A Fresh Approach To A Multi-Band Microwave Station

Presented At:
The 40th Eastern VHF / UHF Conference

By: Fred Stefanik, N1DPM

A Fresh Approach To A Multi-Band Microwave Station

- **1984 (that's right 30 years ago!)(I was 23 years old)**
  - **I first tried 1296 out at my home QTH at FN32qb.**
    - **500mW transverter** (Borrowed from WB1FVS)
    - **13 element Yagi** (Borrowed from K1FO)
    - **100 feet of RG8U Feedline**
    - **I worked….**
      - **W2SZ/1 @ ~ 50 miles**
      - **W1JR @ ~ 73 miles**
  - **The microwave bug bit!**
- **1988**
  - **1296 Gear of my own now!**
    - **SSB LT23S**
    - **45 Element Loop Yagi**
    - **100 Feet of 3/4" *OLD* CATV Aluminum Hardline**
      - **Of Unknown Quality**
    - **Could now work about 6 or 7 stations!**

A Fresh Approach To A Multi-Band Microwave Station

- **1990**
  - **Moved the LT23S to a weatherproof box up on the tower.**
    - **Now I had my 10 watts near the antenna**
    - **I also had my receiver front end there too**
    - **I saw a marked increase in overall performance**
- **The microwave bug bit again!**
  - **Over the next few years I added more bands…**
  - **All Transverters, etc up on the tower.**
    - **903**
      - **10 watts, 3dB NF,Loop Yagi**
    - **2304**
      - **1 watt, 2dB NF, Loop Yagi**
    - **3456**
      - **1 watt, 2dB NF, Loop Yagi**
  - **This stuff worked really good at the antenna!**

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- ~ 1997
  - Time to rebuild the antennas and systems on the tower.
    - The original LT23S had died
      - It was time for a new 1296 system too.
  - The New Tower Mounted Systems Were…
    - 903 - 70 Watts, 0.7dBNF, 39 element 15' Boom Looper
    - 1296 - 35 Watts, 0.3dBNF, 55 element 15' Boom Looper
    - 2304 - 40 Watts, 1dBNF, 76 element 12' Boom Blowtorch
    - 3456 - 10 Watts, 1dBNF, 112 element 12' Boom Blowtorch
      - All feedlines on these systems were ~10' of FSJ4-50B Superflex
    - I also added….
    - 5760 - 2 Watts DEMI Transverter, 2' Dish
    - 10368 - 3 Watts, Kuhne Transverter, DL2AM amplifier, 2' Dish
      - ~2003 I added a DEMI 8 Watt amp to the 10GHz system.
  - This stuff worked great!
  - Time marches on…..

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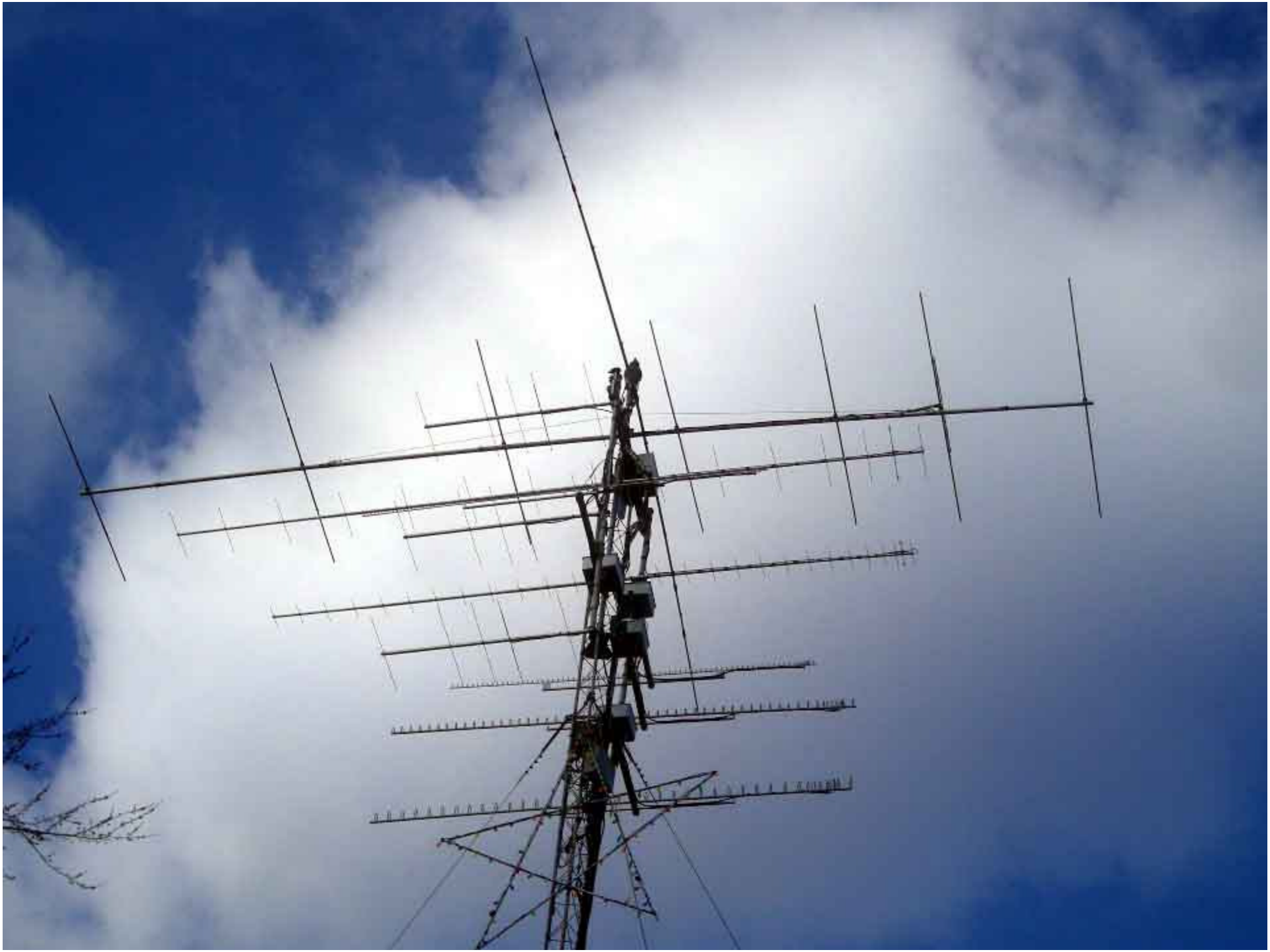
Performance of this gear looks like...

- 903 MHz
  - 17.9dBd Antenna Gain
  - 0.35dB Feedline Loss
  - 3,982 Watts ERP
  - 1.05dB System NF
- 1296 MHz
  - 18.9dBd Antenna Gain
  - 0.41dB Feedline Loss
  - 2,472 Watts ERP
  - 0.71dB System NF
- 2304 MHz
  - 21.3dBd Antenna Gain
  - 0.58dB Feedline Loss
  - 4,721 Watts ERP
  - 1.58dB System NF
- 3456 MHz
  - 23.1dBd Antenna Gain
  - 0.74dB Feedline Loss
  - 1,722 Watts ERP
  - 1.74dB System NF



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- **2013**
  - **It's now 29 years after my first endeavor on 1296.**
  - **It's been ~ 16 years since my antenna system was last overhauled.**
  - **I'm now 52 not 23**
    - **I know I'm young still, but….**
  - **I decided I wanted a really good system on this tower for….**
    - **6 Meters, 2 Meters, 222MHz, and 432MHz**
  - **So I ask my friend John AA1I/R if he could help me as ground crew to do some tower work.**
  - **The first day we took down 903, 1296, and 2304.**
    - **After wrenching apart 16 year old hardware on these 3 systems I was shot!**
    - **More next time….**
  - **A week later when he arrived he said "let me go up and give it a shot"**
    - **OOOOHHHHH….A younger guy to help on the tower!**
    - **We took down the 2 meter yagis, 3456, 5760, and 10GHz.**
    - **This time the "youngster" was shot!**

