A Simple Low-cost 5760 MHz Transverter for the Rover

Paul Wade W1GHZ

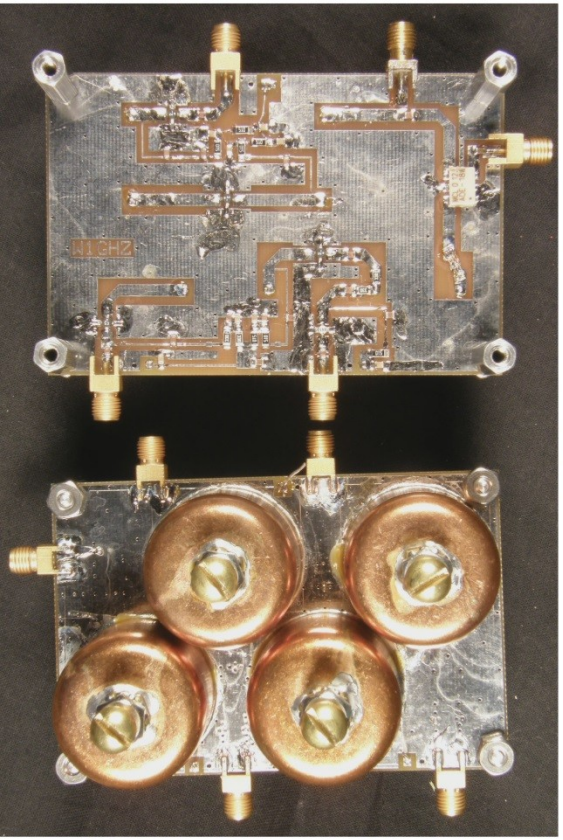
New W1GHZ QTH - Vermont

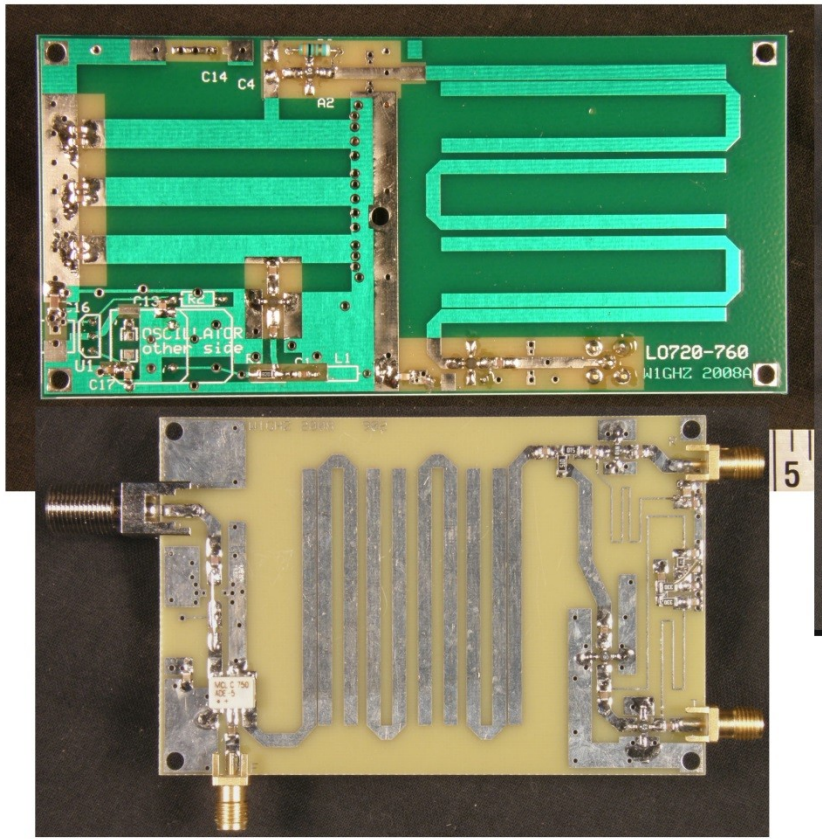


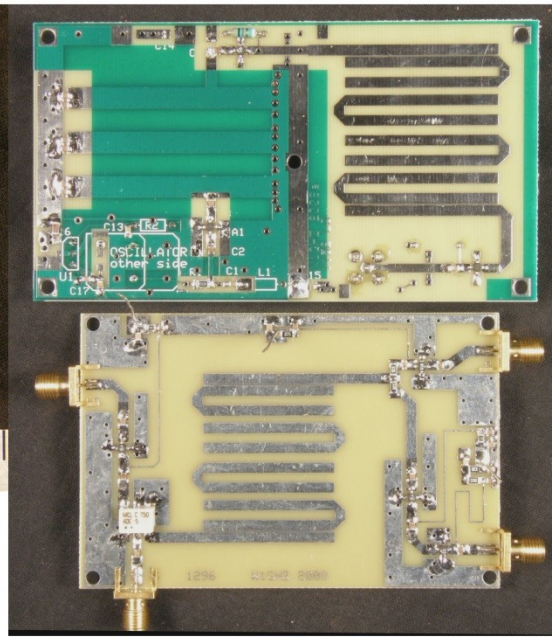
Simple, Cheap Transverters

- Ordinary PC board
- MMICs – ***Gain is cheap***
- Ordinary chip capacitors
- Printed or Pipe-cap Filters
- Simple computer oscillator LO
- 902 to 3456 MHz
- 10 GHz Personal Beacon
- *No 5760* – no convenient oscillator

