



Mt. Union UHF Repeater

**2016 Upgrade Project
YARC *Repeater Committee***

Pete K6VVR – Trustee of W7YRC
John K7PRS – Experienced Repeater Wizard
Doug NO1D – Mt. Goat/presenter

With help from

ARES/RACES Team Members
Bud N7CW, Art KG6AY, Rob KG7LMI

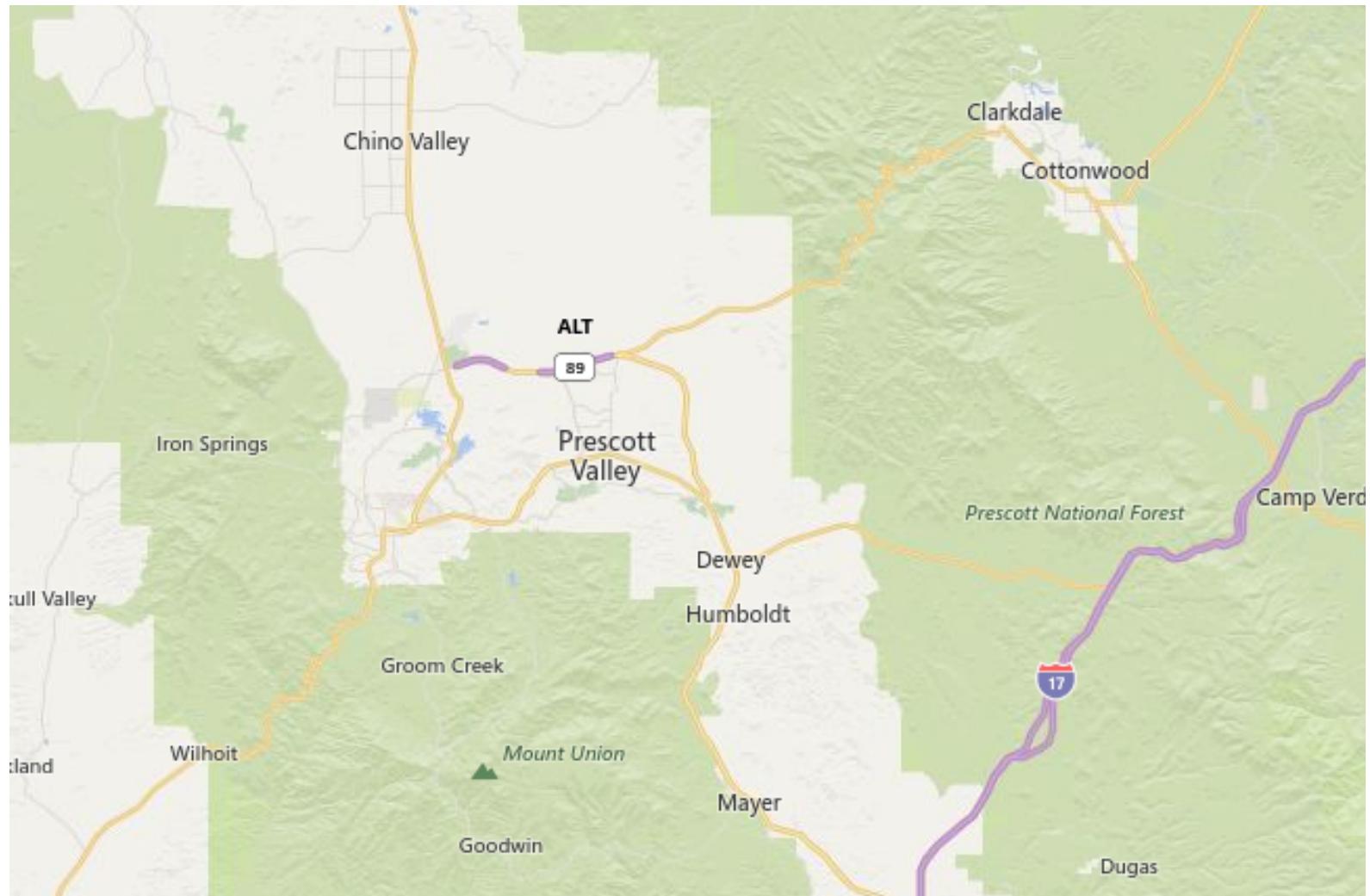
Tonight's Agenda

- Background on UHF 447.65/442.65 Repeater
- 2016 Upgrade Plan
- Eq. Donations/Procurement and Refurbishing
- Photo's Spring Mt. Union Site Survey
- Photo's 2^{nd/3rd} Trip Antenna / Duplexer upgrade
- Moving repeater into ARES/RACES Hut
- Enabling C4FM Digital Mode
- Futures

Background

- UHF 442.65/447.65
 - Tx Tone: 100.0
 - Analog Only
- Operated on Mt. Union
- Fusion DR1x Repeater
- Mot T1500 Duplexer
- Approx 20W
- Comet CG6 Vertical
- Coverage was sub-optimal
- Improvement request Jan 16 meeting; Prescott Junction
- Possible Issues:
 - Duplexer
 - Low Power from DR1
 - Antenna
- Left with basic plan & list of options & research tasks
 - Plenty to do while we await spring access to Mtn.

Mt Union





Yaesu Fusion DR1X Repeater

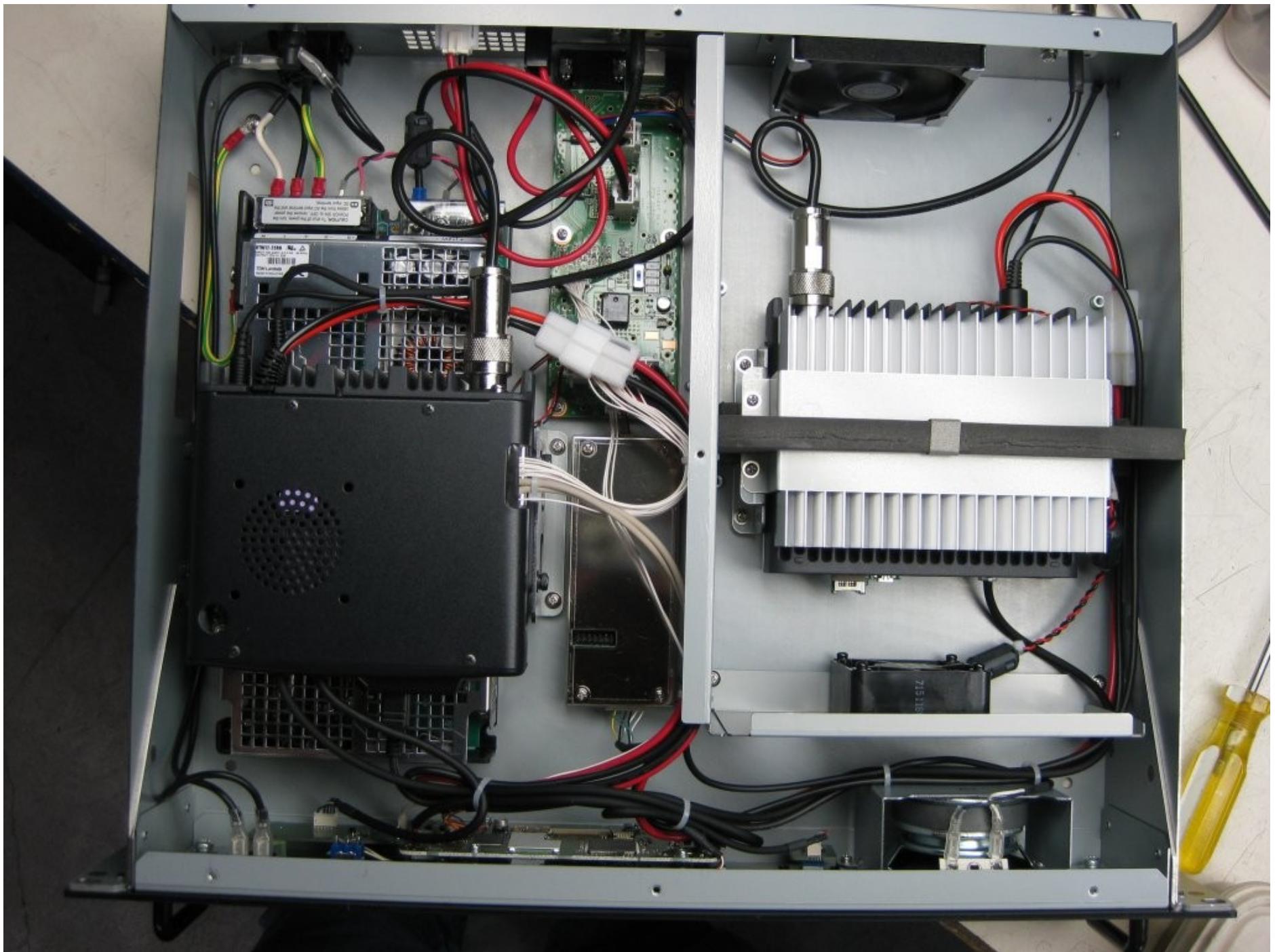
- Club purchased (2) units on special program to clubs by Yaesu
- Supports FM Analog and new C4FM digital Modes
- 2m & 70cm capable
- Basically (2) mobile FT400DR's in single chassis
- UHF high power **spec'd at 50% duty cycle; 50W**
- Infancy failures by ops running high power
- Desire to run at low power to improve longevity

Yaesu DR1X



- 2U sized chassis
- Touch Screen control interface
- Mic, Vol & Speaker
- 115VAC and 12Vdc power
- Built in repeater controller; minimalistic

Inside the DR1X



Equipment Donations / K7PRS

- Motorola MSR 2000 Amplifier
- Micro/Mitrek UHF for Amplifier Spares
- 20W UHF Amplifier and Fans
- Notch Filters – 25dBm ea.
- Decibel Products 4076W Duplexer
- Feed lines, Hard line Connectors, UHF Cable