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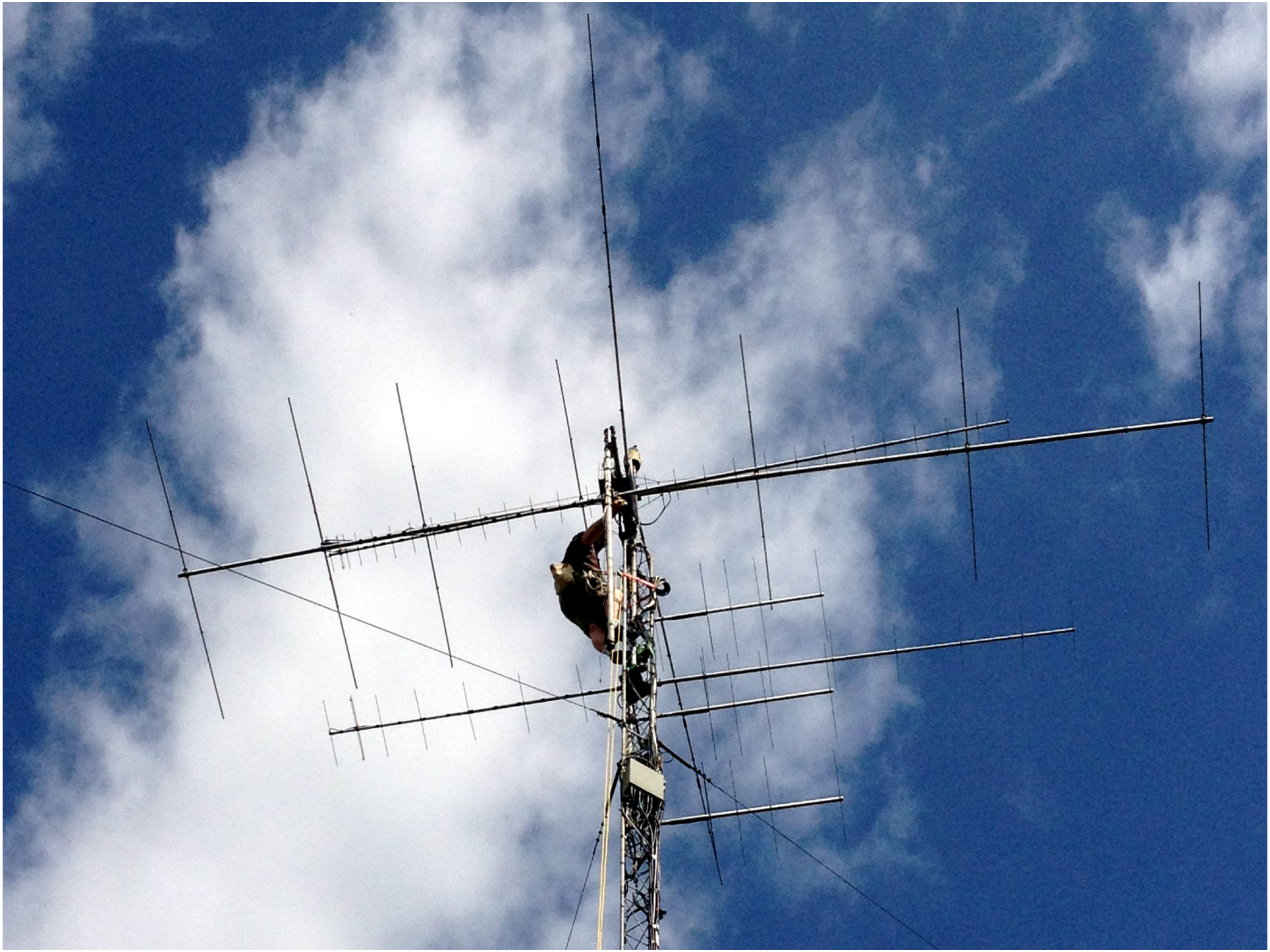
- **2013 continued….**
  - **After his first time on the tower he said something like….**
    - **You got me into this microwave stuff and here I am helping you take apart one of the stations I can reliably work as a rover. Something seems wrong with that!**
  - **Well that had some influence….**
  - **He bought all his own climbing harness, etc and continued to help with the antenna system rebuild.**
  - **I continued to play ground crew!**



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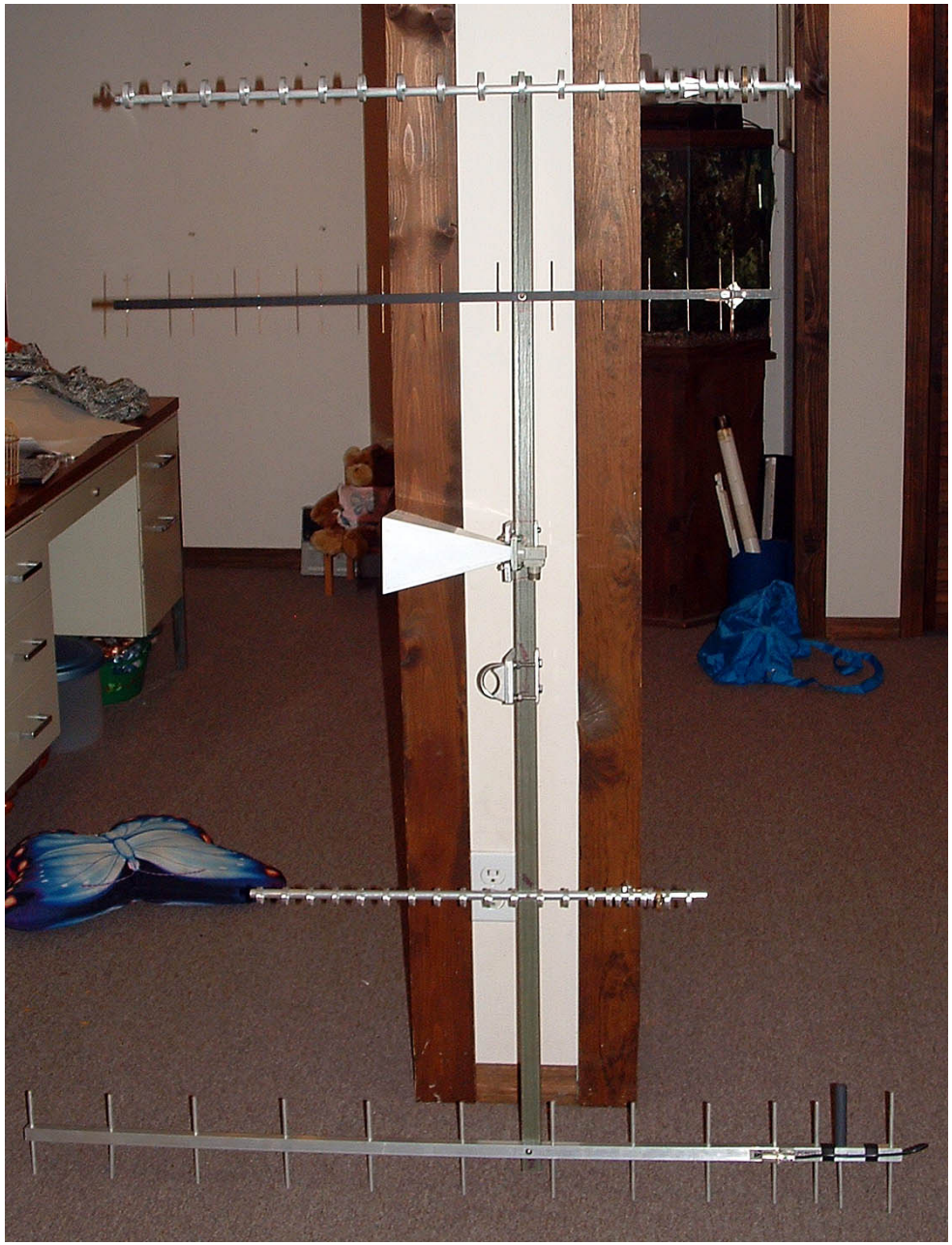
- OK….6 Meters through 432 were up and working
- I started to think about how I may approach the lower 4 microwave bands.
- My old 6 bands worth of gear found a new home in FN43cd
- I looked at what I had kicking around
- And…
- Thought about how I could get on with the goals of…
  - Getting on easily
    - Keep the set up simple
  - Easy maintenance on the tower (I'm not getting any younger)
  - "Reasonable Performance"
    - I want to be able to work AA1I/R where he goes
    - I'd like to work out to the ~100 mile radius or so

A Fresh Approach To A Multi-Band Microwave Station

- **Antennas….**small
  - This is a portable array I only used a few times.
  - 5’ Fiberglass cross boom
- **903**
  - Commercial 13 element yagi spec’d at 13dBd gain
- **1296**
  - Homebrew DL6WU 14 element yagi - 14.2dBd gain
- **2304**
  - W1RIL 22 element looper ~ 17.5 dBd gain
- **3456**
  - Directive Systems 22 element looper ~ 17.5 dBd gain
- **Remove the horn antenna and now I have a place for a LNA**



A Fresh Approach To A Multi-Band Microwave Station

- **Goals:**
  - Simple
  - Bands = 902/3, 1296, 2304, 3456
  - Transverters and PA's in shack
  - LNA on Tower for good RX performance
  - One 100' piece of LDF4-50 Heliax Feedline
    - 903 Loss = 2.2dB
    - 1296 Loss = 2.7dB
    - 2304 Loss = 3.8dB
    - 3456 Loss = 4.6dB
  - Decent Performance

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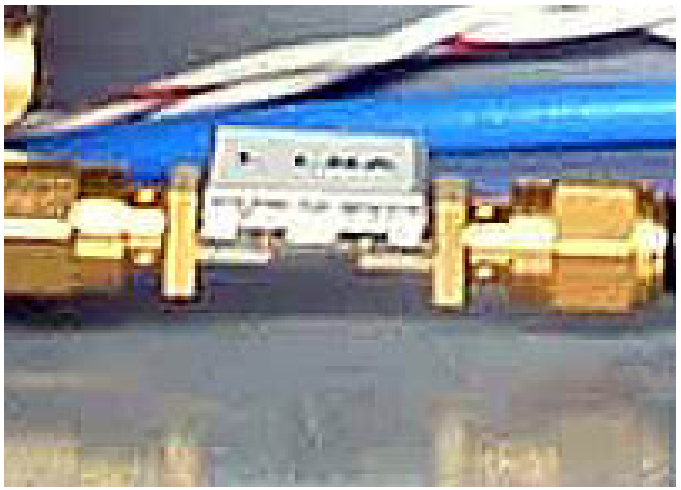
- LNA
  - Switching multiple LNA's too complex
  - Good performance broadband LNA
    - AD6IW HEMT MMIC LNA from NEWS site
      - Contacted Goran and told him what I was looking for
      - He made an LNA for me
      - It tested to the following specs…
        - » 903 - 24.4dB Gain - 0.31dB Noise Figure
        - » 1296 - 22.7dB Gain - 0.30dB Noise Figure
        - » 2304 - 17.8dB Gain - 0.48dB Noise Figure
        - » 3456 - 14.9dB Gain - 0.56dB Noise Figure