Transverters
902 to 3456 MHz



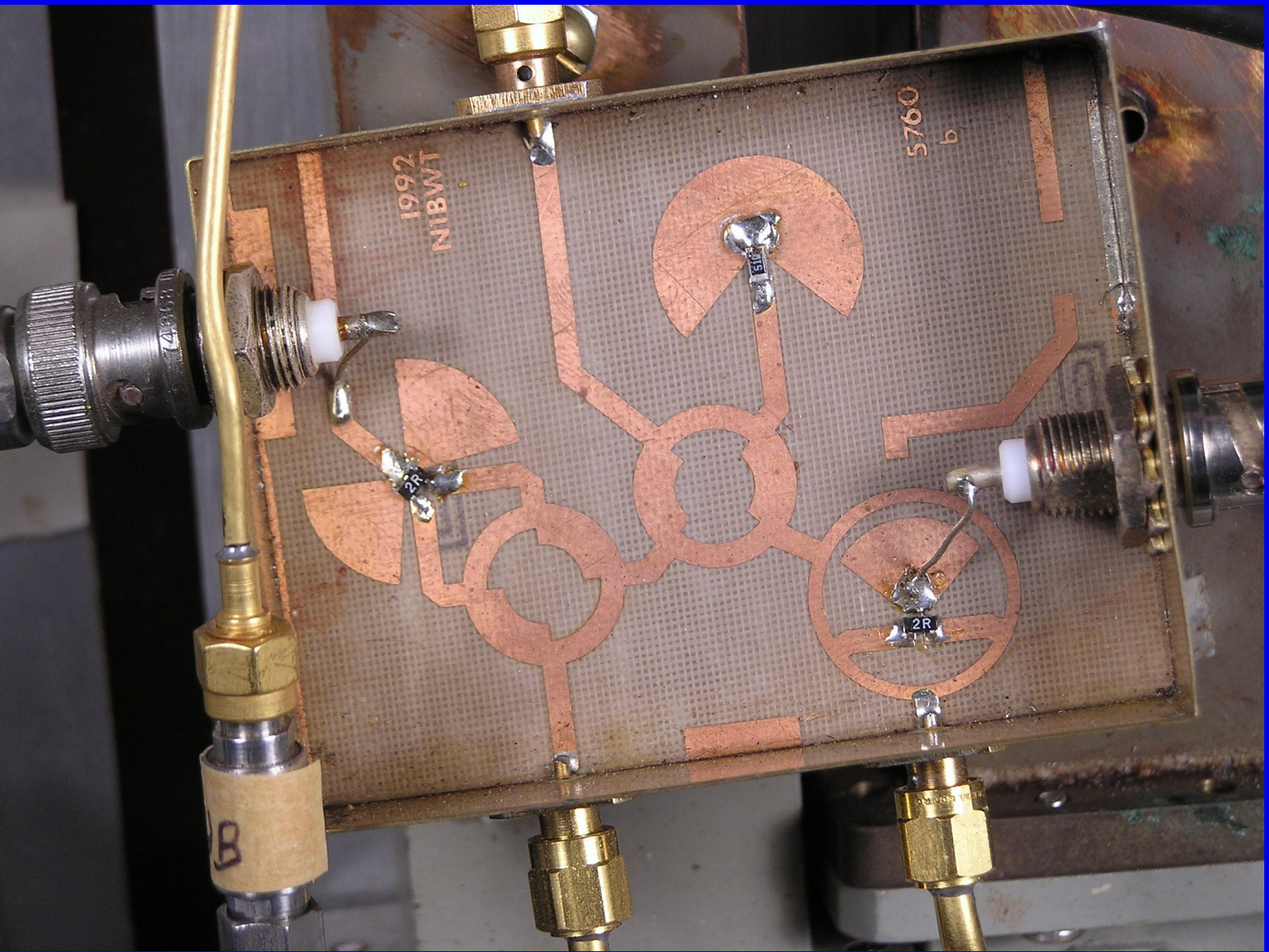




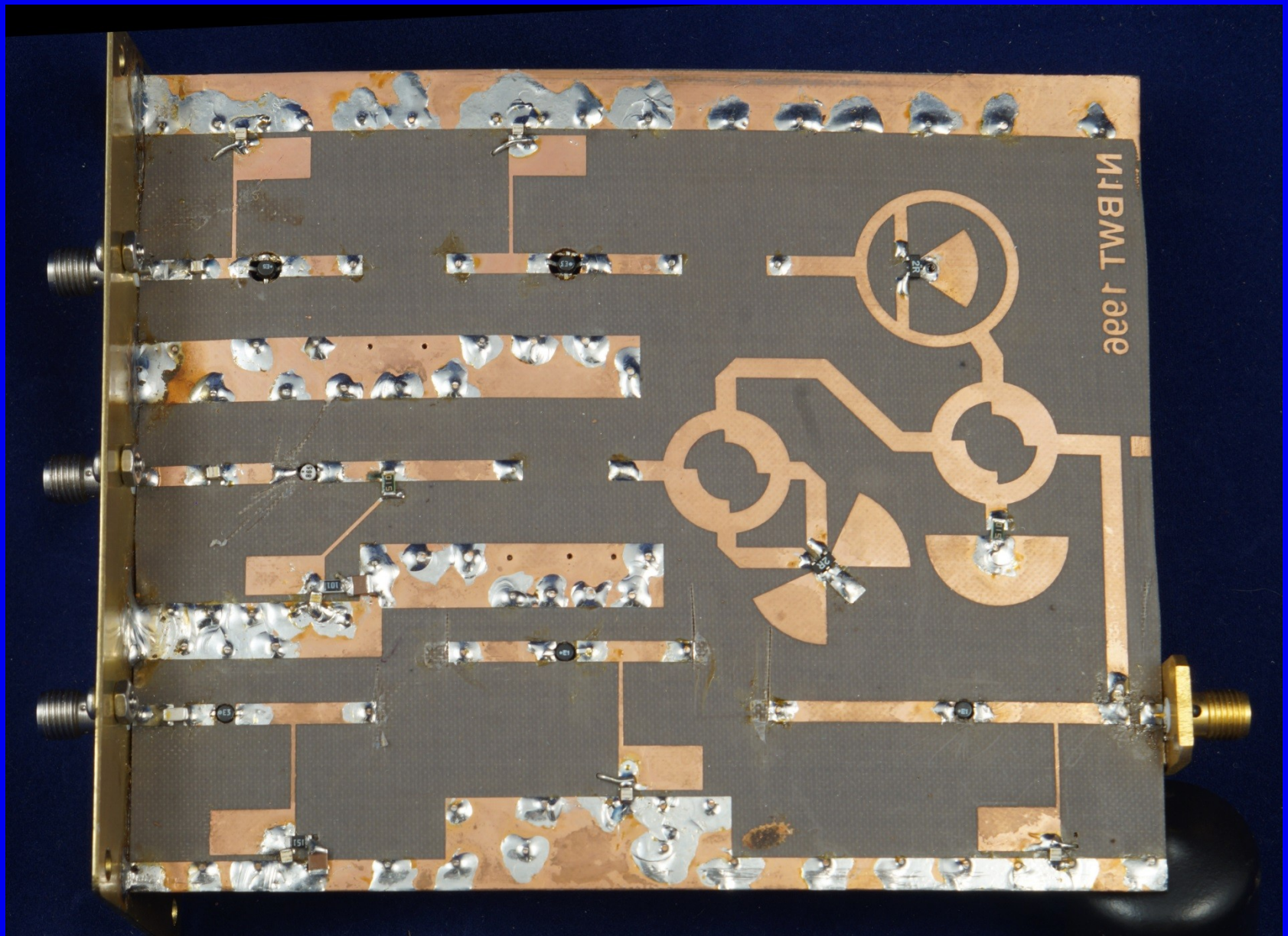
Original 5760 MHz Transverter (1996)

