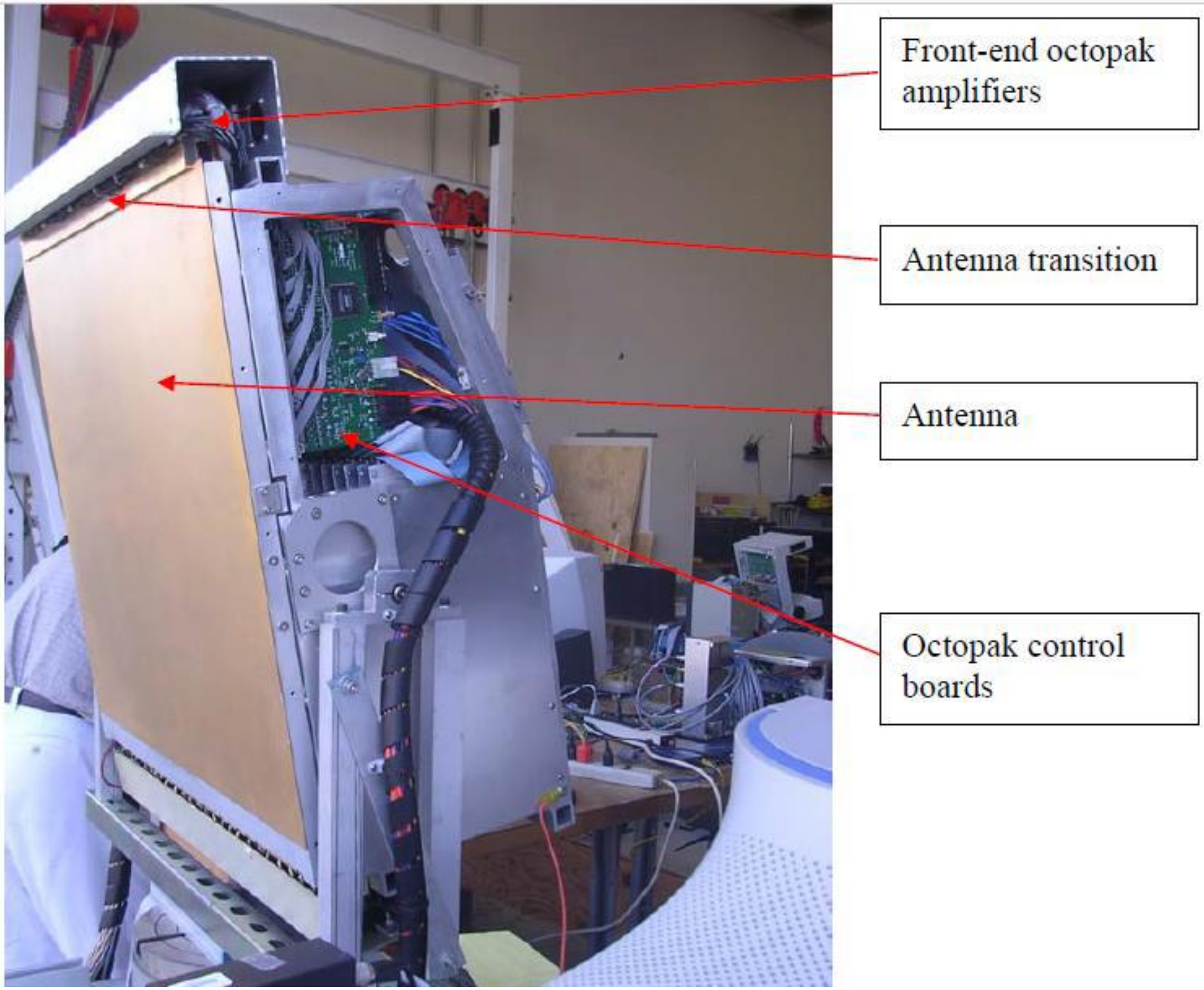
W5LUA

June 5, 2021

Introduction

- Kerry Banke N6IZW procured an 86 GHz imaging radiometer used for thermal imaging
- The radiometer included LNAs that were designed to cover the 75 to 95 GHz frequency range.
- Each LNA was called an Octopak and consisted of 8 individual channels with WR-9 input and output