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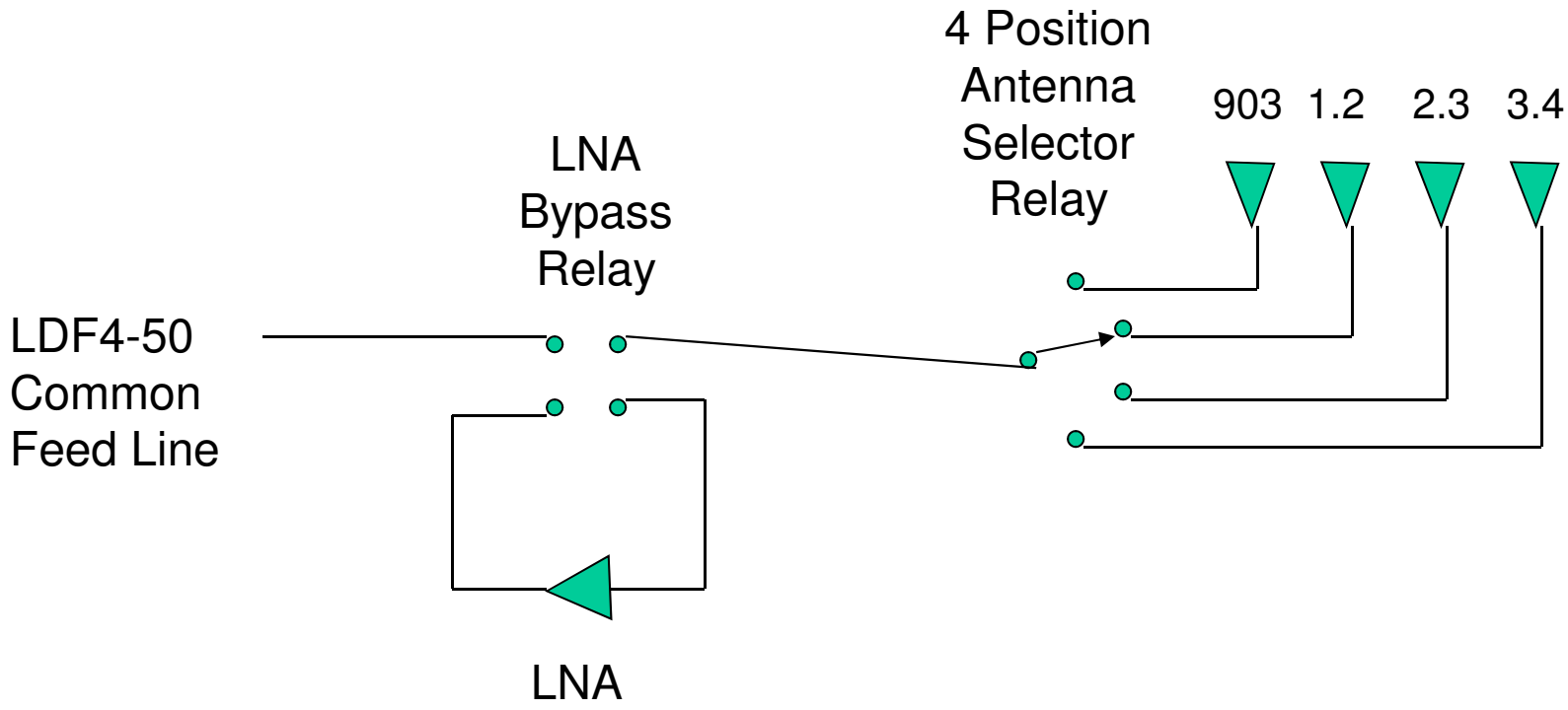

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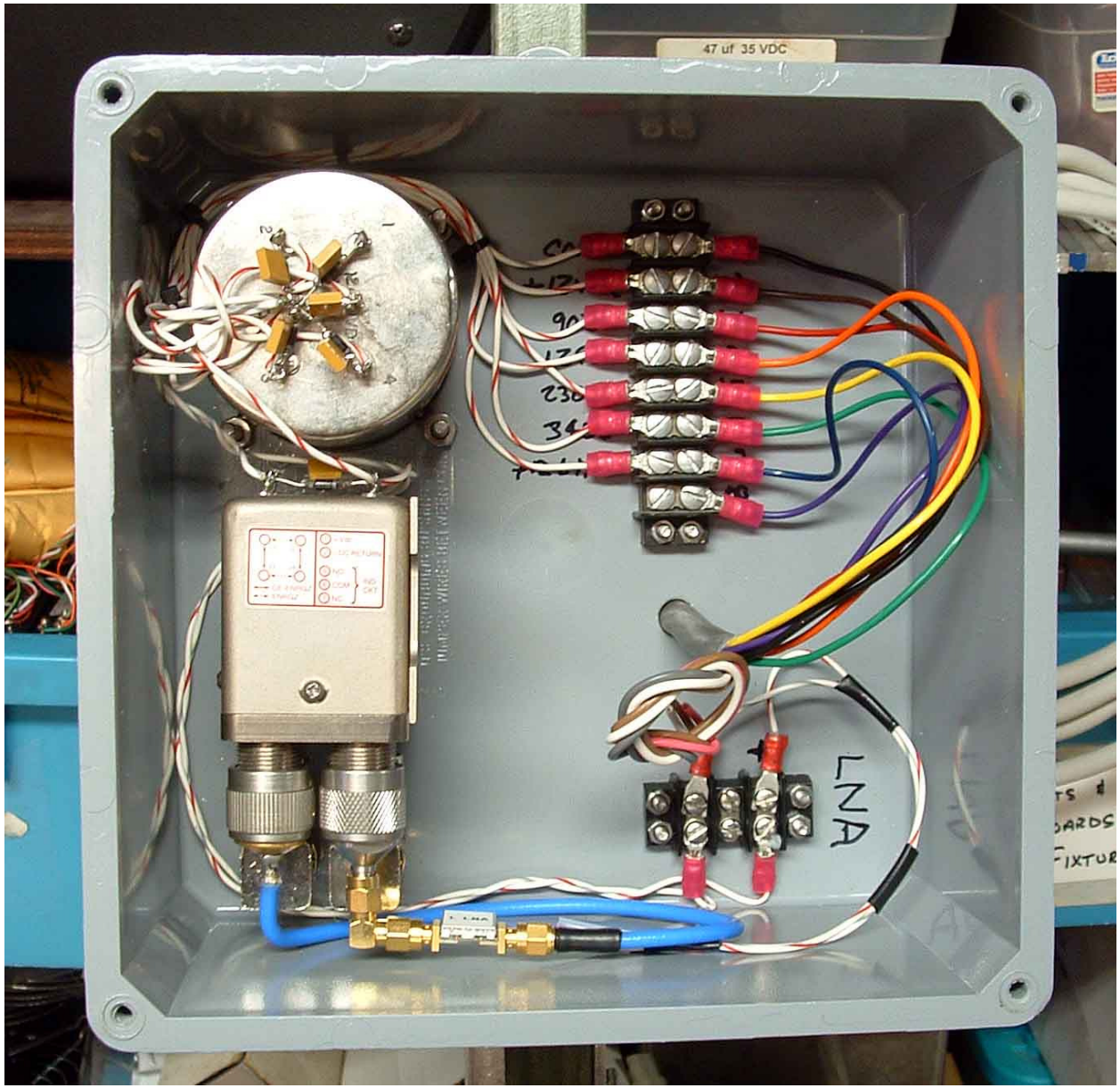

