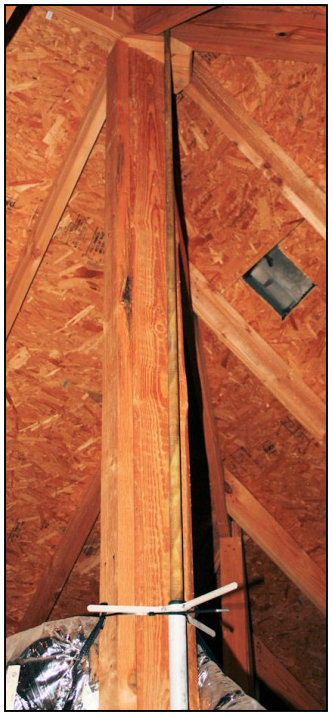
# 12 W 10 GHz Station

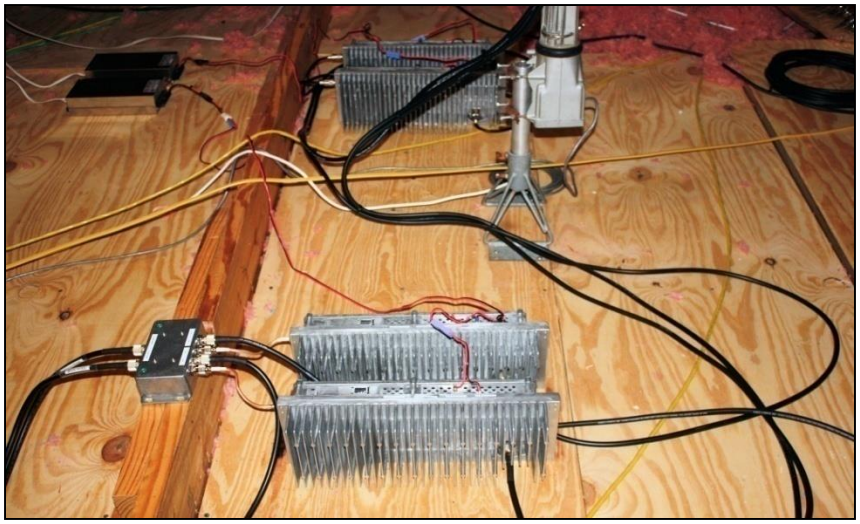
*DESIGNED FOR "ANTENNA CHALLENGED" LOCATION*

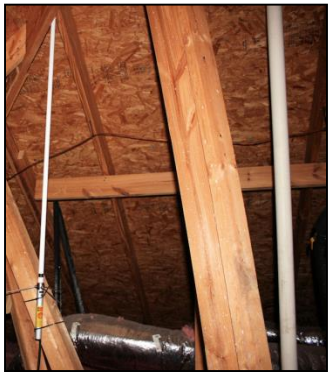
# Initial Comments

- Why 10 GHz ?
  - Microwave interest
  - The challenge
  - Contest multiplier
- 10 GHz propagation characteristics
  - Line of sight propagation
  - Signals can bounce off water towers, rain clouds, airplanes
  - Signals can diffract (spread out) from object edges or apertures
  - Troposcatter can occur
- Why stealth ?
  - Restrictive neighborhood covenants !

# Some Attic Photos







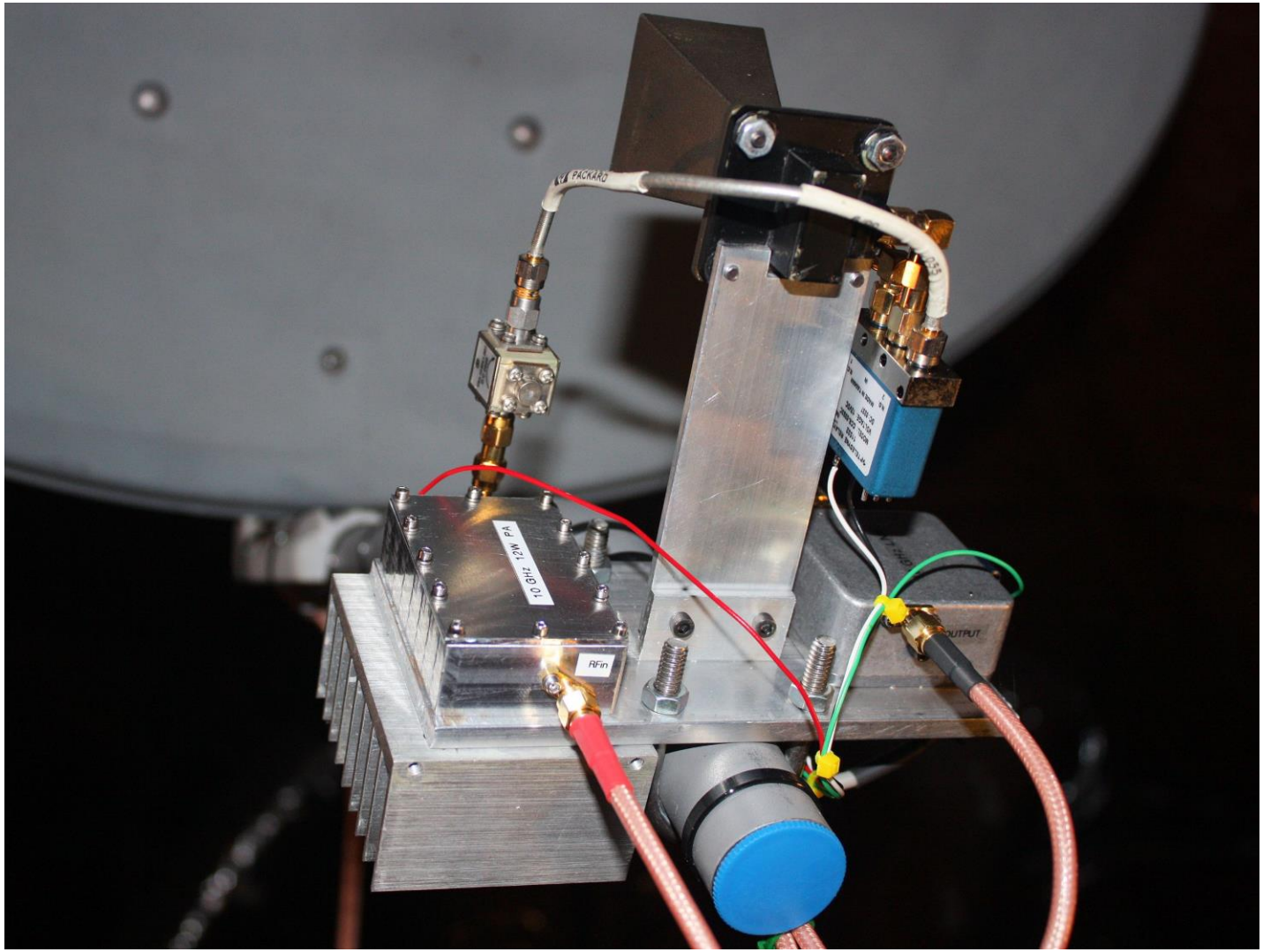
# Transverter & Dish in Attic

# Antenna Considerations

- Location is critically important
  - View of the horizon
  - Elevation
  - Low loss to PA and LNA  (co-located at dish feed)
- High gain
  - Parabolic dish with offset horn feed.
  - Gain is approximately 40 dB
  - Azimuth and elevation control is needed to properly point dish
- Identify bearings of key features around QTH
  - Reflection targets, like water towers
  - Other 10 GHz stations
  - Beacons

