North Texas NTMS Microwave Society

AA5C 222 MHz Transverter

Greg McIntire, AA5C

February 5, 2022

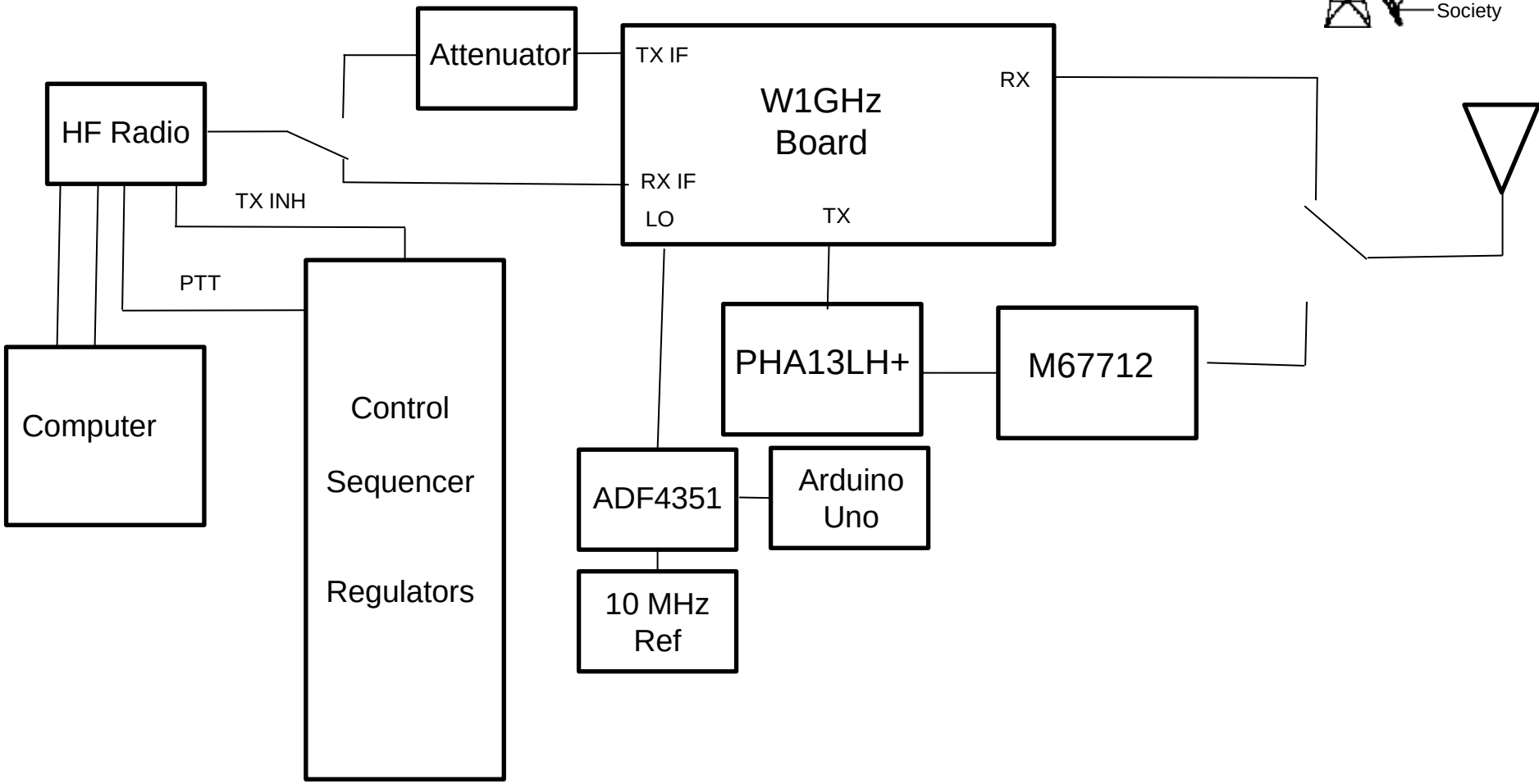
AA5C 222 MHz XVTR

North Texas NTMS Microwave Society

- Objectives
  - Replace original home brew 50-220 MHz XVTR from the 90s with a 28-222 MHz XVTR for portable use or in the shack
  - Reference the LO to accurate 10 MHz source for digital (MSK144) work
  - >=30 Watts RF out
  - Noise Figure =< 3dB
  - Controls for use with external SSPA
- Approach
  - Start with a W1GHZ Mark 3 222 MHz XVTR Board
  - Add IF, PA module, TX driver, control, and switching