86 GHz radiometer



232 Channel Radiometer

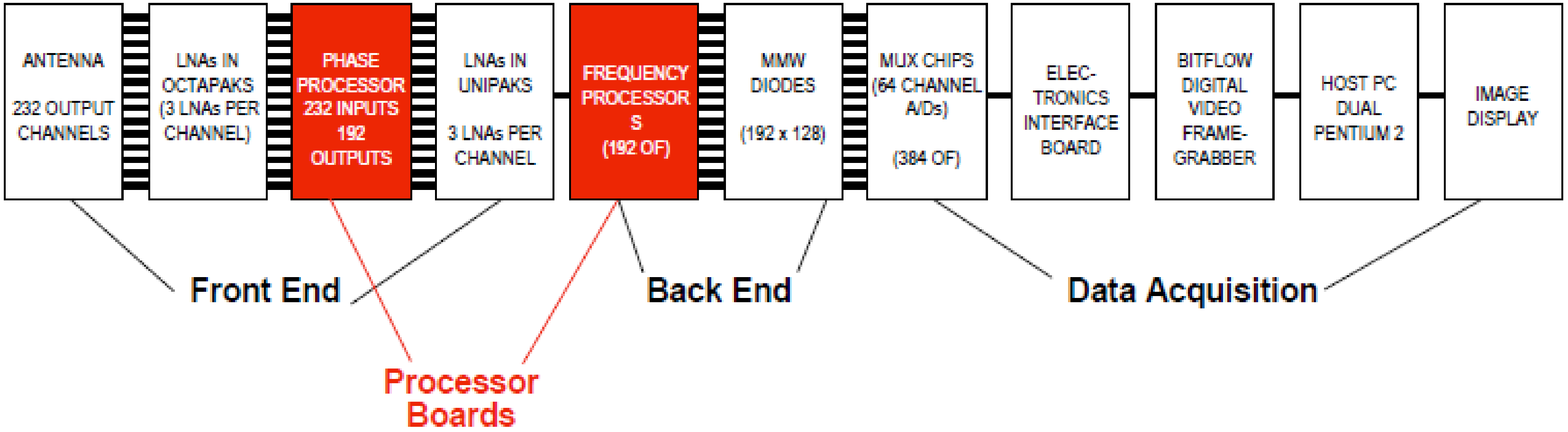
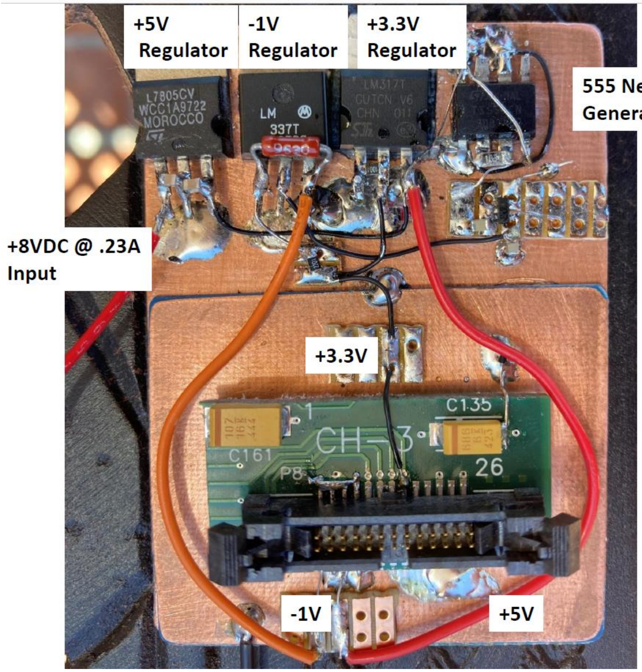


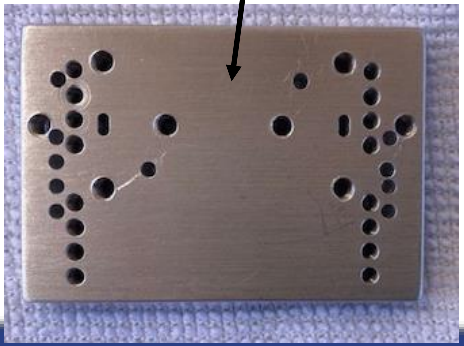
Figure 2: Block diagram layout of PMC major components

N6IZW Octopak Amplifier



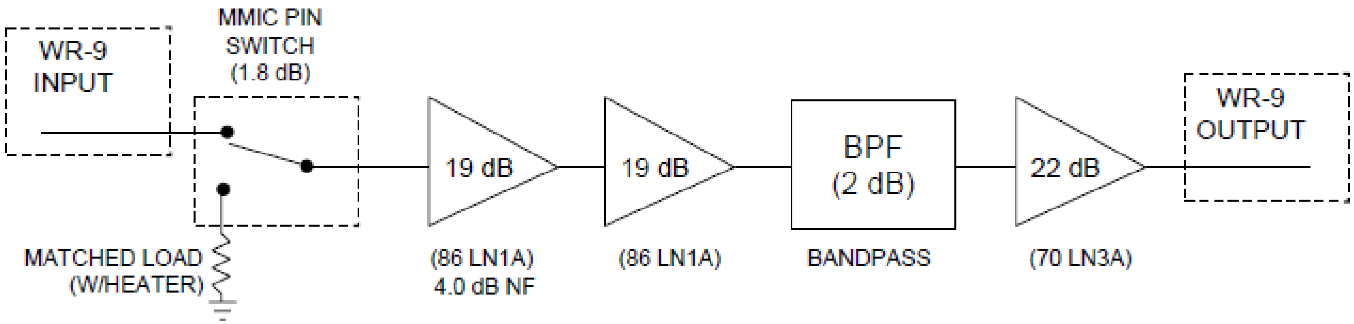
78 GHz LNA Power Supply Breadboard

Drain Supply Configured For LNA Channel 5



The test plate allows any one of 8 LNAs to be tested

Octopak Block Diagram and Manufacturer's Measured Performance



Goals:	Results Summary (to date):
♦ > 53 dB small-signal gain	55.0 dB
♦ 86 GHz center frequency	84.5 GHz
♦ 18 GHz bandwidth	18 GHz
♦ < 6 dB noise figure	6.8 dB
♦ ± 3 dB gain flatness	± 4 dB max
♦ Output power (P_{1dB}) > 0 dBm	0 dBm

Figure 8. Schematic and performance of a receiver channel.

