Experimenting, Prototyping, Building

Presented December 19, 2020 at LARG Monthly Meeting

KØZR – Jeff Crawford

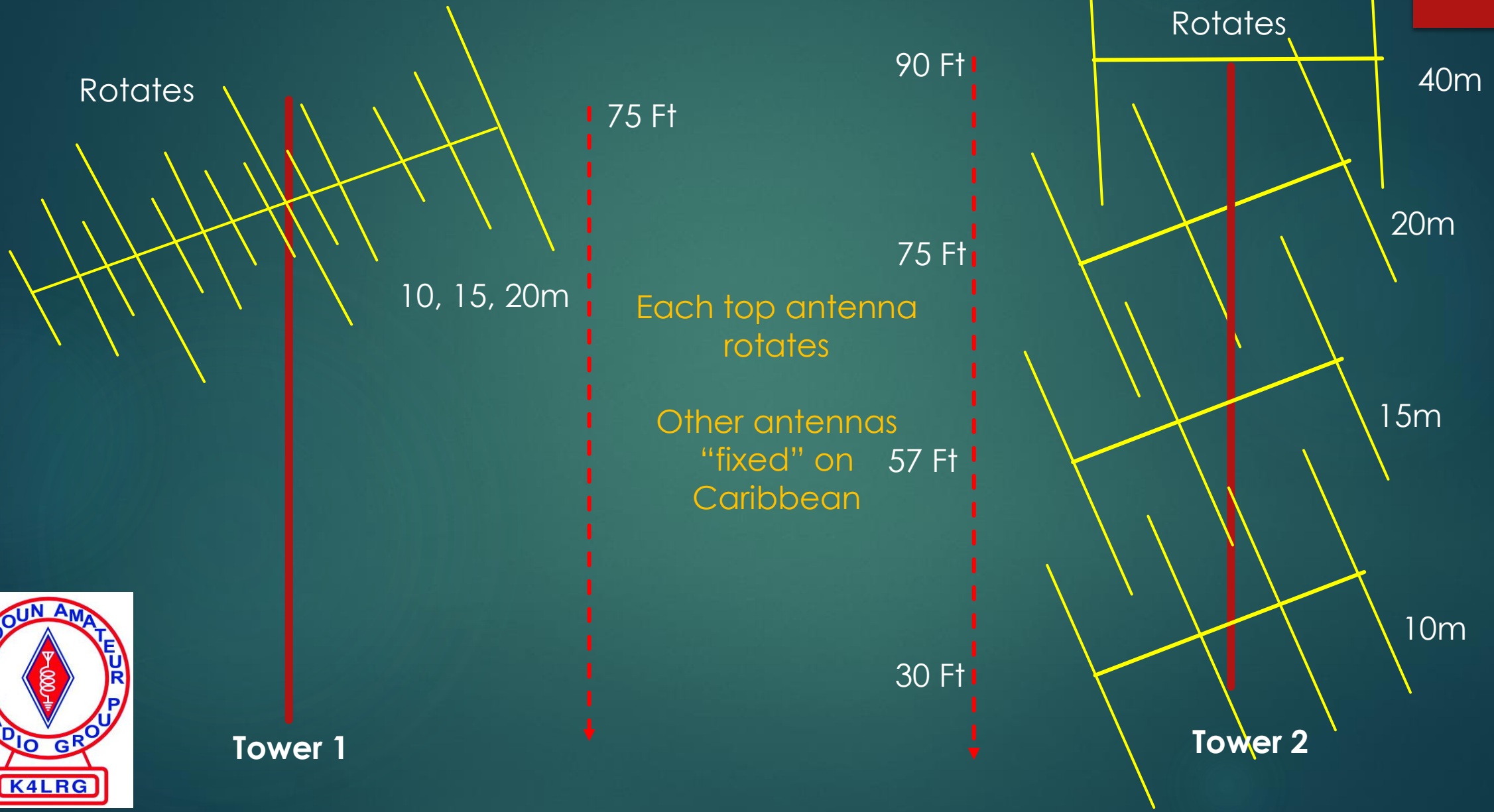
Background

- Years ago amateurs built most of their equipment
  - No commercial vendors like Yaesu, Kenwood existed
  - This aspect of the hobby was attractive to experimenters
- If you only talk on a microphone, type on a keyboard, tap a key, you are missing out on a valuable part of the hobby
  - Building parts of your station:
    - Understand the underlying theories better
    - Potentially save large sums of money
    - Have functionality that is difficult or impossible to buy “at any cost”
    - Makes your station more personal; your fingerprints are all over it
    - Elevates satisfaction level of operating your station

KØZR Project Examples

- Built six different, 2 KW bandpass filters for the HF contest bands
  - Approximate cost was ~ $ 125 each compared to $300 - $400 if purchased
- Designed and built a sequencer to apply/remove power to LNAs in my active 4-square array for receive
  - Done to protect the receive-LNAs while transmitting
  - $25 compared to ~ $ 200 if purchased
- 1x2 antenna transfer switches for antennas
  - Reasons for this will be described shortly
  - Uses center coax conductor to provide 12 V to remote switching relays
- Designed and built custom steel base to hold full-size 80m λ/4 vertical
- Designed and constructed tipover assembly for TX-472 tower