222 MHz XVTR Block Diagram

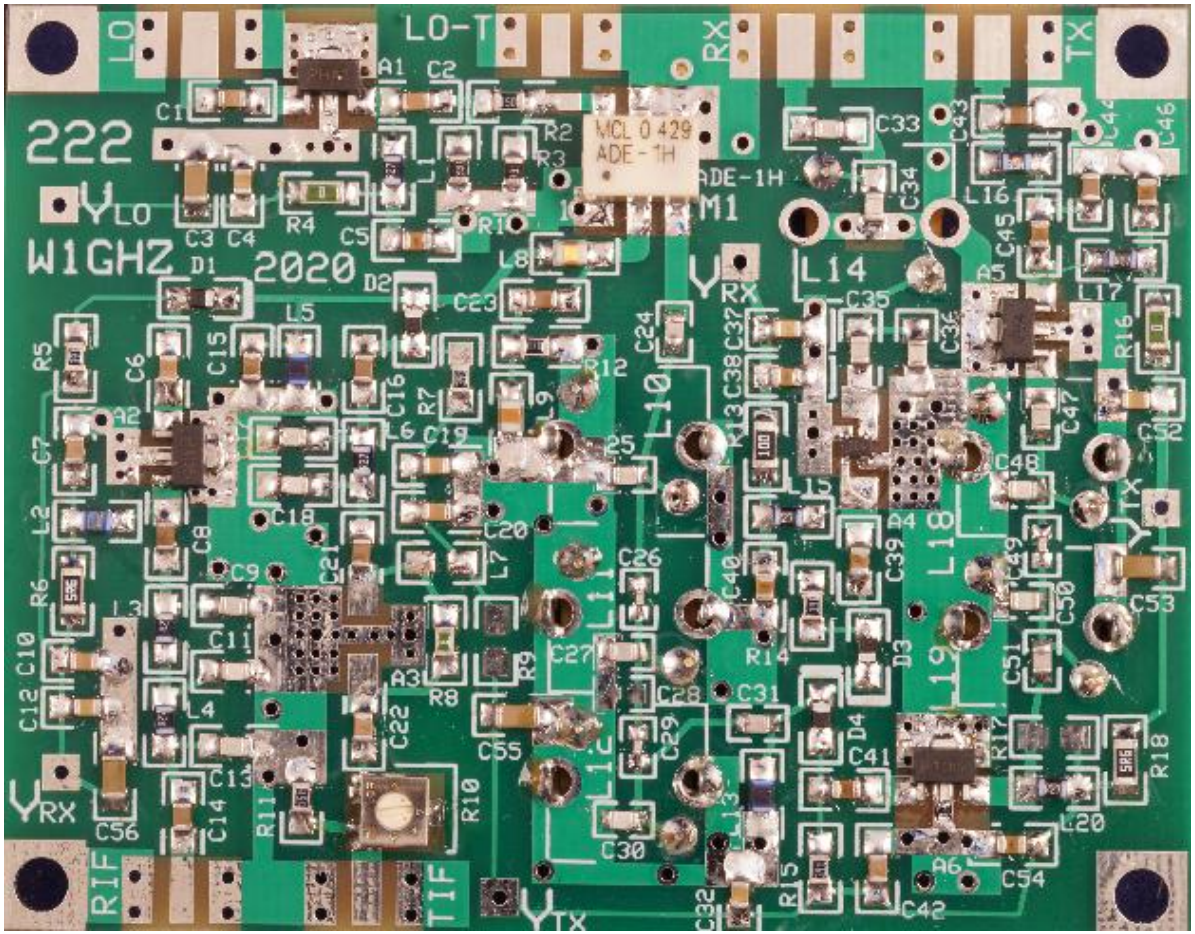
North Texas NTMS Microwave Society



W1GHZ Mark 3 (2021) 222 MHz XVTR Board – Component Side

North Texas NTMS Microwave Society