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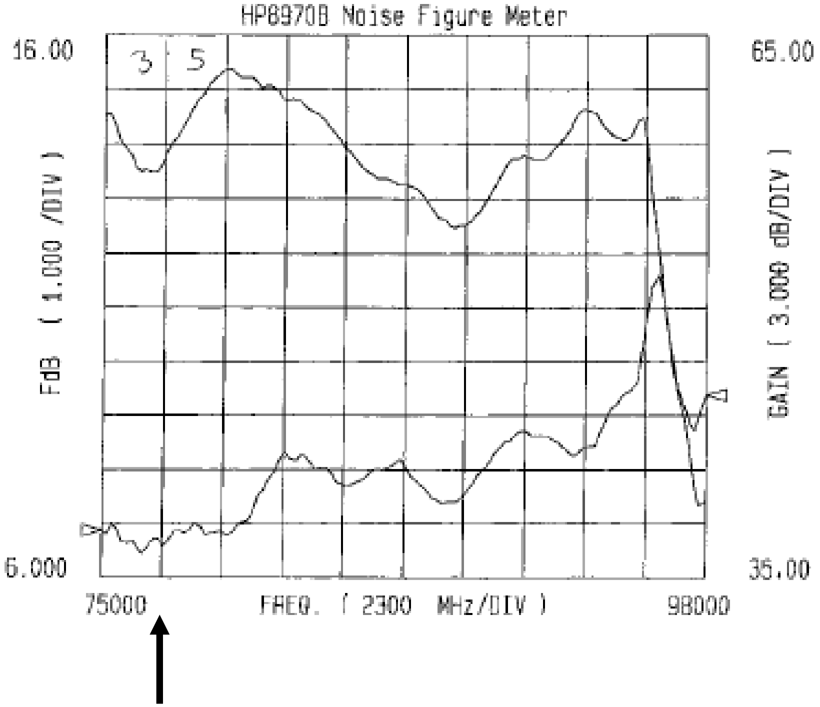
Manufacture Data

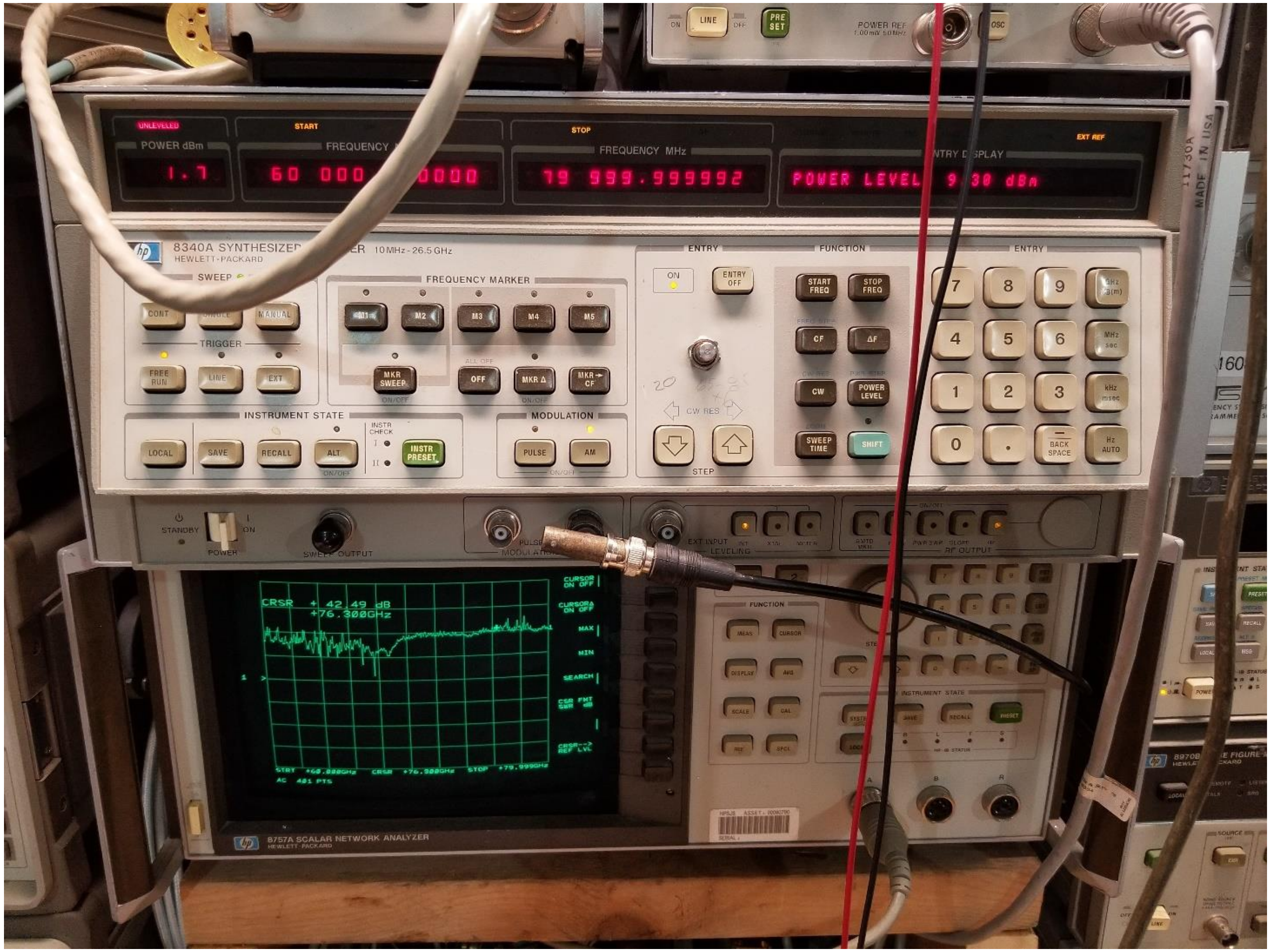
According to manufacturer's data, the device should have potential at 76 and 78 GHz

Octapak Gain and Noise Figure Data
(1.3 V Drain Bias)



- Question is… what will it do at 76 and 78 GHz?
- Kerry made an NC machined test plate that would allow any one of the 8 LNAs to be tested.
- Kerry measured good gain with one unit and asked me if I would be willing to measure a unit in my lab
- And of course I said YES!