Antenna Configuration at KØZR



The Why -- Further Explanation

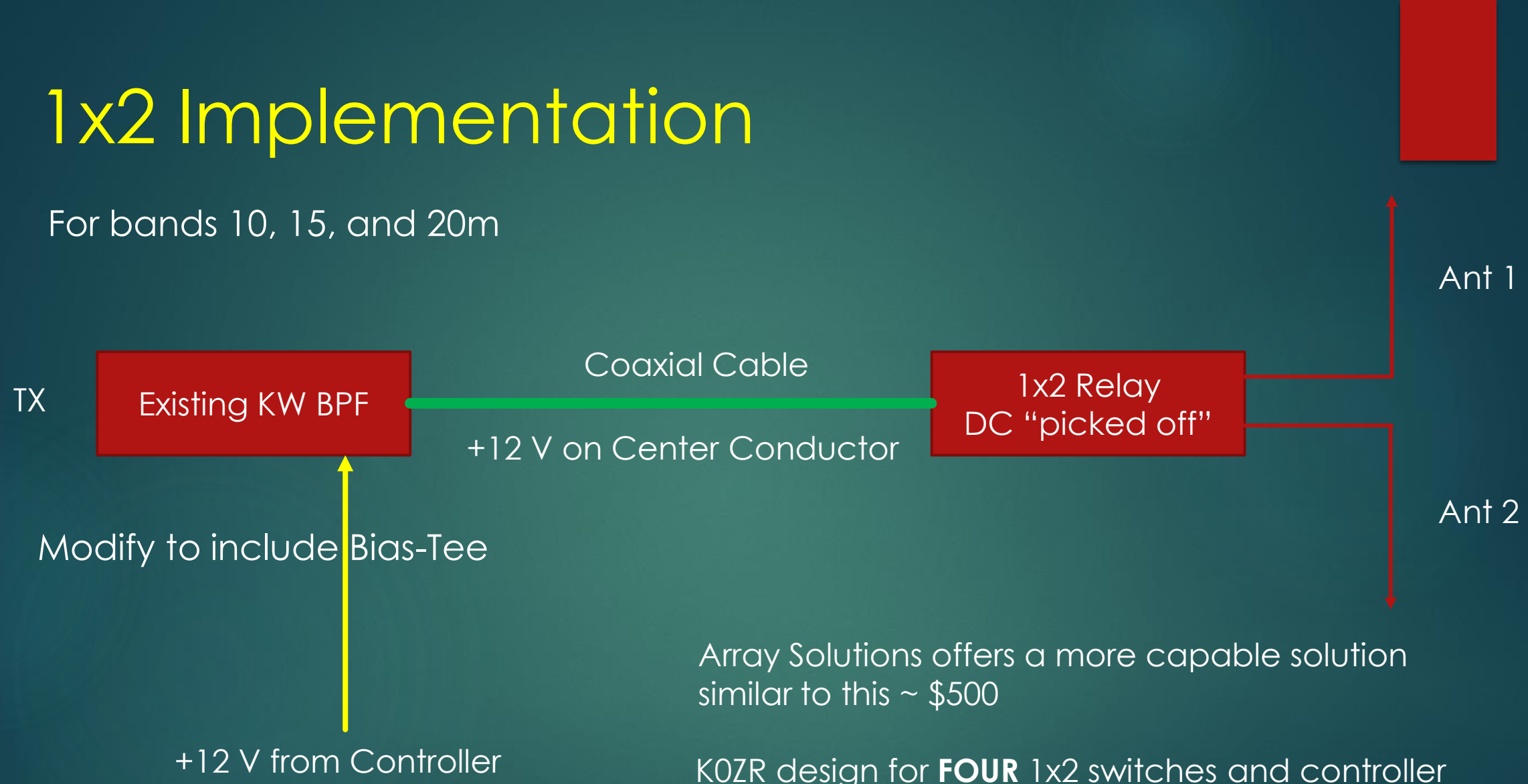
- In large world-wide contests, most QSOs in the European area
  - Occasionally, a station in the Caribbean or South America pops up; these are “multipliers”
    - Two Options:
      - Try to work them off back of the big antennas (that are pointed at Europe)
      - Turn the big antennas south to break through pileups of DX station to the south
- Turning the big antennas takes time
  - Turn from NE to SSE, one way takes ~ 20 seconds
  - Make QSO then turn back to NE; another 20 seconds
  - Complications:
    - In meantime, another station in Europe could “steal” your operating frequency
      - They cannot hear you when pointed south
    - In the 45 seconds required to turn antennas for ONE QSO, could have instead worked 3, possibly 4 other stations in Europe
- 1x2 antenna transfer switches provide for
  - Instant change from big antennas pointed at Europe to southern-pointing antennas
  - Maximizes use of time
  - Less likely to lose operating frequency to someone else in Europe
  - Minimizes wear and tear on expensive rotators

Additionally

- For each coax run you could, theoretically, switch between two different antennas without more expensive commercial switches
- One “down-side” is that the isolation from “Antenna 1” to “Antenna 2” is ~ 40 to 45 dB best case
  - Likely not a problem for all but the most stringent operating conditions
  - So what if some of your transmitted signal, down ~ 40 dB, leaks out the other antenna !
    - Caveat being both antennas are operating in the same frequency band