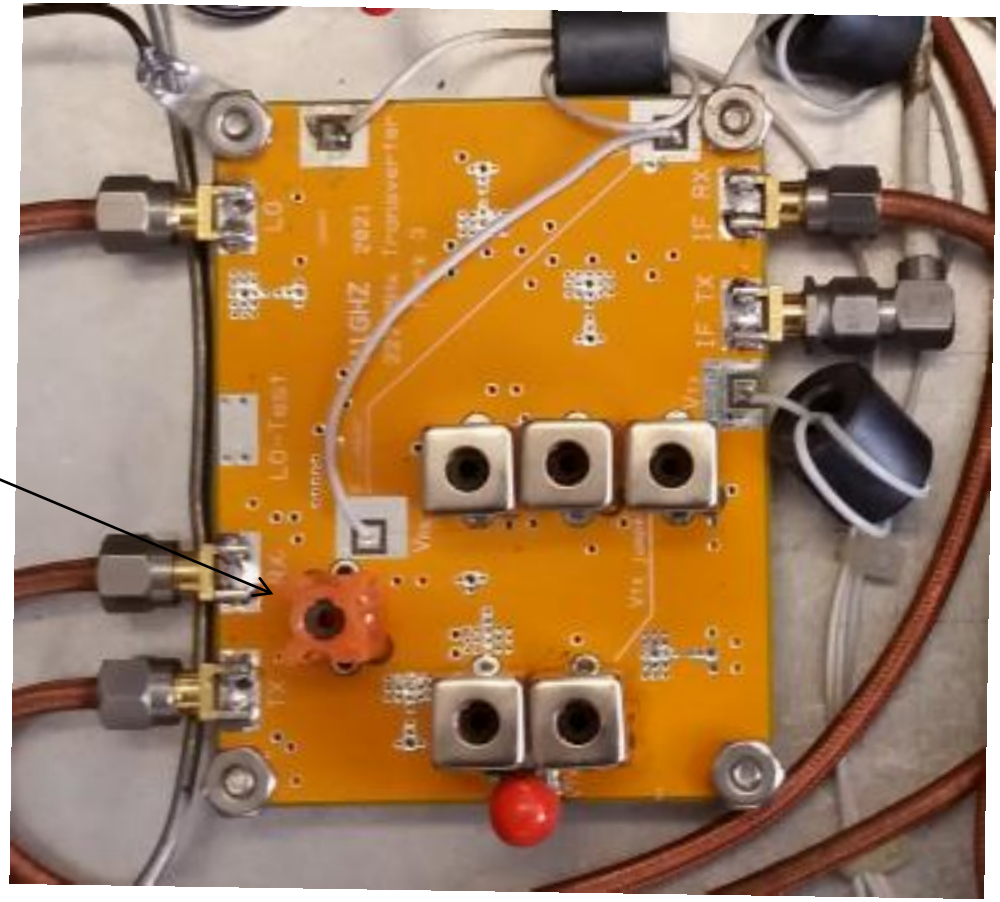
- Boards available from W1GHz
- Paul can provide a project list of parts to order from Mouser (about $70)
- Circuit Options
  - Mixer type and LO buffer
  - TX IF amp
  - LO test port