- Teflon PCB ($$)
- Pipe-cap filters
- Minimum number of stages
- Integrated LO multiplier
- ATC microwave capacitors ($)
- Printed mixers – more PC board space ($)
- Teflon PCB needs mechanical support
- No plated-thru holes in prototype

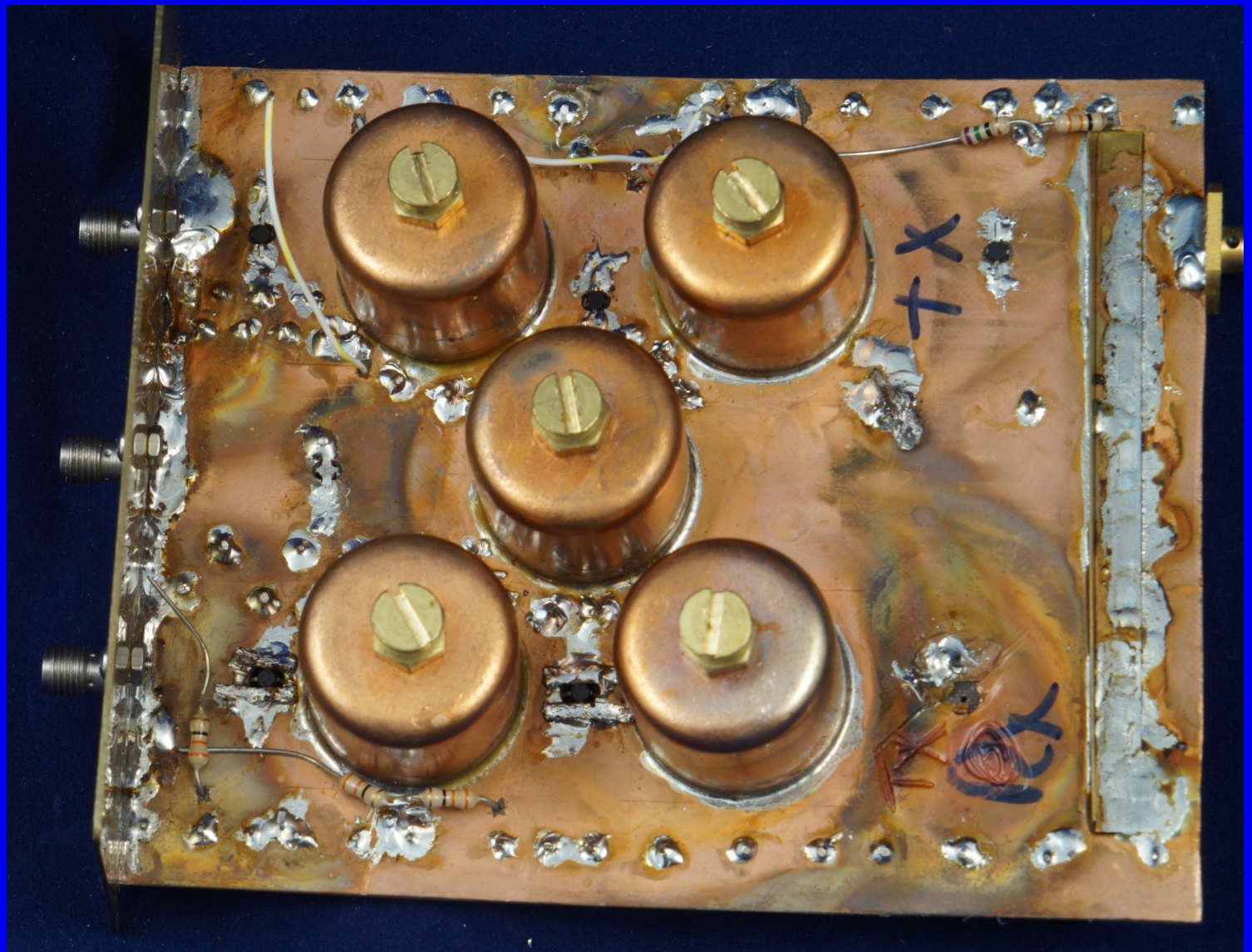
Dual Mixer – 1992



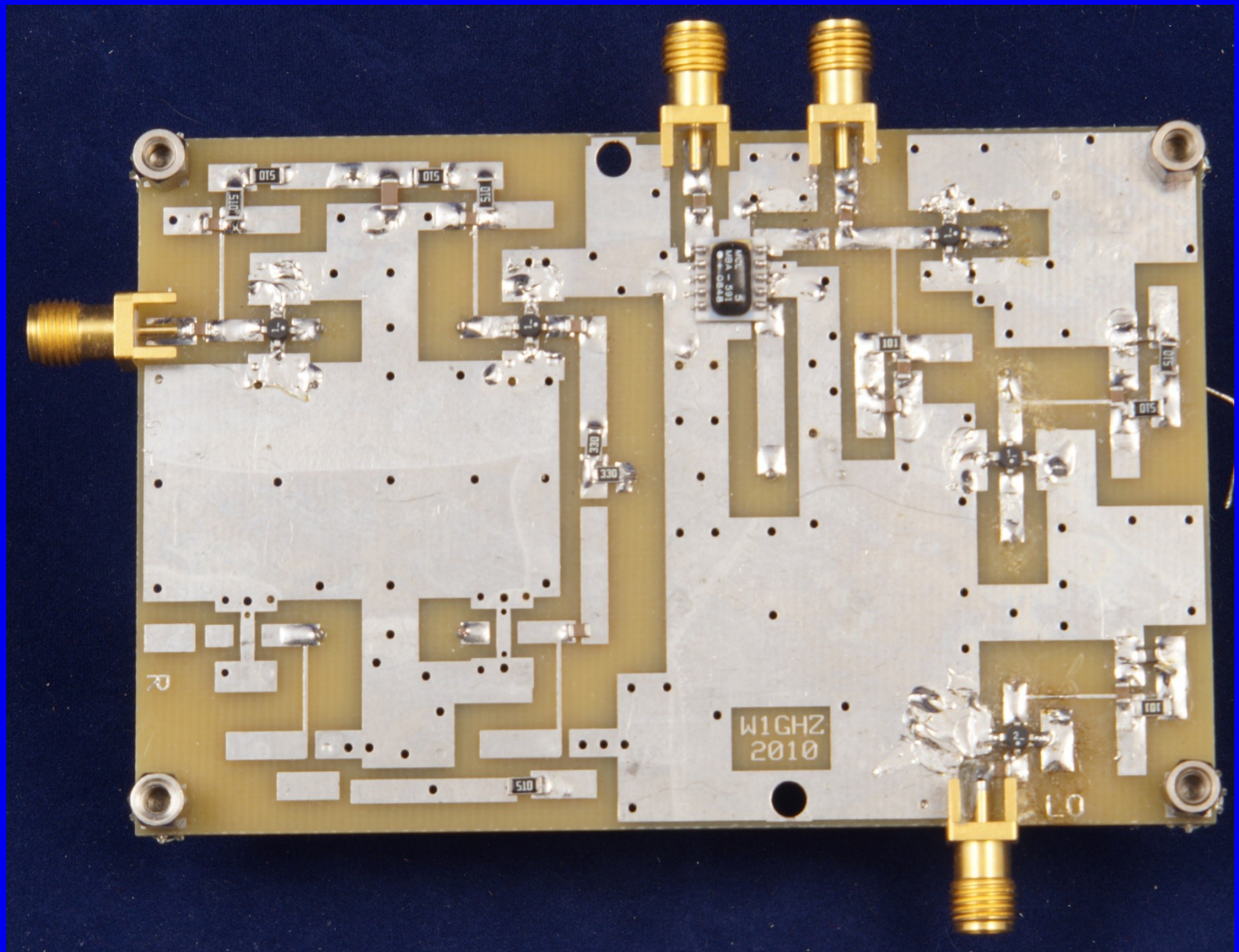