1x2 Implementation

For bands 10, 15, and 20m



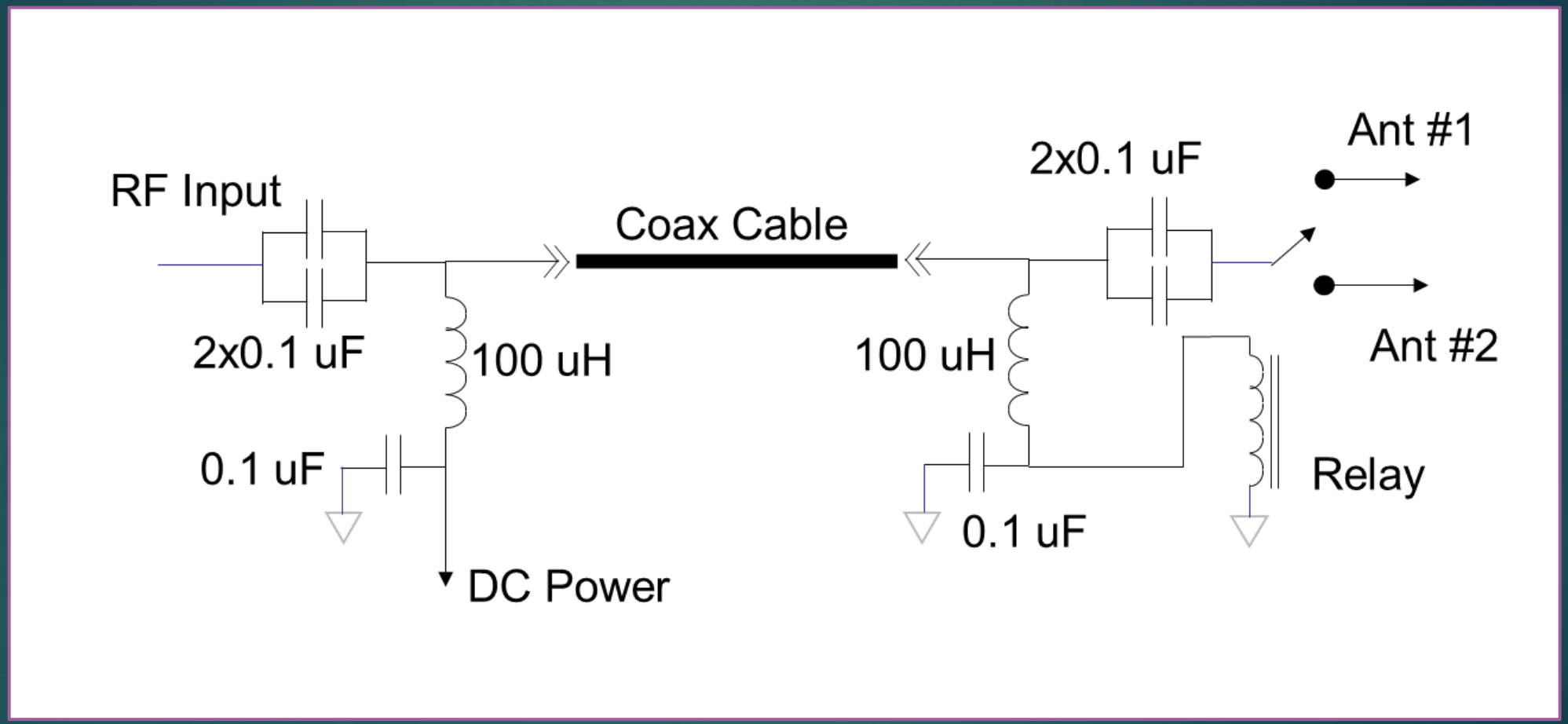
Array Solutions offers a more capable solution similar to this ~ $500

K0ZR design for **FOUR** 1x2 switches and controller ~ $150

What is a Bias-Tee?

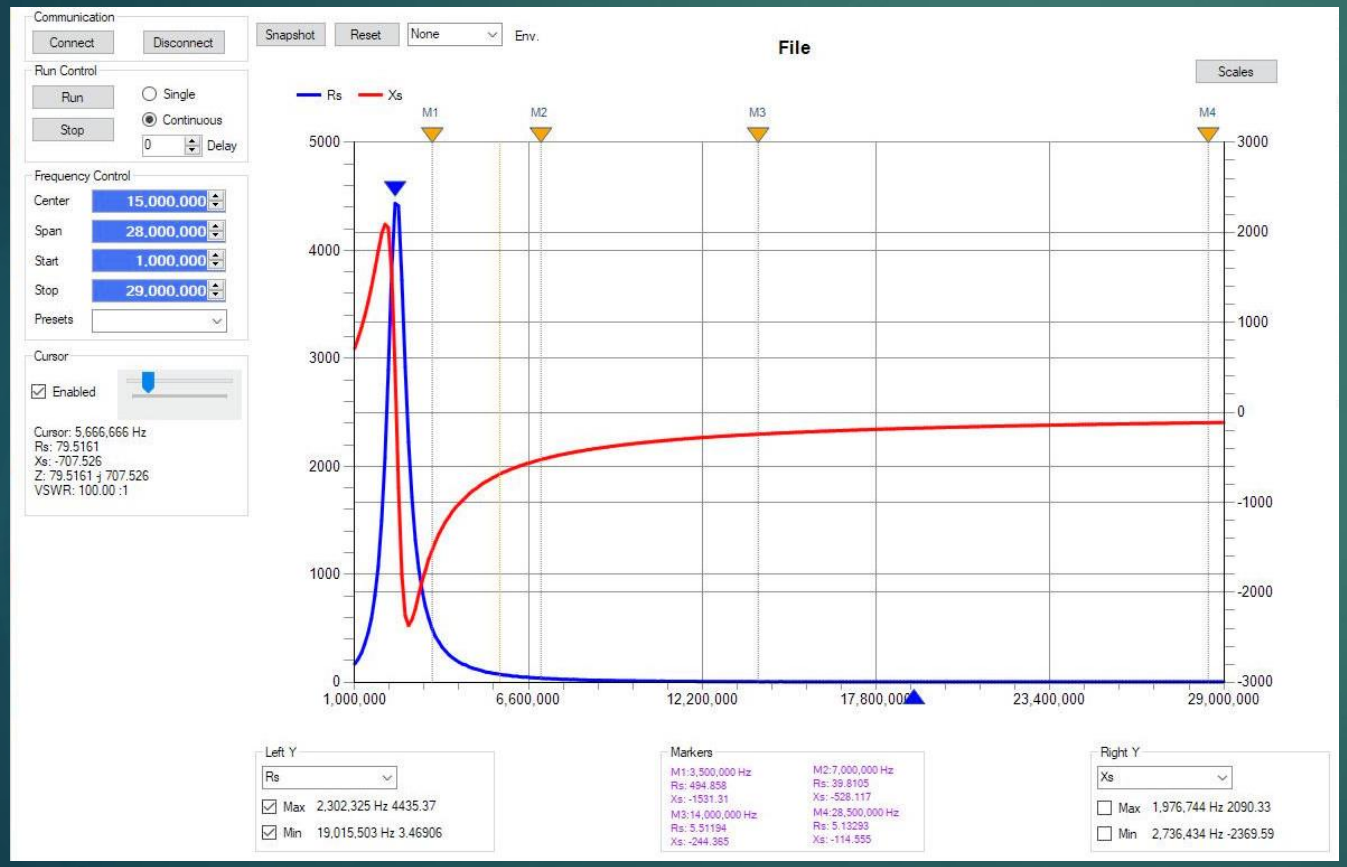
- A bias tee is a circuit making possible the introduction of some DC voltage into an RF "system"
  - Here, introduce 12 VDC onto the coax center conductor to switch a remote relay
- "Good" bias tees:
  - Insert the voltage with minimal voltage drop
  - Prevent RF from entering the DC power line
  - Completely block the transfer of DC to the RF circuits
  - Introduce minimal insertion loss
- At HF (1-30 MHz) bias-tees can be very simple
  - Higher in frequency, i.e. GHz, not so trivial
  - Designer should check for adequate isolation between DC and RF

