

The Evolution of 1296 Power Amplifiers

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Background

- Generating any sort of reasonable power at microwave frequencies has long been a challenge to amateurs.
- Up until recently most amplifiers were tubes—in fact the 2C39/7289 was the workhorse of both 1296 and 2304 for decades.
- Several operators built amplifiers using multiples of the 7289 to generate 500 watts or more.
- For many years I used one 7289 driving a pair(VE3CRU-- Hans(sk)) had made many of the bare amplifier modules available in the 1980's driven by an SSB transverter.

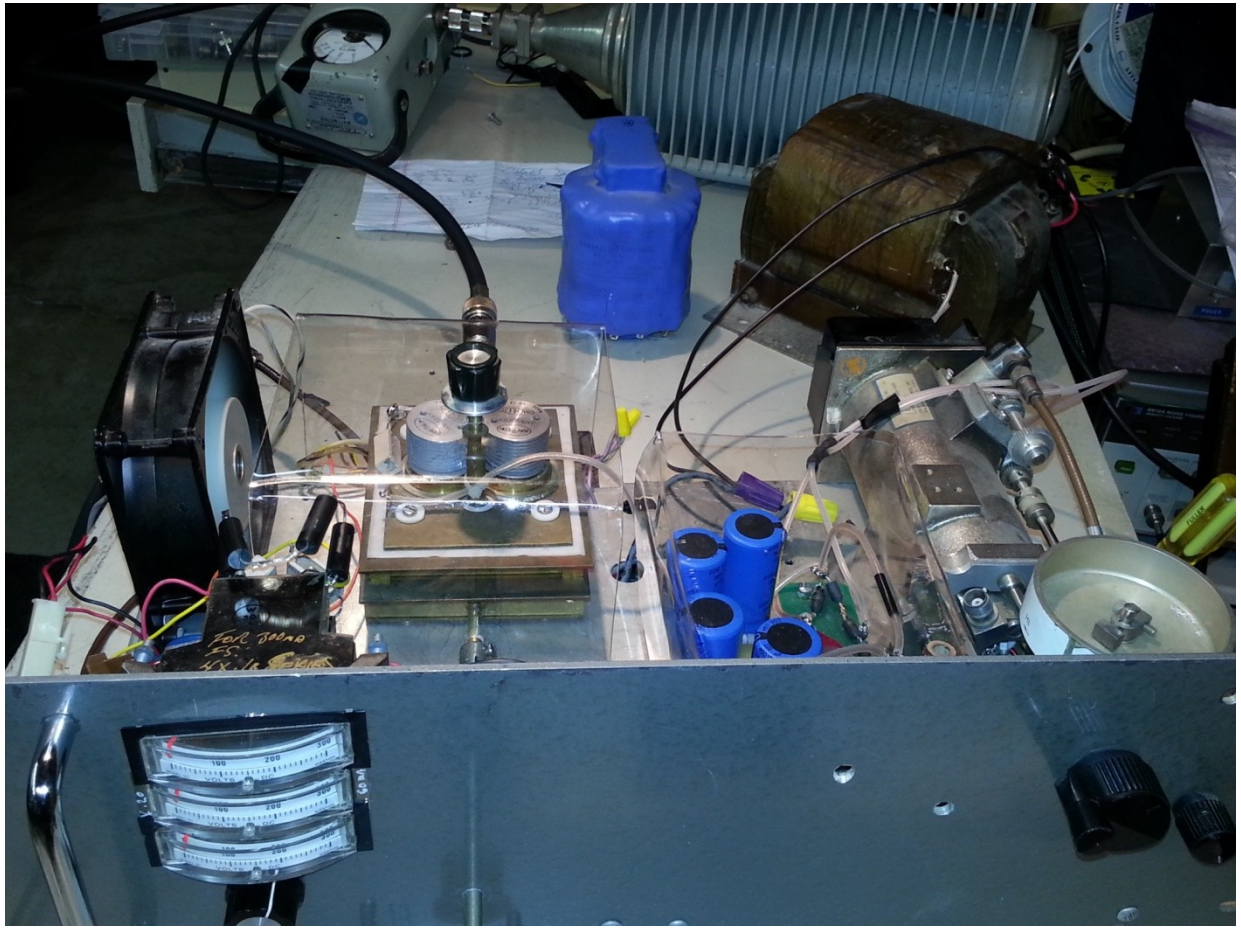
Key 7289 Characteristics

- Needs about 1100 volts on the plate
- Low gain –roughly 8 db
- A pair can produce 150-180 watts although I never had more than 80-100 watts.
- They were cost effective in the 80's but SS devices making great strides currently.