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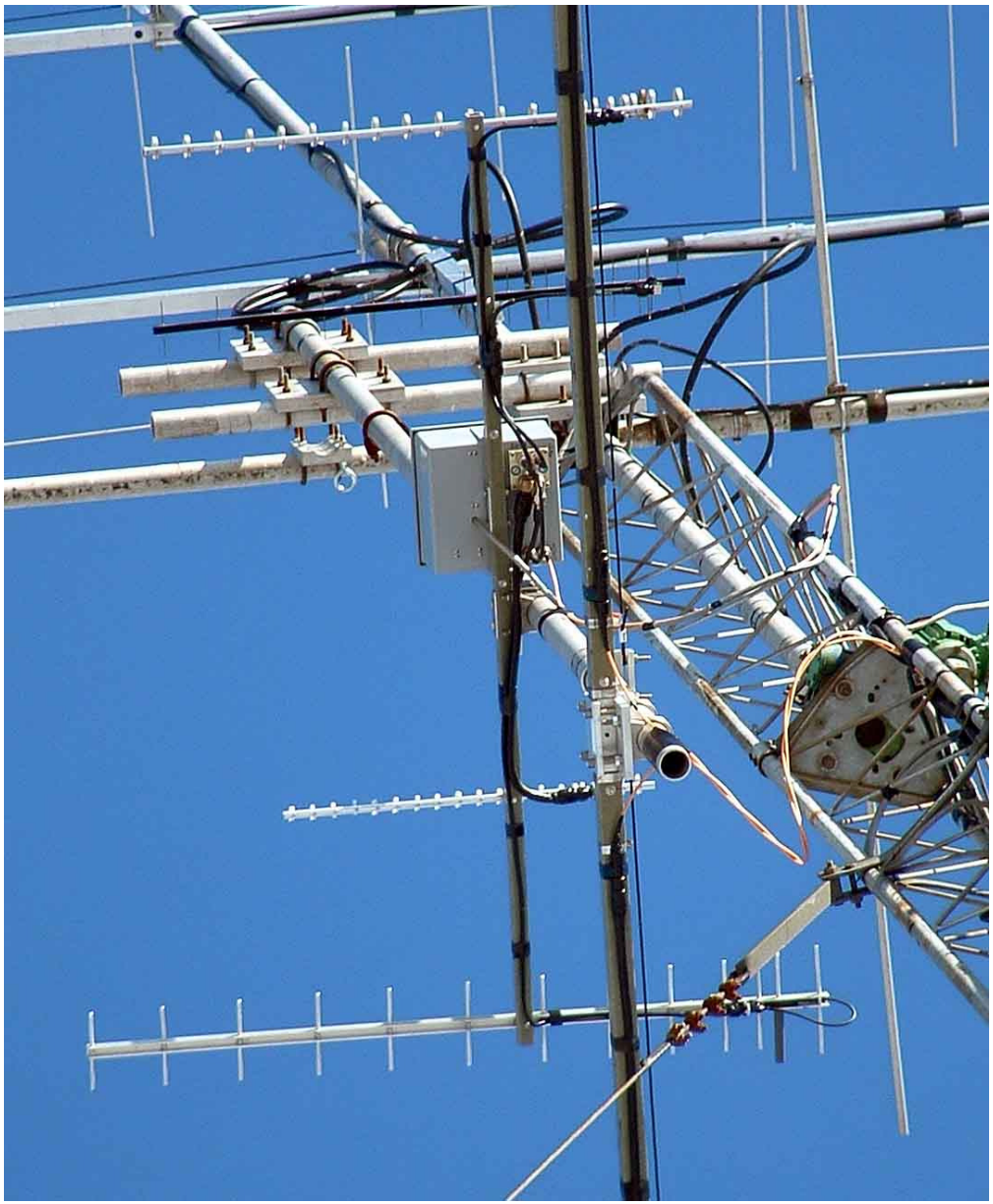
2304 - 22 Element
W1RIL Loop Yagi

1296 - 14 Element
Home Brew DL6WU
Yagi

3456 - 22 Element
Directive Systems
Looper

903 - 13 Element
Cushcraft Commercial
Yagi



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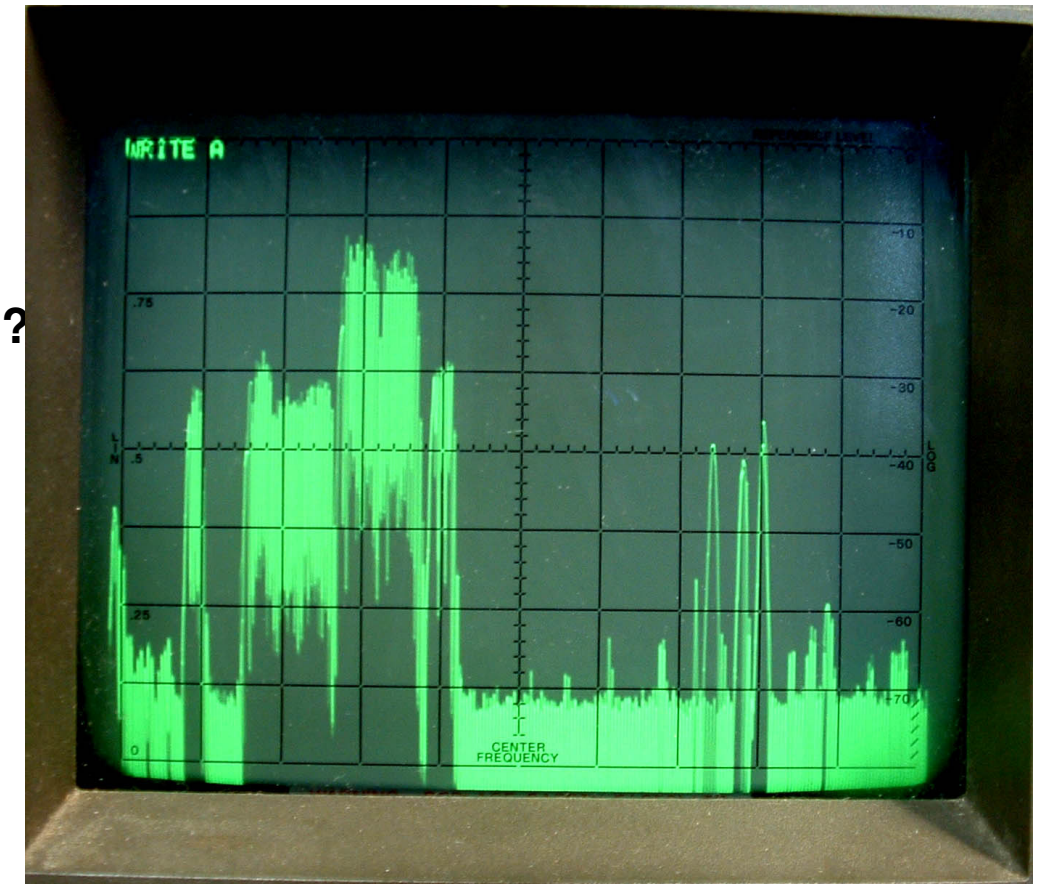
- The LNA works great!
- It has a high P-1dB and OIP3
  - +23dBm P-1dB
  - +40dBm OIP3
  - So it won't overload….but…
  - What about the Transverters?
  - YES THEY DO!!!!



902.600 MHz Center Frequency
10 dB/ Div 10 MHz / Div
0 dBm Top Reference!

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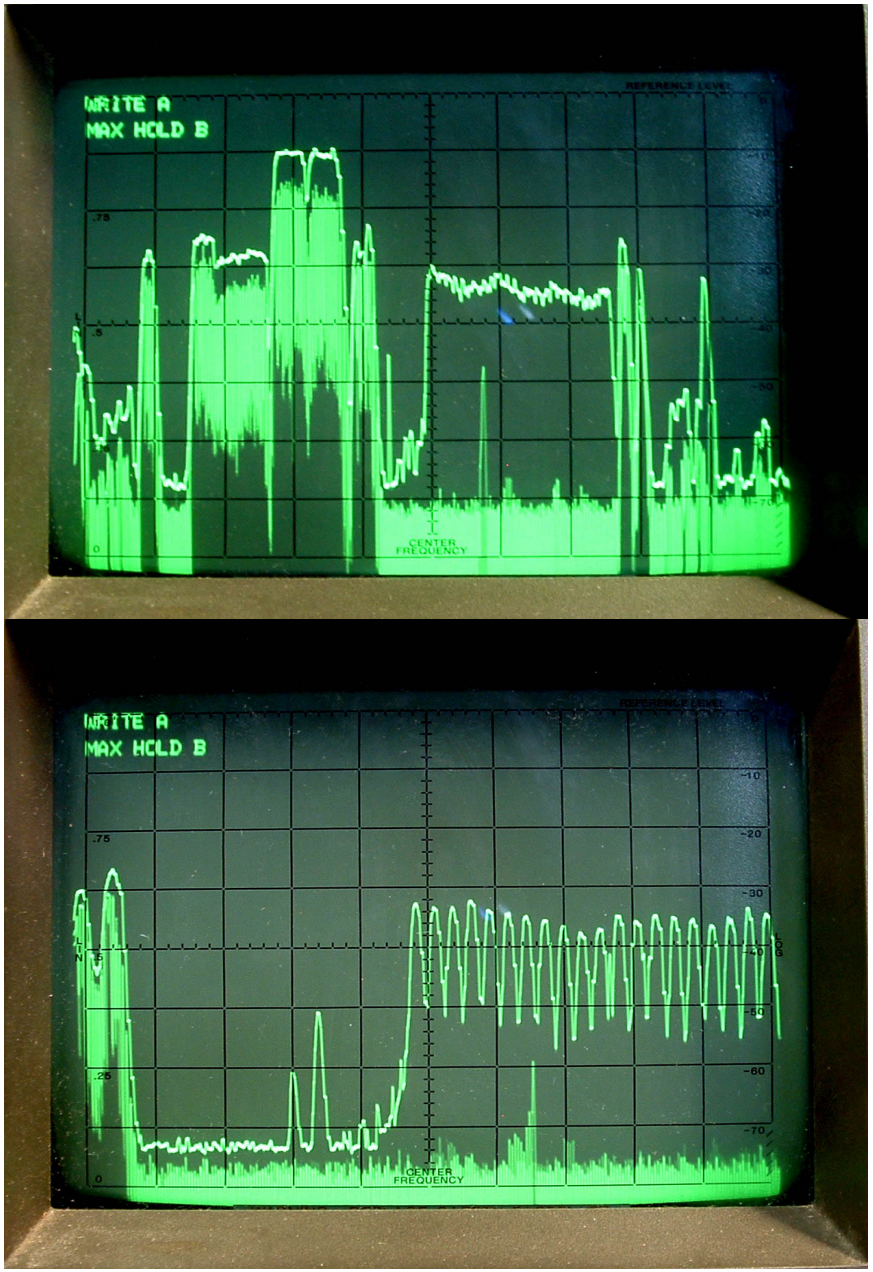
- Now turn on the peak hold function on the spectrum analyzer and let it run a while….
- Same settings as before
- There are peaks at -10dBm!
- You can also see the result of the frequency agile signal that moves from ~902 to ~925 MHz that is -30dBm.
- S9 on my receiver = -100dBm
- This out of band interference is S9 + 90dB!
- The in band interference is S9 + 70dB!
  - Good thing the in band hops around!
- Bottom picture is 2 MHz / Div
- Looks like I need a filter!