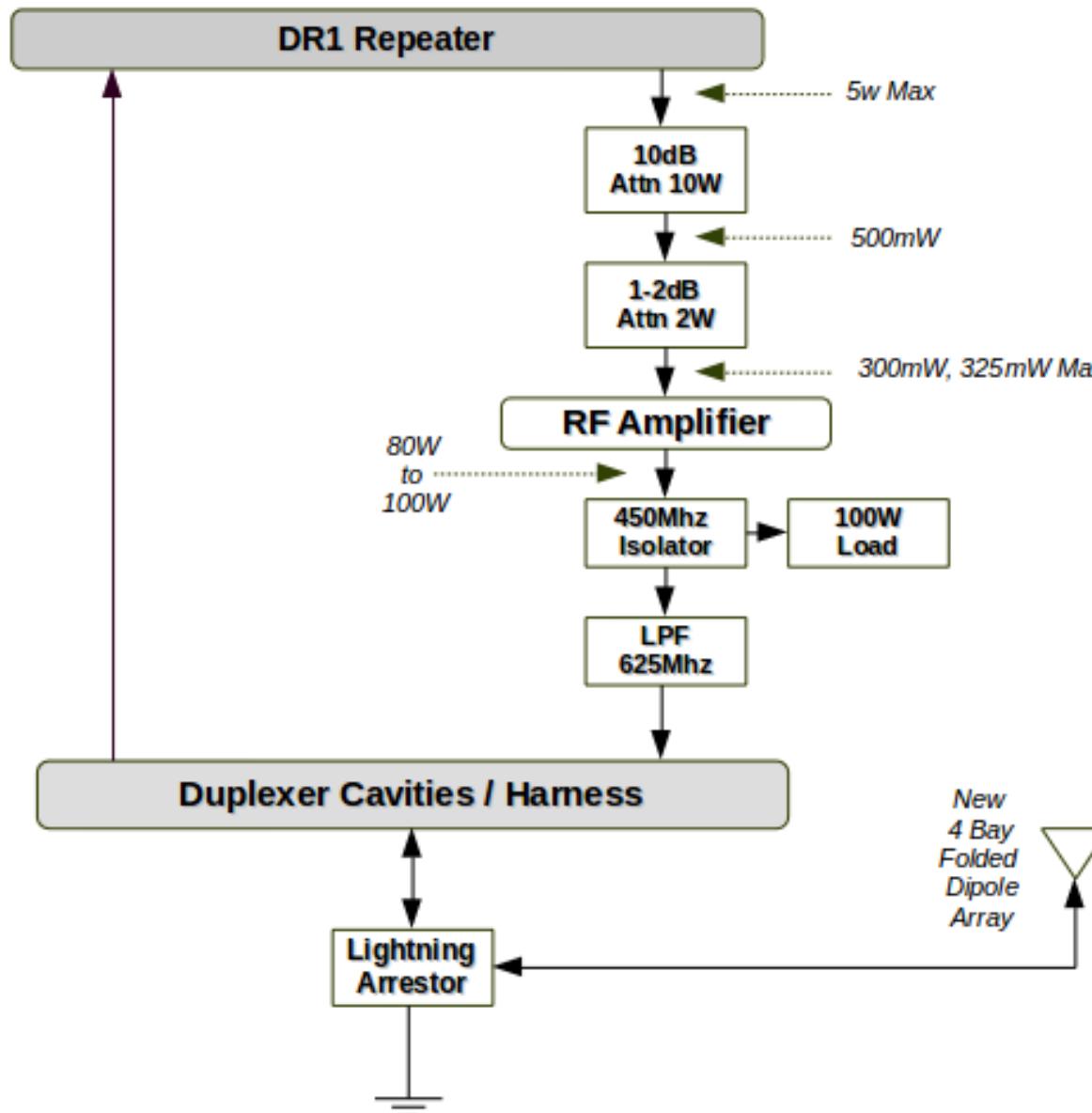
In Addition

- Club also purchased several items, Isolator, LPF, Cables, Lightning Arrestors, loads, feed line and antenna
- 23" to 19" adapter brackets, Rig Runner, 100W load, 7/8" connectors, Z-Match, Attenuators, Rack Panels, Volt/Amp Meter, Shunt, SSR, 12v cables

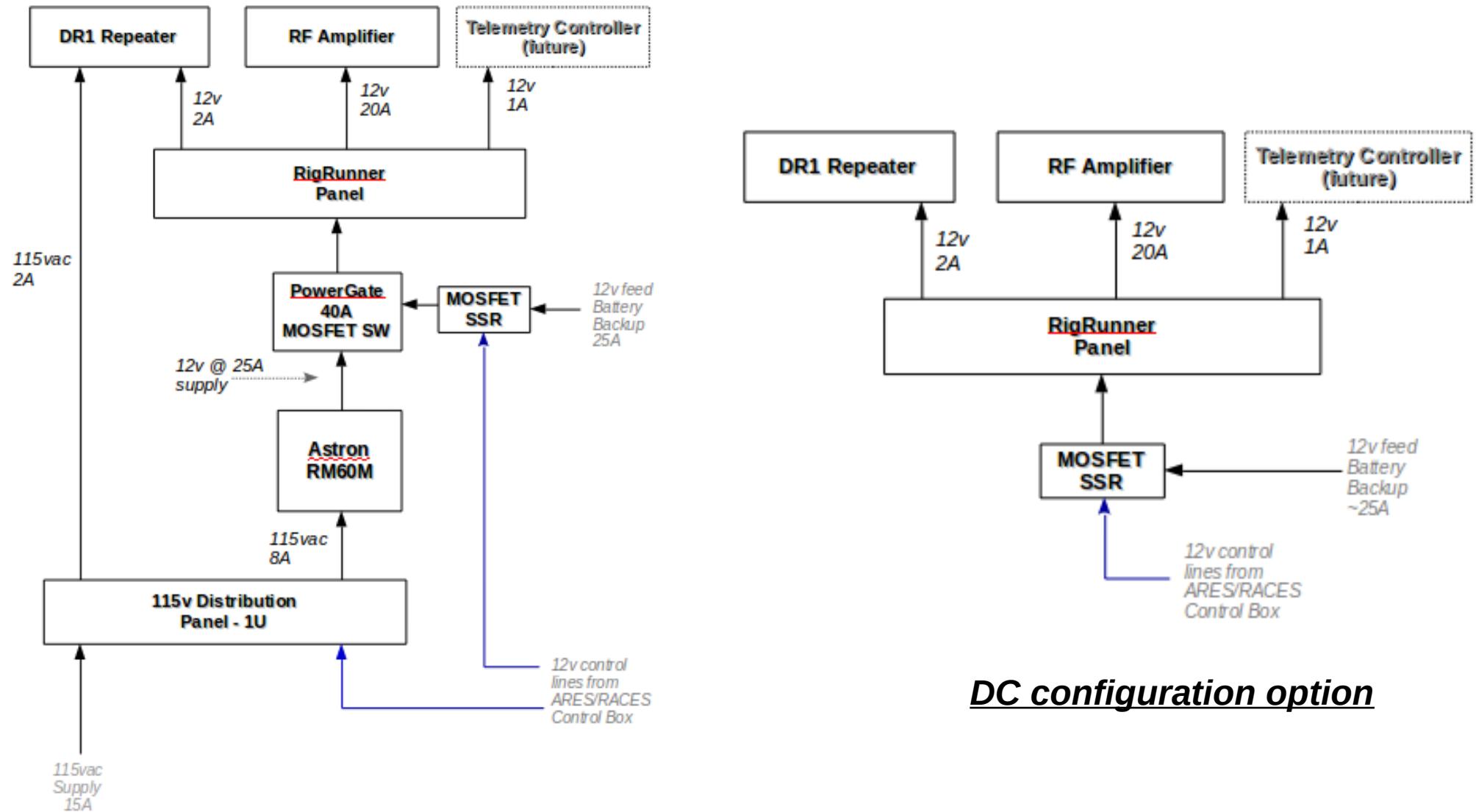
Upgrade Plan

- Configure DR1x to run low power 5W
- Add commercial grade external amplifier capable of 100W
- Look into changing antenna; ideally 4 bay UHF folded dipole @ 9dBi gain or better
- Prepare spare UHF duplexer to swap out existing
- Build up spares list to keep this equipment running
- ARES/RACES team offered to house UHF repeater in S. Hut on the Mtn. Helping reduce monthly club operational costs
- New hut offers (AWESOME) battery backup supply
- Planned to perform site survey as soon as weather cleared in Spring

RF Block Diagram



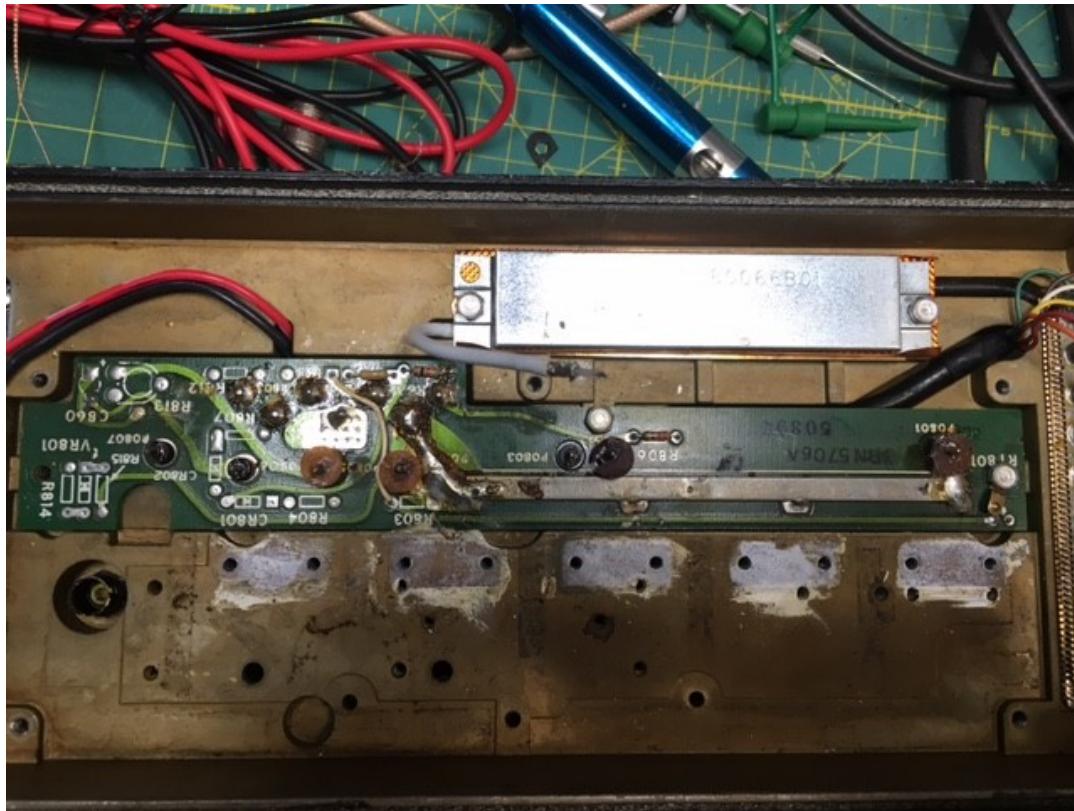
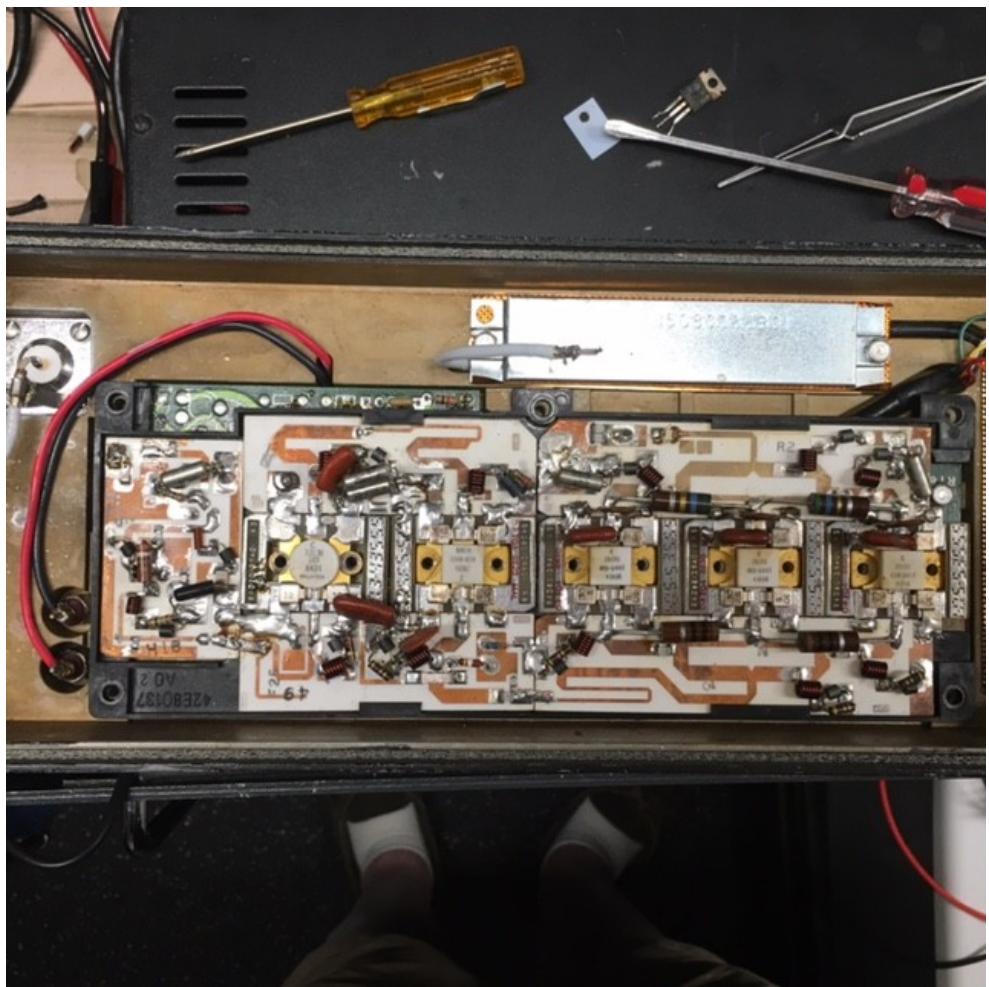
Power Supply