- But—
  - they drift
  - Take a while to warm up(3 minutes or more)
  - Cooling is a challenge(many ops went water cooling)
  - Hard to find good tubes these days

- In 2013 after excellent success with LDMOS amplifiers from 50-432 MHz it was time to see if I could get something going at 1296 MHz.
- I put my tube amplifier " out to pasture" and Stu VE2XX resurrected it and in fact greatly improved it .

7289 amplifier circa 1990/2015



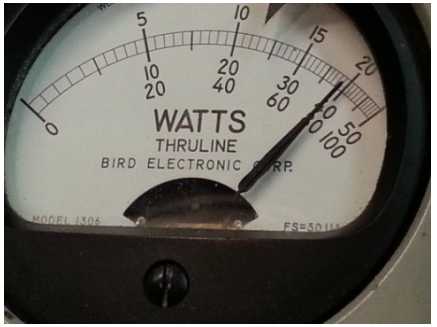


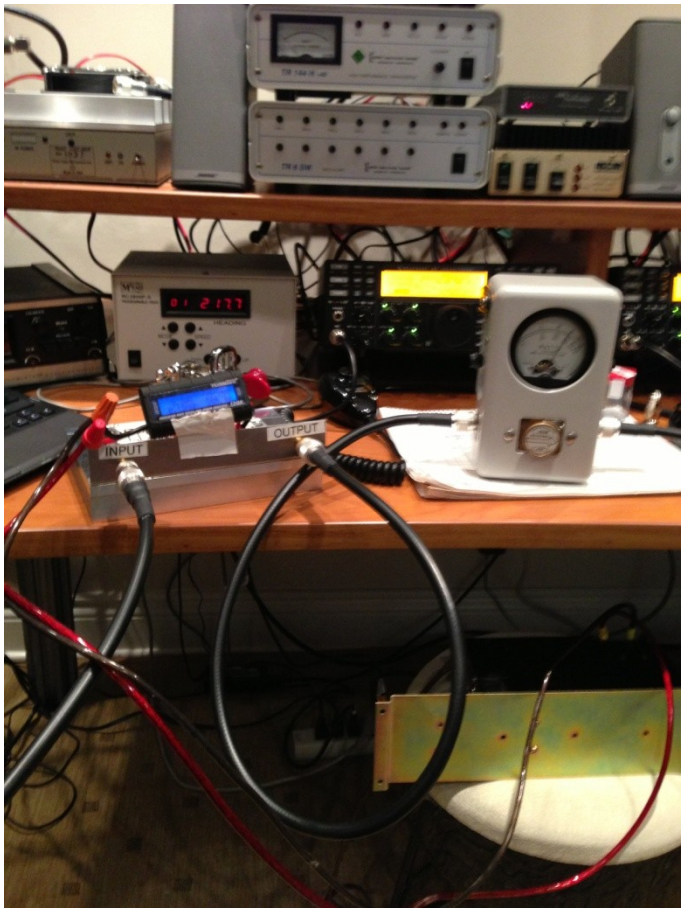
Photo Courtesy of VE2XX

The evolution to SS amps

- Initially I tried MRF 286 amplifier with a pair of devices
  - W6PQL sells a range of options using the devices
  - http://www.w6pql.com/xrf-286_amplifiers_for_23cm.htm
  - A pair will do about 150 watts output ---
  - Devices are getting harder to find but are available from Spectran amplifiers

- LDMOS devices were just beginning to become available in 2013 when I started the project, but are now available from both NXP and Freescale.

Initial Testing of W6PQL MRF286 (pair) module in early 2013







- The initial testing was very positive—about 140 watts output with 8 watts drive
- 255 watts DC input at 27.75 volts
- Motivated me to want more power
- Note several modifications (HB9BDD and VE4MA) to the design to improve performance and gain