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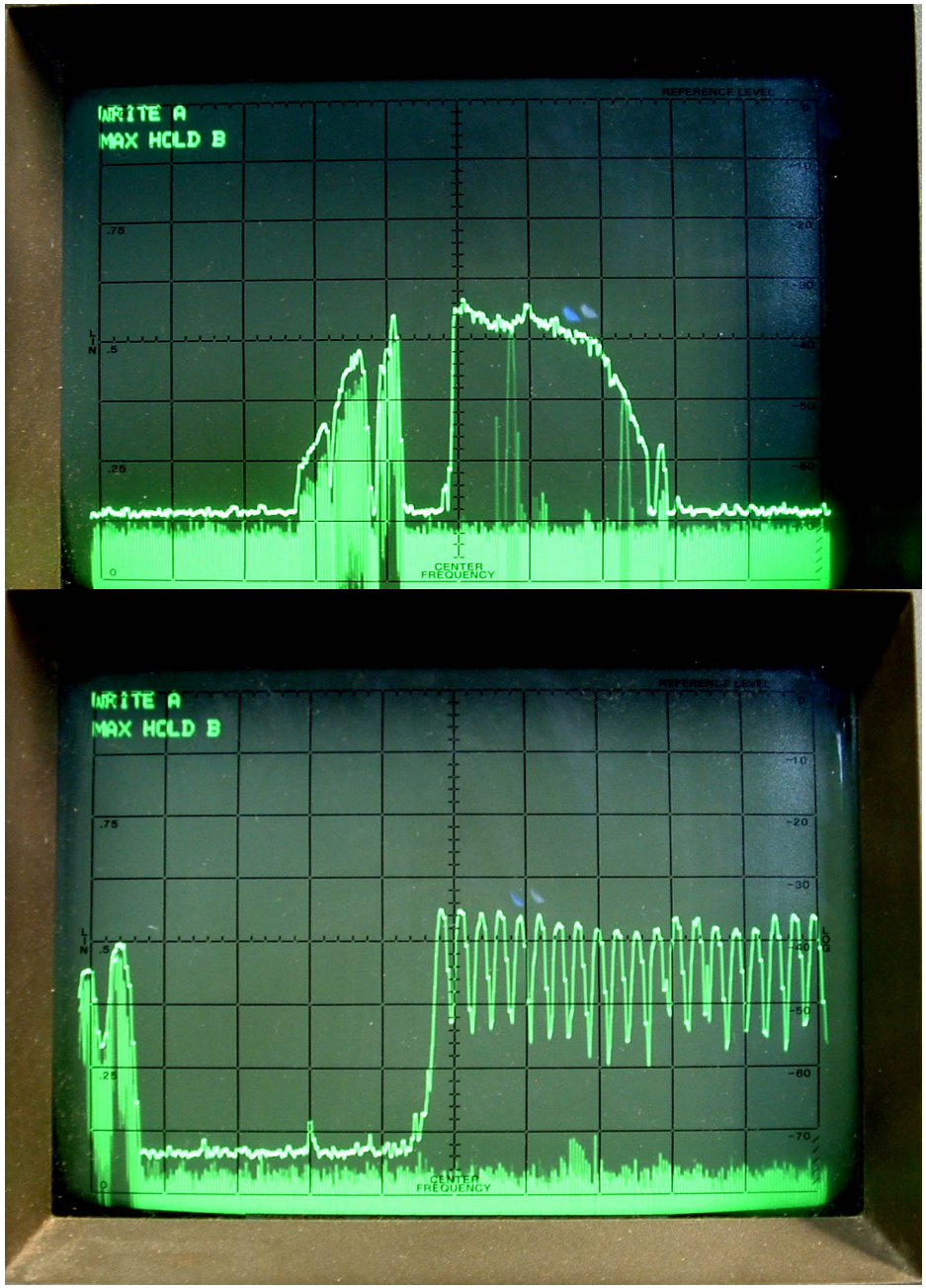
- Here's a picture taken with the 902 / 903 receive filter in place.
- This is more tolerable but still not great.
- Top Picture 10 MHz / Div
- Bottom Picture 2 MHz / Div



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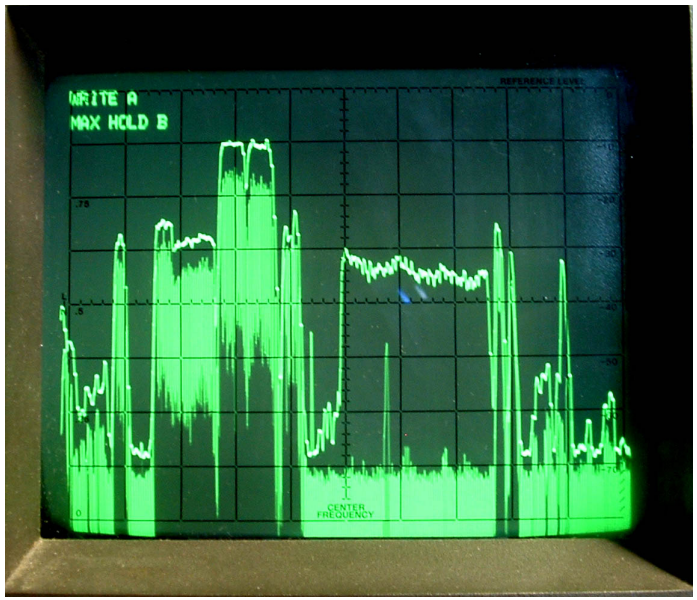
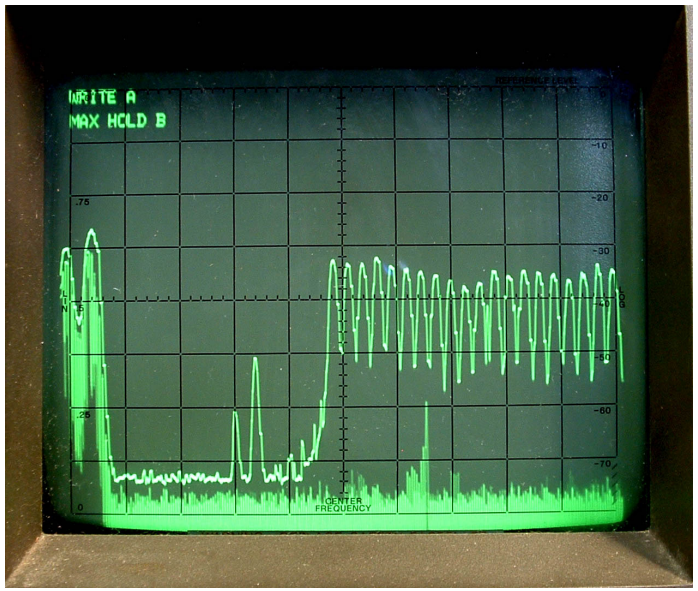
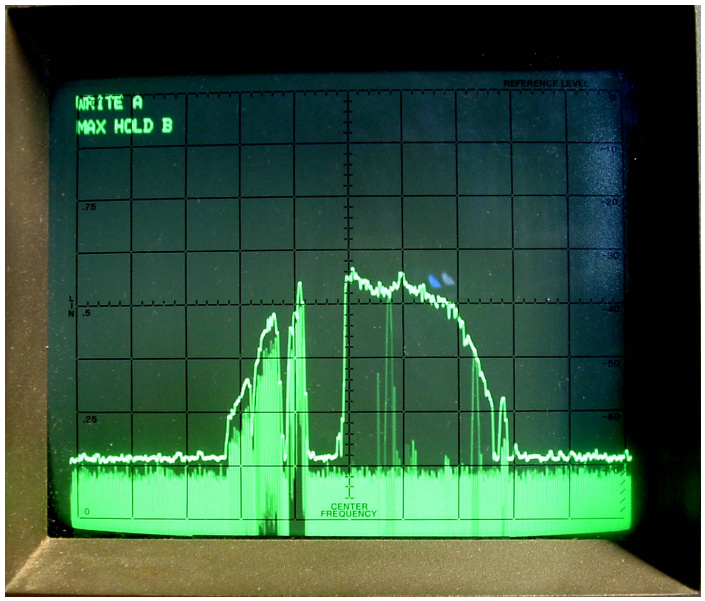
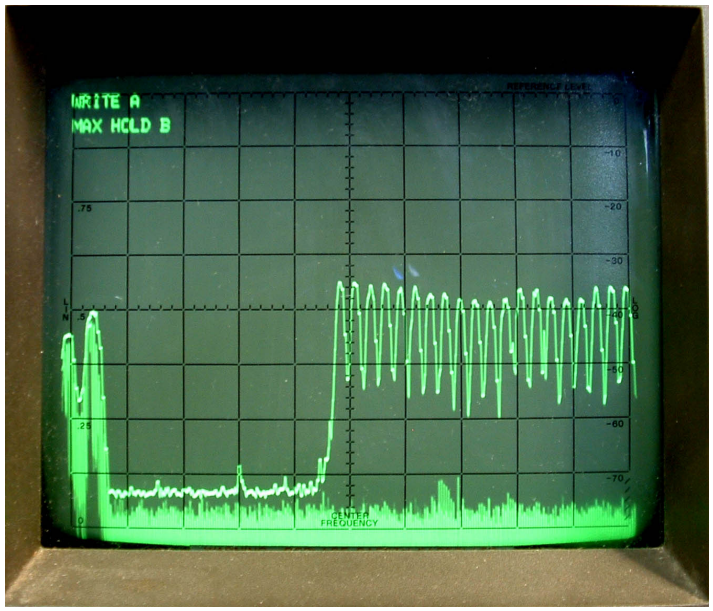