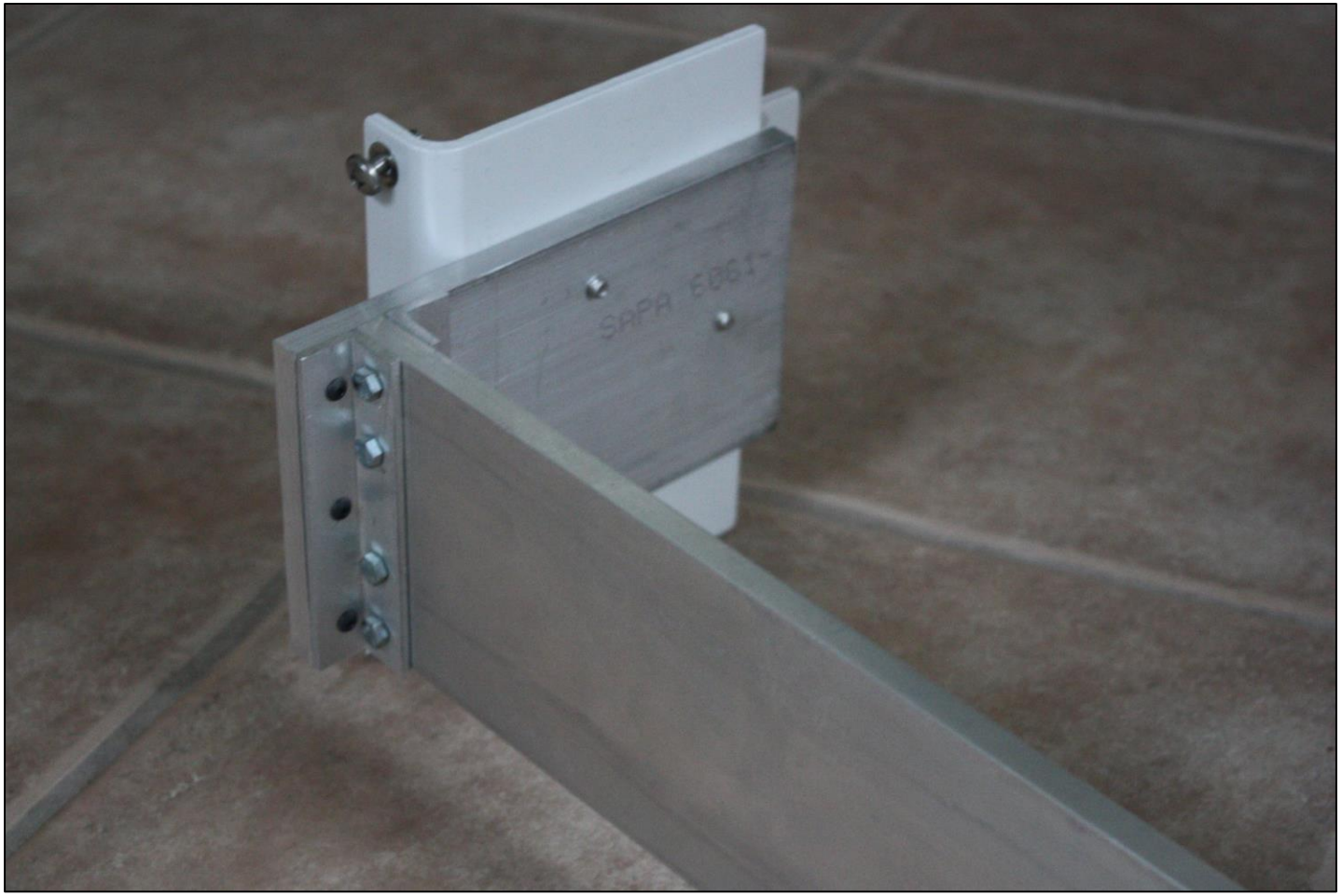
# Dish in Attic

# Dish-feed with LNA and 12W PA



# Mounting Bracket Attached to Dish

# Homebrew Mounting Bracket



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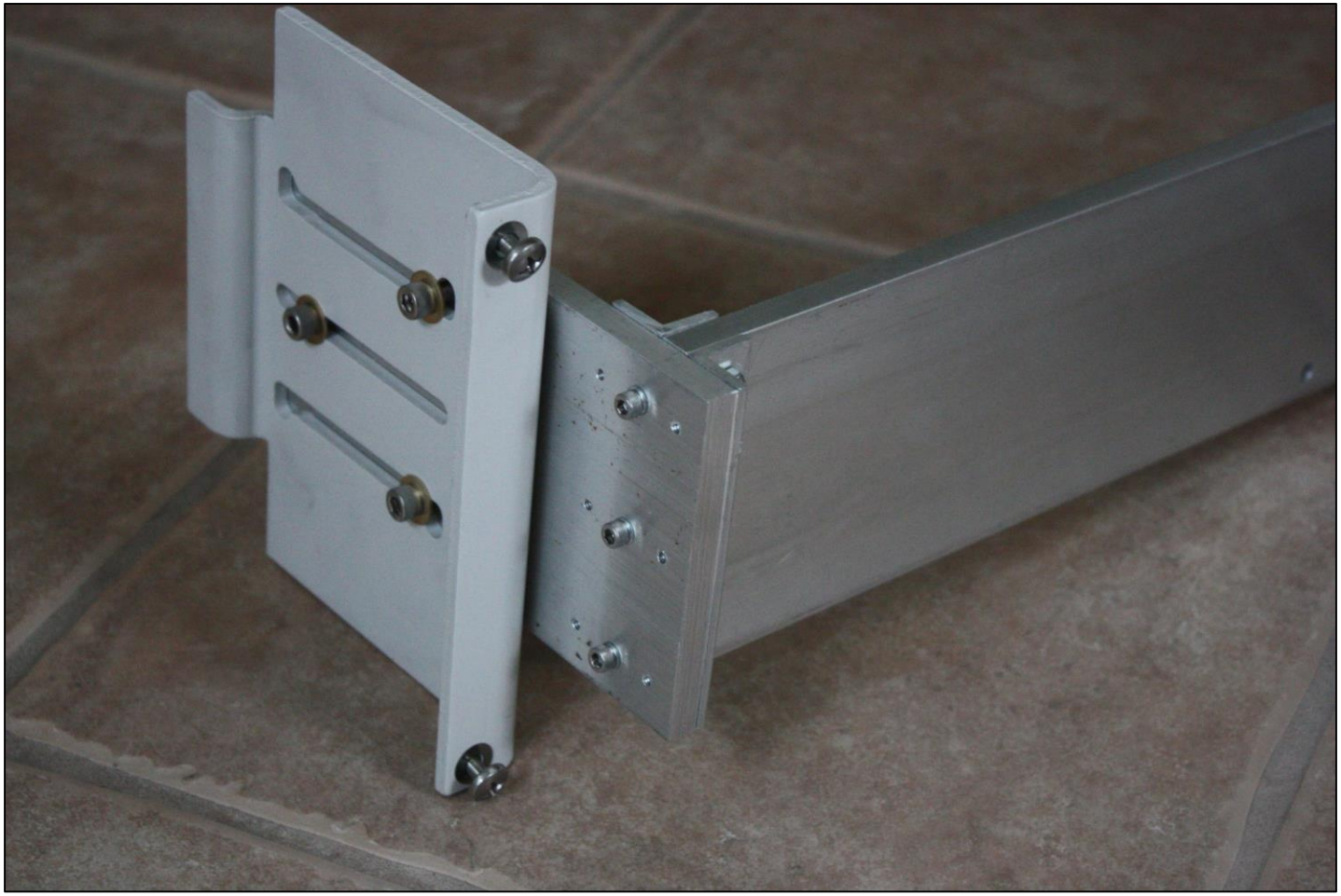
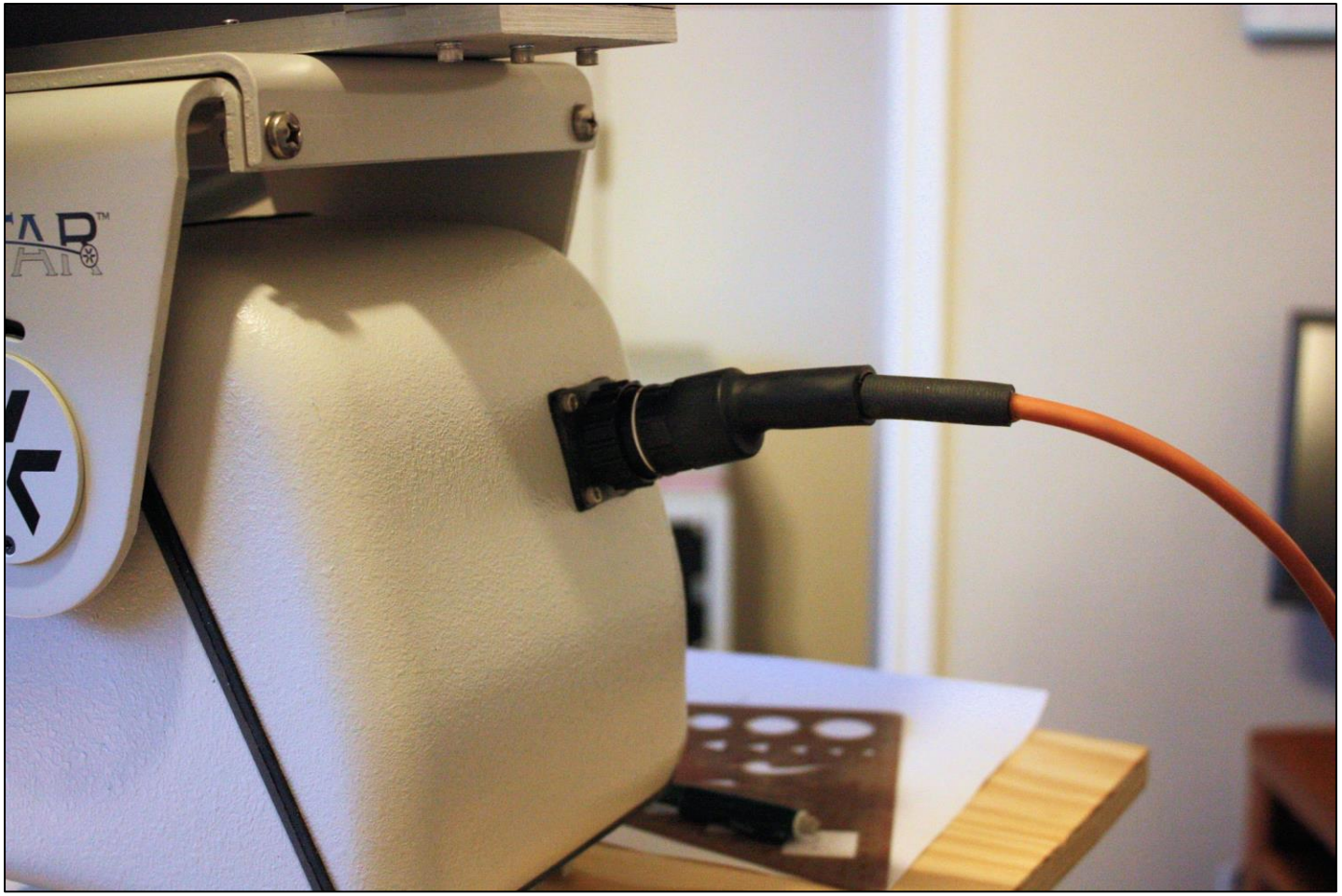