1296 MHz SSPA Design Objectives

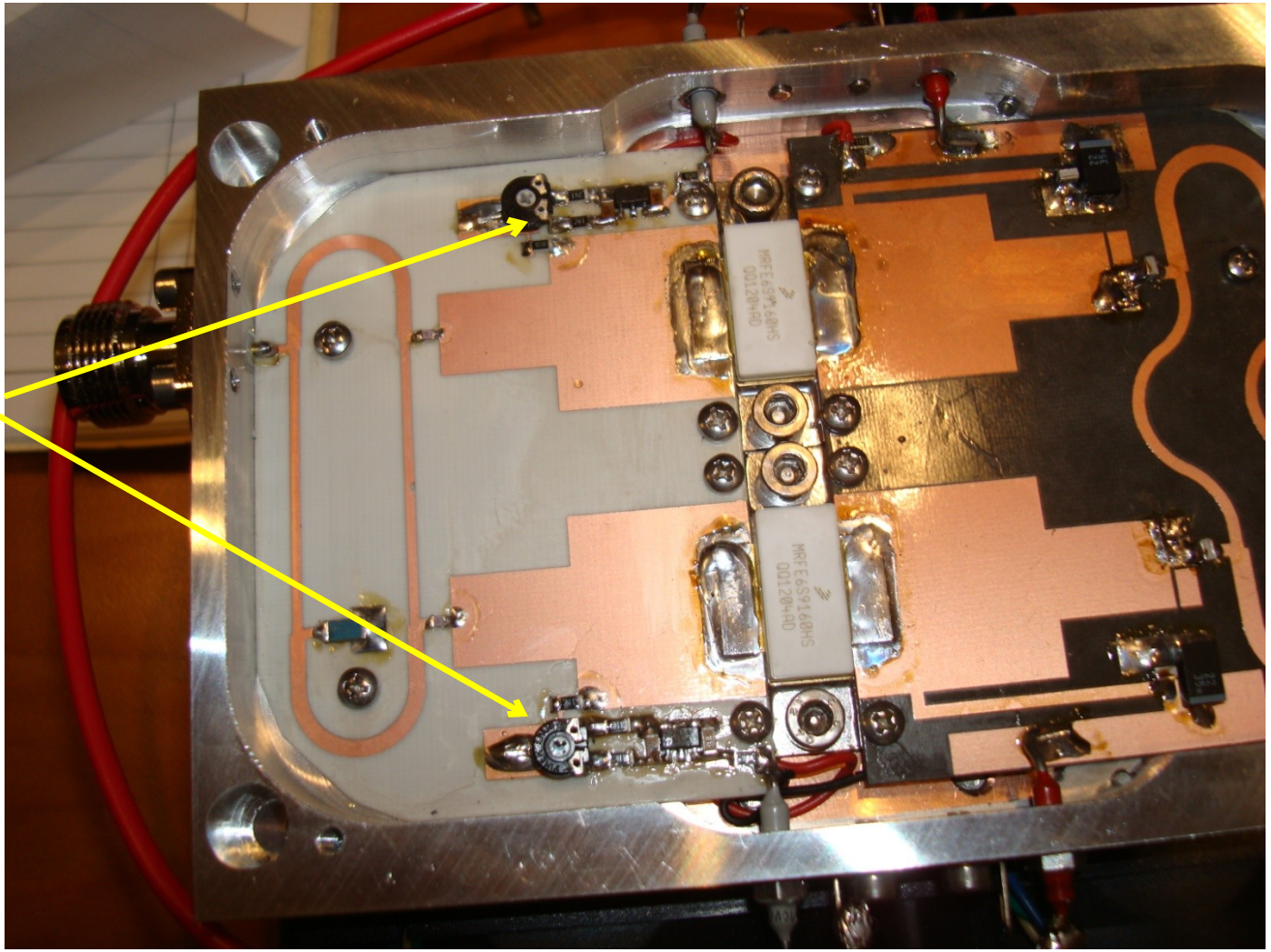
- I wanted " Plug and Play"—no tuning or drifting.
- Simple Power Supply(I was ok for 28 or 50 volts)
- 500 watts output so east coast guys in W1 or W2 could hear me!!
- No buffer amplifiers to complicate switching—directly driven from Kuhne transverter(maximum 18 watts output).

- I settled on experimenting with PE1RKI modules.
  - MRF6S9160HR3 28 volt cellular devices 20db gain@ 1 GHz.
  - Each module is nominal 250 watts output at 3.5 watts drive
    - 4.5 watts input gives 300-330 watts output)
    - P1db is roughly 330 watts