5760 MHz – 1996



5760 MHz – 1996 – 5 pipecaps



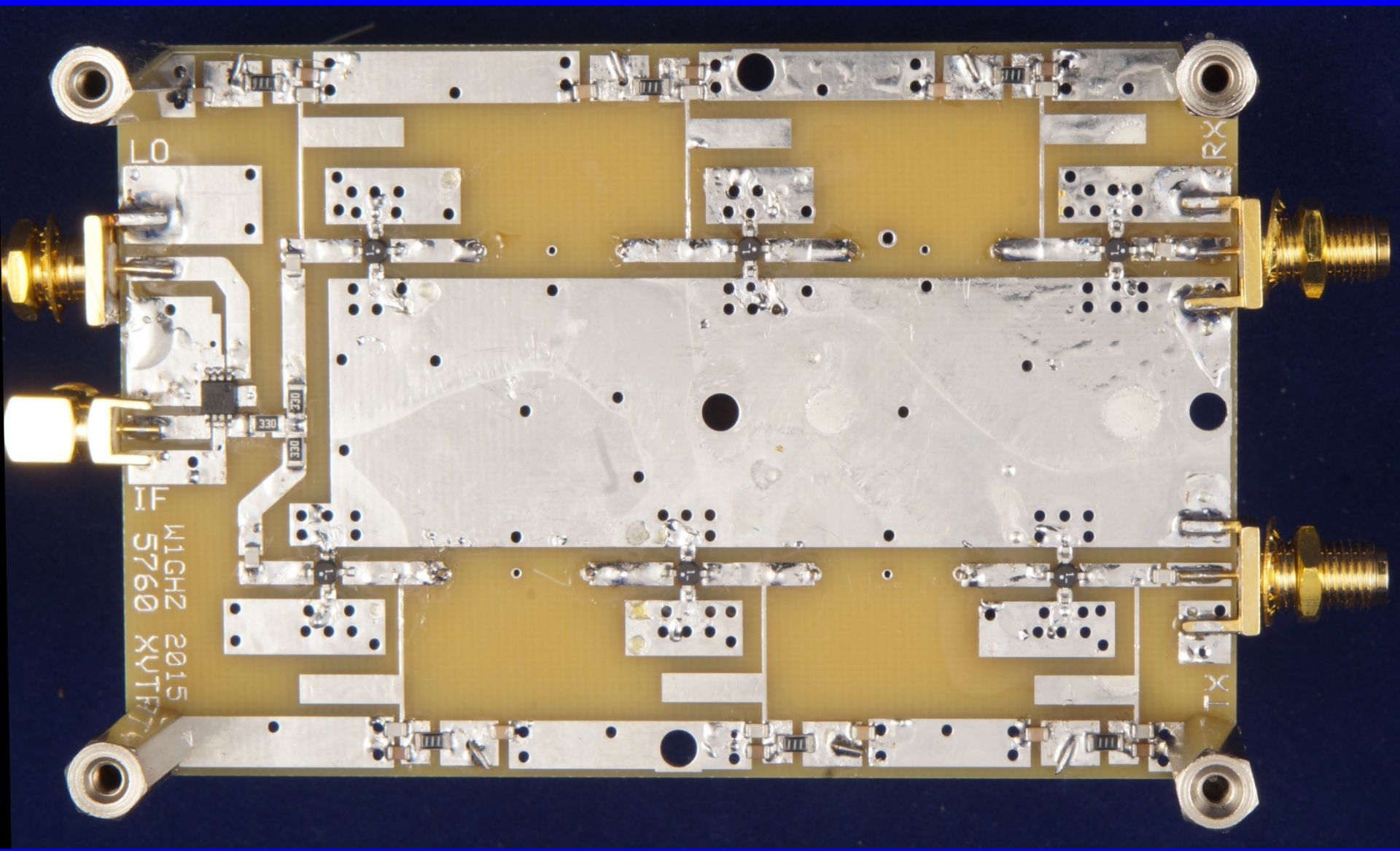
First redesign – 2010



First redesign – 2010

- ExpressPCB board – ordinary FR-4
- Minicircuits mixer
- Still 5 pipecaps, integrated LO
- Problems:
  - Not enough LO power
  - Hard to tune
  - Inadequate gain