The Case Here….



Precautions

Need to ensure that X_L of the inductor is sufficiently high for good isolation
Generally 5X the system impedance, i.e. 5 x 50 = 250 ohms

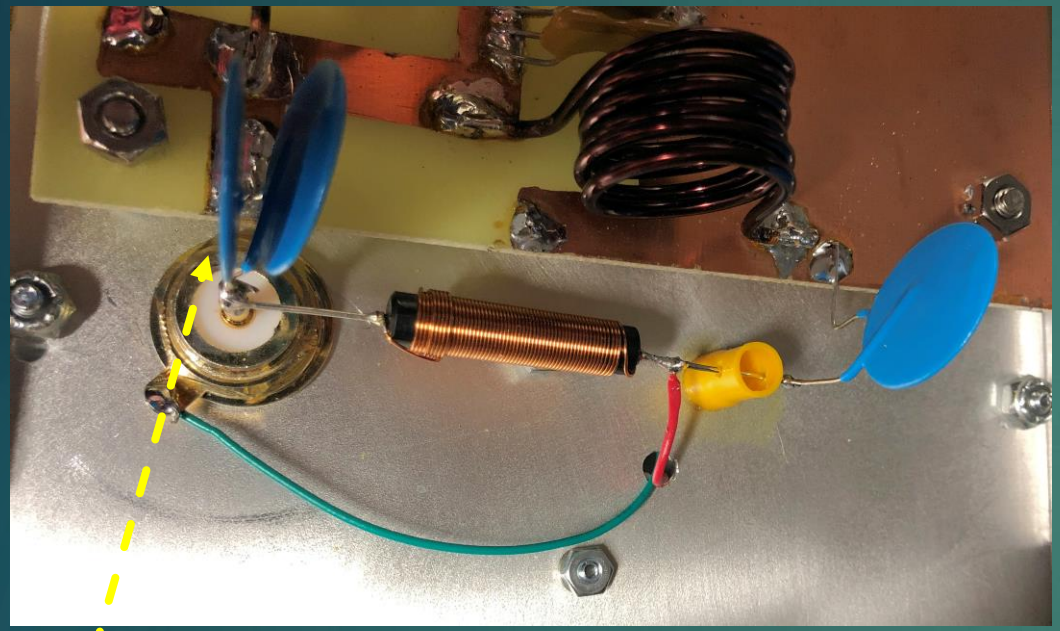


The 100 uH inductor goes through self-resonance ~ 2.3 MHz
High DC resistance at that point

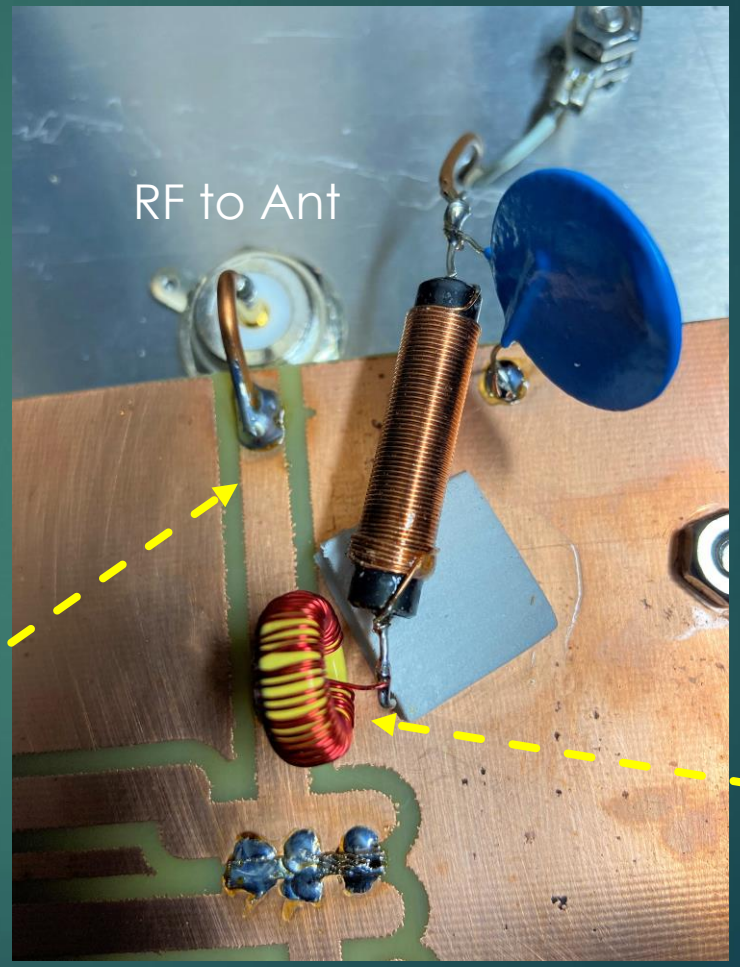
Precautions needed for 21 & 28 MHz
X_L = 159.8 ohms @ 21 MHz
X_L = 114.6 ohms at 28 MHz