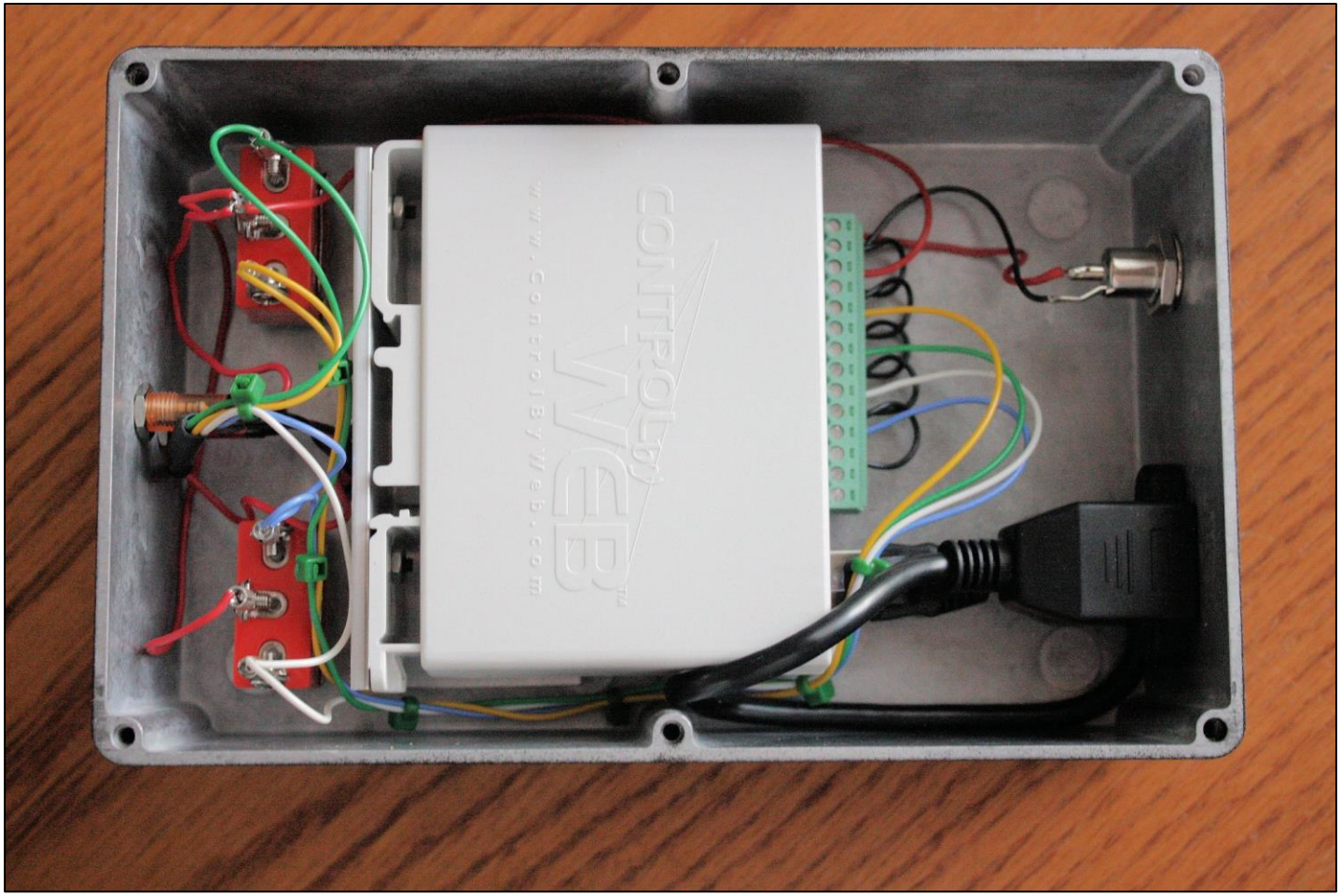
# Azimuth – Elevation Positioner



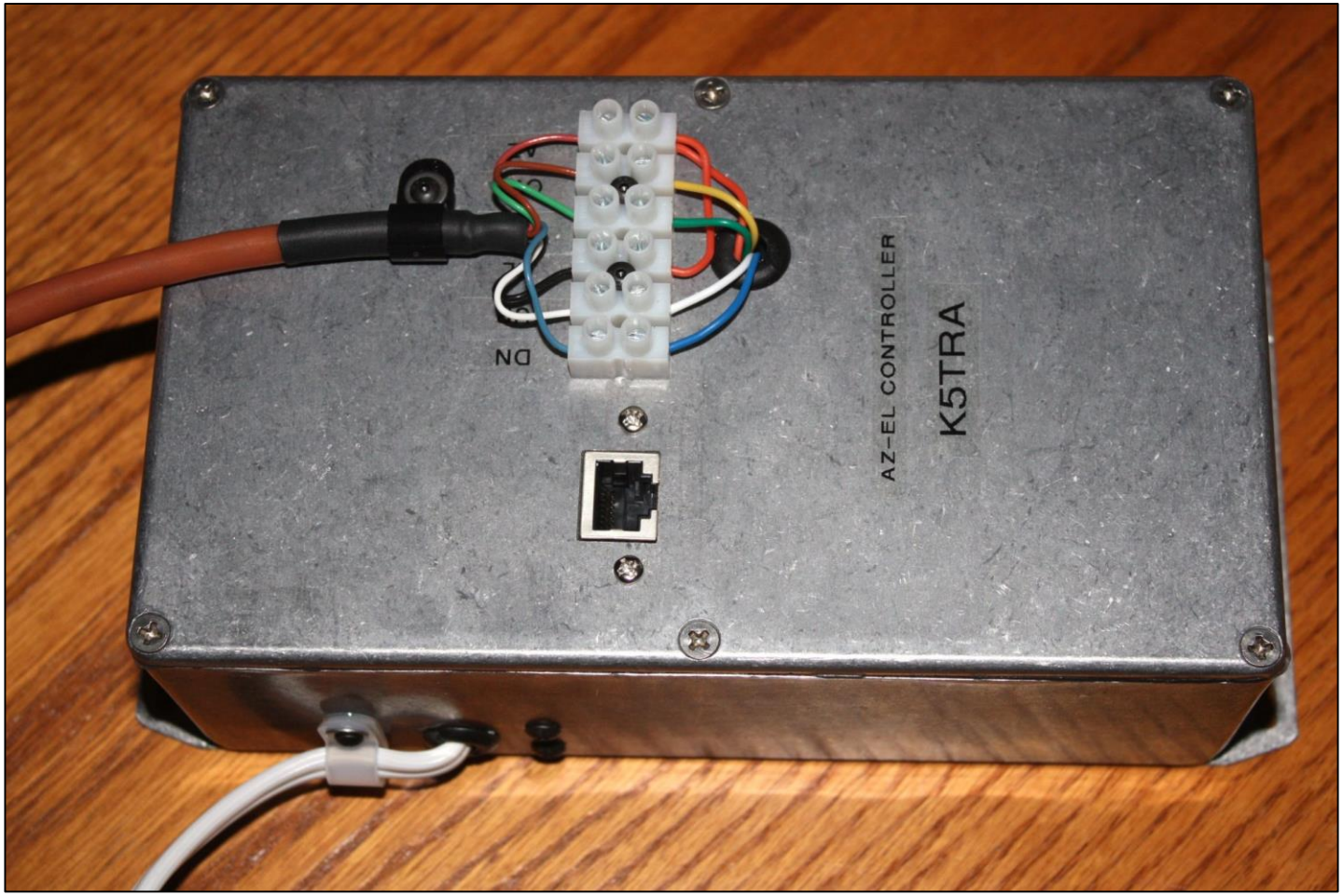
# Positioner Controller - Front

# Positioner Controller - Rear

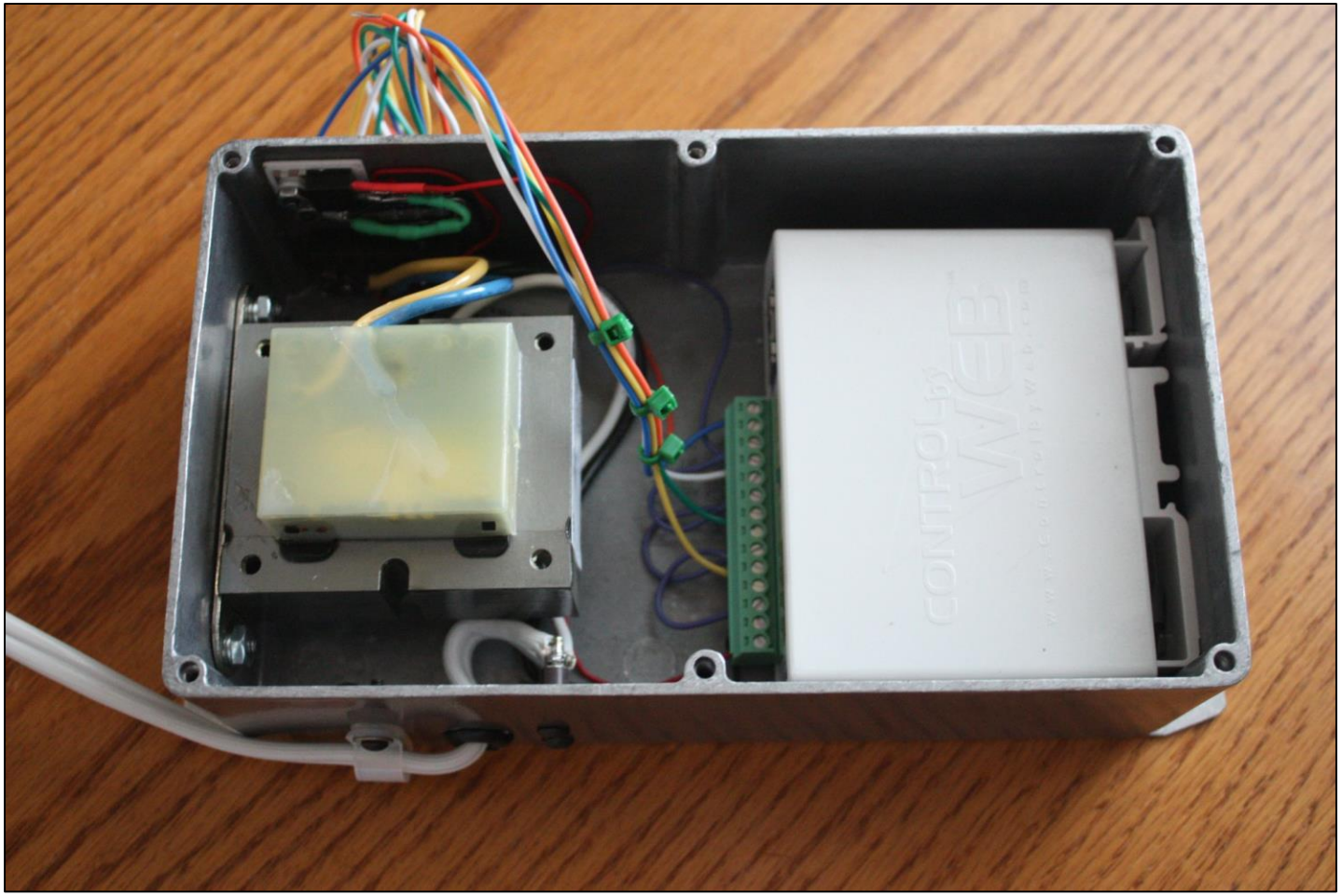
# Positioner Controller - Interior



# Positioner Remote Interface



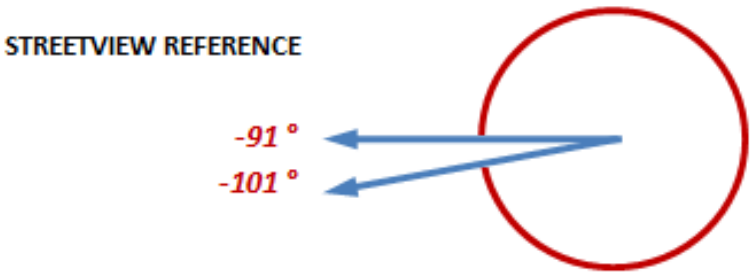
# Positioner Remote Interface - Interior



# Pointing Chart

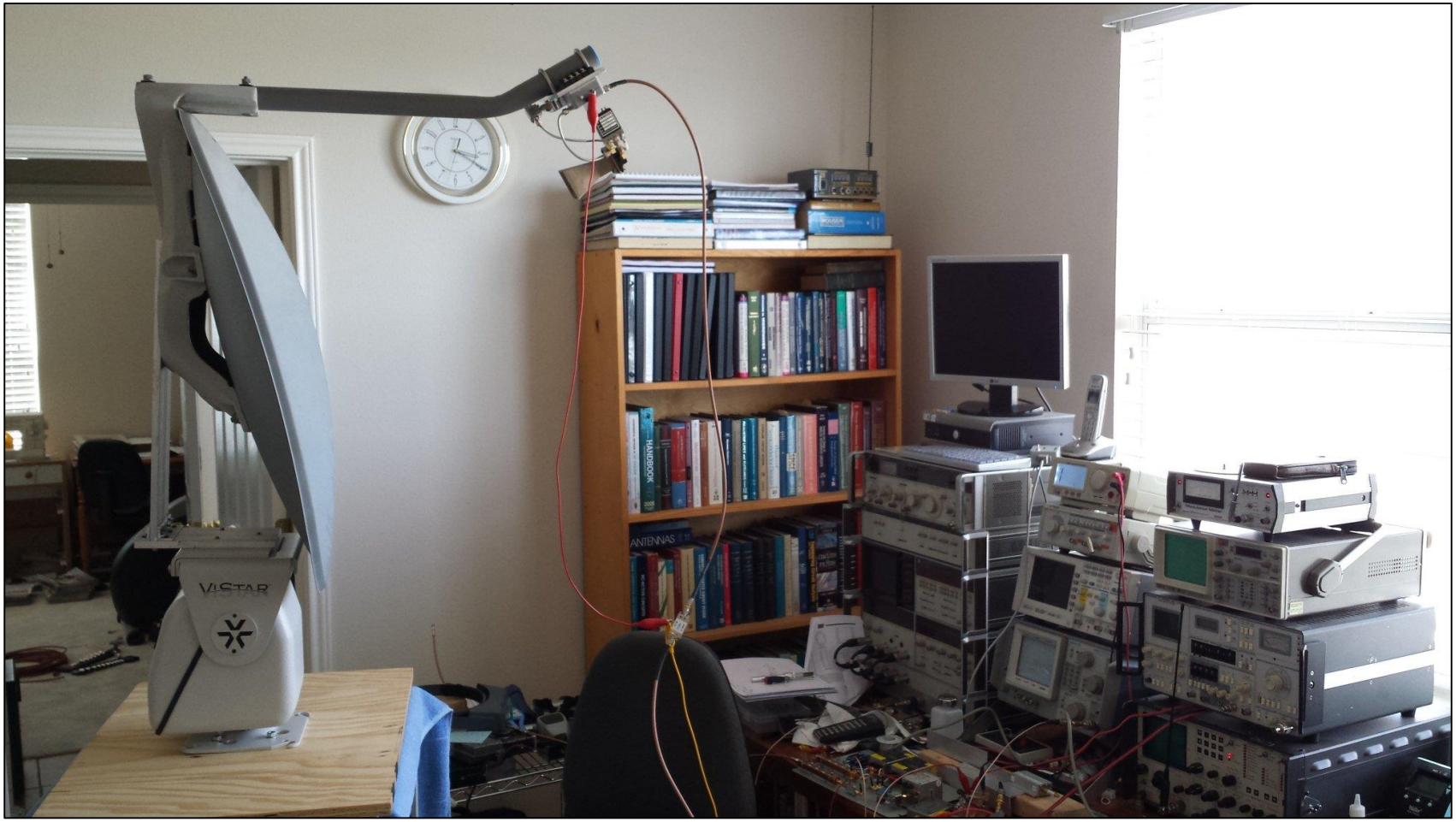
| ID | Bearing | Alt.Bearing | Street Ref. | Alt.Street Ref. | CW ΔT (Sec) | CCW ΔT (Sec) |
|---|---|---|---|---|---|---|
| K5AND | 296 | -64 | 269 | -91 | 0 (ref) | 58 |
| K5GJ | 315 | -45 | 288 | -72 | 3 | 55 |
| NO5K | 15 | 15 | -13 | -13 | 13 | 45 |
| BEACON | 54 | 54 | 27 | 27 | 20 | 38 |
| WmCannon TOWER | 63 | 63 | 36 | 36 | 21 | 37 |
| K5LLL | 90 | 90 | 63 | 63 | 26 | 32 |
| N5YC | 136 | 136 | 109 | 109 | 33 | 25 |
| WA6UFQ | 156 | 156 | 129 | 129 | 37 | 21 |
| K5VH | 249 | -112 | 222 | -139 | 52 | 6 |
| W3XO | 266 | -94 | 239 | -121 | 55 | 3 |
| K5TR | 268 | -92 | 241 | -119 | 55 | 3 |
| ThomasSprings TOWER | 280 | -80 | 253 | -107 | 57 | 1 |