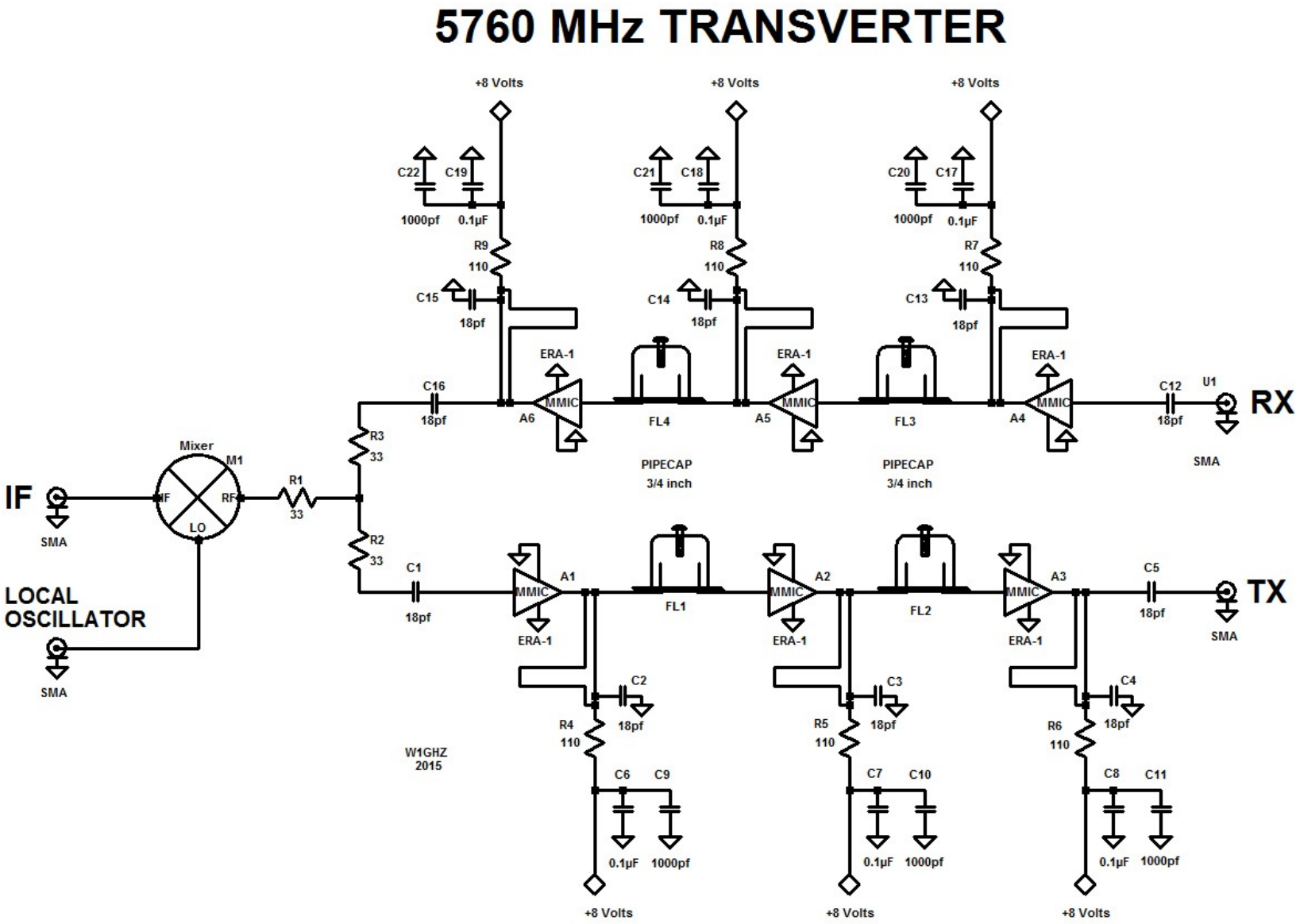
5760 MHz – 2015



5760 MHz – MUD 2015

- Ordinary FR-4 PC board
- Cheap MMICs – Minicircuits
  - PCB footprint for both 4-lead and SOT-89 package
- Ordinary chip capacitors
- 3 gain stages TX and RX
- Pipe-cap filters – 2 TX and 2 RX
- Packaged mixer – Hittite HMC218
- Separate LO
  - Simplify tuneup
  - More options