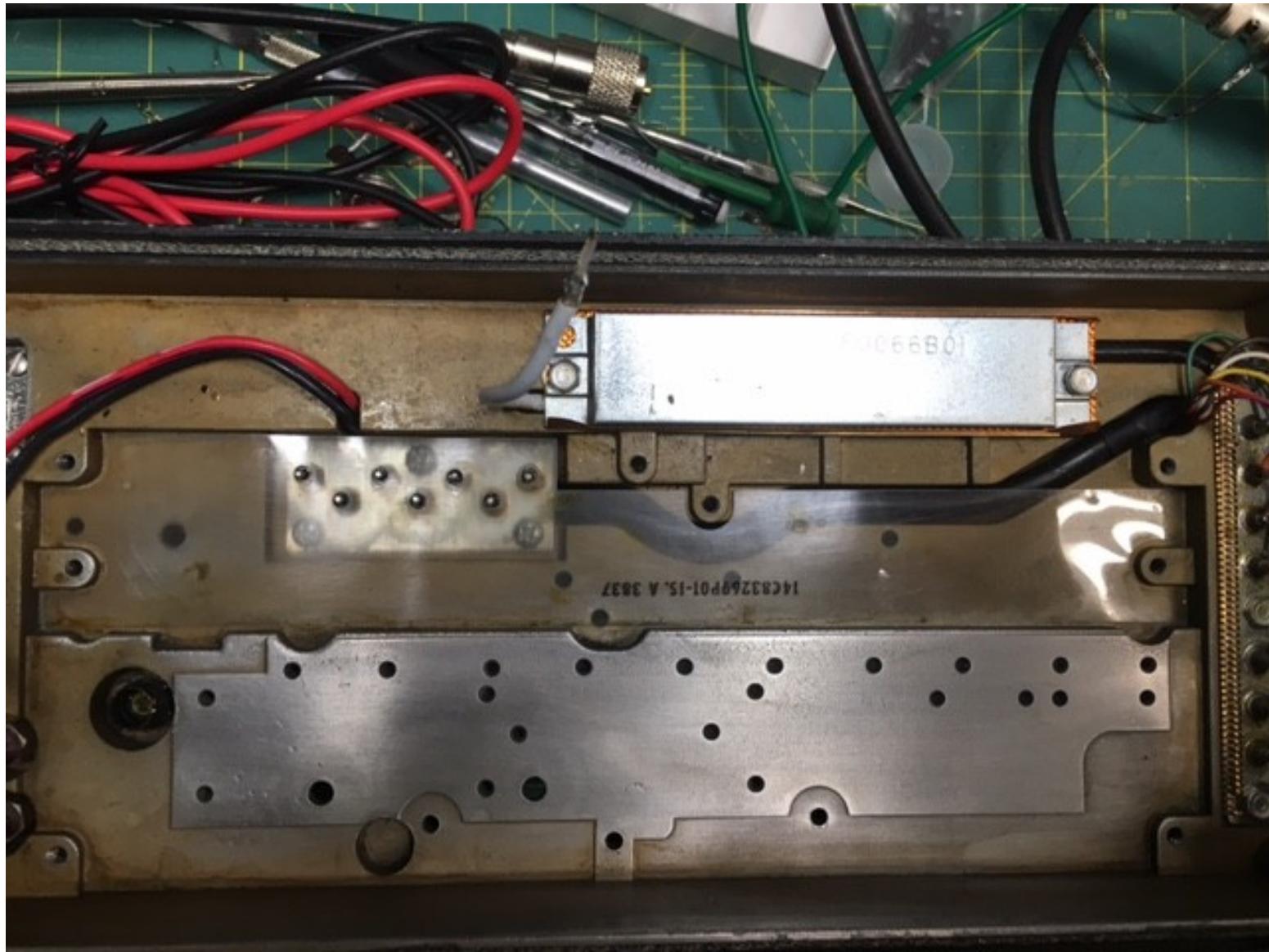
Amplifier Refurbishment

- Before snow melted started work on MSR2000 amplifier
- Was in good shape; 40W of power but not up to spec
- Had some custom options & bypassed RF control board
- So stripped it down
- Removed customizations
- Repaired RF control board
- Added 9.5vdc supply
- Added external 12v Fan
- New Power cables
- Bench test

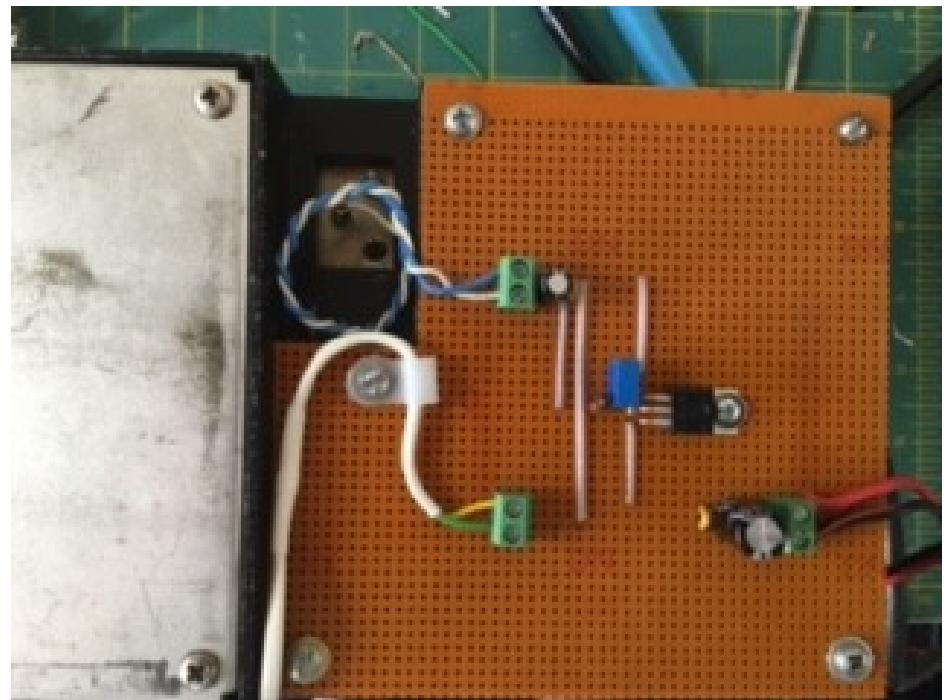
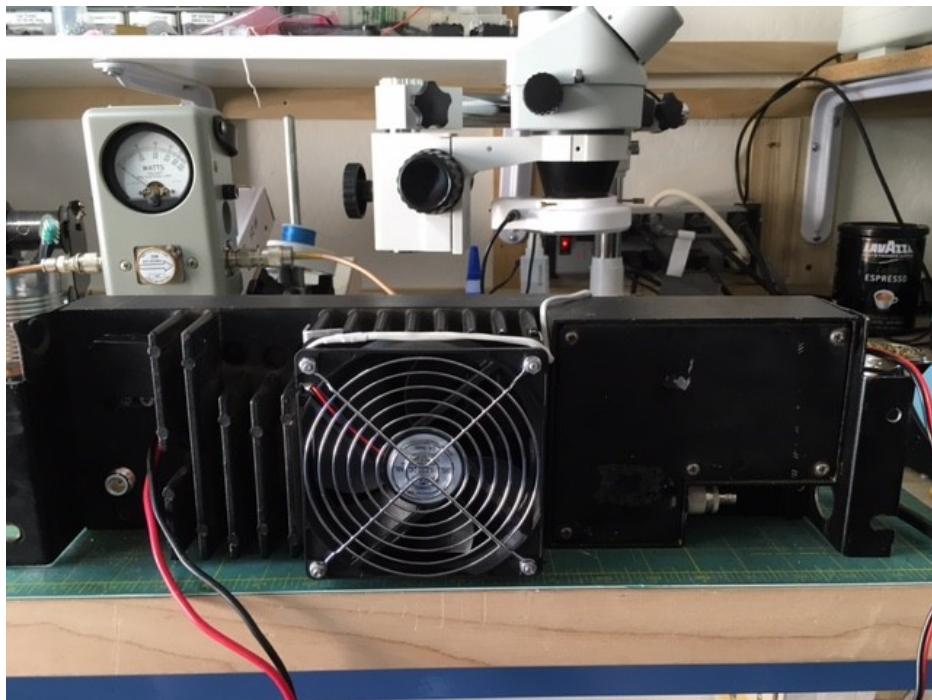
MSR2000 Refurbishing