W1GHZ Mark 3 (2021) 222 MHz XVTR Board – Back Side

North Texas NTMS Microwave Society

Cover intentionally left off



222 MHz XVTR Front Panel

North Texas NTMS Microwave Society

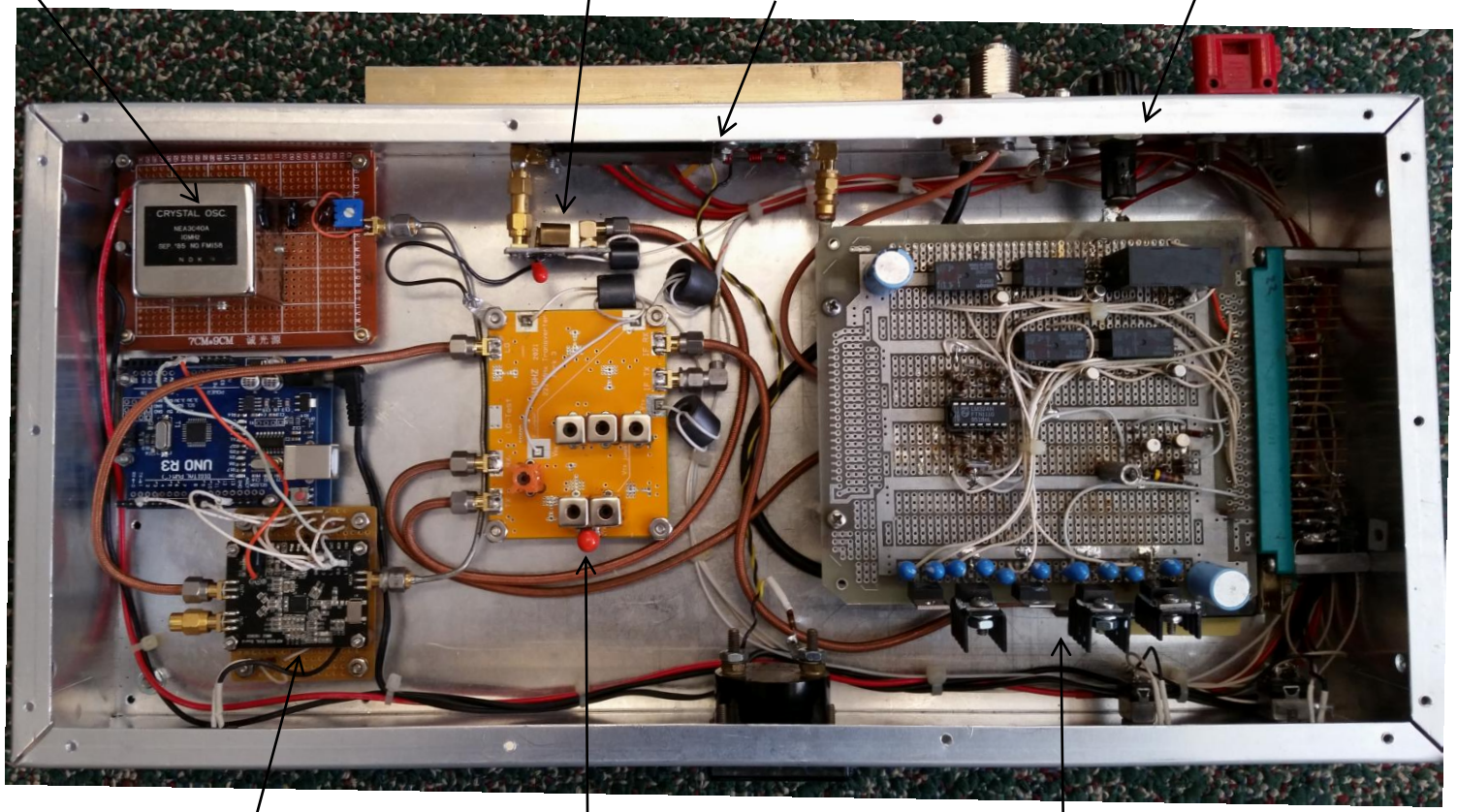
- Controls
  - Power
  - Enable TX
  - PA Bias
- Indicators
  - Power
  - ADF4351 Locked
  - Relative RF Output Power
  - XVTR Keyed

222 MHz XVTR Back Panel

- Power In
- Fuse
- PTT In – ground to TX
- TX Inhibit – 12VDC current limited in RX mode, off in TX mode
- RF
- IF
- Ext Amp Key – relay contacts off sequencer