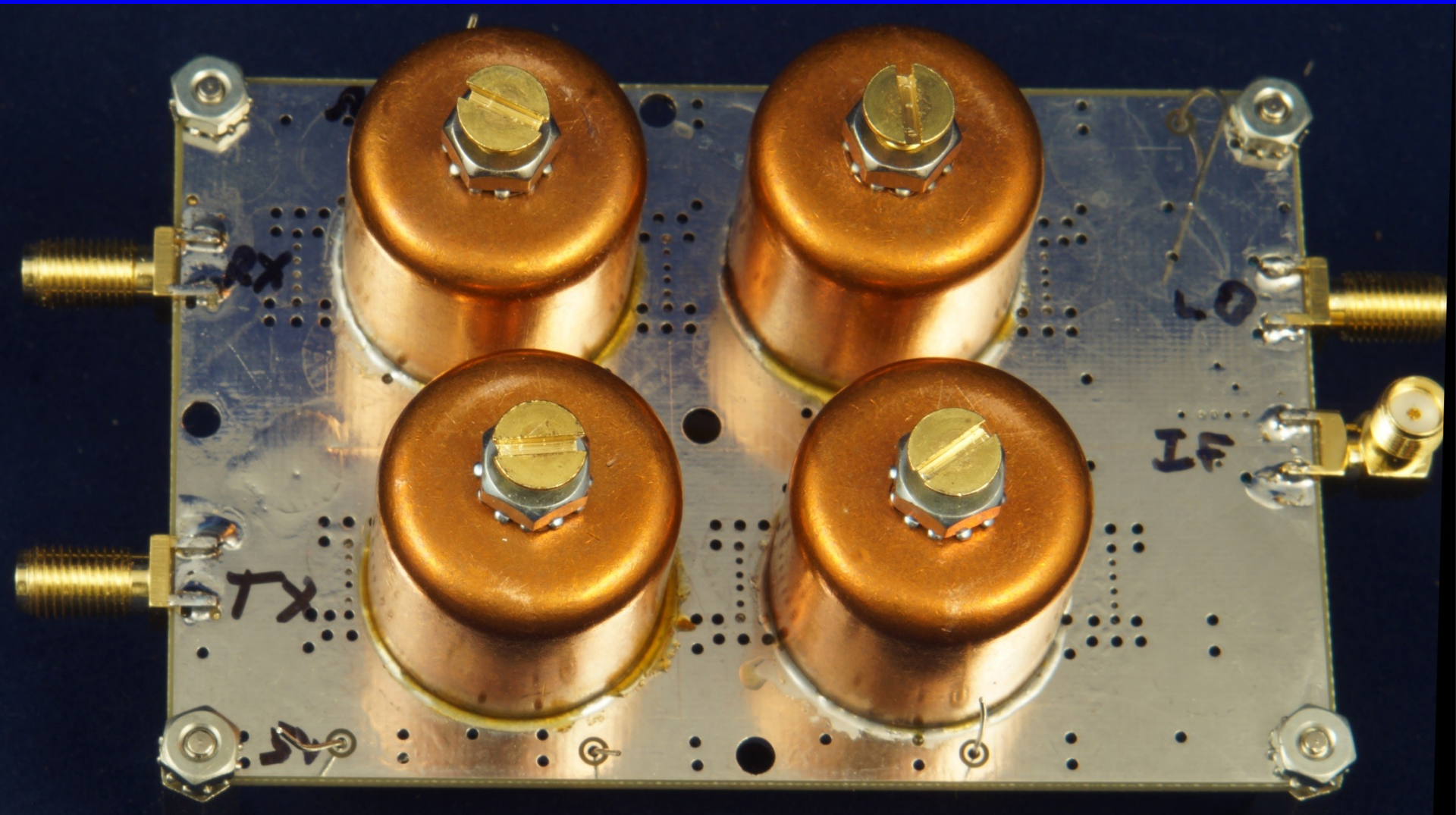
5760 MHz – 2015



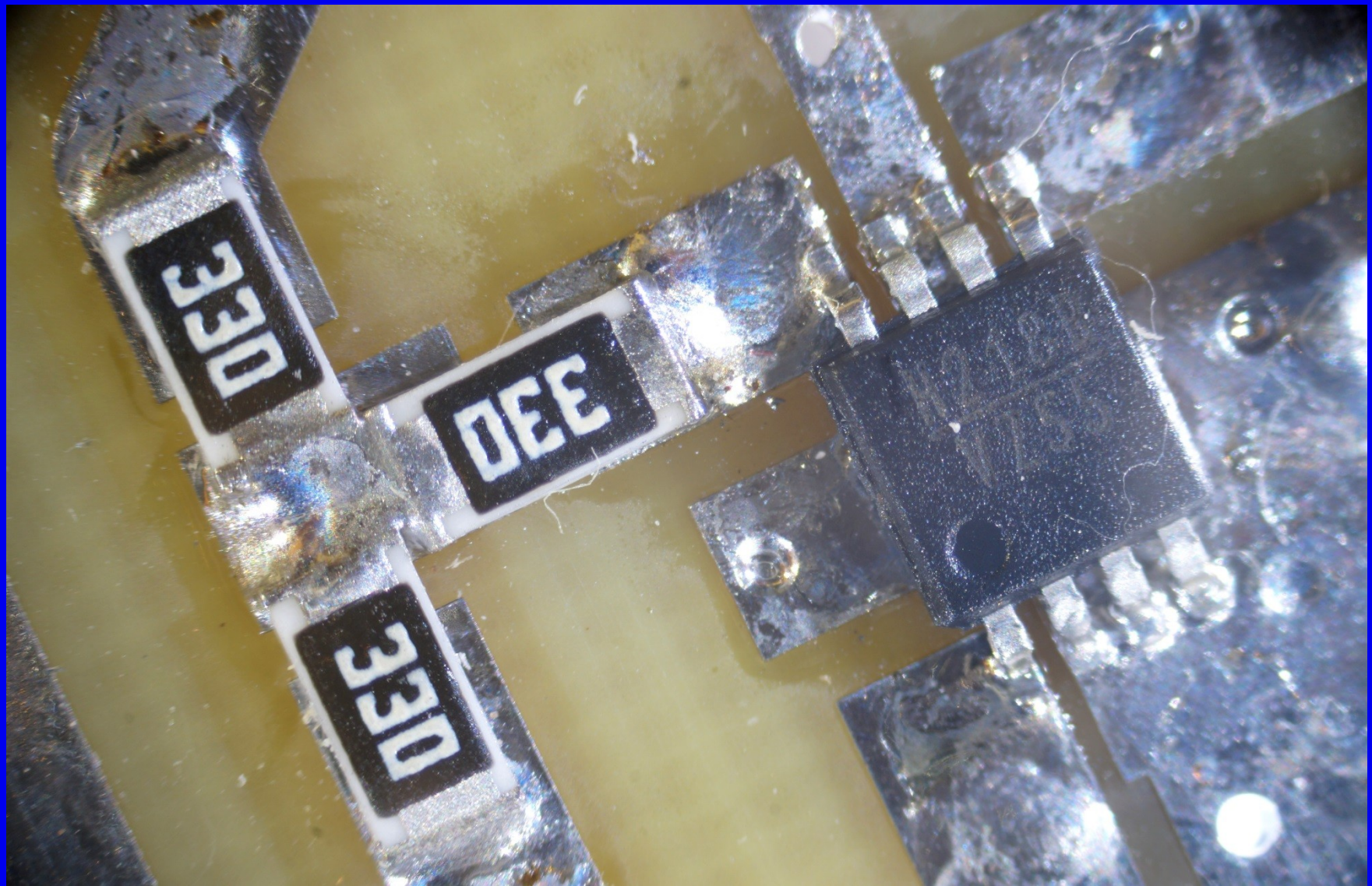
Minimize Part Types

- Parts are cheap in quantity, so fewer different parts reduces cost
  - One MMIC type
  - Two resistor values
  - Three capacitor values
  - One mixer
  - One pipe-cap size
  - SMA connectors from ebay
  - plus PC board