In these two cases the single 100 uH inductor is augmented with an additional inductor

Bias Tees at TX Side (Inside the KW BPFs)



DC blocking caps

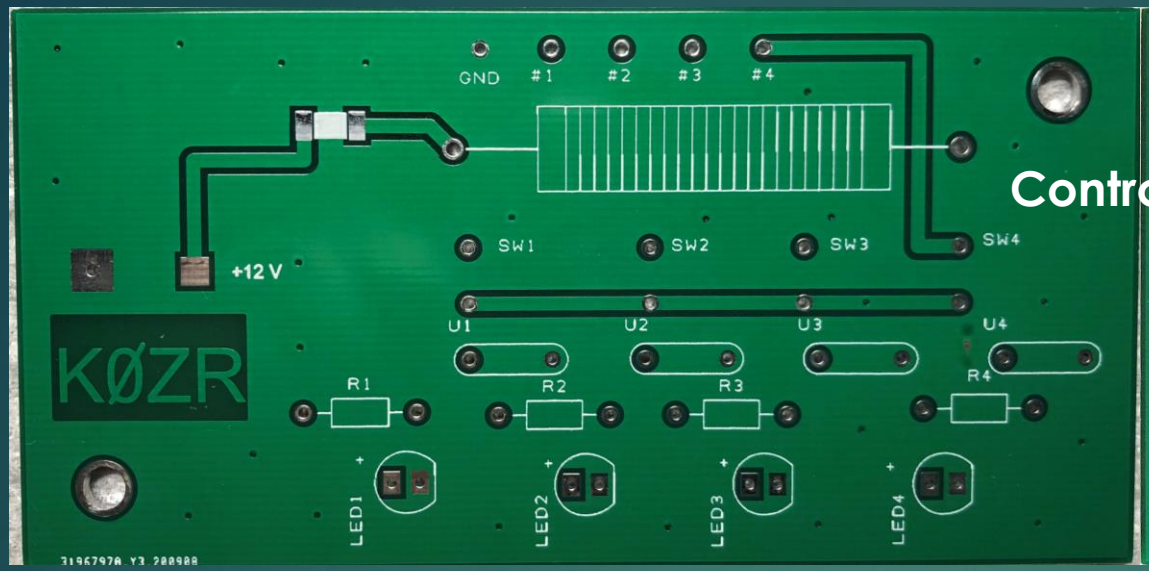


No DC blocking caps required
since filter was highpass,
i.e. already blocks DC

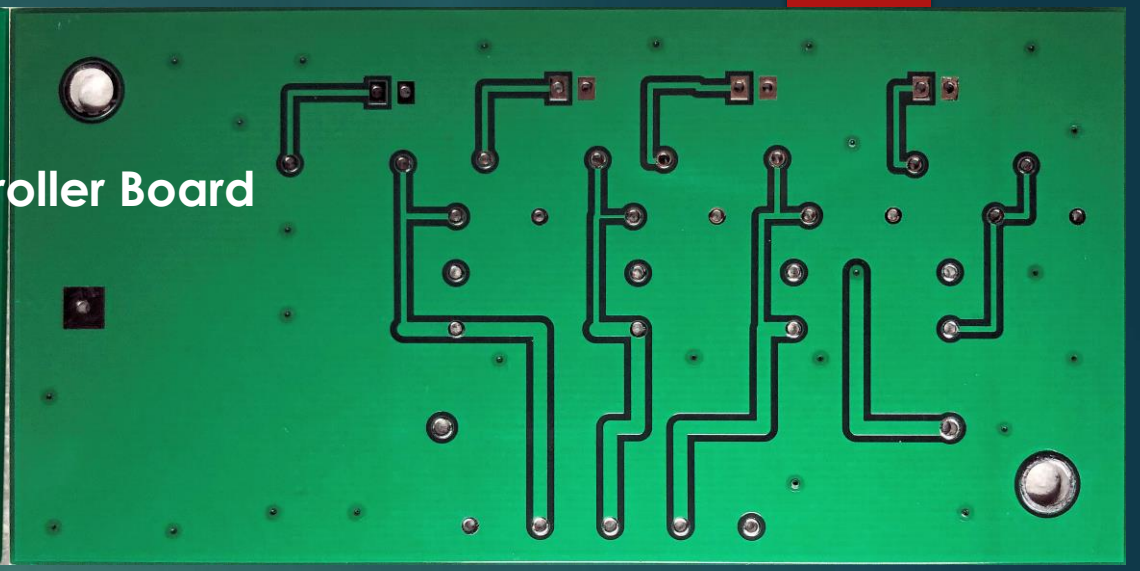
Added Inductor

TOP

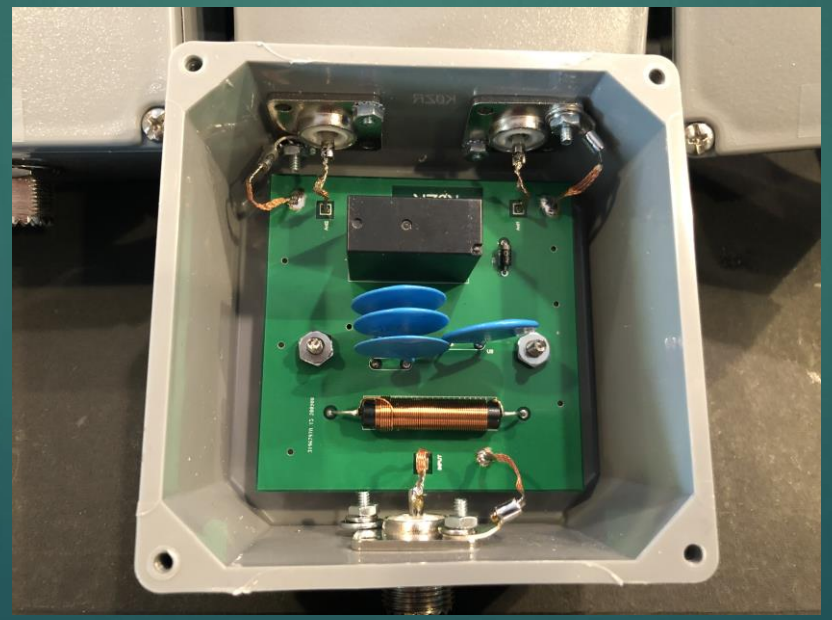
BOTTOM



Controller Board