Without Filter





With Filter



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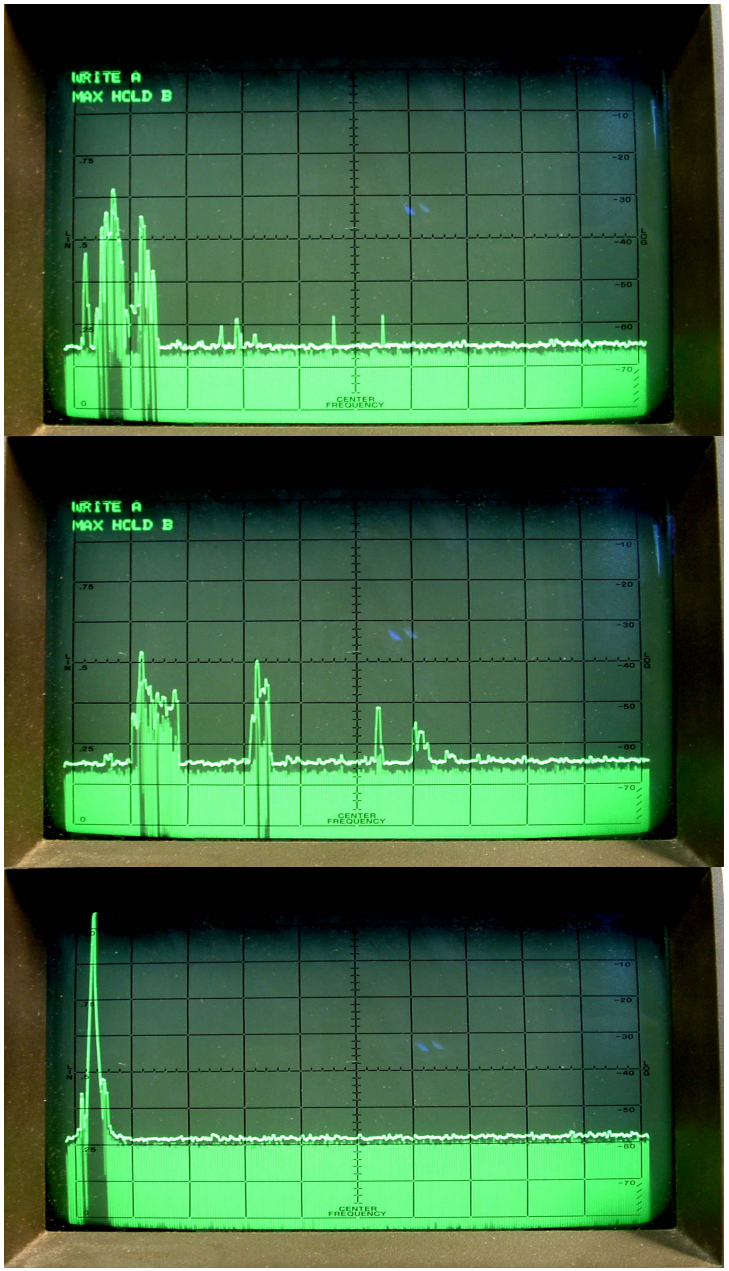
- These are the other bands
  - 1296 Could use a filter
    - Seems to hear OK now
  - 2304 Could use a filter
    - Seems to hear OK now
  - 3456 Is clean as is
- These pictures are taken at
  - 1296 MHz Center
  - 2304 MHz Center
  - 3456 MHz Center
  - 0 dBm reference
  - 10dB / Division
  - 100 MHz / Division



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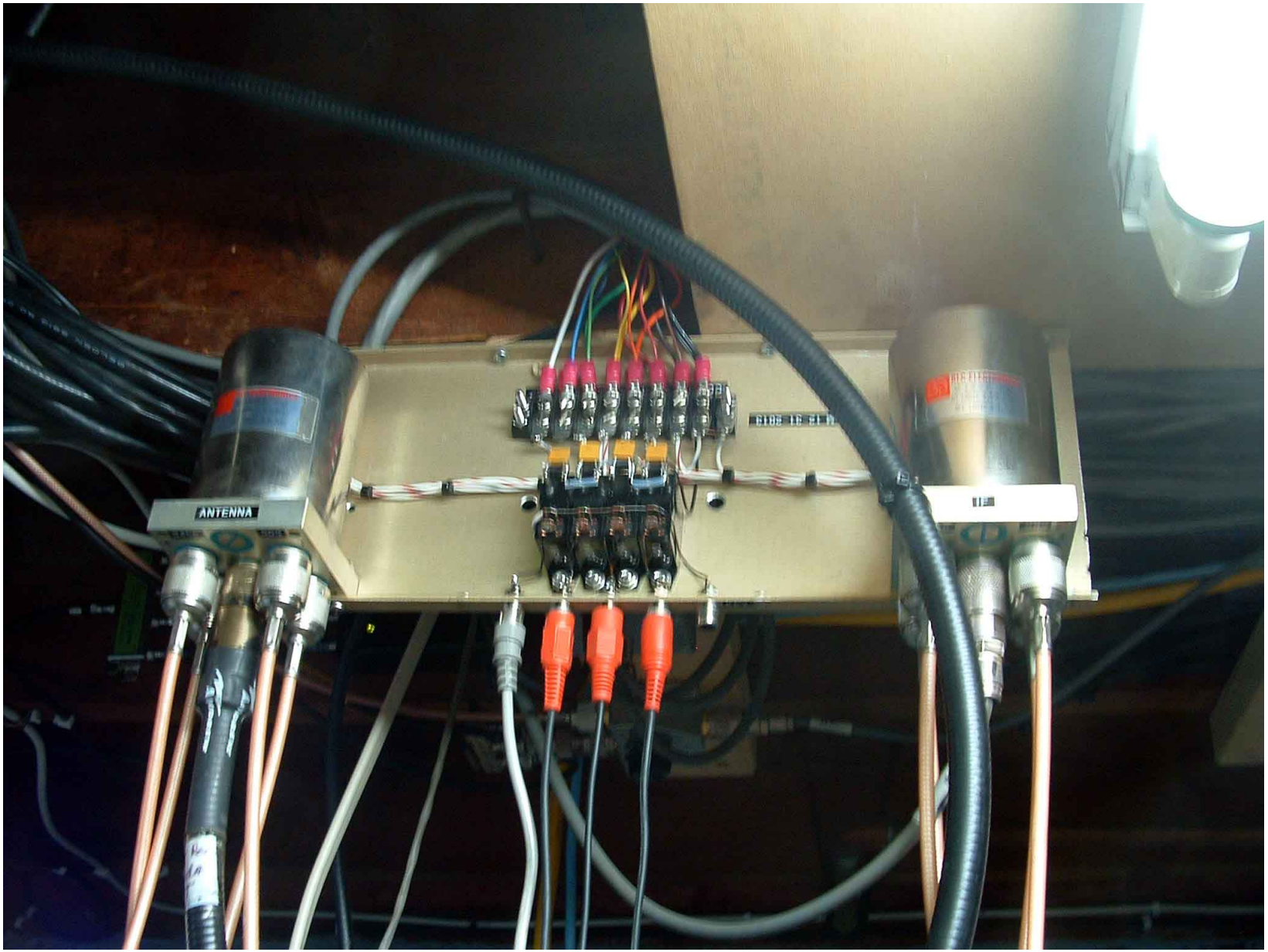