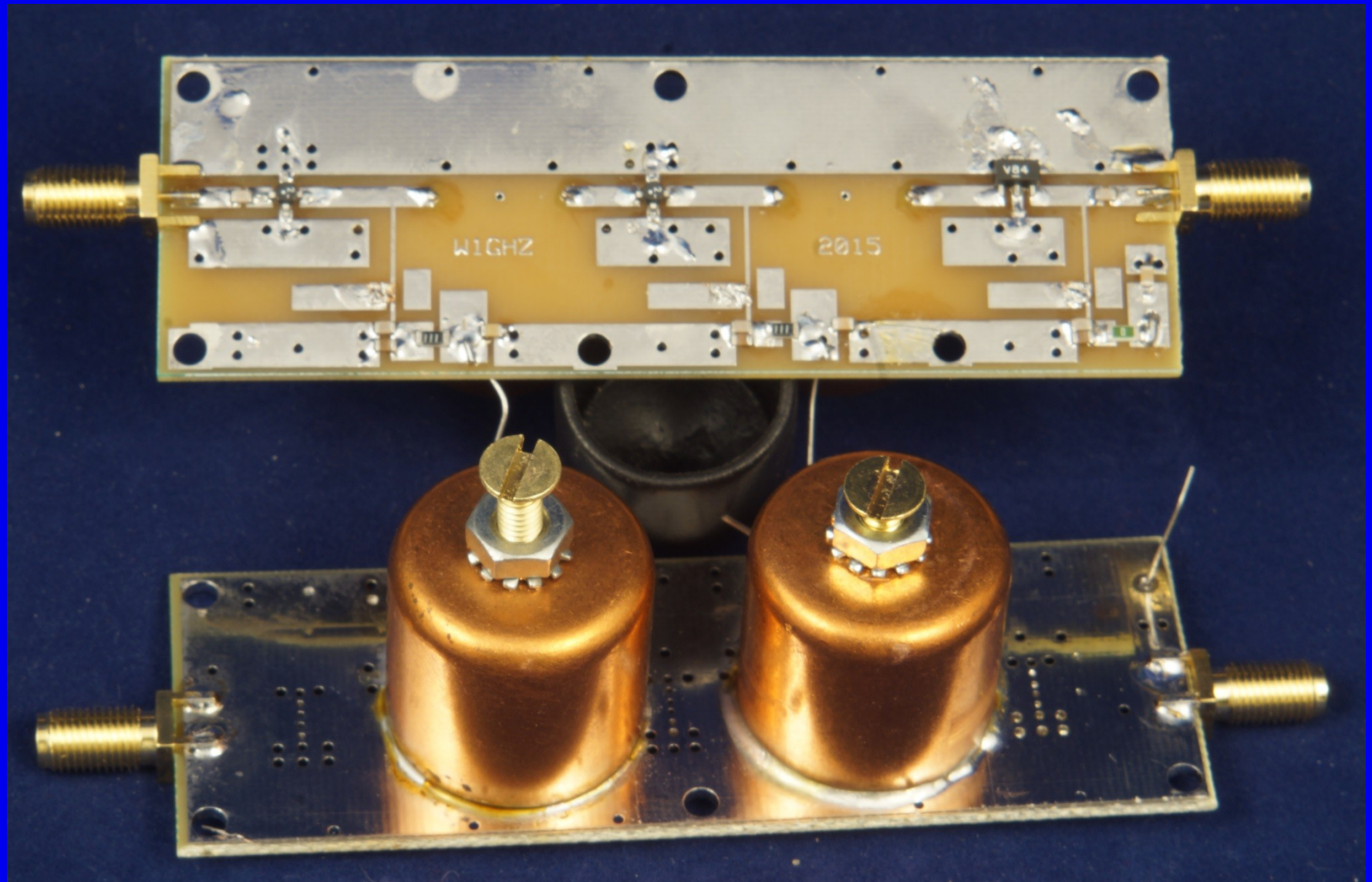
5760 MHz – 2015



Mixer – Hittite HMC218



LO multiplier
aka Personal Beacon



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