HP8340 & HP8757



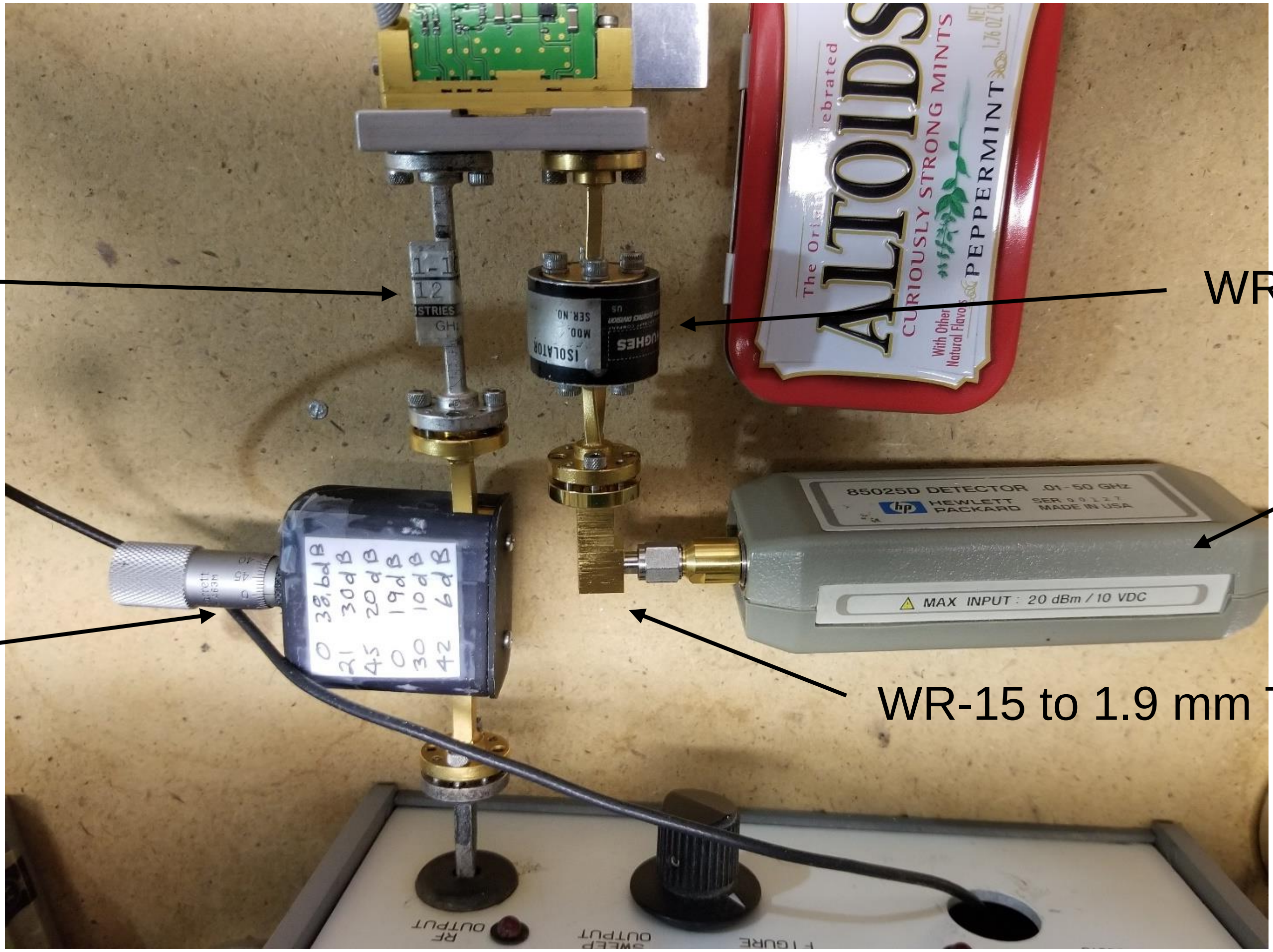
Setup for Measuring Gain from 70 to 80 GHz