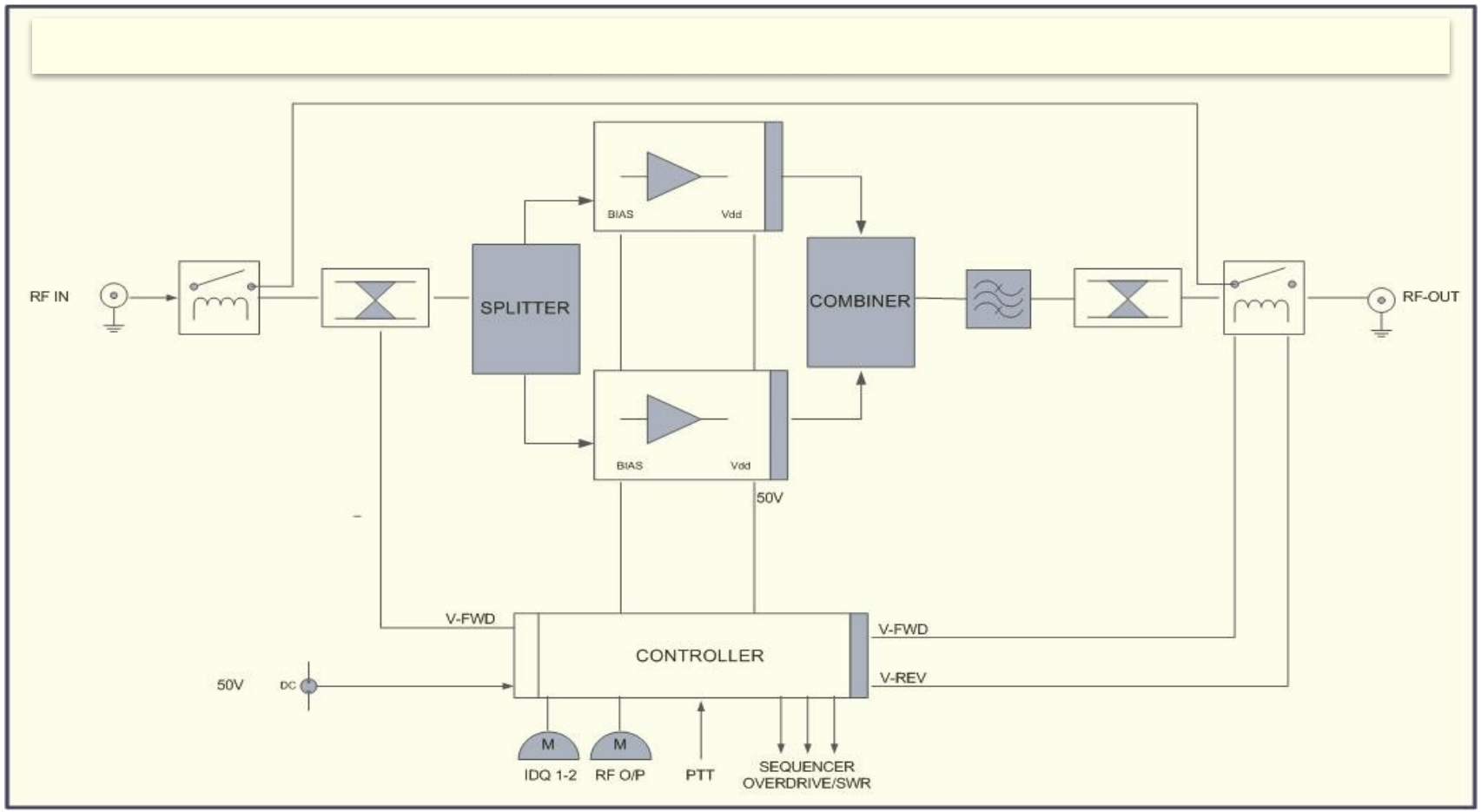
Single PE1RKI module