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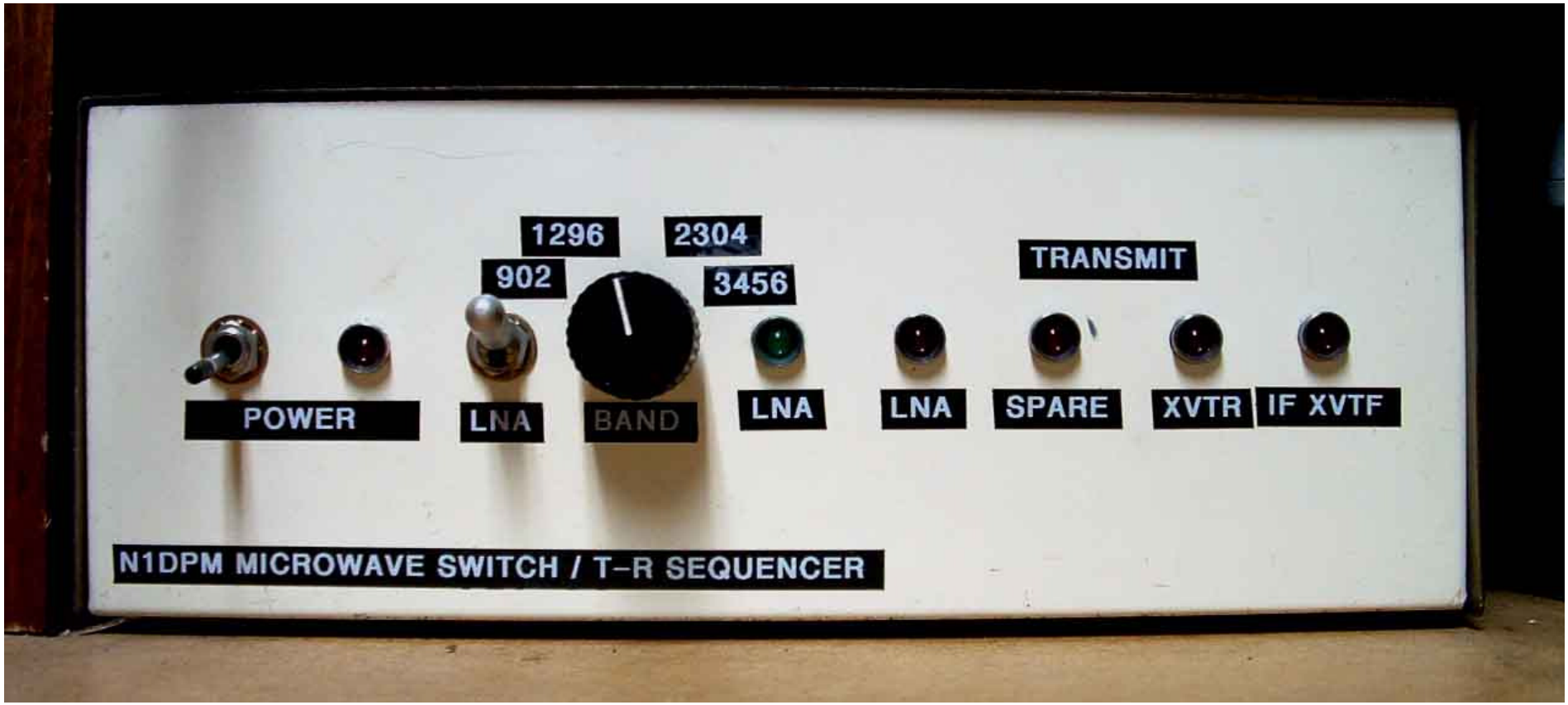

A Fresh Approach To A Multi-Band Microwave Station

- **Microwave Station:**
  - **IF**
    - **TS850S ->Down East Microwave 28-144 Transverter**
  - **903**
    - **Down East Microwave 902/3-144 Transverter**
    - **Freescale MRFE6VP8600H LDMOS Amplifier**
      - **300+ Watts**
  - **1296**
    - **Down East Microwave 1296-144**
    - **Infineon PTF141501 LDMOS Amplifier**
      - **150 Watts (I have 250 watt amplifier, I just need to hook it up!)**
  - **2304**
    - **SHF Systems 2304-144**
    - **Surplus MMDS amplifiers**
      - **8 Watts**
      - **LDMOS amp in the works for ~250 W (NXP BLF2425M7L250P)**
  - **3456**
    - **Down East Microwave 3456-144**
    - **California Microwave Amplifier**
      - **8 Watts (Toshiba amp in the works for ~60 W)**

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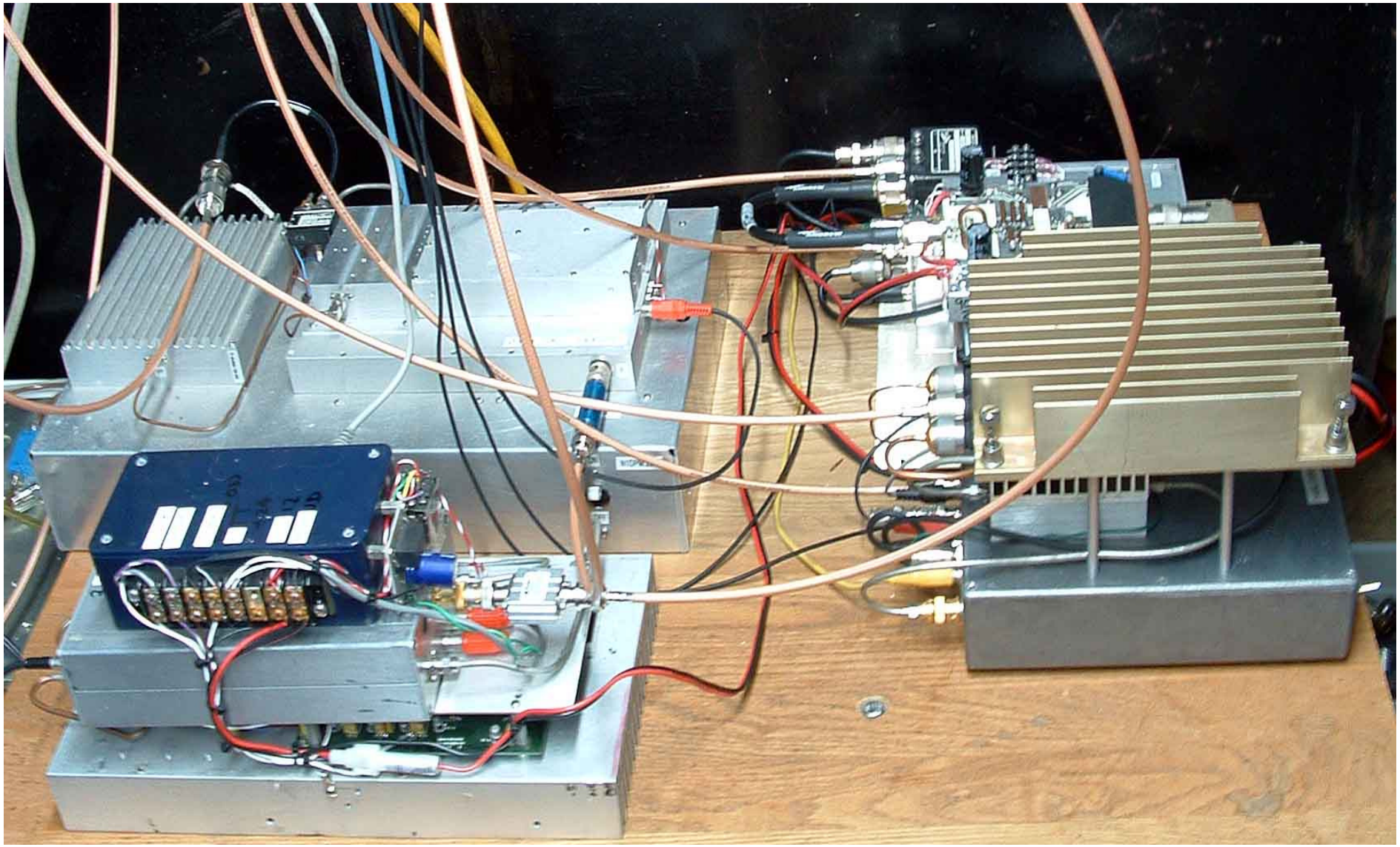


BLF2425M7L250P; BLF2425M7LS250P

Power LDMOS transistor

Rev. 4 — 12 July 2013 Product data sheet

1. Product profile

1.1 General description

250 W LDMOS power transistor for Industrial, Scientific and Medical (ISM) applications at frequencies from 2400 MHz to 2500 MHz.

The BLF2425M7L250P and BLF2425M7LS250P are designed for high-power CW applications and are assembled in high performance ceramic packages, available in eared and earless versions

Table 1. Typical performance

RF performance at T_{case} = 25 °C in a common source class-AB production test circuit.