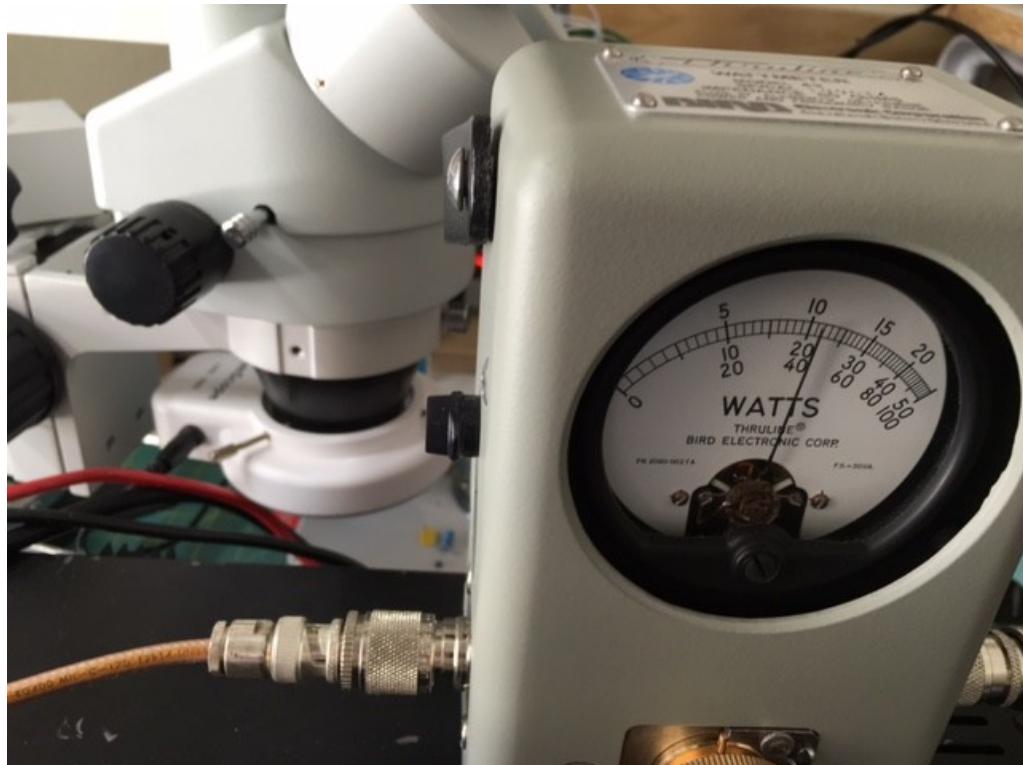
Cleaning up heat sink



End Result



Before ~ 42W



After Solid 100W

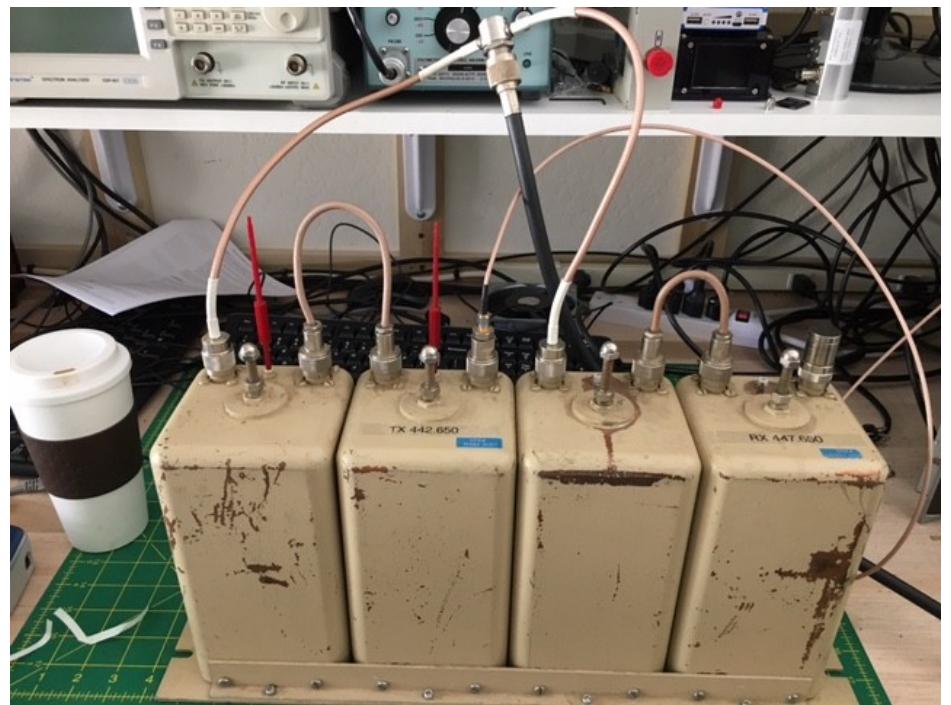


Fusion Low Power Drive

- 5w output from DR1X too high for MSR2000
- Opted to use In-Line attenuators
 - Vs modification of Amp
- Calculated 14dB atten to get necessary 345mW power into Amplifier
- 10dB → 3dB → 1dB
- (Photo's of Atten)

Next Up, Duplexer

- Key to a repeaters performance
- Isolates Tx from Rx
- Poor isolation results in desense
 - Or worse, Rx damage
- 100dB isolation goal
- Performance can drift due to temperature extremes
- Good to check 1-2 times/yr
- Combination BPF and Notch

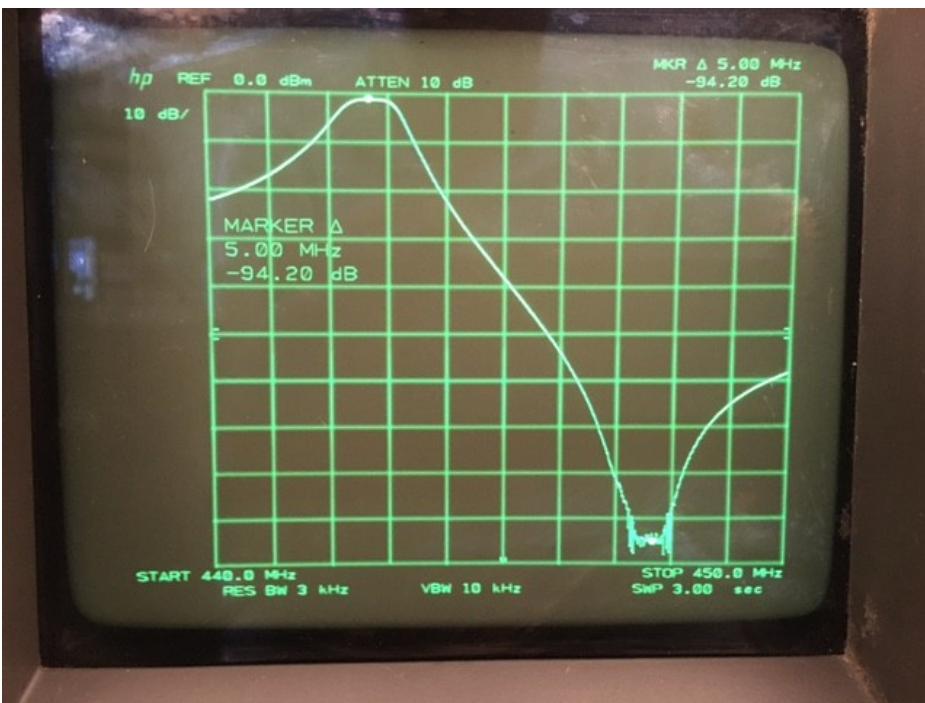


Tuning Test Equipment

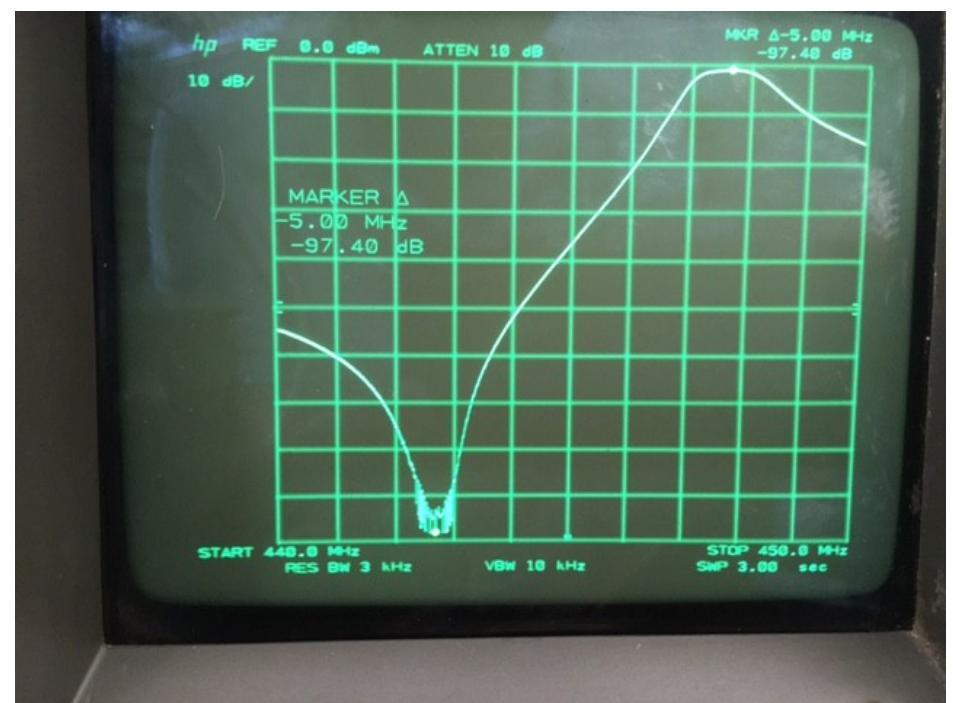
- HP 16475 Tracking Generator
- HP8566b Spectrum Analyzer
- Sweeping 440Mhz to 450Mhz
- 10dB/div, 3Khz BW
- Tune & Tweak



Tune for Max Tx / Rx Isolation & Minimal Insertion Loss



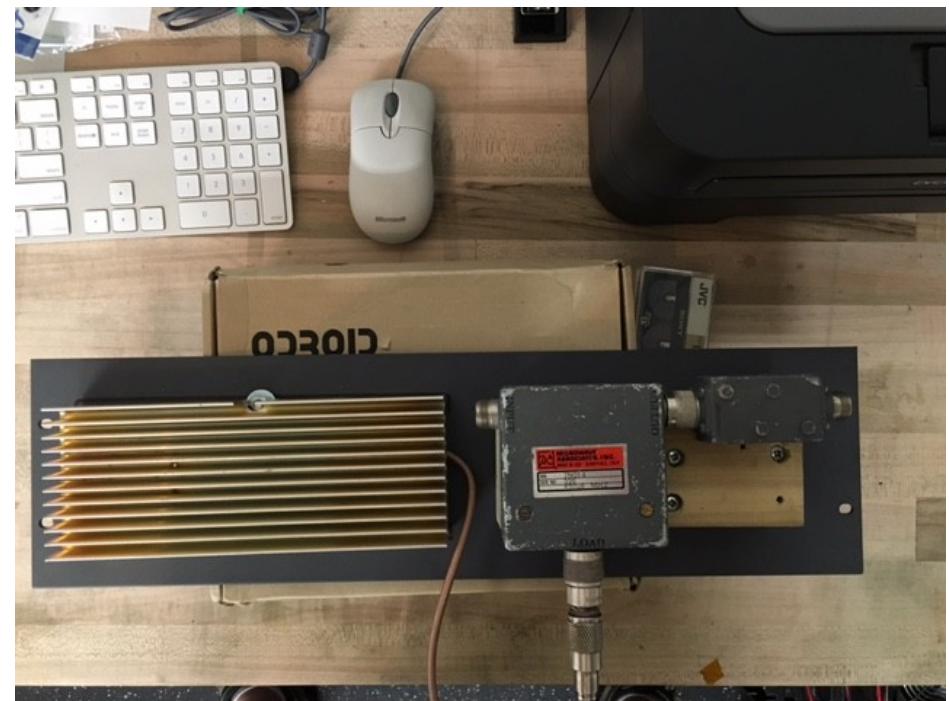
Rx Pass, Tx Notch



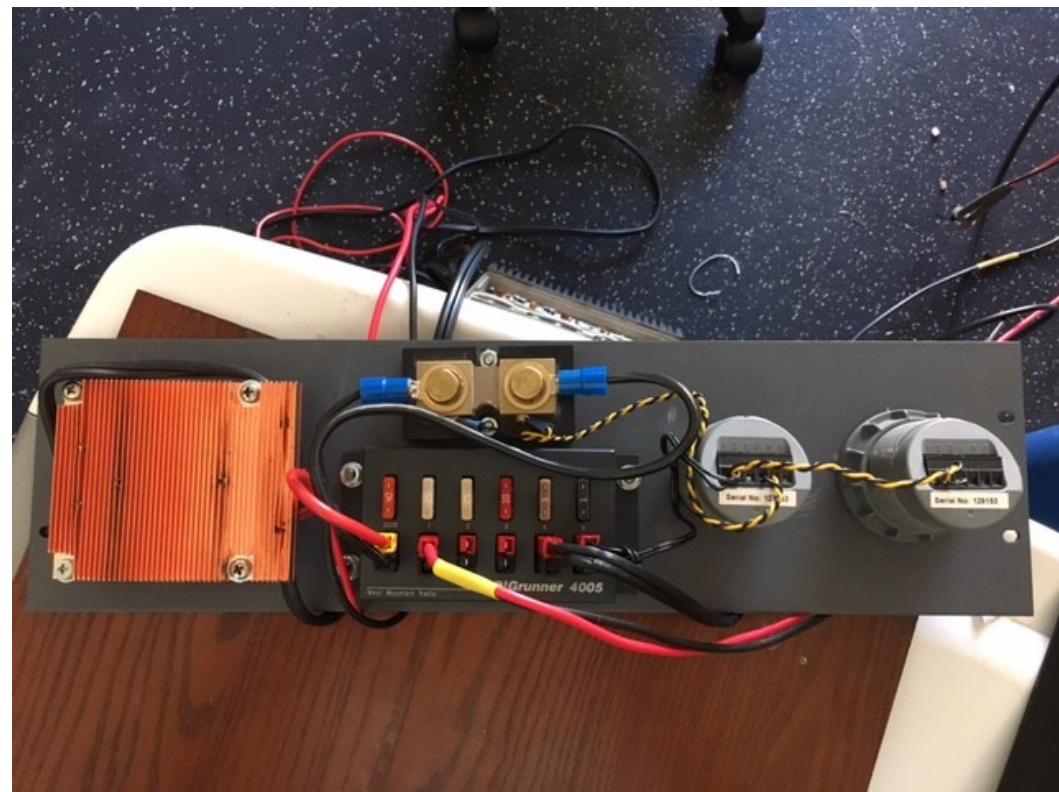
Rx Notch, Tx Pass

Isolator, LPF and Load

- Isolator is 3-Port device; input, output, load
- Redirects RF power from Amplifier into Load on any VSWR
- Non-Linear Device
 - LPF needed due to harmonics generated
- Protects Amplifier
- Isolator is Ferrous/Magnetic so mounting panel should by non-ferrous
- LPF -3dB @ ~500Mhz