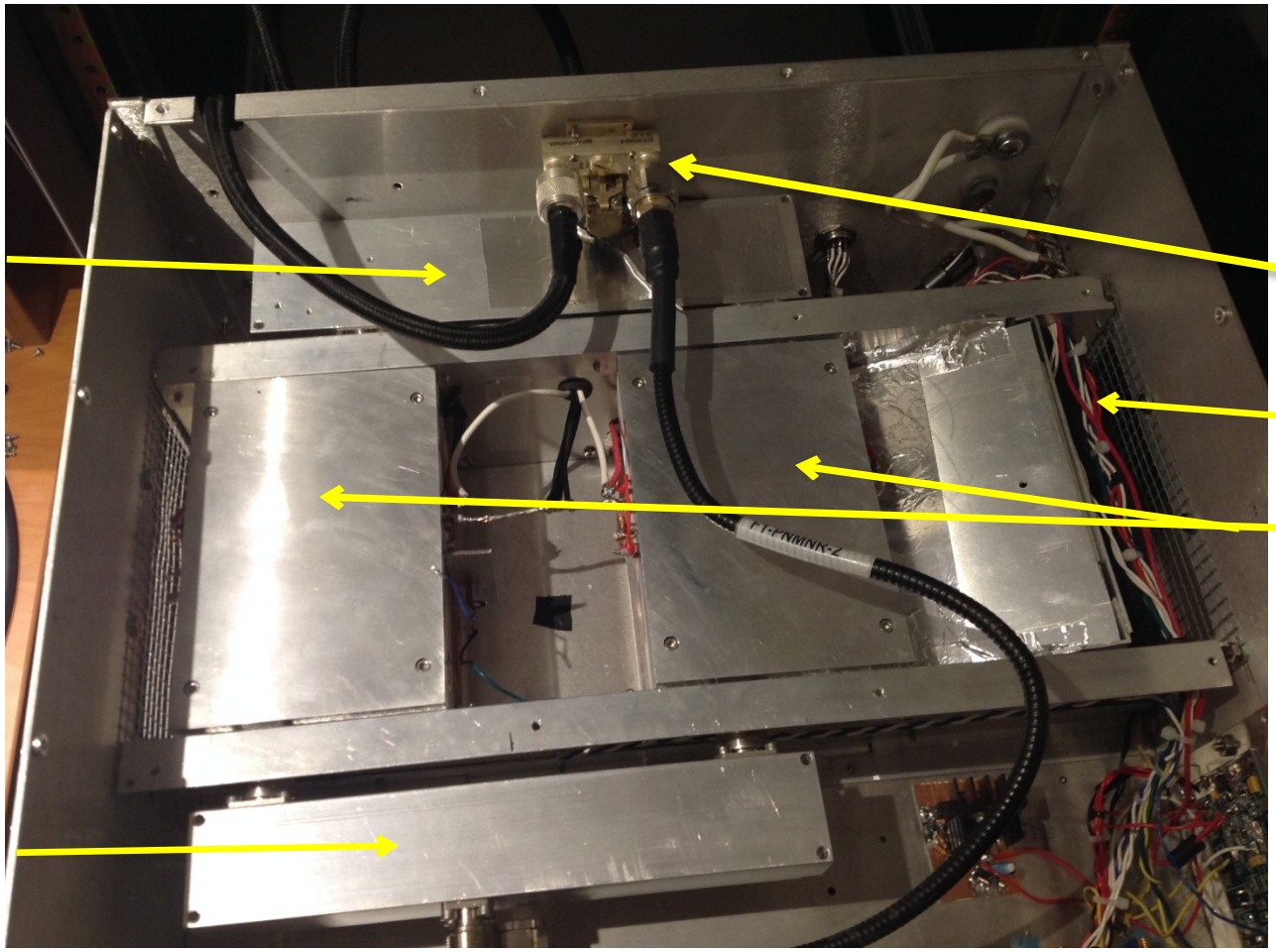
1296 Pallet with Motorola MRF 6S9160 devices