**Covered Bridge ---> points +27 °**

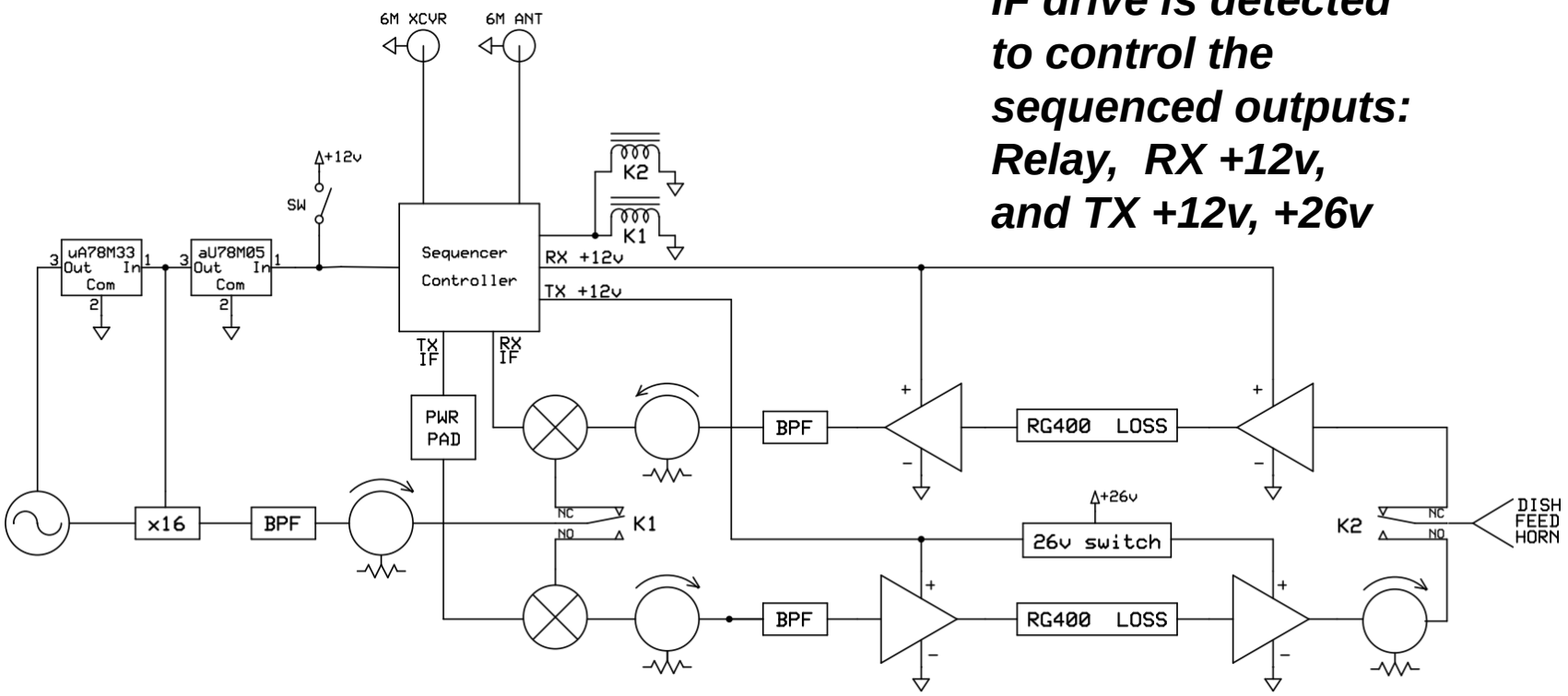



T.Apel

# Bench Test of Dish Assembly and Positioner



# Block Diagram




***IF drive is detected to control the sequenced outputs: Relay, RX +12v, and TX +12v, +26v***

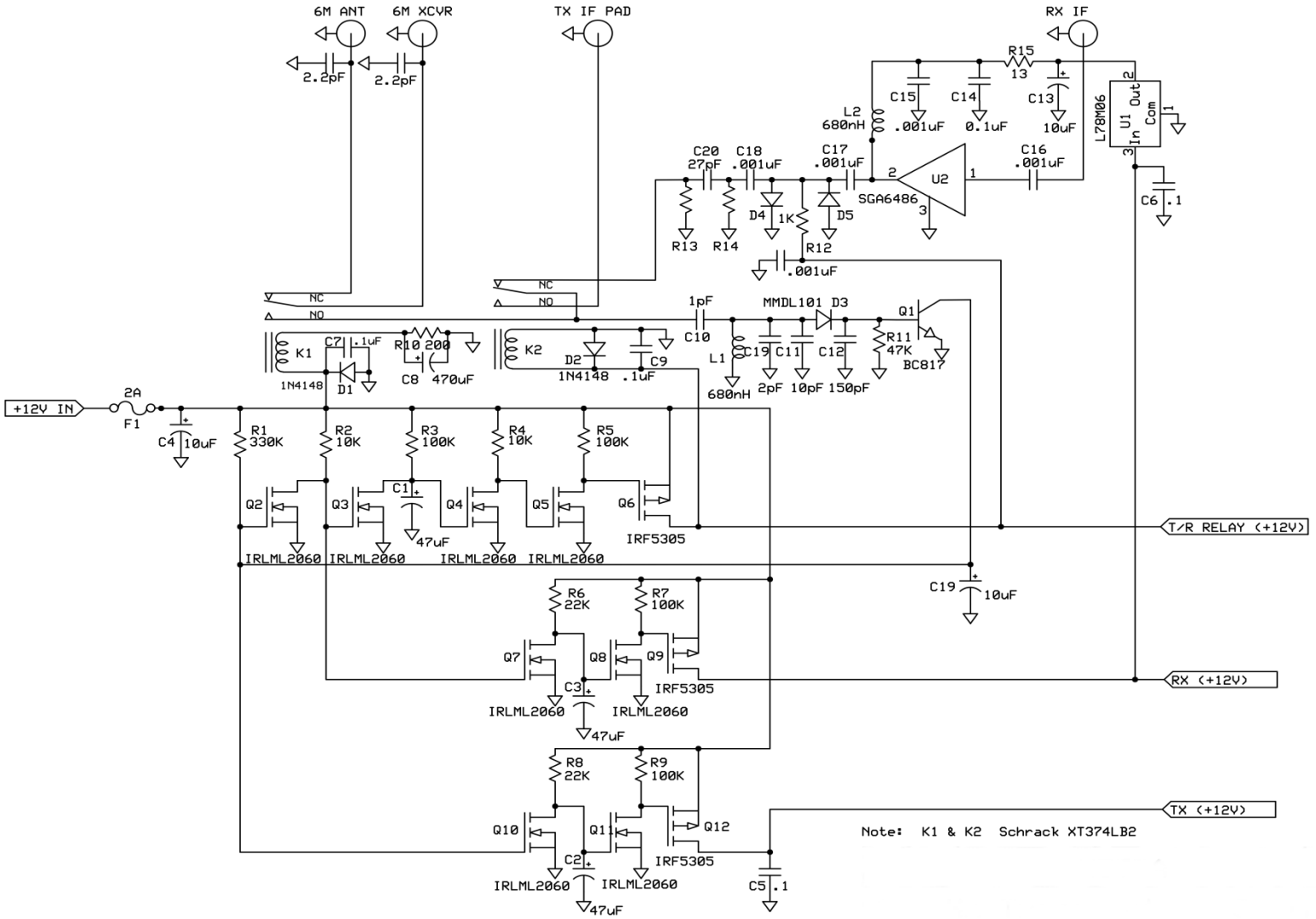
***LNA and PA are located with a SMA coaxial relay at the dish horn-feed***

# Gain & Power Budget

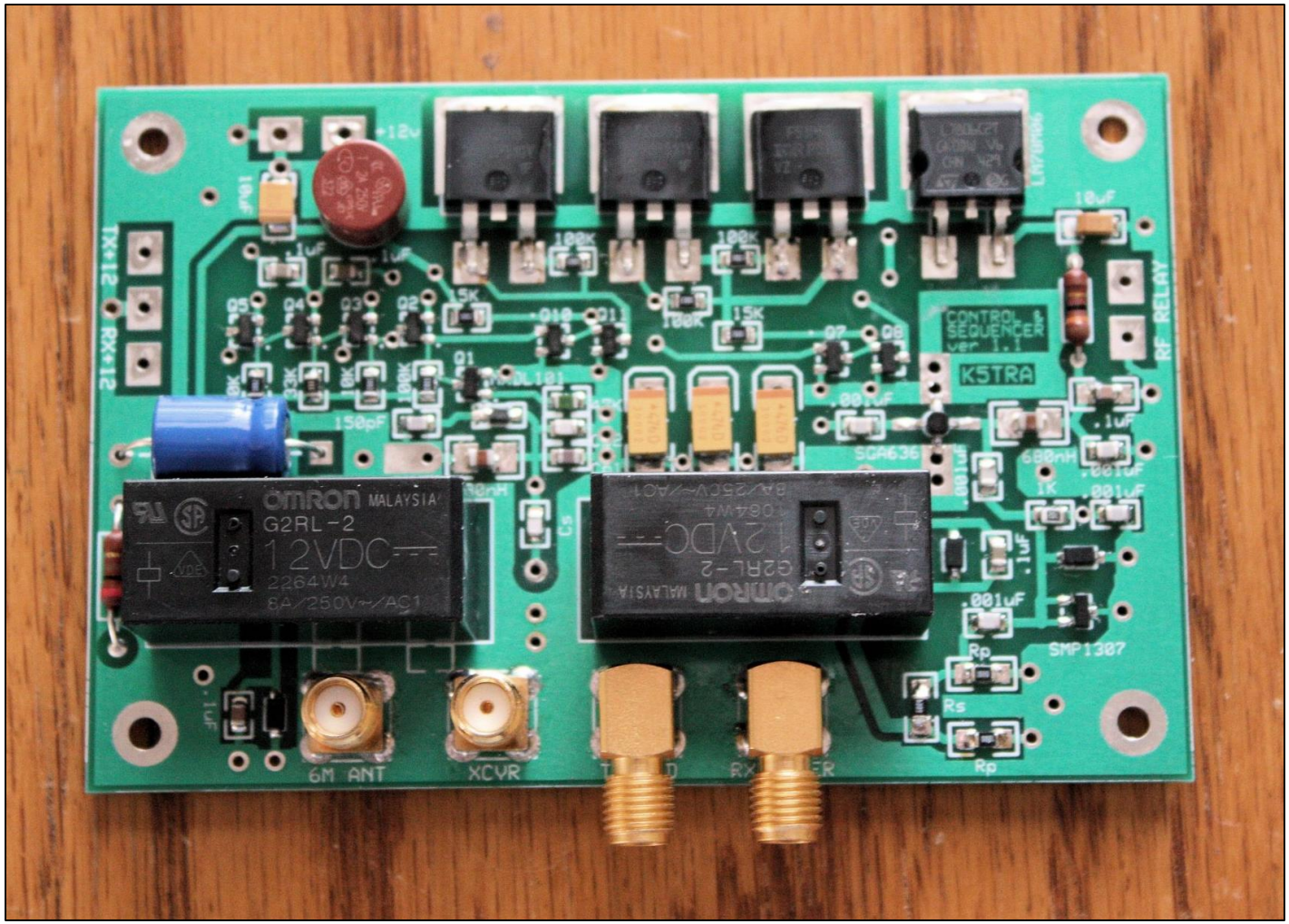
| TRANSMIT | Gain | Output Level |
|---|---|---|
| Isolator | -0.3 | 41.7 |
| PA | 26.0 | 42.0 |
| RG400 | -8.0 | 16.0 |
| Driver | 38.4 | 24.0 |
| BPF | -2.0 | -14.4 |
| Isolator | -0.3 | -12.4 |
| Mixer | -7.5 | -12.1 |
| TX IF pad | -55.0 | -4.6 |
| IF XCVR | | 50.4 |
| Total Gain = | -8.7 | |

| RECEIVE | Gain | Input Level |
|---|---|---|
| LNA | 18.0 | -140.0 |
| RG400 | -8.0 | -122.0 |
| RF Amp-2 | 17.0 | -130.0 |
| BPF | -2.0 | -113.0 |
| Isolator | -0.3 | -115.0 |
| Mixer | -7.5 | -115.3 |
| RX IF Amp & pad | 12.0 | -122.8 |
| IF XCVR | | -110.8 |
| Total Gain = | 29.2 | |