North Texas NTMS Microwave Society

222 MHz XVTR Interior



RF and IF Relays and IF TX Attenuator

North Texas NTMS Microwave Society

RF Relay

55 dB Attenuator

IF Relay

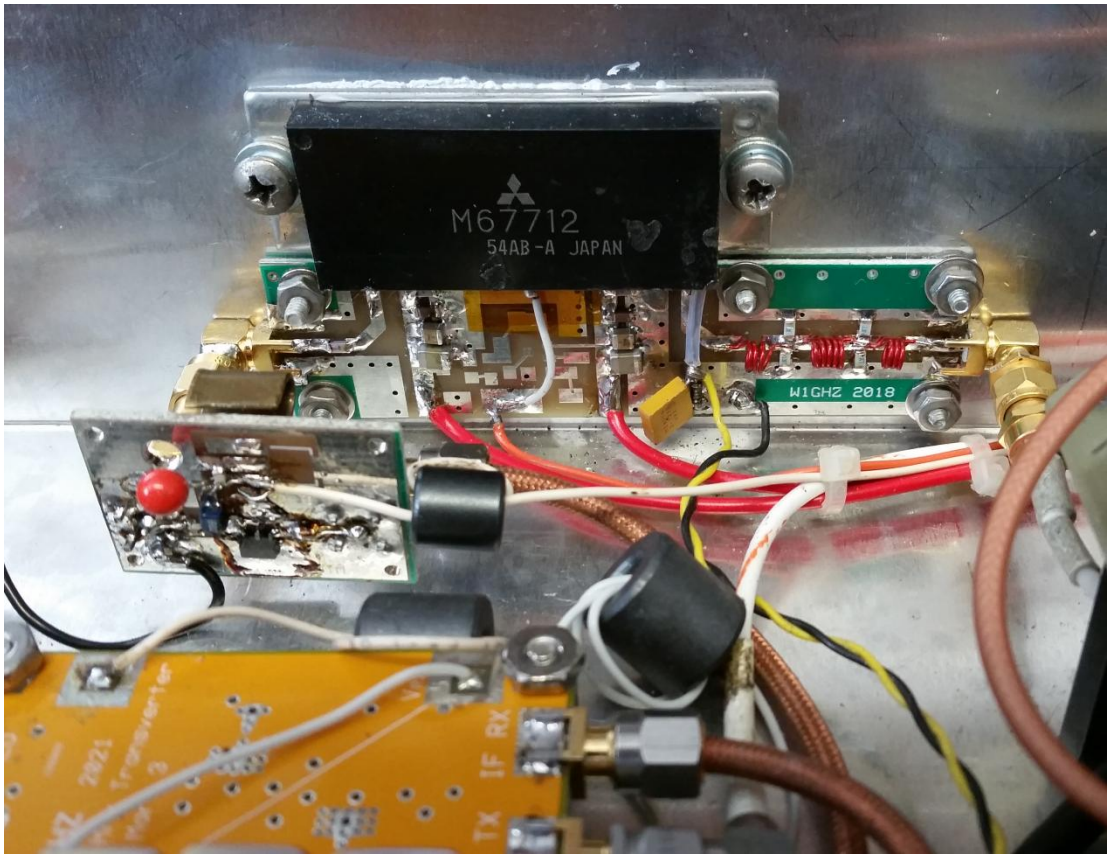
Located Under the Control Board to Save Space

28 MHz IF TX Attenuator

- 55 dB IF Attenuator
  - G150N 50W4B used for termination
  - 150 Watt Flange Mount
  - Used chassis for heat sink
  - DC-2.7 GHz
  - <$8 at Mouser
- Target IF Rig is a Yaesu FT897D
  - No XVTR output available
  - Minimum selectable output power on 28 MHz is 5W
  - No variable drive control
  - Provides PTT output
  - Accept TX INH for holding off RF output

Power Amplifier Section

- M67712 PA Module
  - 30W min, 40W max
  - +27 dBm max RF in
- PHA-13HLN+ Driver
- Output Low Pass Filter
- Output Power Detector
  - 1N5711 diode in parallel with 0.1 uF cap
  - Insulated lead close to output line for coupling
- M67712 bias line run from LM317 to control output power via front panel pot



RF Driver Amplifier

North Texas NTMS Microwave Society

- Amplifies output of W1GHz Board to fully drive M67712 PA module
  - W1GHz board max output = +17 dBm. I set HF drive for -15 dBm input to the XVTR board to balance TX chain power levels
  - 27 dBm from driver to M67712 module for 40W out
- Used Mini-Circuits PHA-13HLN+ MMIC
  - 1 MHz to 1 GHz part
  - 23 dB gain at 250 MHz
  - P1dB 28.4 dBm at 250 MHz
  - SOT-89 Package
  - ~250 mA at 8V = 2W power input => lots of plated through holes and heat sinking on back of board for cooling
  - ~ $10 each at Mini-Circuits
- Two Lessons Using This Part
  - VERY static sensitive
  - Had failure at rated 8 VDC Vd so reduced Vd to 6 VDC

222 MHz XVTR Performance

North Texas NTMS Microwave Society

- Transmit
  - 40 Watt output power - max from M67712 module
  - Power meter set for full scale at 40 W output
  - PA Bias control provides variable drive level to 1 KW SSPA
- Receive
  - 2.1 dB NF
  - 22.8 dB gain
- General
  - Takes OCXO about 15 minutes to warm up but then very stable

222 MHz XVTR Summary

North Texas NTMS Microwave Society

- Result is a nice, modern 28 MHz to 222 MHz XVTR for about $200 total parts
- W1GHZ board worked well and Paul provides good documentation
    - Several areas of flexibility depending upon your needs
    - Did have a TX oscillation issue that was dependent on board height above the chassis
- Mitsubishi power modules still available for a reasonable price on eBay
- Sequencer mandatory
        - Easy to blow out IF RX back end if you aren't careful
        - TX INHIBIT control to Yaesu FT-897D a weak but manageable link in the system.