WR-10 10 dB Attenuator

WR-10 Isolator

50 GHz Detector

WR-15 Vari Attenuator



WR-15 to 1.9 mm Transition

Gain Measurement

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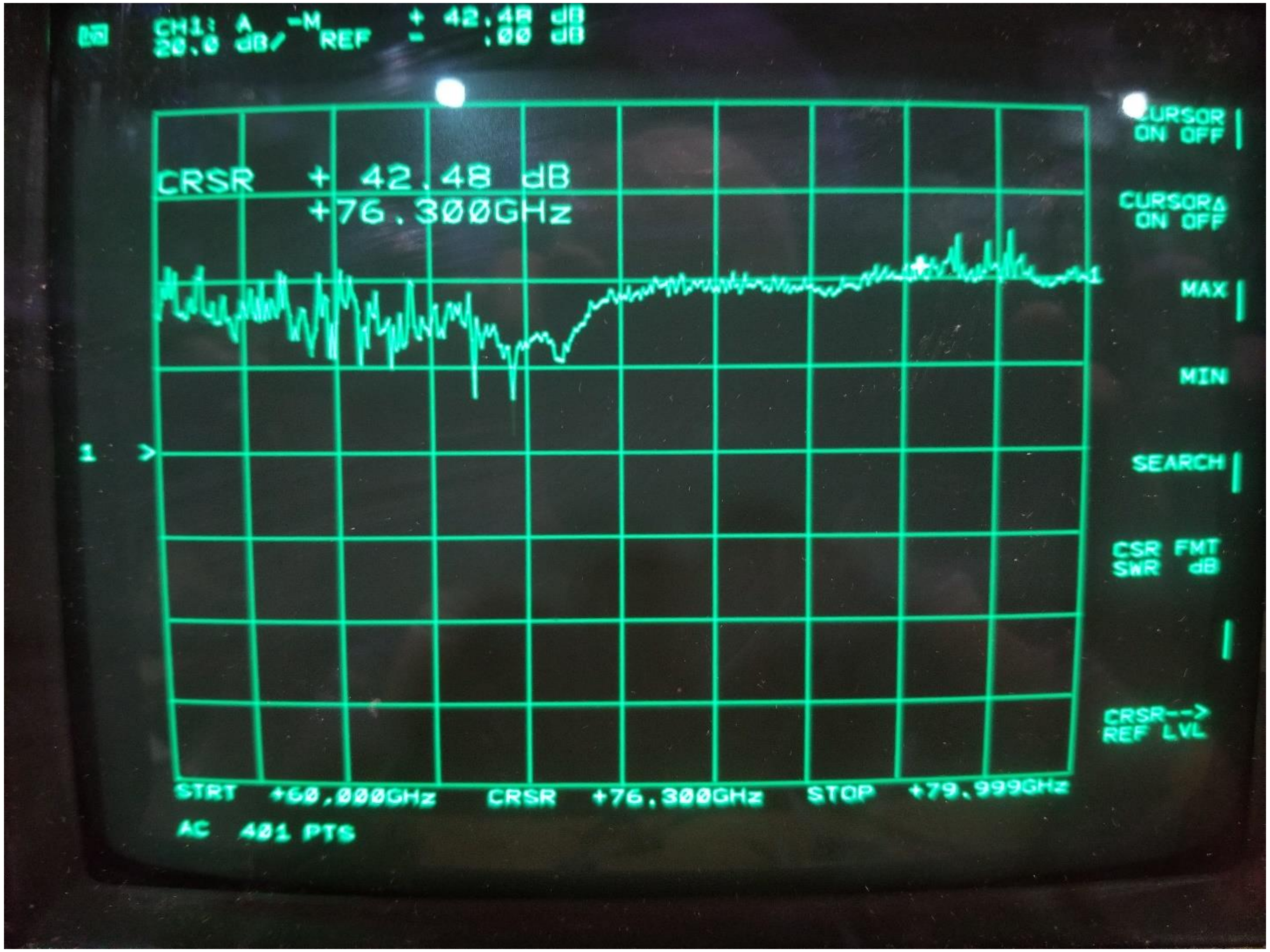

Very hard to get a good clean gain plot due to limited dynamic range of equipment and not wanting to compress DUT

Although noisy, I believe the gain number is close

Noise Figure Testing

- DB6NT Transverter 6.5 dB NF at 76032 MHz
- Added in 2 inch twist and about 12 inches of WR-15 to bring test bed above existing transverter. Noise Figure now 11.8 dB which can be zeroed out with 8970
- DUT measured 46.1 dB gain and 17.6 dB NF at 76032 MHz

LNA with 16 dB attenuator at output

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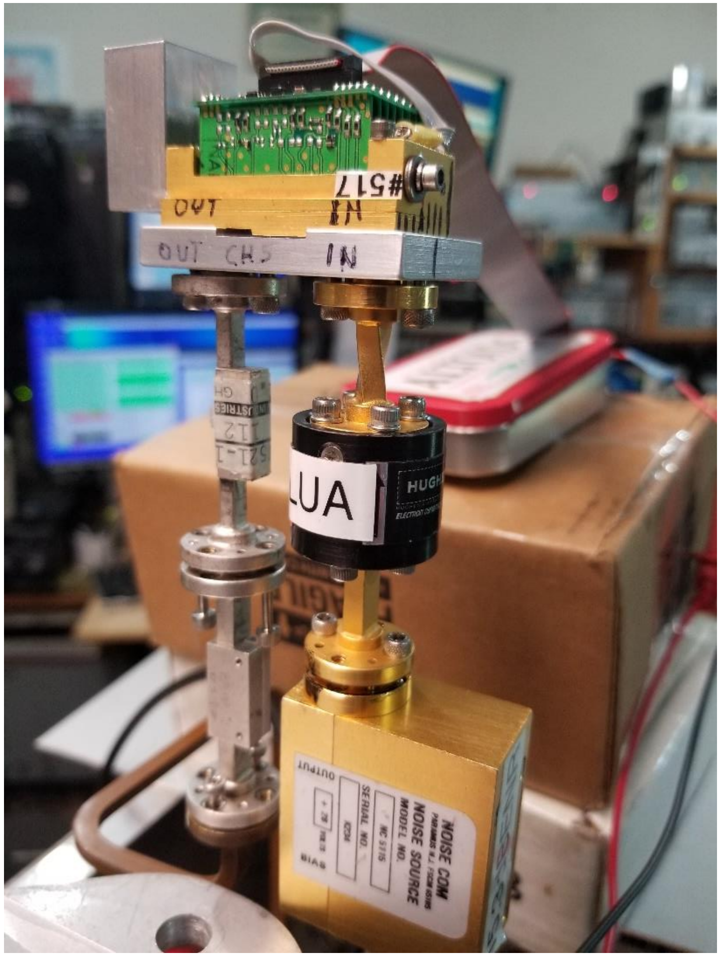
I tried various attenuators on output side of LNA to attempt to keep from overloading the HP8970B