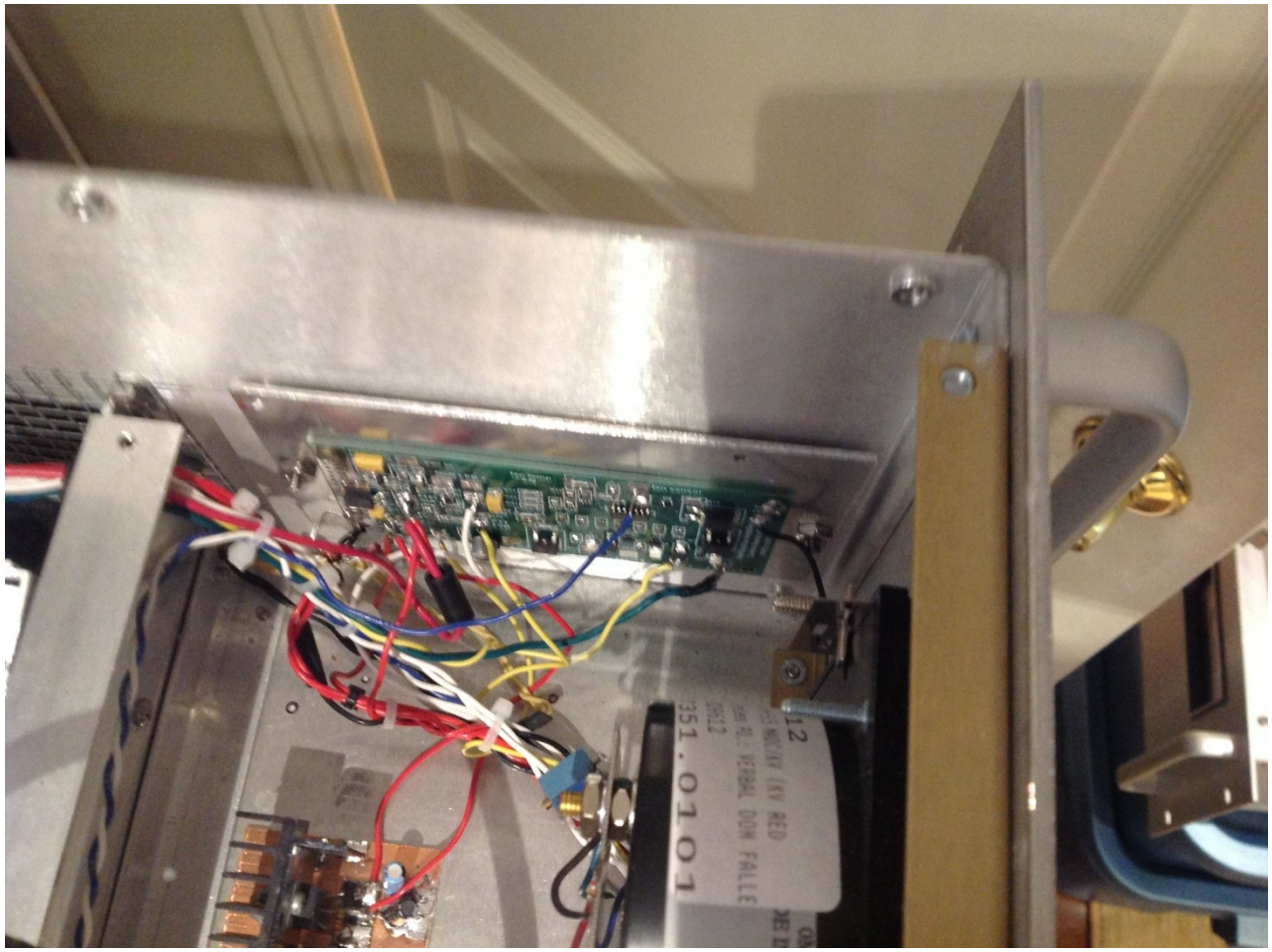
Basic Layout of the amplifier



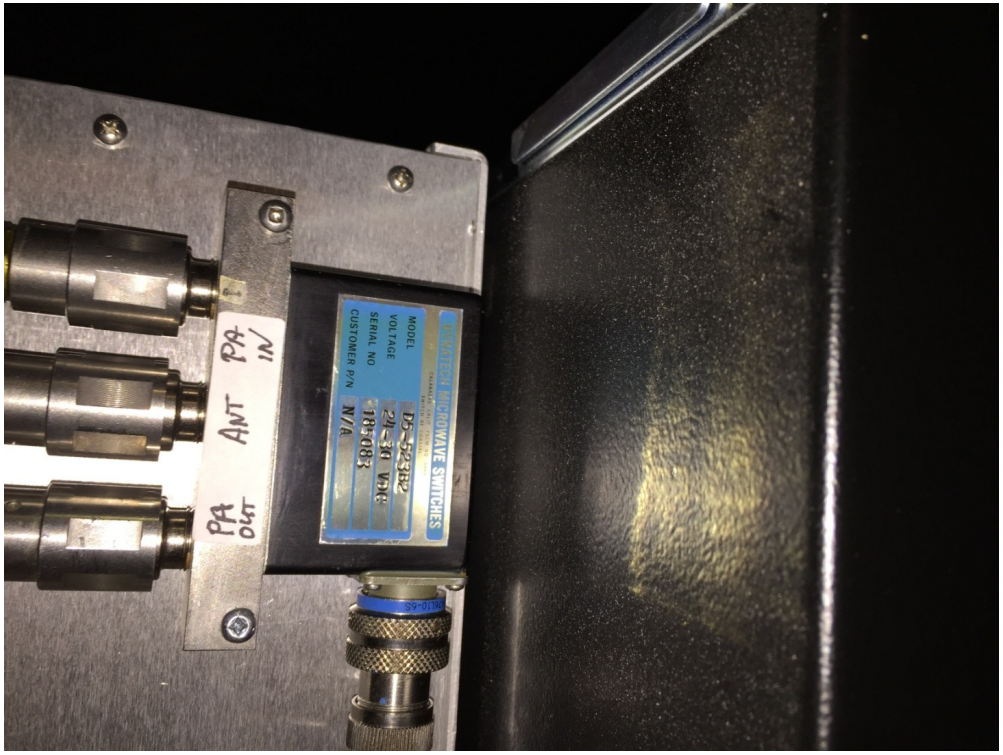
Inside the 1296 SS amp(not much to see!)