Test signal	f	V_{DS}	$P_{L(AV)}$	G_p	η_D
	(MHz)	(V)	(W)	(dB)	(%)
CW	2450	28	250	15	51

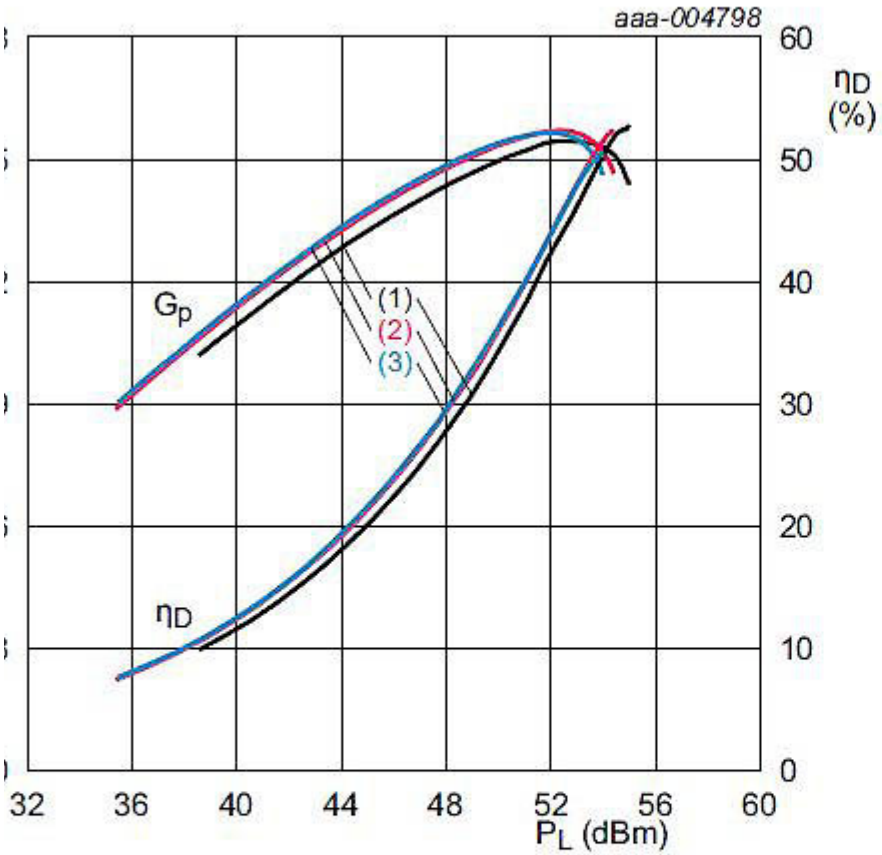
1.2 Features and benefits

- High efficiency
- Easy power control
- Excellent ruggedness
- Excellent thermal stability
- Integrated ESD protection
- Designed for broadband operation (2400 MHz to 2500 MHz)
- Internally matched
- Compliant to Directive 2002/95/EC, regarding Restriction of Hazardous Substances (RoHS)

1.3 Applications

- RF power amplifiers for CW applications in the 2400 MHz to 2500 MHz frequency range such as ISM and industrial heating.

7.4 Graphical data



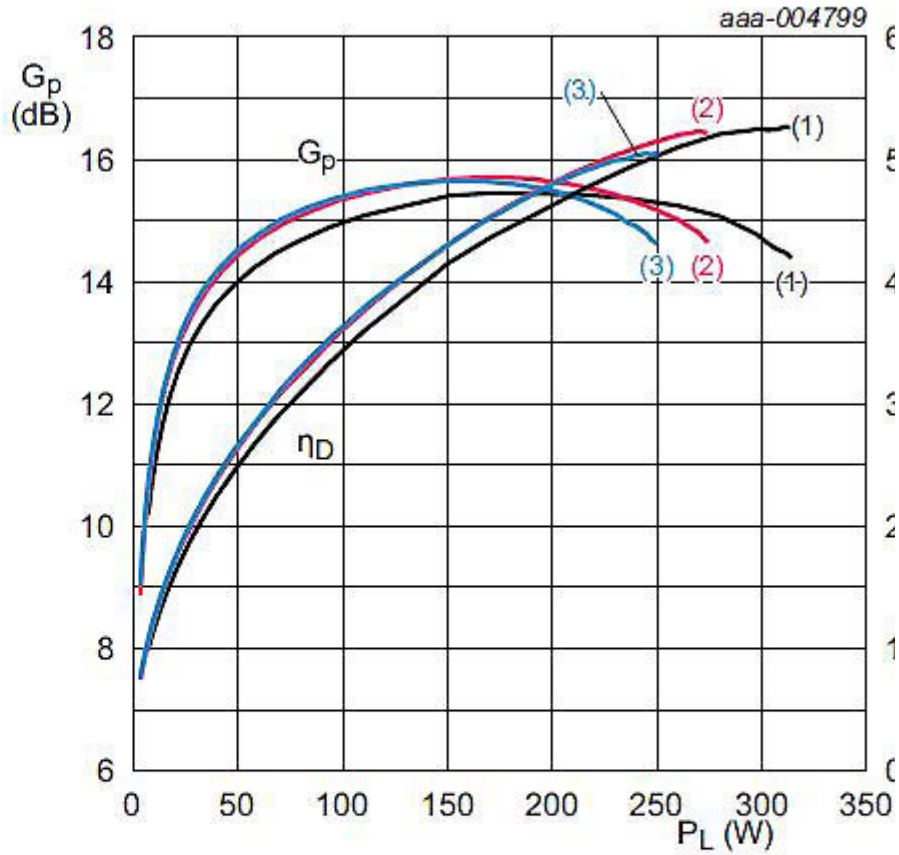
V_{DS} = 28 V; I_{Dq} = 20 mA.

f = 2400 MHz

f = 2450 MHz

f = 2500 MHz

Power gain and drain efficiency as function of load power; typical values



V_{DS} = 28 V; I_{Dq} = 20 mA.

(1) f = 2400 MHz

(2) f = 2450 MHz

(3) f = 2500 MHz

Fig 4. Power gain and drain efficiency as func load power; typical values

NXP

NXP

BLF2425M7L250P Series 2.4 GHz 65 V 15 dB Power LDMOS Transistor - SOT-539A

Mfr Part#: BLF2425M7L250P,112
Mounting Method: Surface Mount
Package Style: SOT-539A
Packaging: TRAY
Std Packaging Qty: 60

RoHS COMPLIANT LEAD Free

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Datasheet

Prices

$162.01 USD (each)

1+	$162.01

Availability

Qty in Stock :	2
Reserve Stock :	0
In Transit :	N/A
LT:	N/A
Min. Order Qty:	1
Multiple of:	1

Quantity 1 Add To Cart

A Fresh Approach To A Multi-Band Microwave Station

- **Old Station**
  - **903 MHz**
    - 17.9 dBd Antenna Gain
    - 0.35 dB Feedline Loss
    - 3,982 Watts ERP
    - 1.05 dB System NF
  - **1296 MHz**
    - 18.9 dBd Antenna Gain
    - 0.41 dB Feedline Loss
    - 2,472 Watts ERP
    - 0.71 dB System NF
  - **2304 MHz**
    - 21.3 dBd Antenna Gain
    - 0.58 dB Feedline Loss
    - 4,721 Watts ERP
    - 1.58 dB System NF
  - **3456 MHz**
    - 23.1 dBd Antenna Gain
    - 0.74 dB Feedline Loss
    - 1,722 Watts ERP
    - 1.74 dB System NF

- **New Station**
  - **903 MHz**
    - 13 dBd Antenna Gain
    - 2.2 dB Feedline Loss
    - 3,606 Watts ERP (- 0.43 dB)
    - 0.5 dB System NF
  - **1296 MHz**
    - 14.2 dBd Antenna Gain
    - 2.7 dB Feedline Loss
    - 2,119 Watts ERP (- 0.67 dB @ 150W)
    - 3,531 Watts ERP (+ 1.55 dB @ 250W)
    - 0.5 dB System NF
  - **2304 MHz**
    - 17.5 dBd Antenna Gain
    - 3.8 dB Feedline Loss
    - 188 Watts ERP (- 14 dB @ 8W)
    - 5,861 Watts ERP (+ 0.94dB @ 250W)
    - 0.75 dB System NF
  - **3456 MHz**
    - 17.5 dBd Antenna Gain
    - 4.6 dB Feedline Loss
    - 156 Watts ERP (- 10.4 dB @ 8W)
    - 1,170 Watts ERP (- 1.68 dB @ 60W)
    - 0.9 dB System NF

A Fresh Approach To A Multi-Band Microwave Station

- **2014 January VHF SS (dead band January conditions)**
  - **903 - 18 QSO's x 11 Grid Squares (FN's 20,30,31,32,34,41,42,43,44, FM's 19,29)**
    - **Best DX K1RZ FM19jh @ 306 Miles**
    - **2nd Best DX N3NGE FN20bd @ 215 Miles**
  - **1296 - 20 QSO's x 10 Grid Squares (FN's 20,30,31,32,41,42,43,44, FM's 19,29)**
    - **Best DX K1RZ FM19jh @ 306 Miles**
    - **2nd Best DX N3NGE FN20bd @ 215 Miles**
  - **2304 - 7 QSO's x 3 Grid Squares (FN's 31,32, 43)**
    - **Best DX AF1T FN43cd @ 86 Miles**
    - **Best DX Heard N3NGE FN20bd @ 215 Miles 539 didn't hear me**
  - **3456 - 1 QSO's x 1 Grid Square (FN31)**
    - **Best DX K1TEO FN31jh @ 60 Miles**
  - **Most importantly I worked AA1I/R!!**
    - **4 grids on 903 (FN31,32, 41,42)**
    - **4 grids on 1296 (FN31,32, 41,42)**
    - **2 Grids on 2304 (FN31,32)(he had a problem on 2304)**
    - **0 Grids on 3456 (he had a problem on 3456)**

A Fresh Approach To A Multi-Band Microwave Station

- **Conclusions…**
  - **Simple system**
    - **One Feedline**
    - **Small Antennas** (really small)
    - **Wideband LNA is the only "electronics" on the tower**
      - **Not available in past years…needed separate LNA's**
      - **Can be bypassed if "something happens"**
    - **Transverters and Power Amplifiers are all in the shack**
      - **High Power SSPA's**
        - » **Continue to be come more available and or affordable**
    - **Performance is (or can / will be) equivalent to the old system**
      - **Higher performance can always be realized with larger antennas**