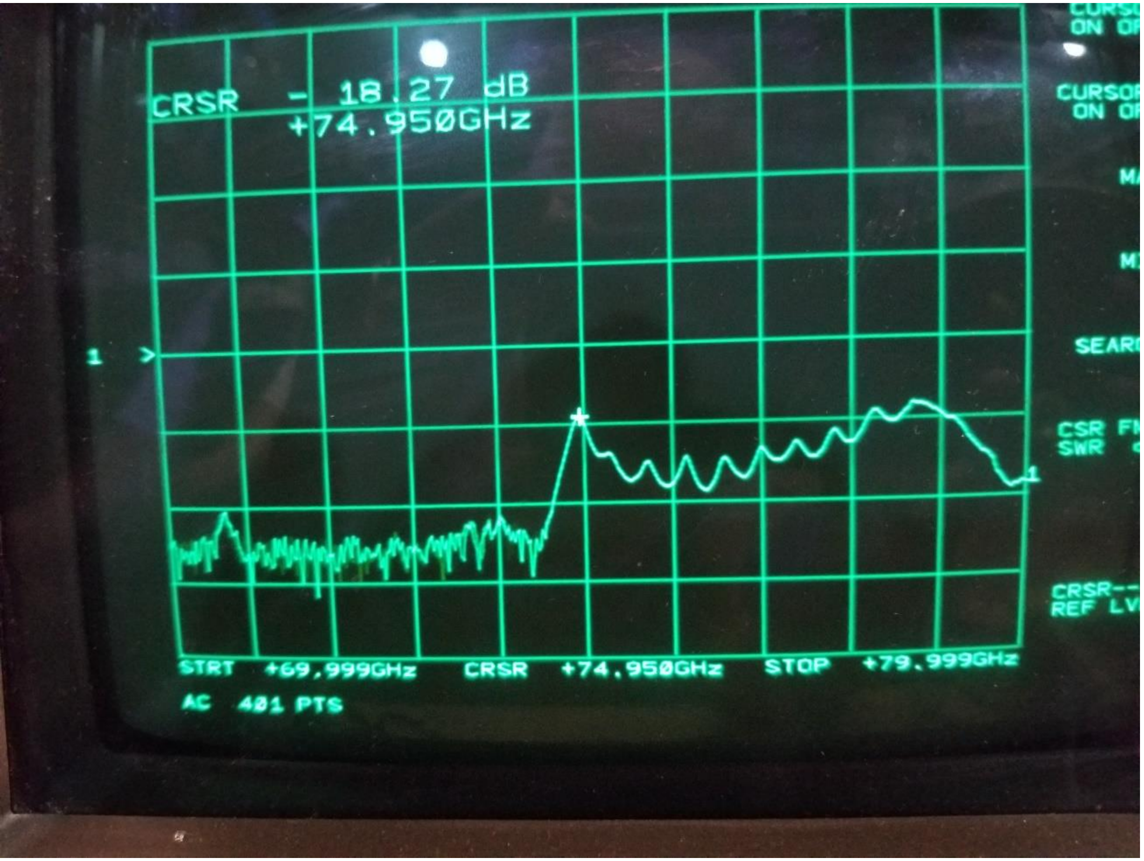
Noise Figure Test Results

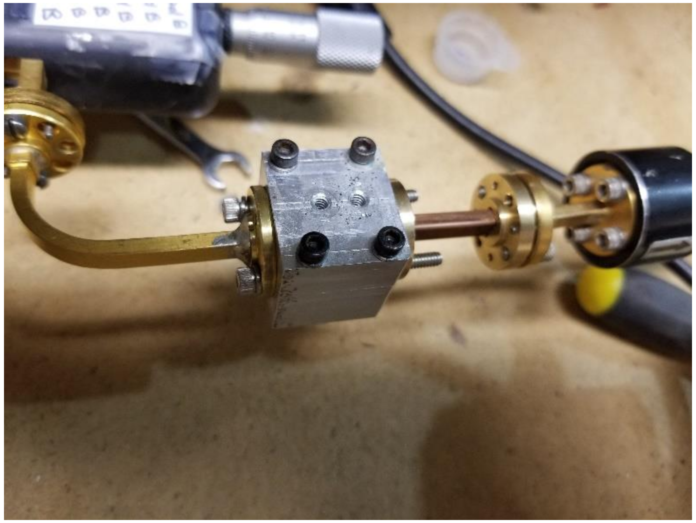
- Since the DUT has significant gain, I decided to just measure system NF which is basically the HP8970 in the “Uncorrected” mode.
- With the DB6NT transverter set for Max gain I measured system NF of 17.6 dB at 76032 MHz, 15.2 dB NF at 77184 MHz and 15.9 dB NF at 78192 MHz
- With the DB6NT transverter set for Min gain I measured system NF of 14.7 dB at 76032 MHz, 12.9 dB NF at 77184 MHz and 14.0 dB NF at 78192 MHz
- With the DB6NT transverter set for Middle gain I measured system NF of 14.5 dB at 76032 MHz, 12.8 dB NF at 77184 MHz and 14.2 dB NF at 78192 MHz
- I don’t understand why the xvtr gain effects the system noise figure the way it does. It looks like some sort of gain/bandwidth compression in the DB6NT or the 8970

Noise Figure Testing

- I then connected the +3.3V line to a variable power supply and varied from 0 to +3.3 V. System noise figure was always best at +3.3V.
- I need to carefully try to vary the gate voltage and monitor NF and Gain.
- Prior to doing that I decided to add in a homebrew lossy 78 GHz filter to see if this helped with system noise figure