W6PQL control board

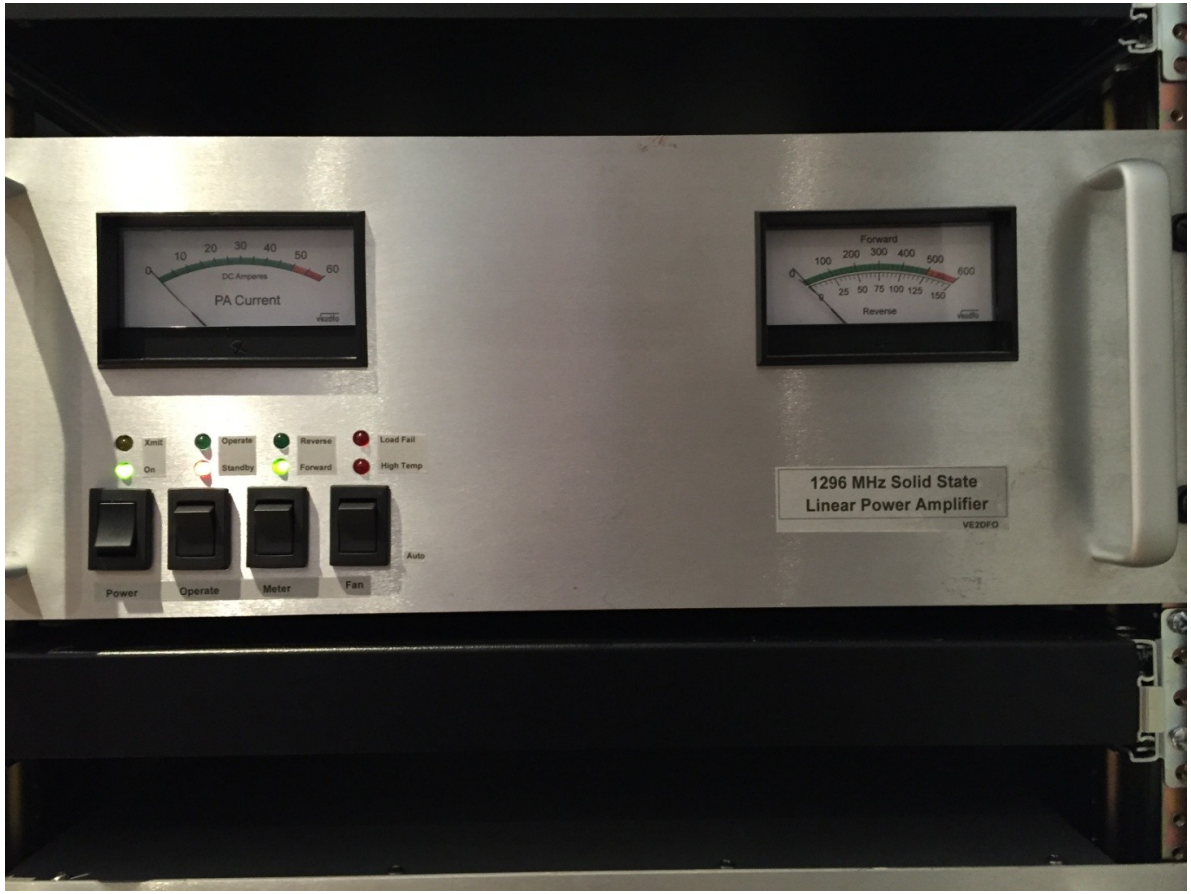


Tx-RX relay



- Must be able to handle high Power— Dynatech rated at 5KW@400 MHz—type SC connectors(hard to find!)
- 2nd relay required for high isolation (Transco SMA measured at 80 db isolation at 1296