Power Panel



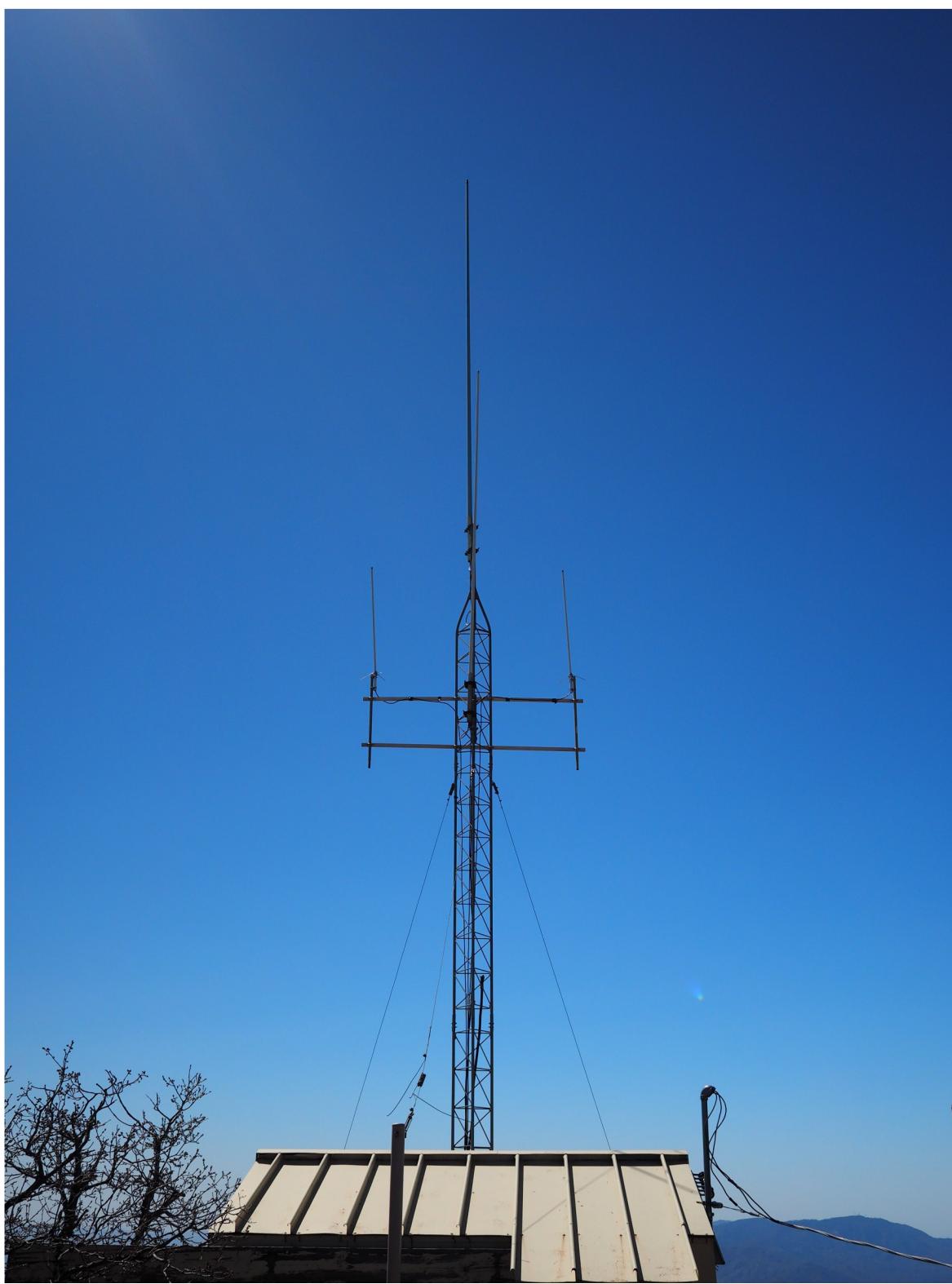
Site Survey

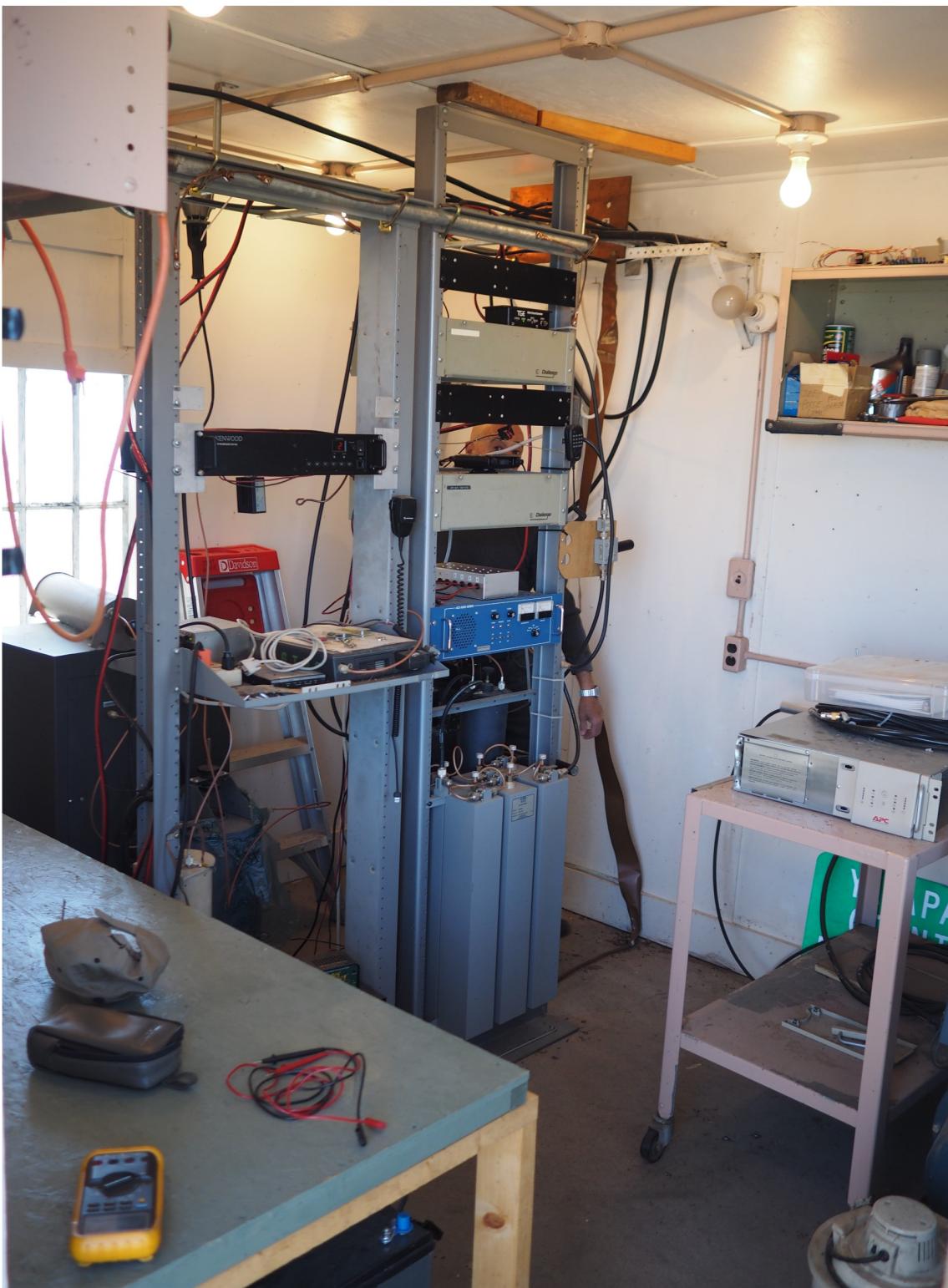
Spring 2016 trip to Mt Union





















Feed line and Scala Antenna

- N2THD Chuck had some goodies for the club
- 50ft 7/8" feed line
- Several interesting UHF antennas
- Scala Omni Vertical
- Thanks to Mike K7QDX for Scala contact and data sheet !

SCALA
PROFESSIONAL ANTENNA SYSTEMS FOR
BROADCAST AND COMMUNICATIONS

The Scala OG6-450 and OGB6-460 are ruggedized omnidirectional antennas intended for use in professional fixed-station applications in the 406–470 MHz band. They feature:

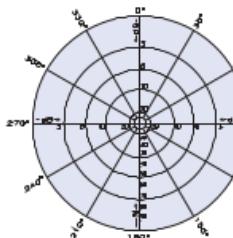
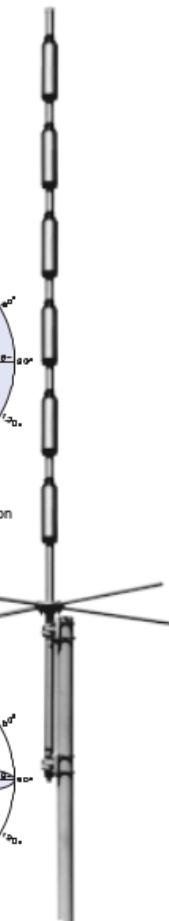
- Parallel-fed collinear dipole array.
- Unique coaxial feed system completely housed within the antenna.
- OGB6-460 broadband across 450–470 MHz.
- Parallel feed design ensures consistent element phasing, even in extreme icing conditions.
- Entire antenna at DC ground potential.
- Anodized for corrosion protection.
- Heavy duty aluminum castings.
- Stainless steel hardware and fasteners.
- Insulating materials chosen for high mechanical and electrical characteristics.
- Electrical downtilt versions of the OG6-450 are available.
- Special hardware and reflector kits are available for offset and bidirectional patterns.