Filter #3 Natural Resonance





This filter is one of the early prototypes that Bob Gormley WA5YWC built for me

W5HN

Filter #3 optimized for 78.2 GHz

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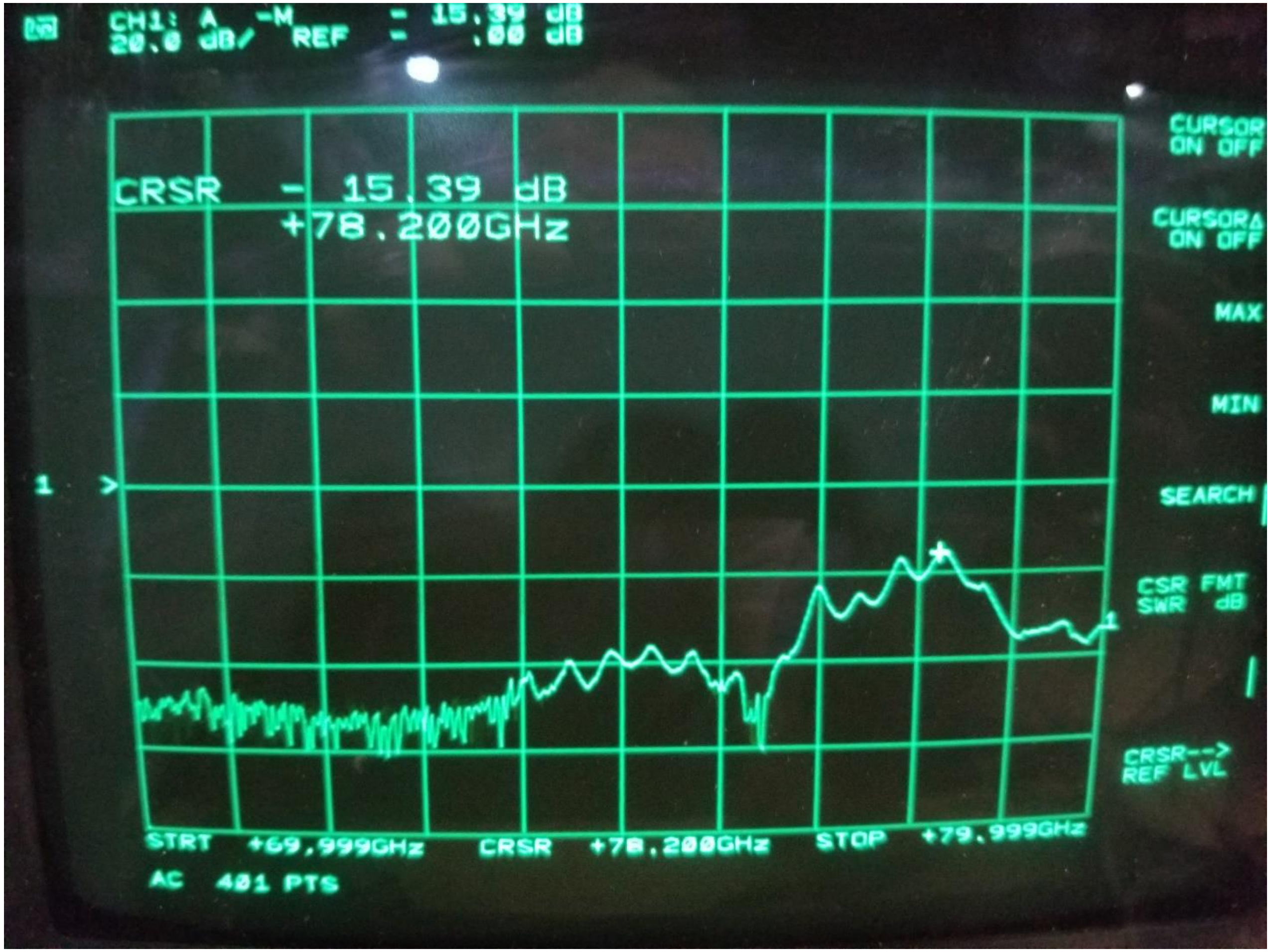

LNA with Filter #3 added in place of 10 dB attenuator

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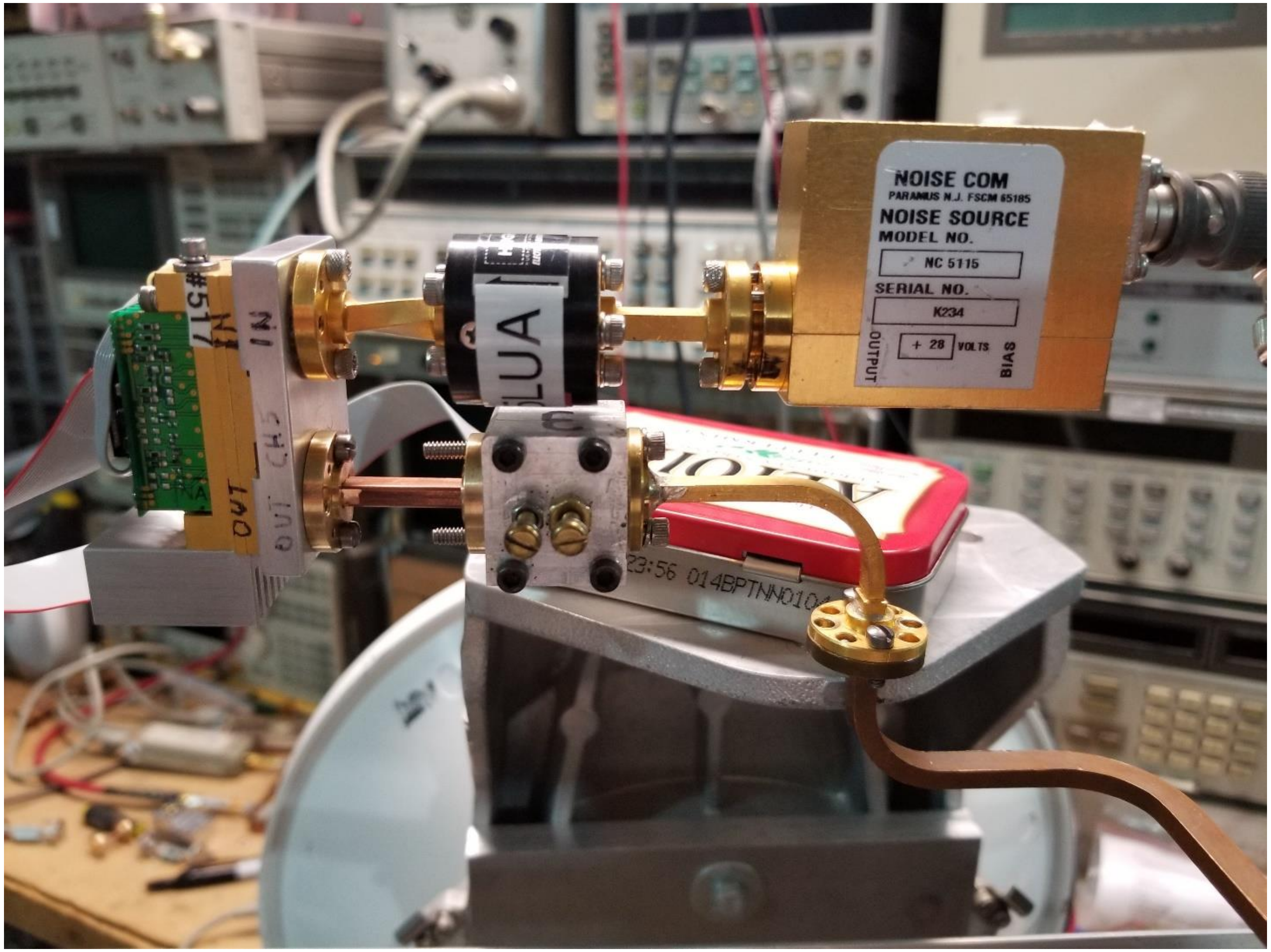