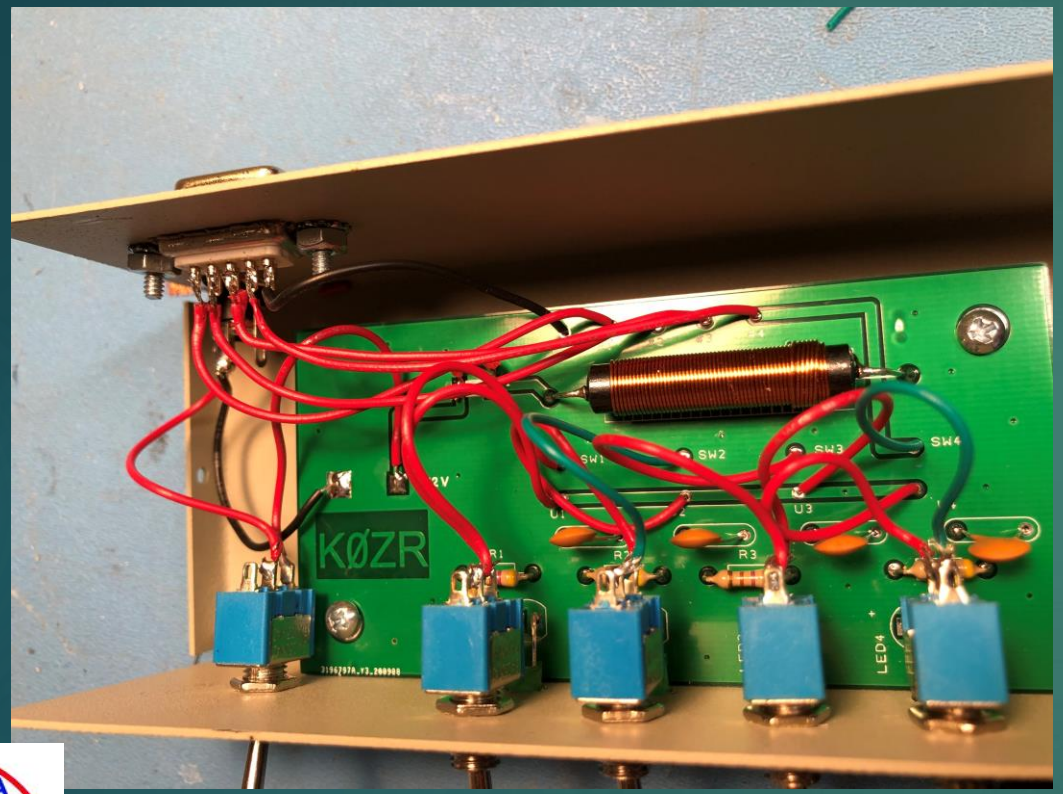


Remote Relay



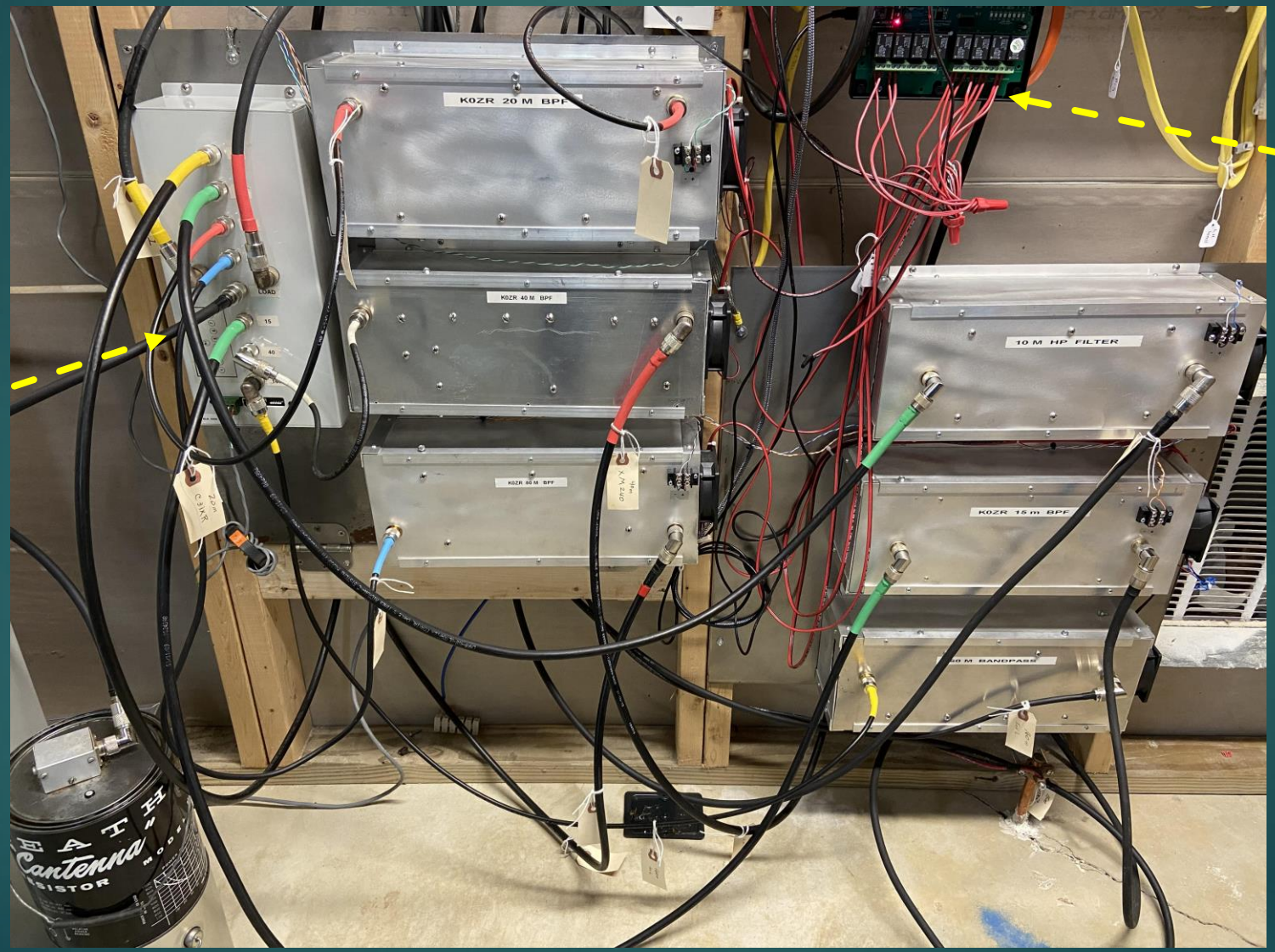
Weatherproof Housing

Controller – Four 1x2 Remote Switches



LOUDOUN AMATEUR RADIO GROUP
K4LRG

Beneath the Shack



2x8 antenna switch matrix

Remotely-commanded fan controller for each KW filter to keep them cool

6, 2 KW BPF with 4 internal bias tees for antennas that can be switched

DOUN AMATEUR RADIO GROUP
K4LRG

Ready to Go !