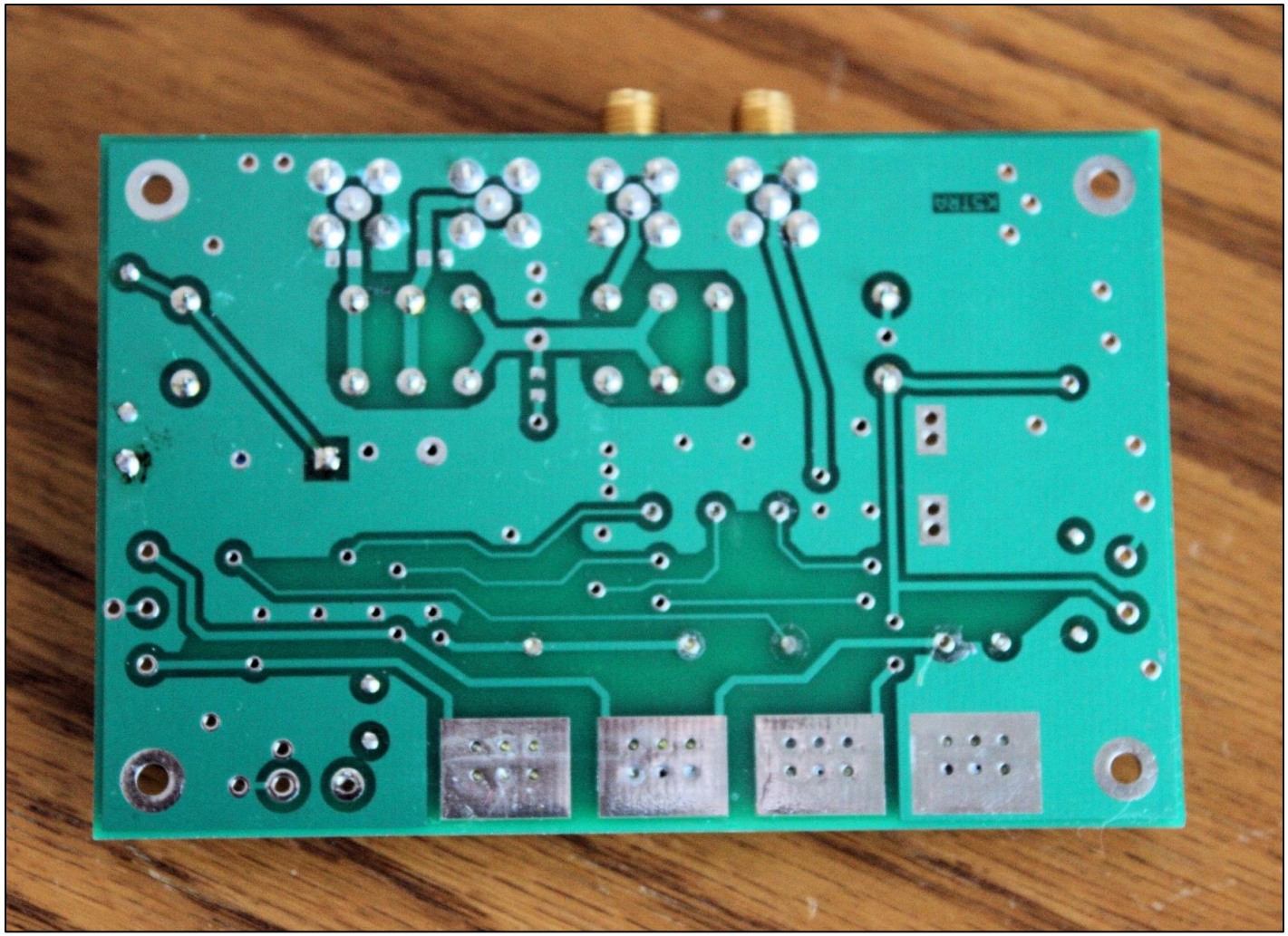
# Sequencer – Controller Schematic



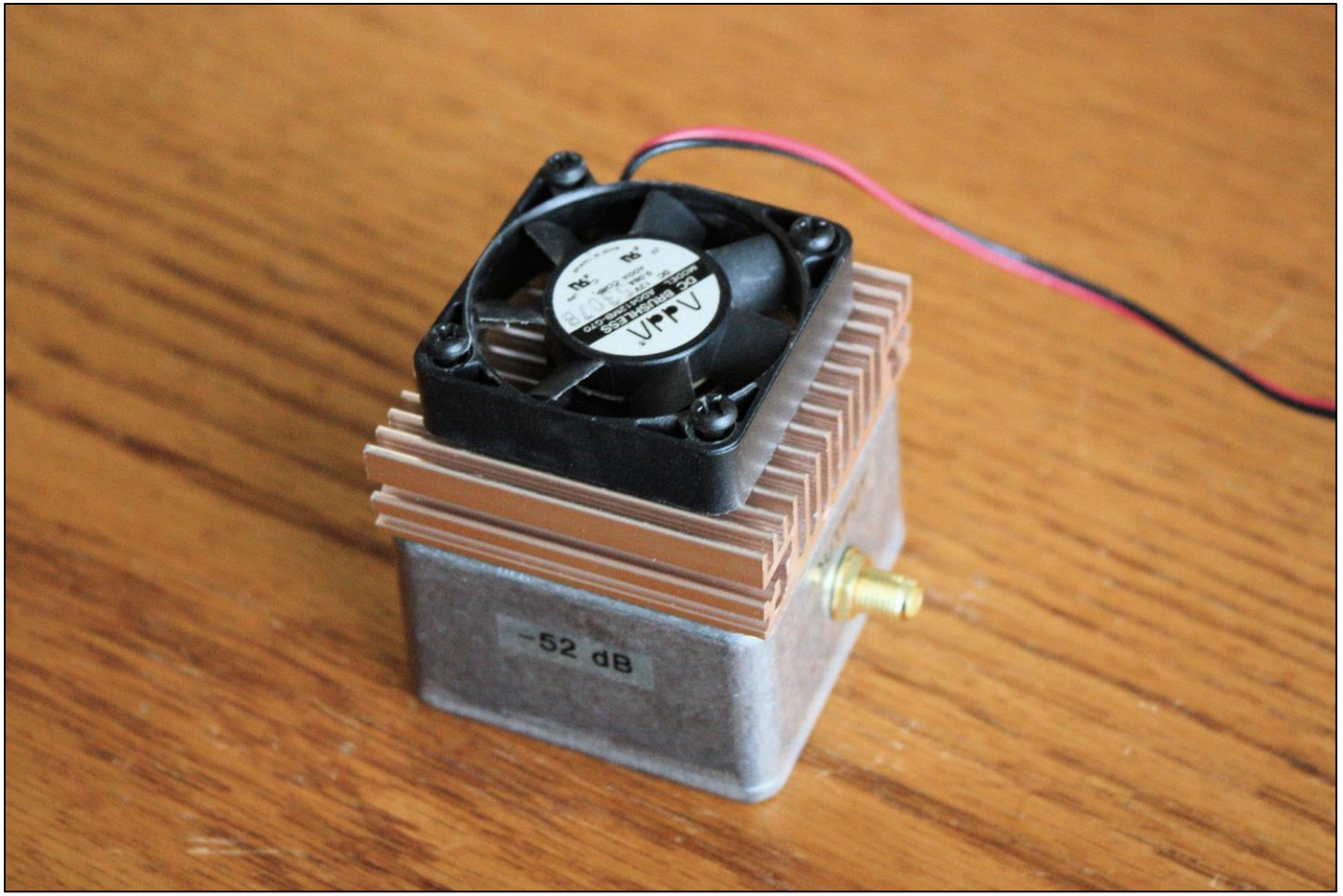
# Sequencer – Controller



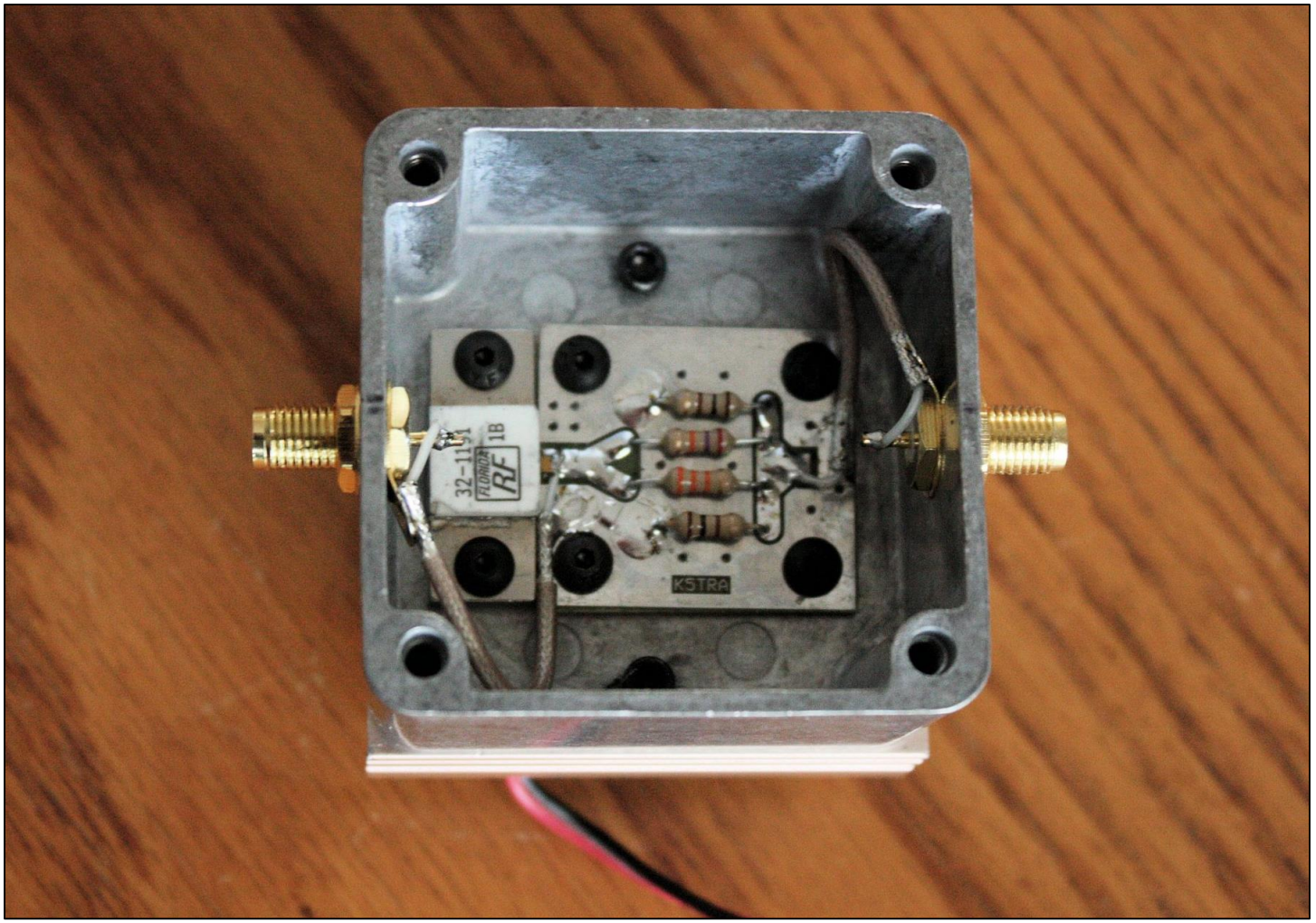
# Sequencer – Controller (back side)