System Noise Figure

	DB6NT IF Gain at Min		DB6NT IF Gain at Mid
Frequency	**w/10 dB Atten**	**w/10 dB Atten and Filter**	**w/10 dB Atten and Filter**
76032 MHz	15.8 dB	19.6 dB	15.2 dB
77184 MHz	13.9 dB	12.8 dB	12.7 dB
78192 MHz	14.8 dB	14 dB	14 dB

Although the results today show that the filter did help lower system NF, compared to the results on slide 8 from several days ago, there is not any real difference. Best is about 12.7 dB NF at 77184 MHz and 14 dB NF at 78192 MHz.

Why is the Noise Figure so high!........

Octapak Connections

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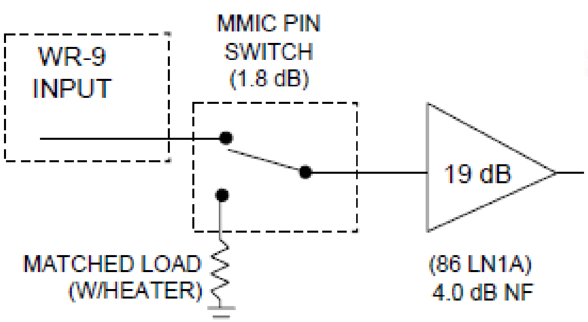
I need to better understand how to program these terminals to make sure the PIN switch is in the correct position and the termination is not on and generating excess noise

1	Gate Bias	-1V
2	Heater CTRL	gnd
3	Common	gnd
4	Heater Current	gnd
5	Switch Bias	+5V
6	Heater Current	gnd
7	Pin SW Control	gnd
8	Return	gnd
9	Ch1 Drain	
10	Ch8 Drain	
11	Ch2 Drain	
12	Ch7 Drain	
13	Ch3 Drain	
14	Ch6 Drain	
15	Ch4 Drain	
16	Ch5 Drain	

All active drains 3.3V

17-20 are to be GND on LNA conn.
21-26 t0 LNA chassis



Later green version

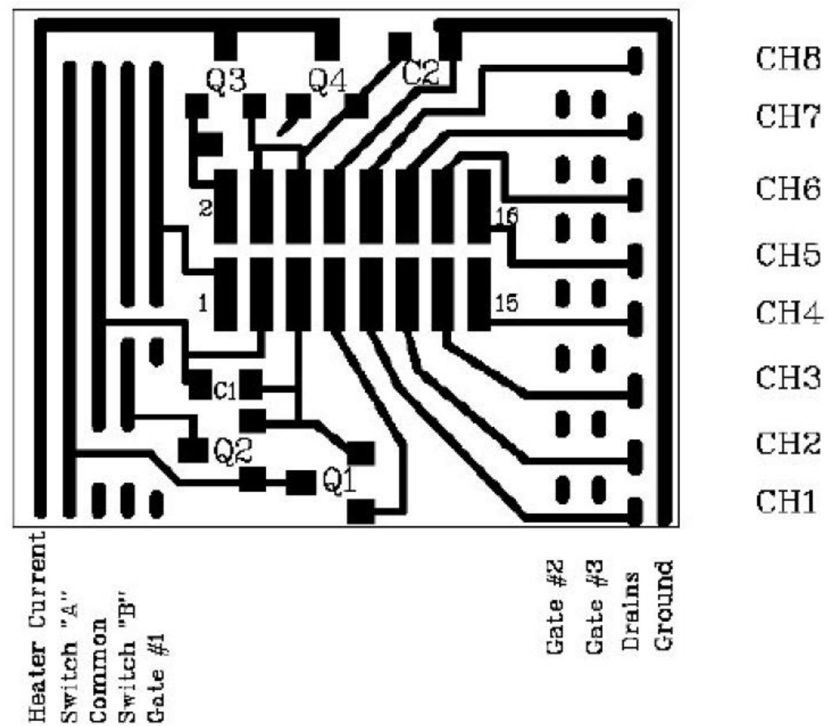


Figure 10: Octopak distribution board layout and pin functions

Next Steps

- Make sure that we have the input switched into the waveguide input and not the internal termination.
- Vary gate bias and monitor noise figure
- Anyone have any additional insight on these nice little amplifiers?
- Work continues….
- Thanks to Kerry N6IZW for the opportunity to help with this project

The good news is that Kerry says more LNAs are available!

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