Specifications:

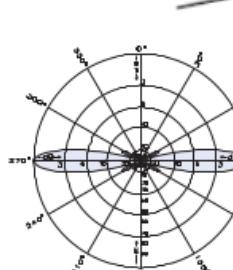
| Frequency range | OG6-450 | OGB6-460 |
|----------------------------|--|-------------------------|
| | 406 to 470 MHz (specify frequency) (other frequencies on request) | 450–470 MHz (broadband) |
| Gain | 6 dBD | |
| Impedance | 50 ohms | |
| VSWR | < 1.5:1 | |
| Polarization | Vertical | |
| Maximum input power | 250 watts (at 50°C) | |
| H-plane beamwidth | Omni | |
| E-plane beamwidth | 16 degrees (half-power) | |
| Electrical downtilt | 7° or 11° (optional on OG6-450 only) | |
| Termination | N female | |
| Weight | 14 lb (6.35 kg) | |
| Height | 98 inches (2489 mm) | |
| Equivalent flat plate area | 1.51 ft ² (0.14 m ²) | |
| Wind survival rating | 100 mph (160 kph) | |
| Shipping dimensions | 99 x 6 x 6 inches (2515 x 152 x 152 mm) | |
| Shipping weight | 23 lb (10.4 kg) | |
| Mounting | For masts of 2.375 inches (60 mm) OD. <i>See reverse for order information.</i> | |

**OG6-450
OGB6-460**

OMNIDIRECTIONAL ANTENNA
6 dBD gain
406 to 470 MHz
450–470 MHz (broadband)



H-plane
Horizontal pattern – V-polarization

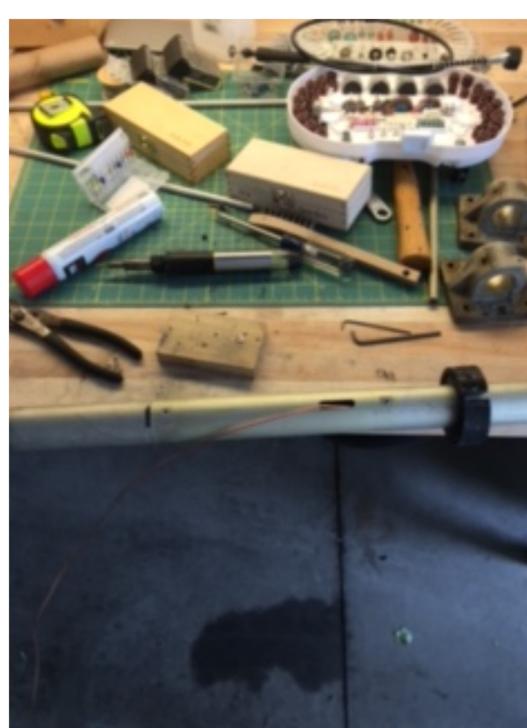
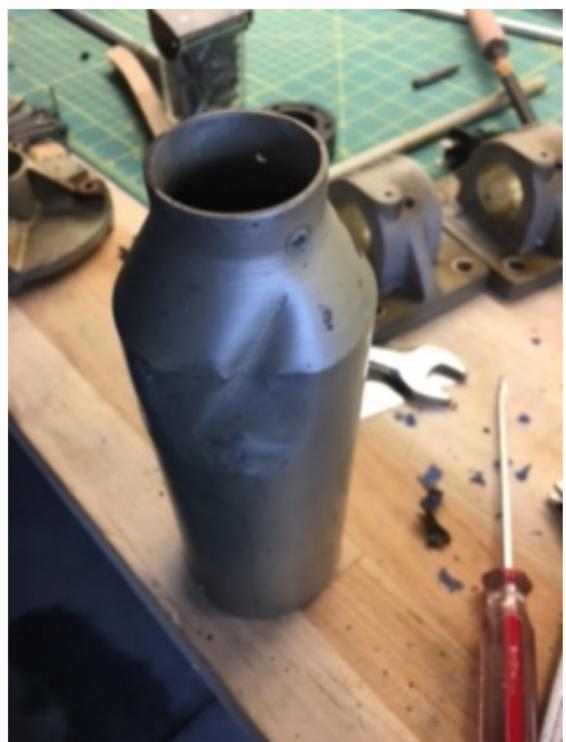


E-plane
Vertical pattern – V-polarization

SCALA ELECTRONIC CORPORATION

Post Office Box 4580 Phone: (541) 779-6500
Medford, OR 97501 (USA) Fax: (541) 779-3991
<http://www.scala.net>

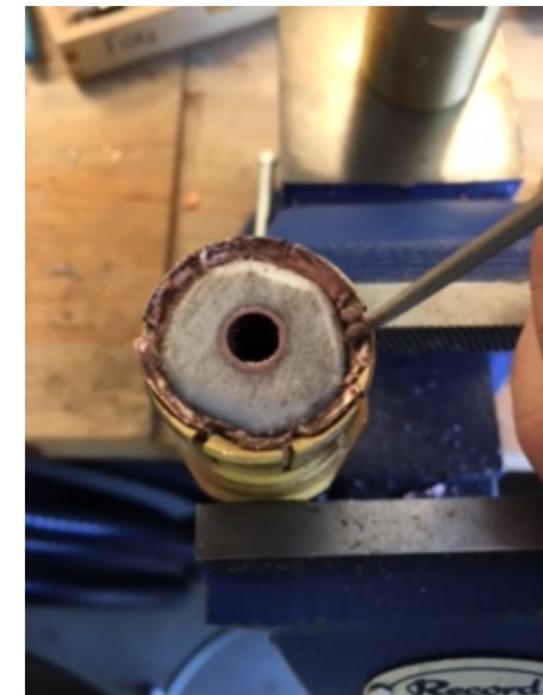
Scala Electronic Corporation is a member of the Kathrein Group

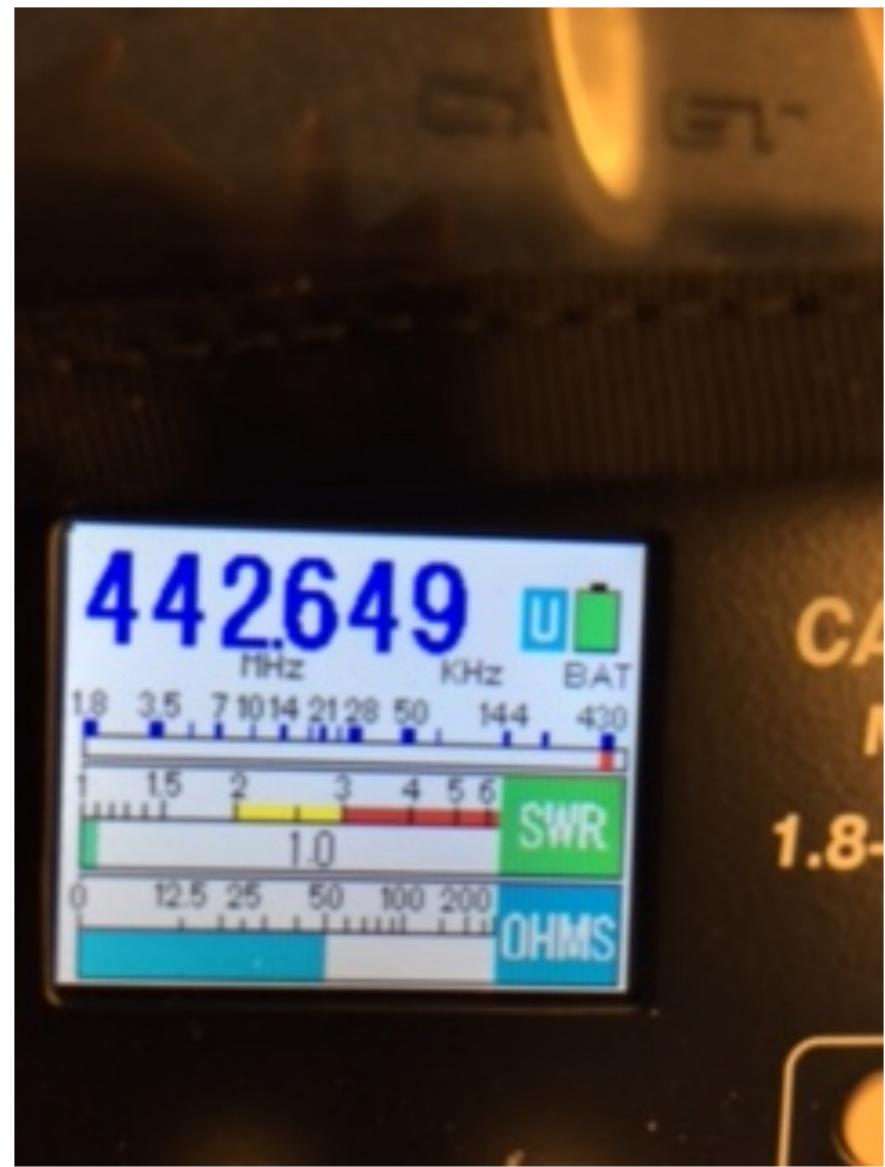


Scala Antenna

- Brought home and began to strip it down
- 6 “cans” which act as folded dipole (or hairpin match)
- Removed dents best I could
- Cleaned and repaired connections
- Winterized/Sealed
- New SS HW and 4 new radials





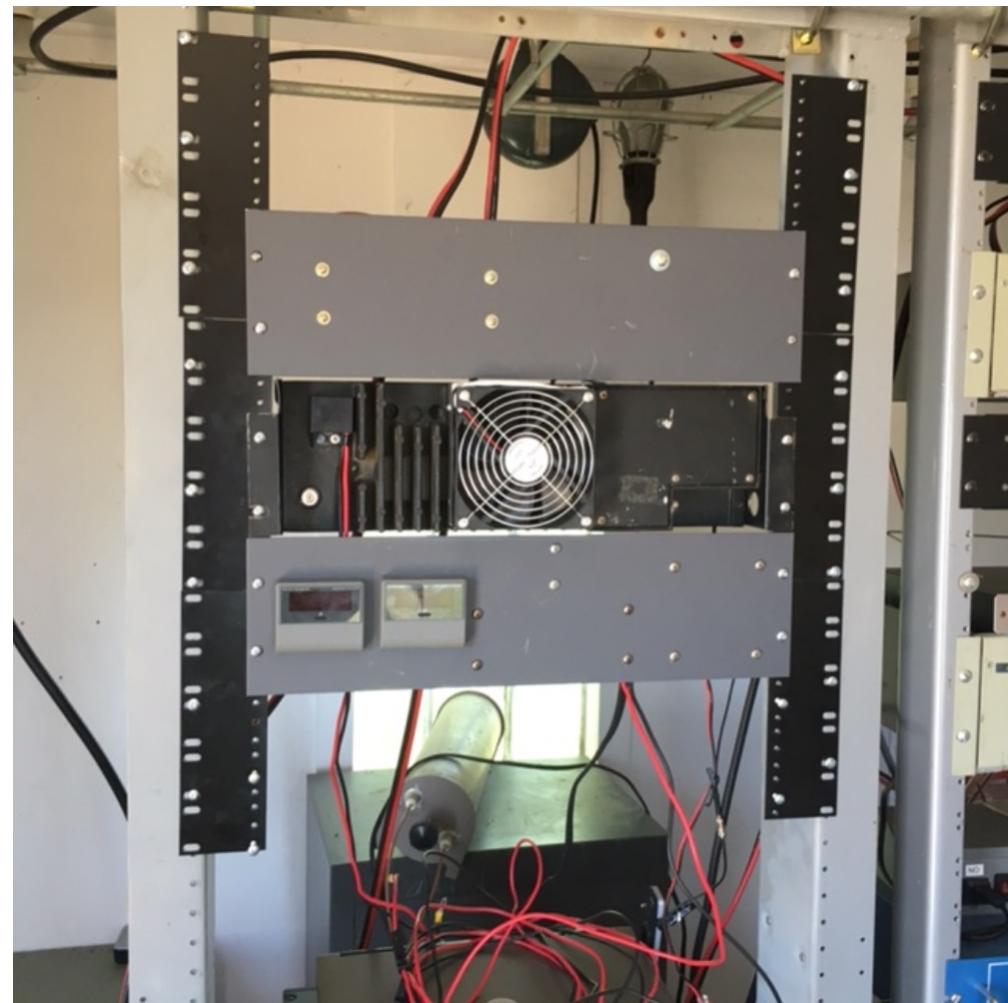


Install Scala, Replace Duplexer

- Repeater was experiencing severe desense
- Replaced Duplexer
- Replaced Comet w/ Scala
- Took Several VSWR and Power Measurements
 - Tuned radials, Replaced/Tuned Tx → Duplexer cable
 - Increased from ~15W to 20W
- Results promising, much better coverage and overall improvement from upgrades during this trip
- Took opportunity to install several new components into ARES/RACES Hut