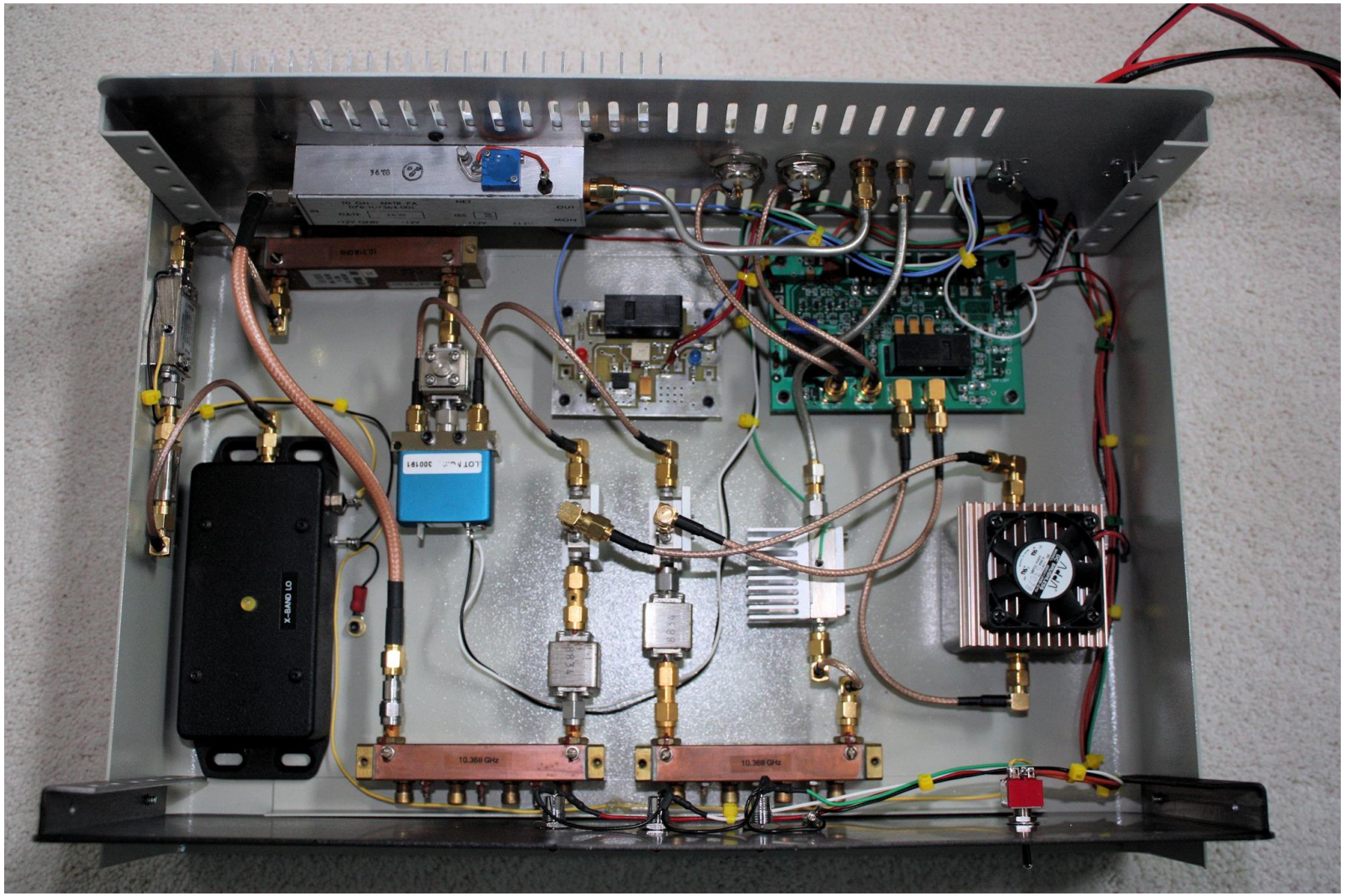
# IF Power Pad



# IF Power Pad Interior



# Transverter Interior



# Transverter - Front

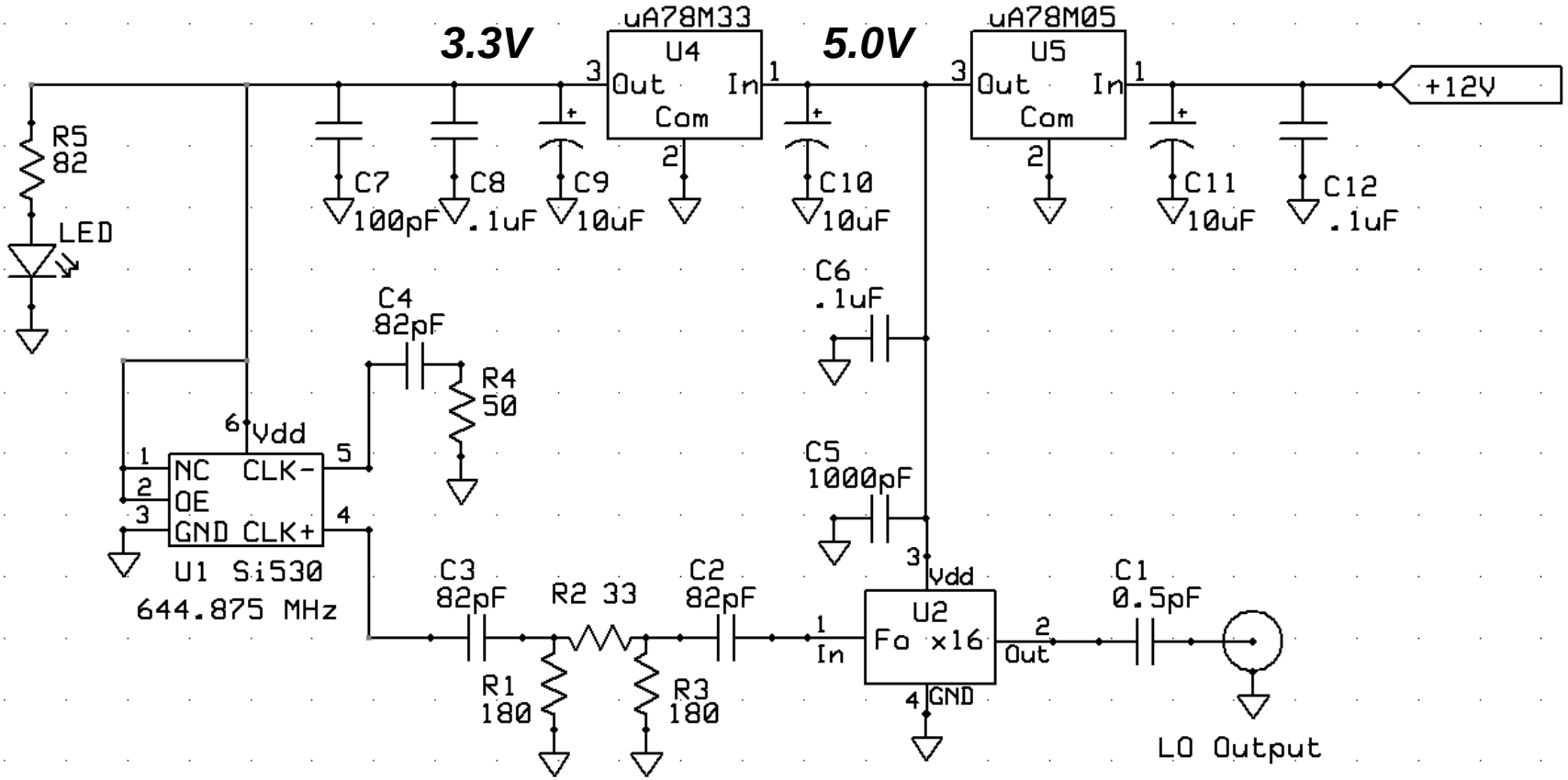
# Transverter - Rear

# Frequency Plan and LO Design

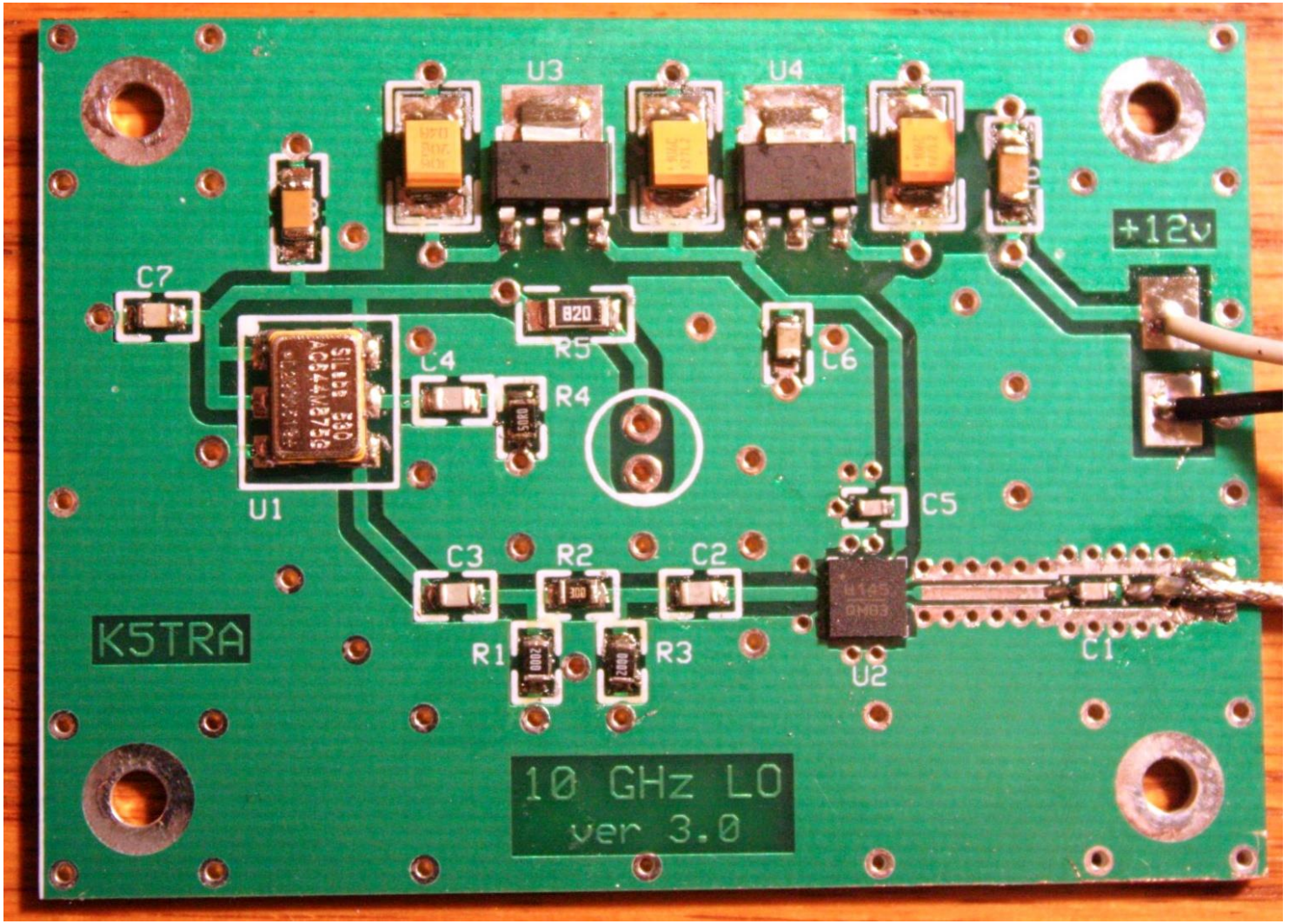
- IF frequency = 50 MHz
- LO frequency = 10,318 MHz  (RF= 10,368.0 MHz)
- Silicon Labs **Si530** source at 644.875 MHz
- Hittite **HMC445LP4E**  x16 frequency multiplier
- Si530 DC supply is double regulated for stability
- LO filter:  Farinon 4 pole evanescent mode WG
- Also in LO path: isolator and coaxial relay
- Magnum Microwave mixers