1296 SSPA Panel -- 7 X16 inches deep



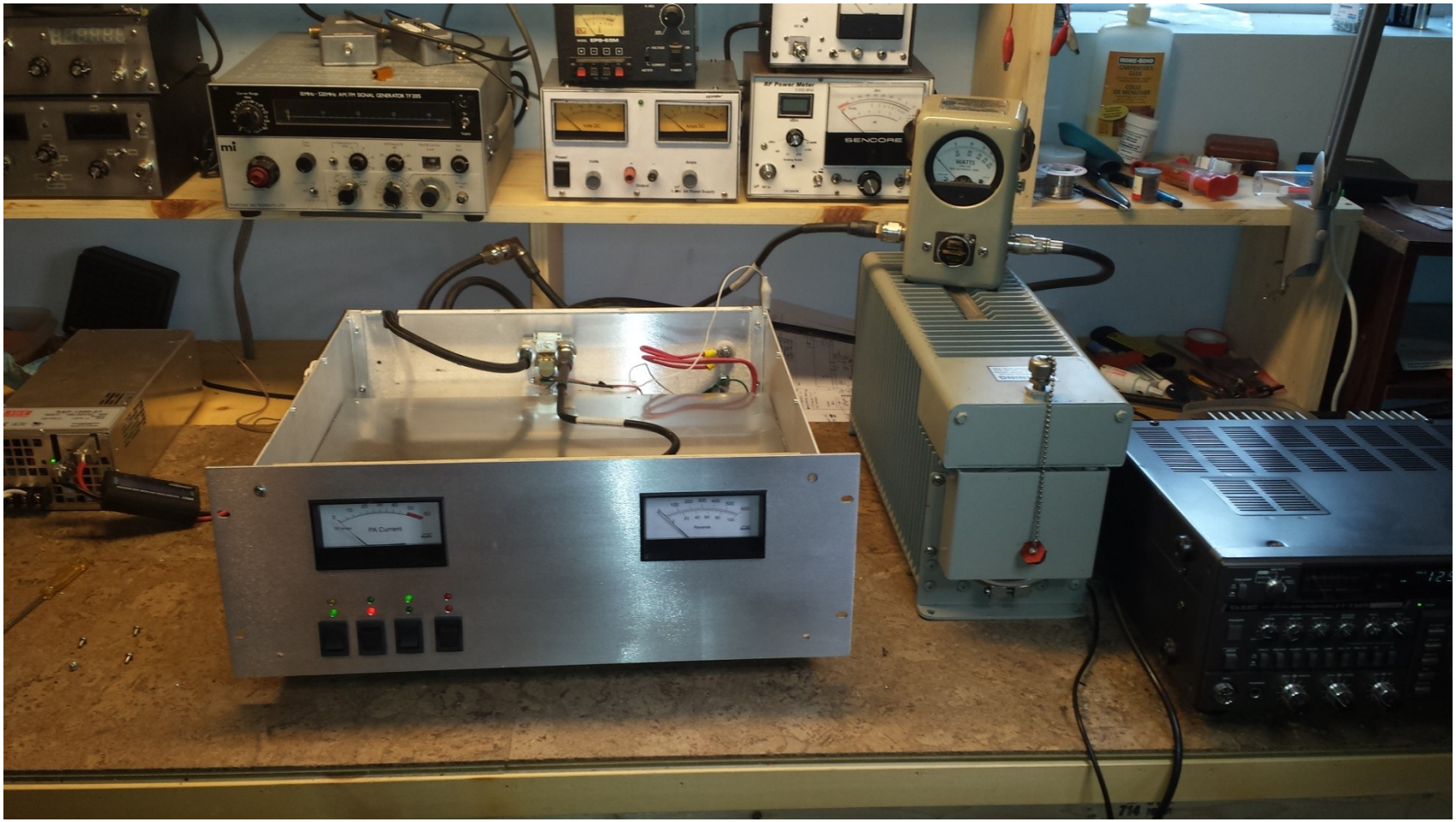
- Meters read current and forward and reverse power(built in directional coupler)
- Thermal protection
- SWR protection
- Built in sequencer

Matching Power Supply



- Meanwell 28 volt 1500 watt switching supply
- Adjustable to 32 volts –rated to 60 amps
- Excellent regulation, very light weight

Initial test set up at VE3DEW



Initial test set up at VE3DEW



- Almost 500 watts output from FT 736 R at 10 watts

Initial test set up at VE2DFO



550 watts output at 1296 MHz



Rack Layout for SSPA's



Some conclusions and acknowledgements

Conclusions:

- Excellent overall performance on 10 -12 watts in for 550 watts output
- 28 volts @ 46 amps around 42% net efficiency after combiner losses.
  - How do you know it really puts out that power?? The coax gets warm!
- I also discovered you need a good preamp at 1296 as close to the antenna switch as possible. –"**You can't work them if you can't hear them!"**
  - Reduced the interconnection losses to the amp with LMR600U jumpers.
- Does it work?? January VHF contest (worse conditions) I worked K1TEO (FN 31JH) with excellent signals from FN25VJ nearly 500+ Km !

Acknowlegments:

- -PE1RKI(Bert)—outstanding craftsmanship for the modules
- VE3DEW(Peter) for his metal work and system integration
- VE2XX(Stu) for his support and encouragement