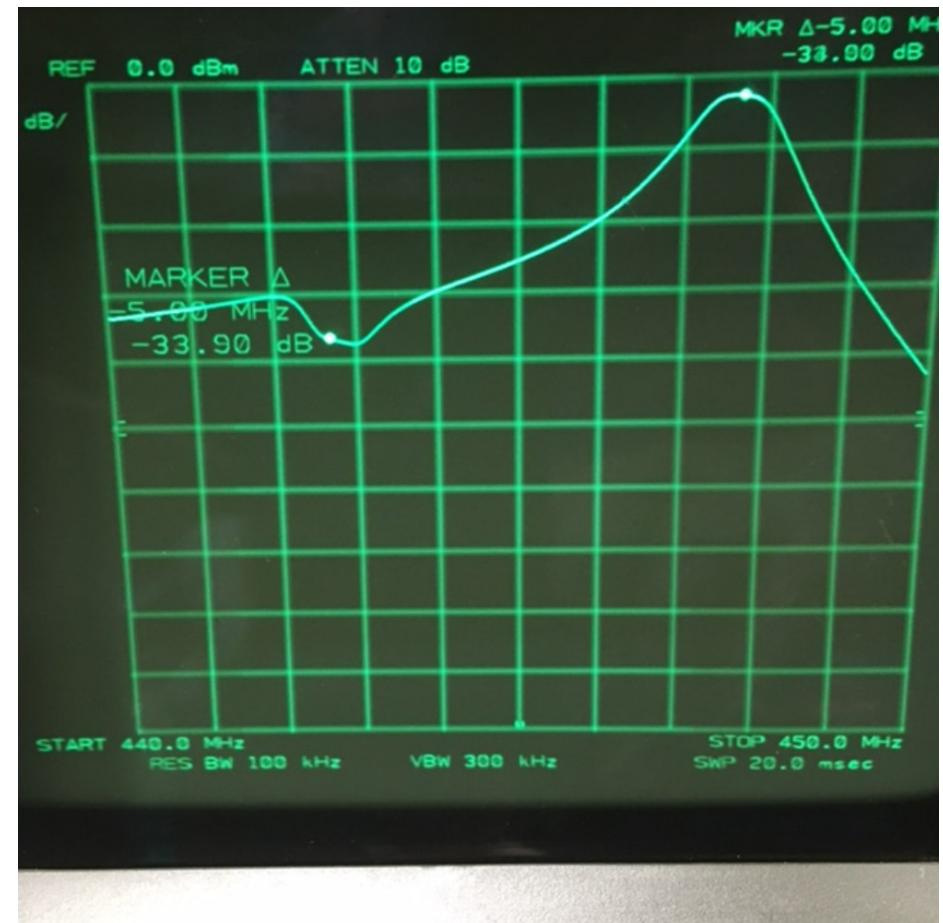
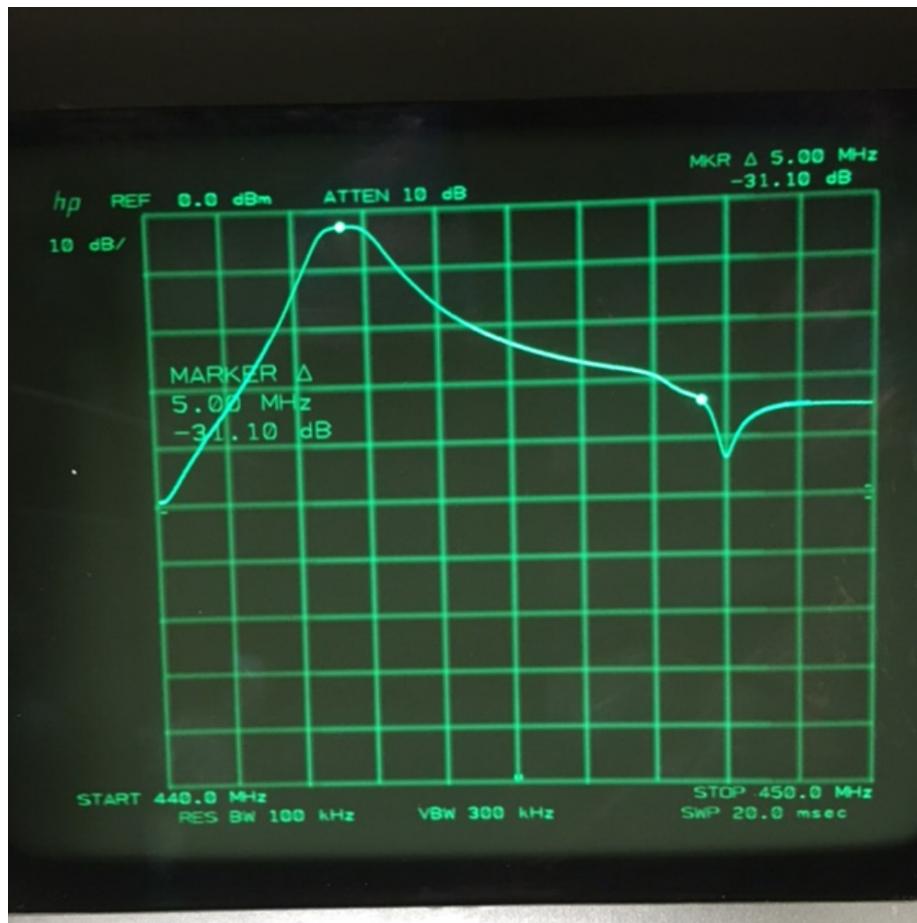




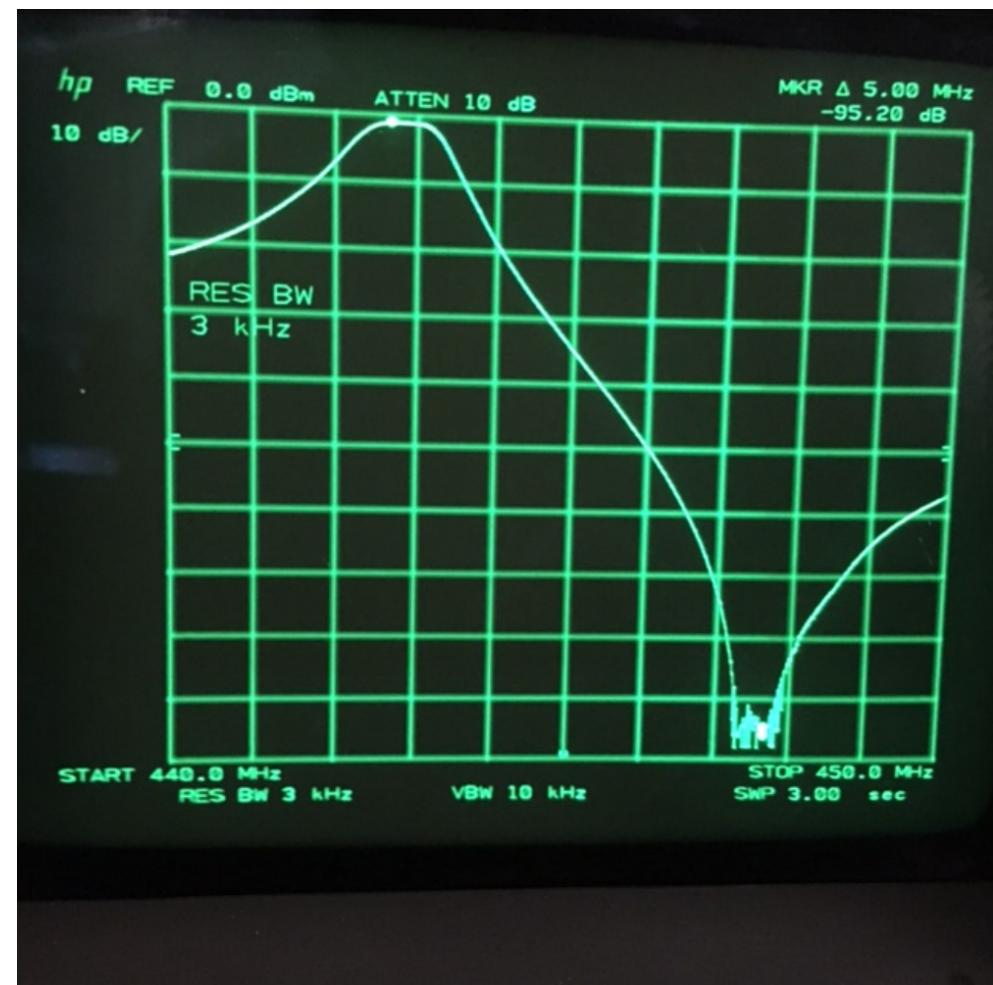
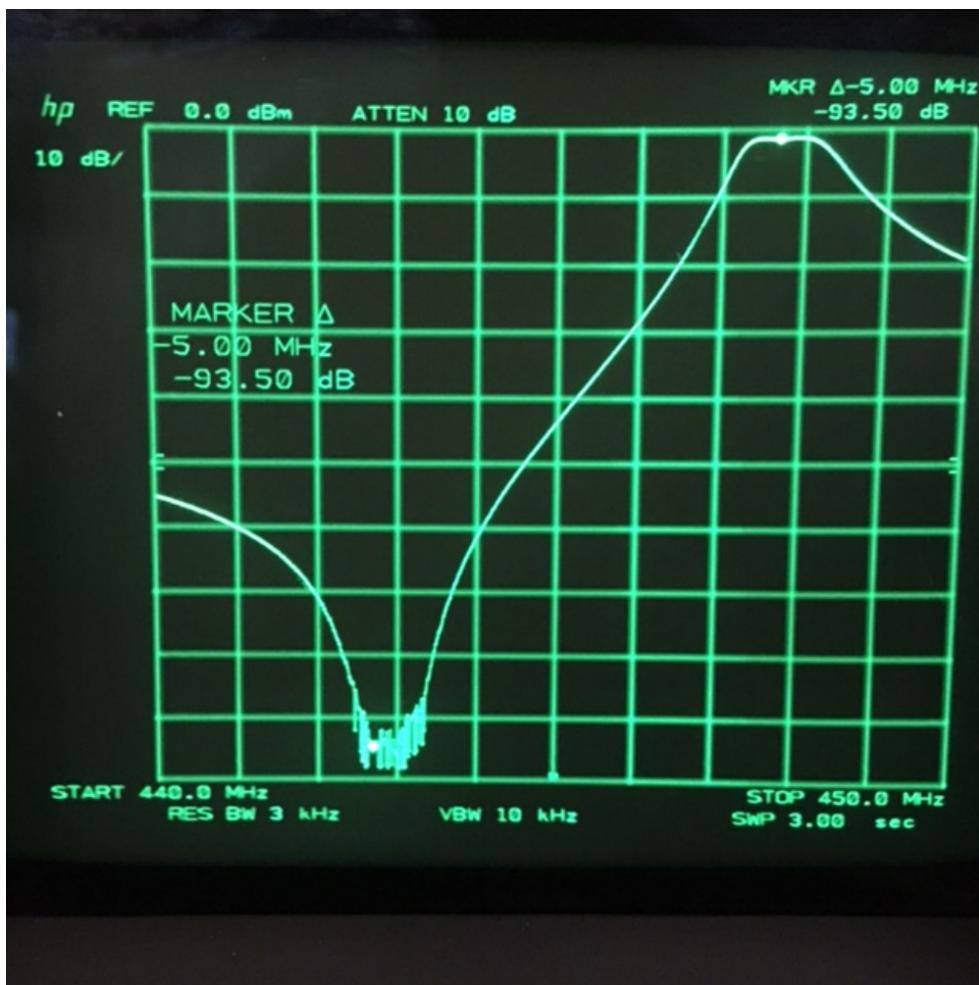