# LO Module

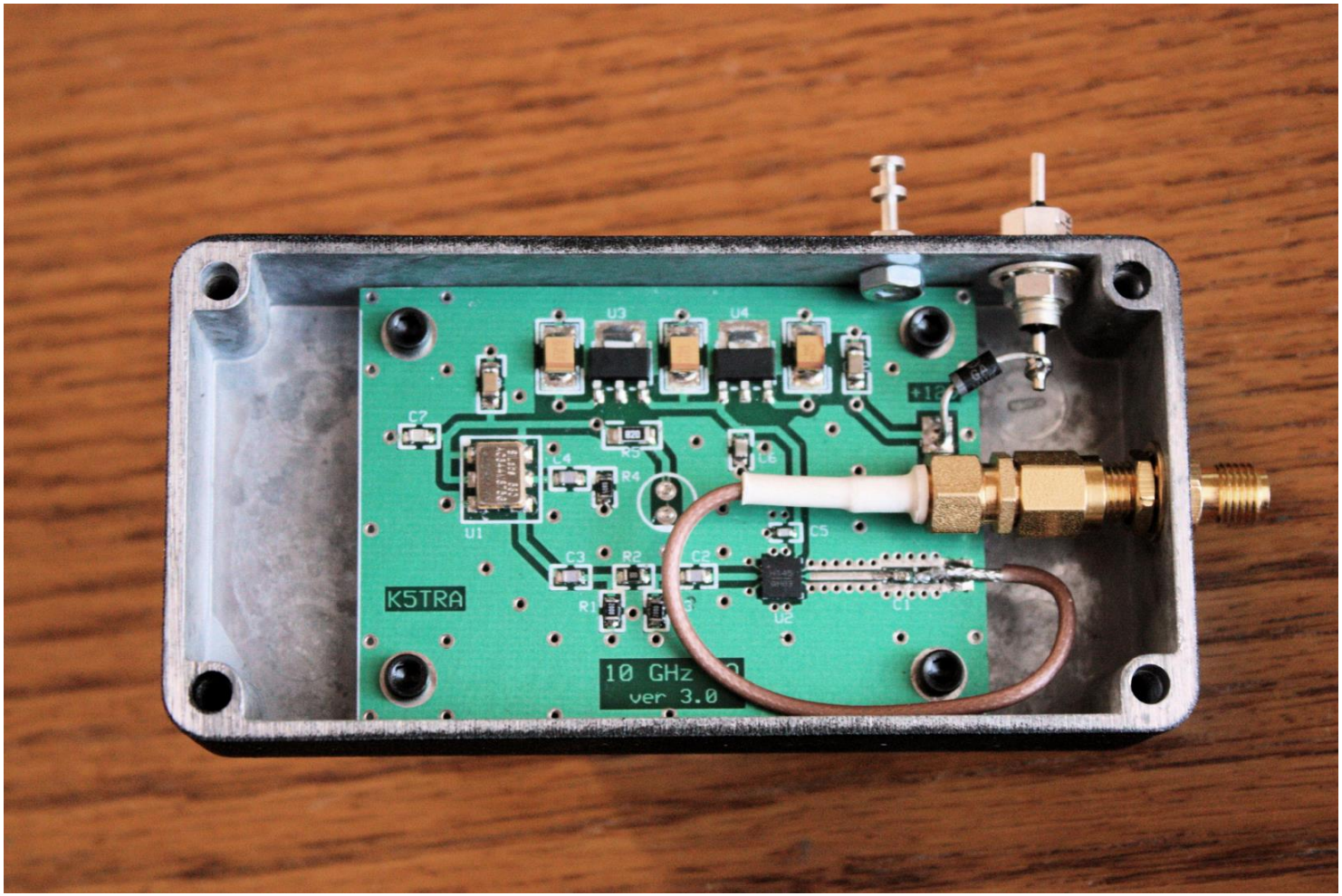
# Schematic Diagram



# 10 GHz LO Board



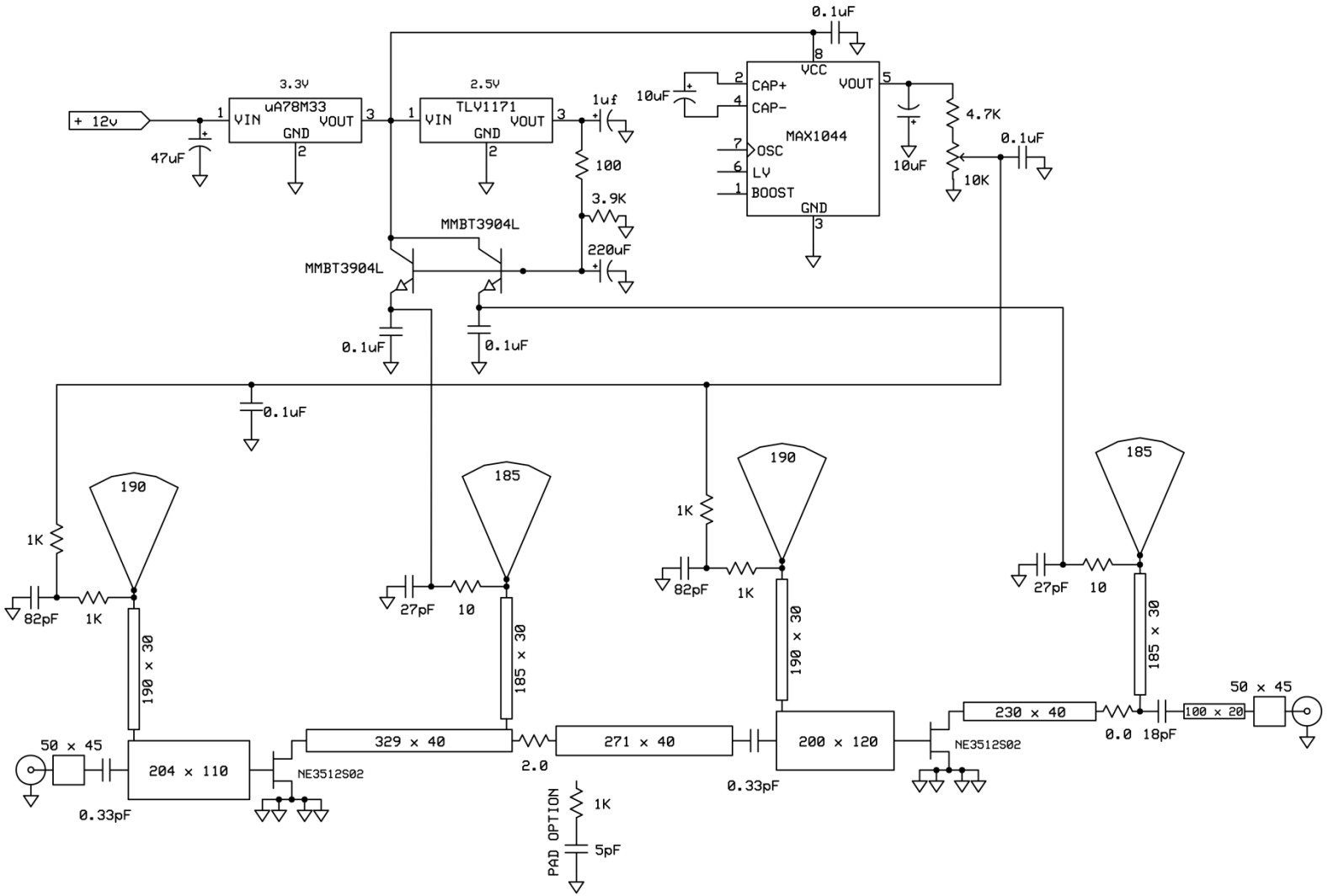
# LO Module Interior



# Receiver

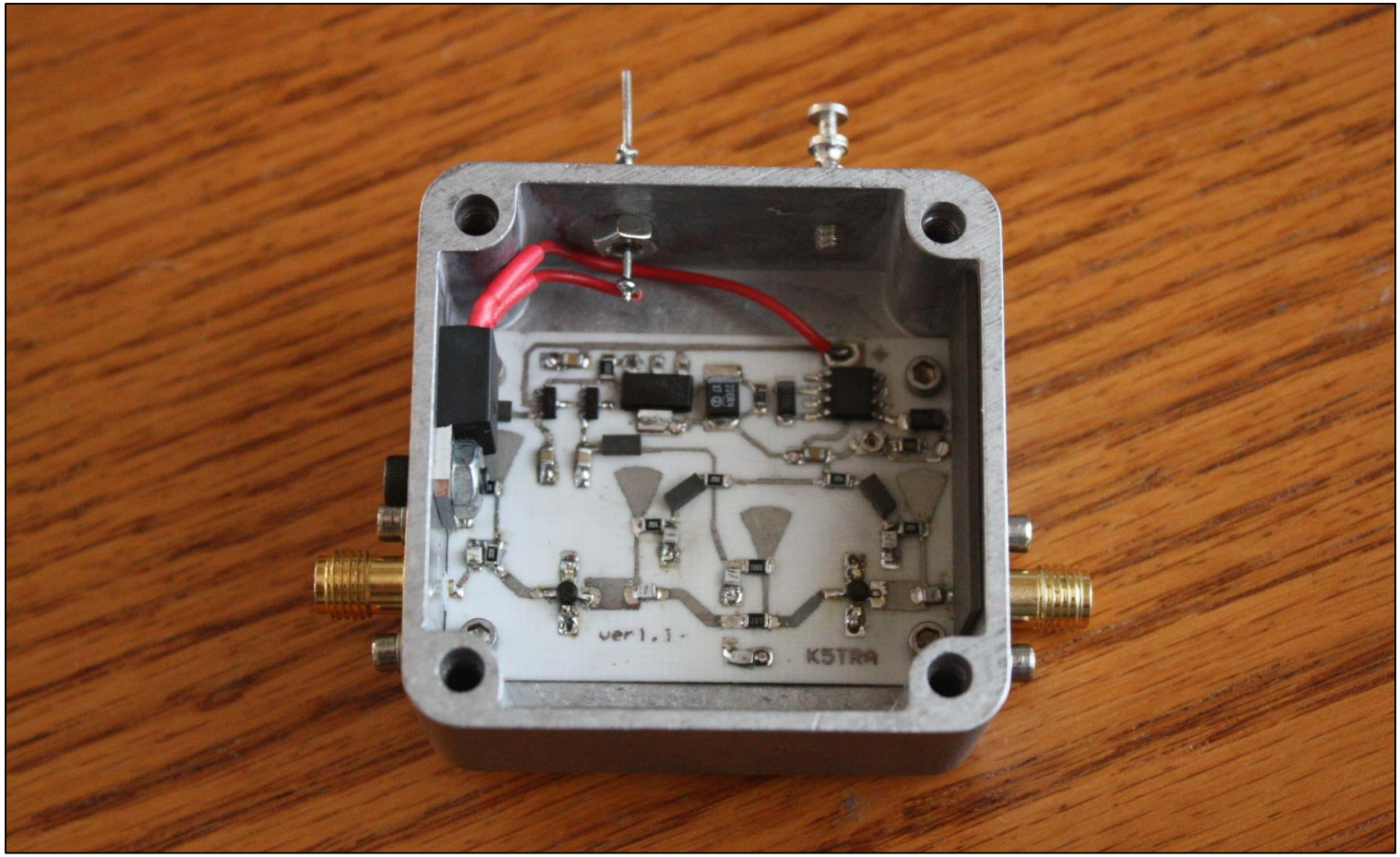
- Homebrew pHEMT LNA
- Two stages of NE3512S02  from NEC-CEL
- Rogers R04003 20 mil board
- Patterning and etching was done at home
- Wire through holes
- AML +17 dB post-LNA amplifier
- Farinon 4 pole WG filter
- Harris isolator to RF port of the receive mixer
- Sirenza SGA6486 IF amplifier followed by a $\pi$ pad
- $\pi$ pad also has PIN diode to step attenuation during transmit

# LNA Schematic



# LNA

# LNA Interior



# Transmitter

- PA is home brew 12W using Qorvo GaN MMIC
- Driver amplifier is 25 dBm Harris
- Farinon 4 pole WG filter and Harris isolator follow transmit mixer
- Transmit mixer IF drive is -5 dBm
- IF power pad is -52 dB