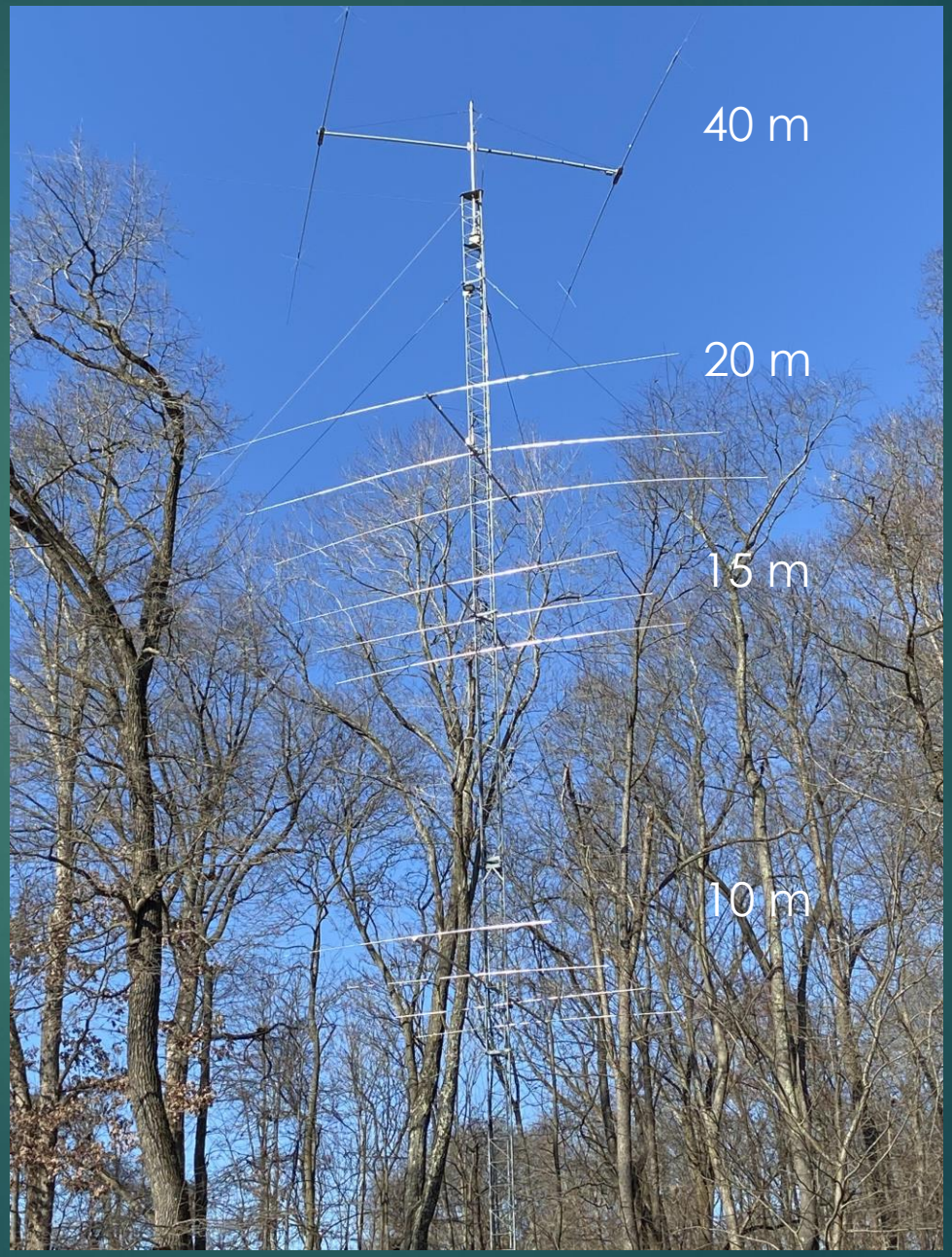
40m -- 2 elements @ 90 ft

20m -- 3 elements @ 67 ft

15m -- 3 elements @ 57 ft

10m -- 4 elements @ 30 ft

Tower is guyed at
26 ft, 56 ft, and 80 ft

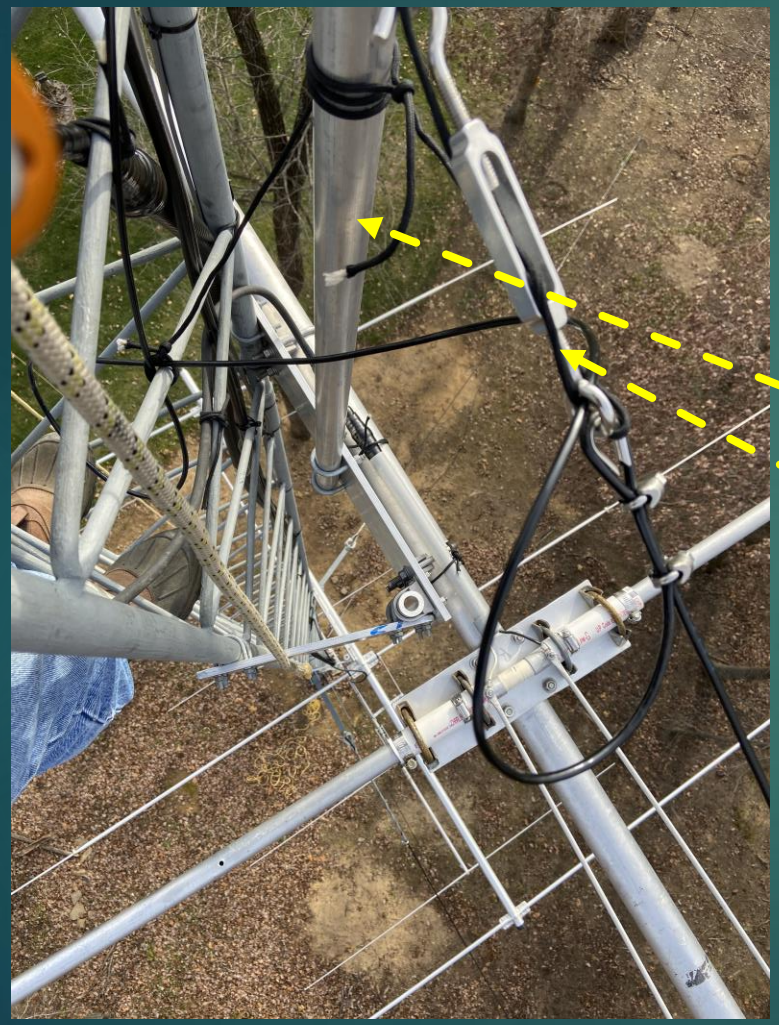


BUT, This Was the Simple Part

- The guyed tower was installed in the only possible orientation such that guy lines were not in unsuitable places

- Side-mounting the antennas gave an azimuth of ~ 190°; desired ~ 155°

Solution – Offset Each Yagi by ~ 50°



Antenna boom mounted on 6" x 20" x 3/8" aluminum plate

Need to cant the boom ~ 50 degrees to the East
Antenna mast plate augmented with another 4" plate to "push off" the boom to desired direction

3 ft high "post" for truss cables giving additional boom support

Turnbuckle to tension phillystran truss cable

A Closer Look

Working on 20m yagi at 67 Ft

1 ¼" OD aluminum tubing
Serves as hinge point

4" wide aluminum plate to interface with 6" boom aluminum plate

First instantiation of offset mount done on lower (30 ft) 10m yagi then duplicated for higher yagis

Some drilling required "at height"

Solution more than adequate for this size of antenna; rethink for larger yagis with > 24 ft booms

In Summary

Added significant operational flexibility and timeliness to station with the addition of three more yagis and the rapid switching ability

Saved significant dollars compared to a "bought" solution

Cannot "buy" the boom offset mounts

All antennas and remote switches played magnificently in the just-completed CQWW CW contest the end of November

- 2,477 QSOs across 350 countries
- 40 hours BIC
- Cracked tooth behaved "mostly" during the contest !!!

The End
C U Next Year