Root Cause Found

T1500 Duplexer Bench Scan



Improvement



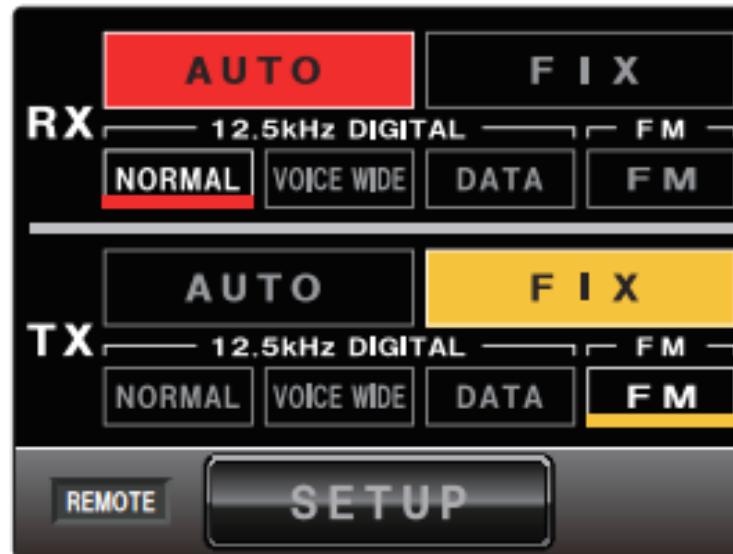
Moving into ARES/RACES Hut

- Would like to do this ASAP
- Antenna Mounting bracket being made
- Big job, need WX to cooperate & plan to be safe
 - Team to meet prior to review tasks/duties
- Will need UHF capable stations to be available afternoon of installation for signal reports
- Run new feed line up tower
- Move/mount Scala on tower
- Secure feed line into hut
- Move repeater and Duplexer
- Connect to power supply
 - Verify power controller
- RF Interconnects and Lightning arrestor
- Measure performance
- Enable C4FM AMS mode

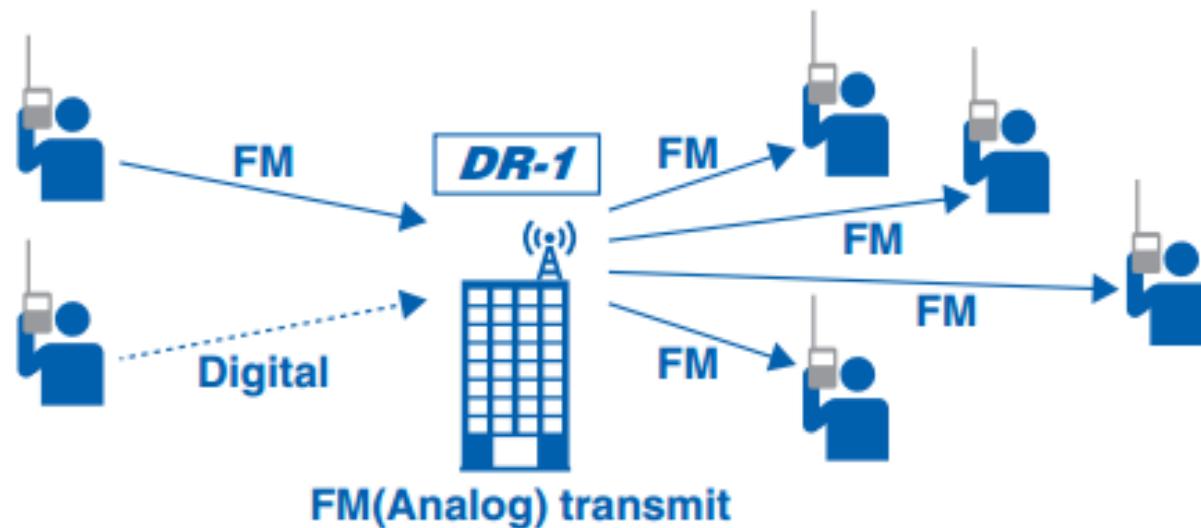
Let's Talk C4FM Digital

- Continuous 4level Frequency Modulation
 - A type of 4 level FSK
 - Similar to Phase 1 P25 (not compatible)
- Automatic Mode Selection (**AMS**)
 - **FM Analog Fixed mode**
(current config)
 - **AMS Rx, FM Tx**
 - a) FM Analog to FM Analog
 - b) C4FM Digital to FM Analog (no digital info transfer)
 - **AMS Rx, AMS Tx**
 - a) FM Analog to FM Analog
 - b) C4FM Digital to C4FM Digital
 - Out of the Box, C4FM is not compatible w/ D-Star or other Digital modes
 - w/ hardware and internet we can interface with other systems
 - C4FM digital info; GPS, Callsign, images
 - C4FM provides high quality audio w/ error correcting
 - High quality audio or
 - Data transmission mode
 - Images via C4FM with appropriate equipment.

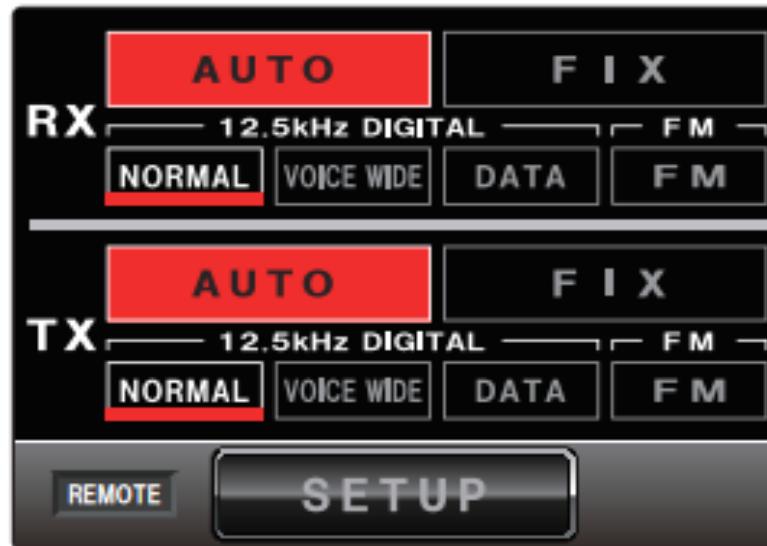
AMS FM Tx Mode



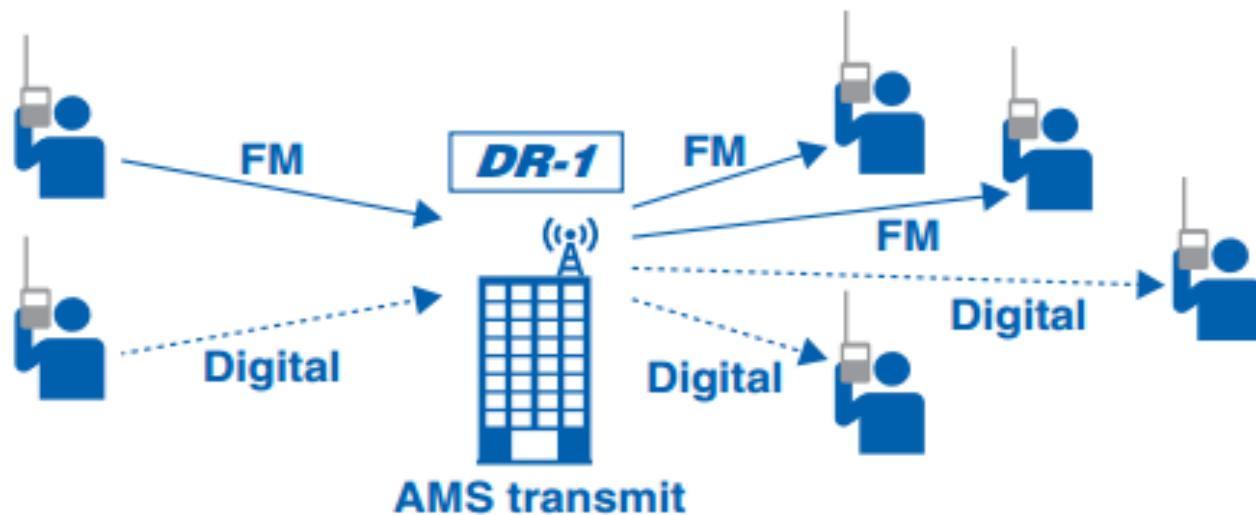
AMS receive → FM transmit



AMS Tx Mode



AMS receive → AMS transmit



W7YRC UHF Repeater Configuration

- Full AMS mode enabled
 - C4FM ==> C4FM, digital to digital
 - FM Analog ==> FM Analog
- FM Analog, looking for 100.0 PL on Receiver
- FM Analog, sends 100.0 PL from Transmitter
- There is no priority, digital vs analog

Analog FM Users

- Remember to enable RX CTCSS T-SQL to prevent squelch opening during C4FM transmissions
 - RX T-SQL: 100.0 Hz PL same as TX
- Failure to use RX T-SQL you will hear digital burst opening your squelch during digital coms
- Continue to use TX CTCSS PL Tone 100.0 Hz
- Double check S-Meter before TX as digital coms may be underway and your squelch will not be open

Yaesu Digital Users

- Read up on capabilities of your rig; **AMS Mode**
 - **DN** mode: Digital Audio w/ error correction
 - **VW** mode: Digital Audio, Full 12.5Khz BW high qual
 - **DW** mode: High Speed Data coms, auto for video
 - **FM** mode: Analog FM mode, if your digital cuts out, fall back
- **AMS Auto Tx** mode allows you to answer in mode last received
 - Useful when there's analog users mixed in with digital users
 - You can override and force your Tx to only be sent digitally however leaving in Auto Tx mode will help include analog only users into coms/nets.
 - Experimentation to gain experience needed
- Full C4FM mode should exchange GPS coords as well as call sign information.

Futures

- Performance Mapping
 - Radio Model, SPLAT
 - Actual Field Measurements
- Add Telemetry via embedded system based controller
- D-Star / AllStar interfaces
 - Perhaps IRLP if there is desire.
 - Wires-X to C4FM
- Dependent upon Internet Access to Mt.
 - High Speed Mesh Network?
- Maintenance Visits
 - Antenna, Power and Duplexer checking
- Build inventory of VHF / UHF gear as spares / deployments
- Deploy Spare Fusion repeater for 2nd C4FM repeater, somewhere...

Closing

- ✓ Remember to turn on RX T-SQL when we turn on C4FM
- ✓ C4FM capable rigs please give it a try; use AMS
- ✓ Send us your feedback, suggestions, recommendations / requests.

Email: no1d.doug@gmail.com

or find me on Mt. Union 447.65/442.65

73, thanks, ***W7YRC Repeater Committee***