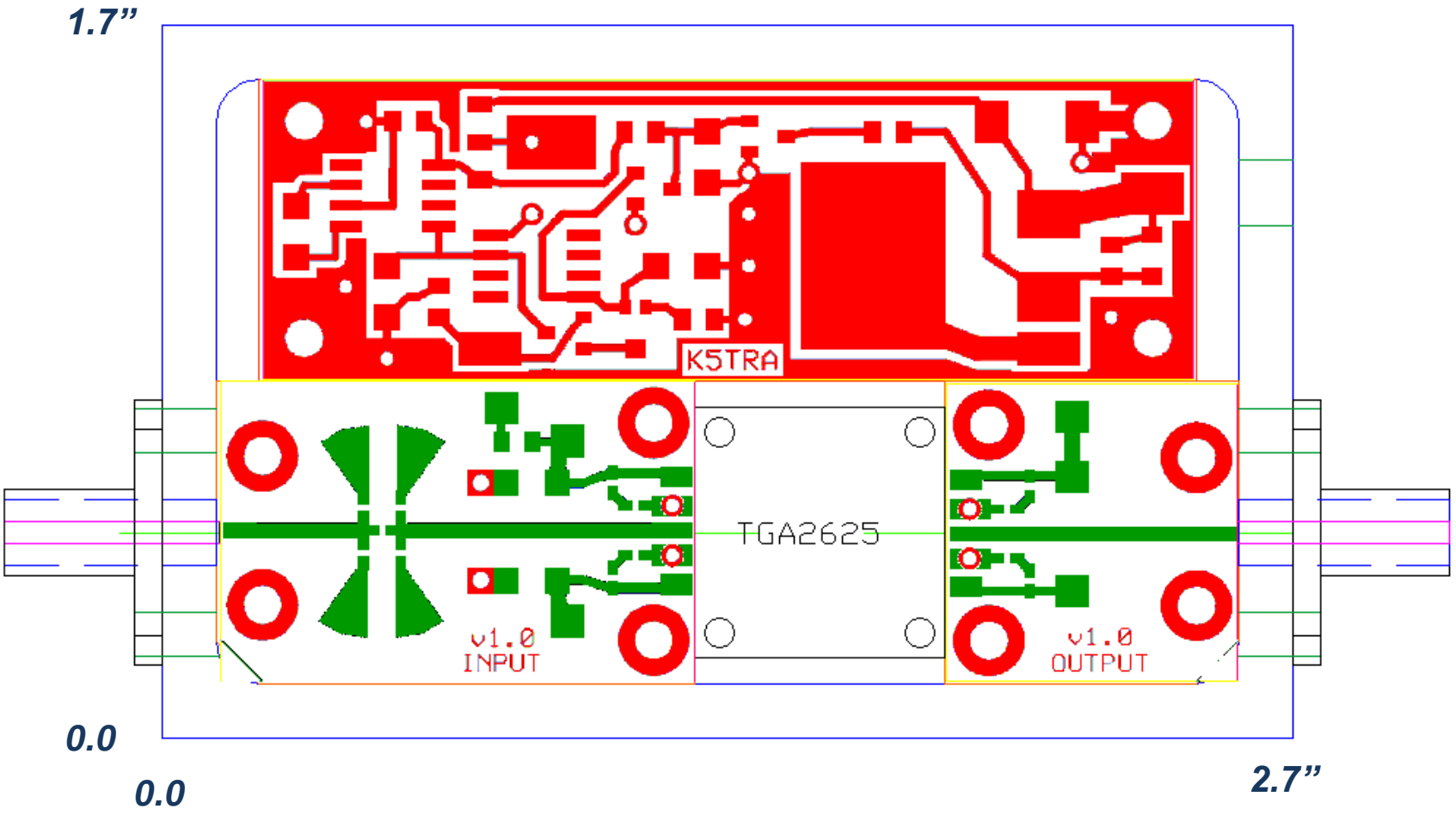
# PA Details

- TGA-2625-CP  GaN MMIC from Triquint / Qorvo
- Milled Aluminum 2.7” x 1.7” x 0.75” housing
- Sequenced negative before positive bias circuit
- 12 W linear power output
- +28 V  power supply
- Thermal design provides < 147°C channel temp.

# Completed PA

# Interior View

# PA Module Floor Plan



# Packaged MMIC

TriQuint

## TGA2625-CP

***10 to 11 GHz, 17 W GaN Power Amplifier***

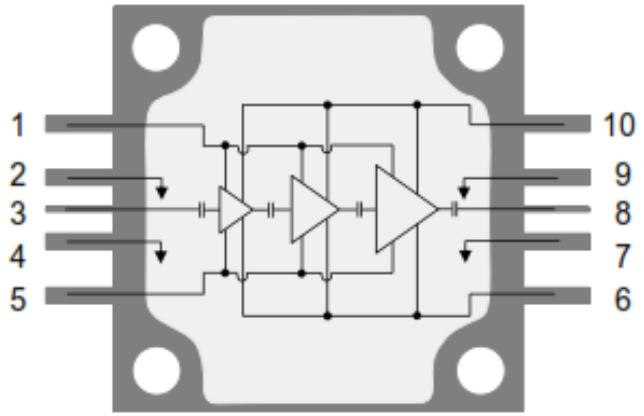
### Applications

- Radar
- Communications

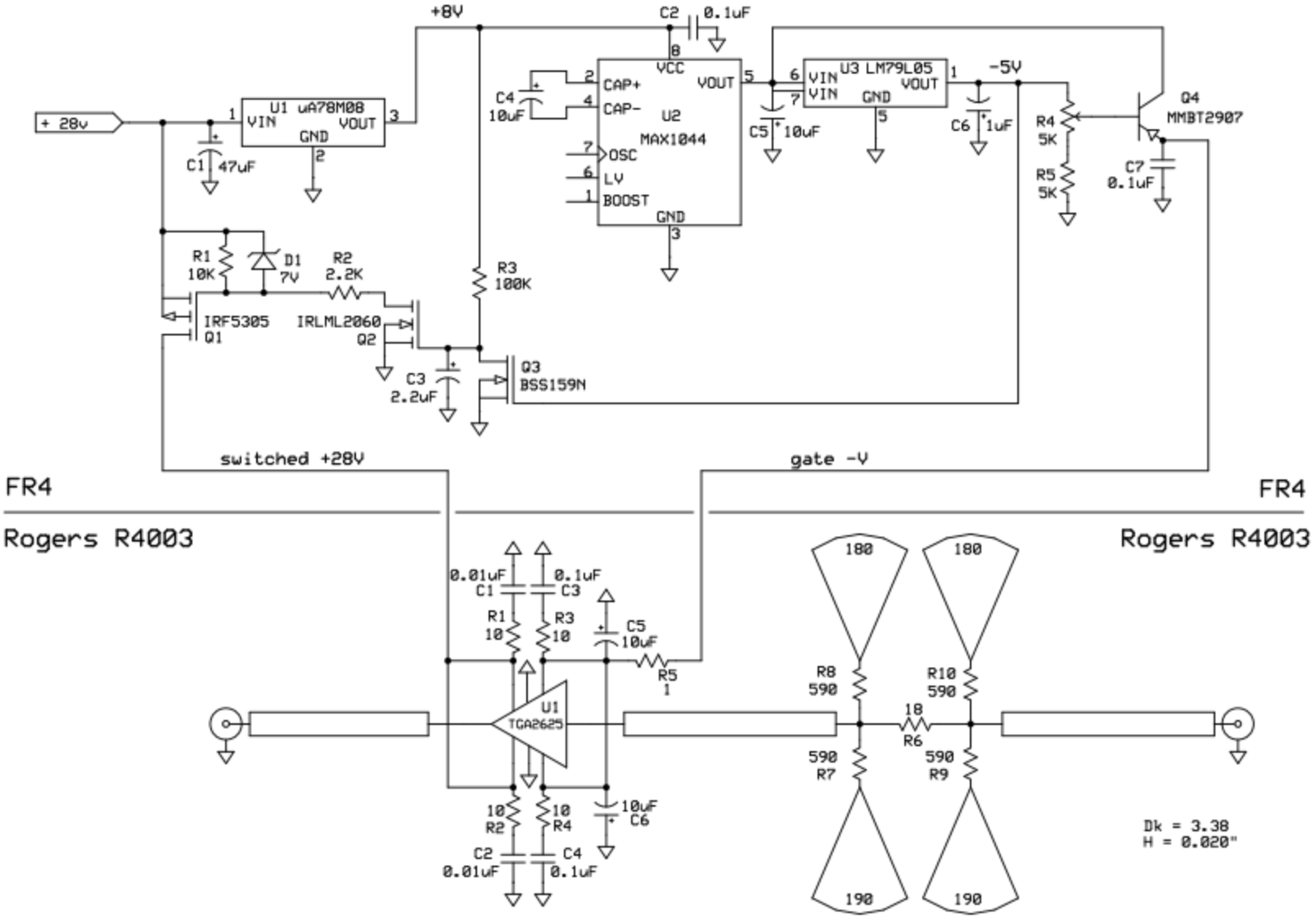

### Product Features

- Frequency Range: 10 – 11 GHz
- Pout: 42.5 dBm (at $P_{IN}$ = 15 dBm)
- PAE: > 40 %
- Power Gain: 28 dB (at $P_{IN}$ = 15 dBm)
- Bias: $V_D$ = 28 V, $I_{DQ}$ = 365 mA, $V_G$ = -2.6 V typical, pulsed (PW = 100 µs, DC = 10 %)
- Package Dimensions: 15.2 x 15.2 x 3.5 mm
- Package base is pure Cu offering superior thermal management

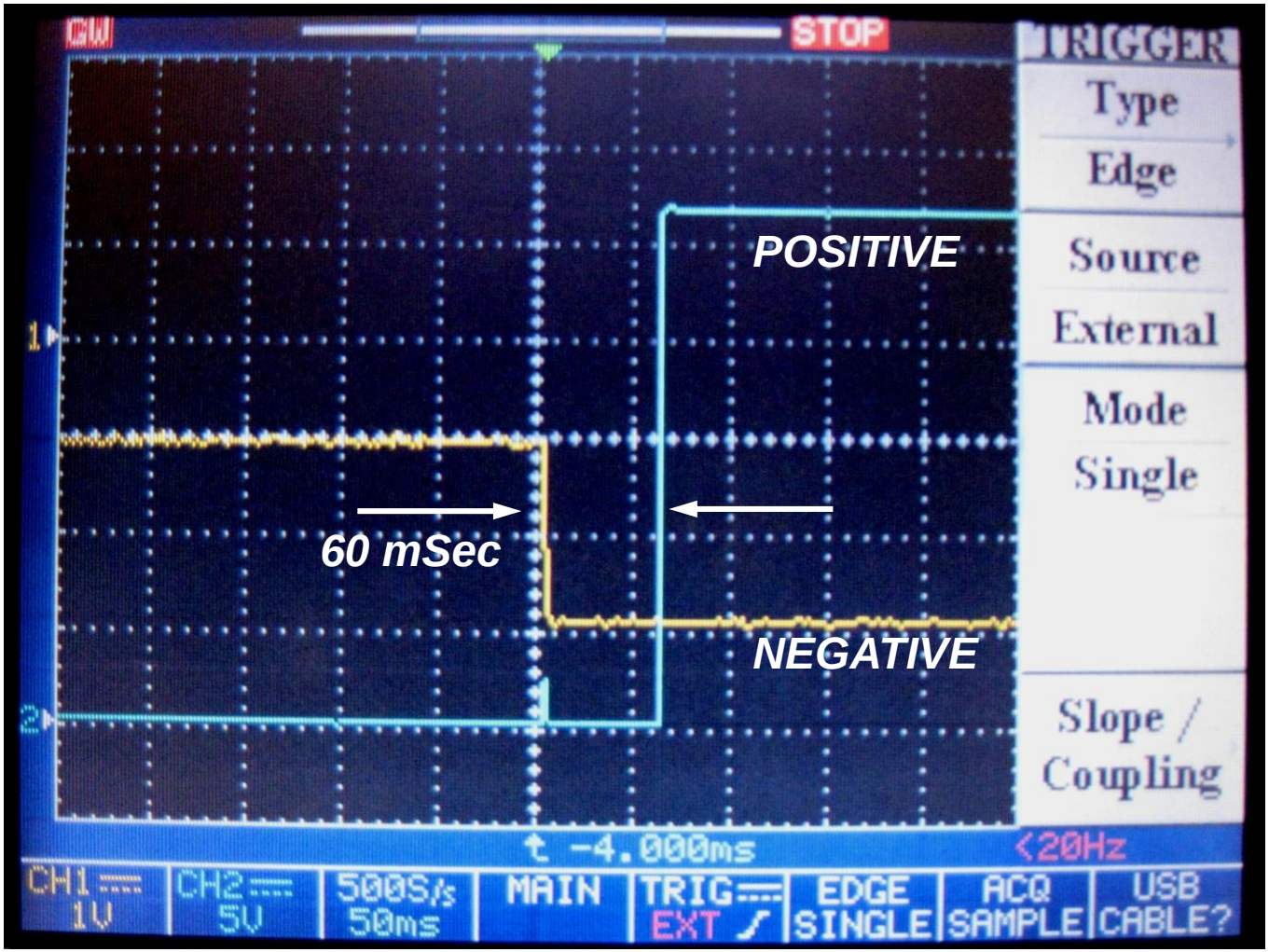
### Functional Block Diagram



# Schematic Diagram



# Bias Sequencer Test



# Results

- 10 GHz station operational 16 September 2015

- September 10 GHz contest results:
  - W5LUA 213 miles !!
  - NO5K 19 miles
  - K5LLL 44 miles
  - NN5DX 44 miles
  - K5GJ 5 miles
  - K5TR 24 miles
  - K5VH 8 miles

# Questo è Tutto