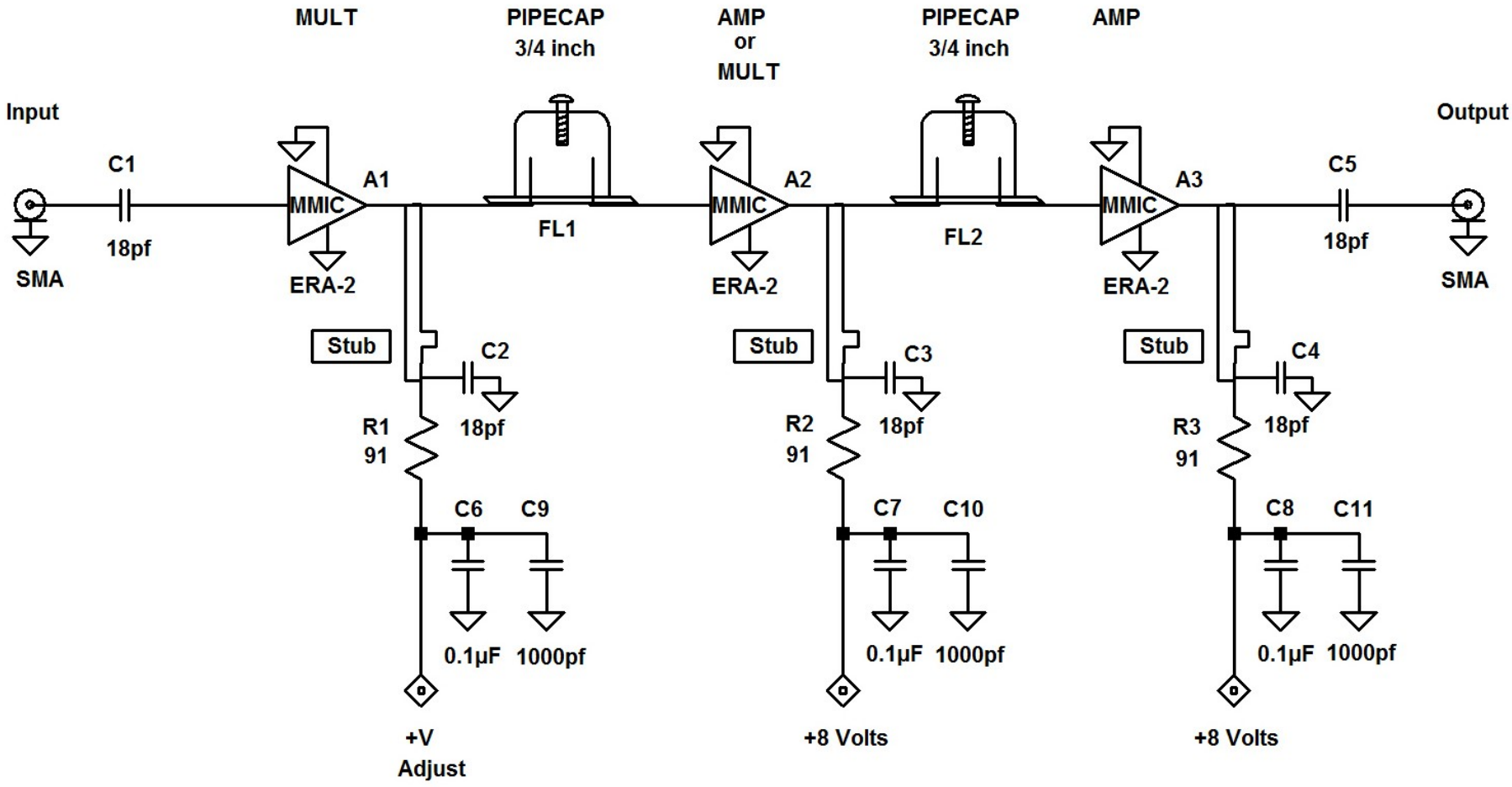
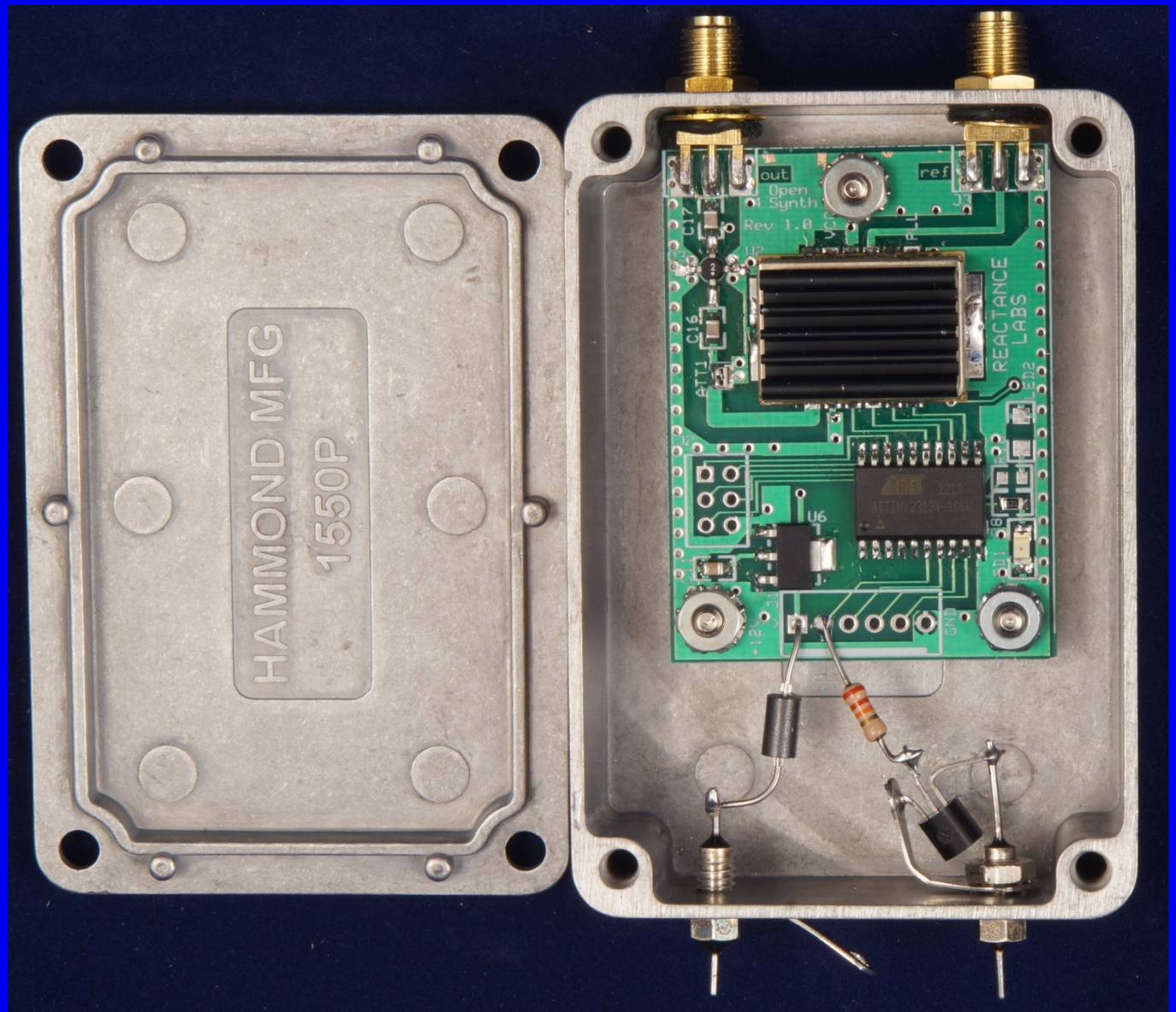


LO Synthesizer

Reactance Labs (KC6QHP)



5760 MHz Performance

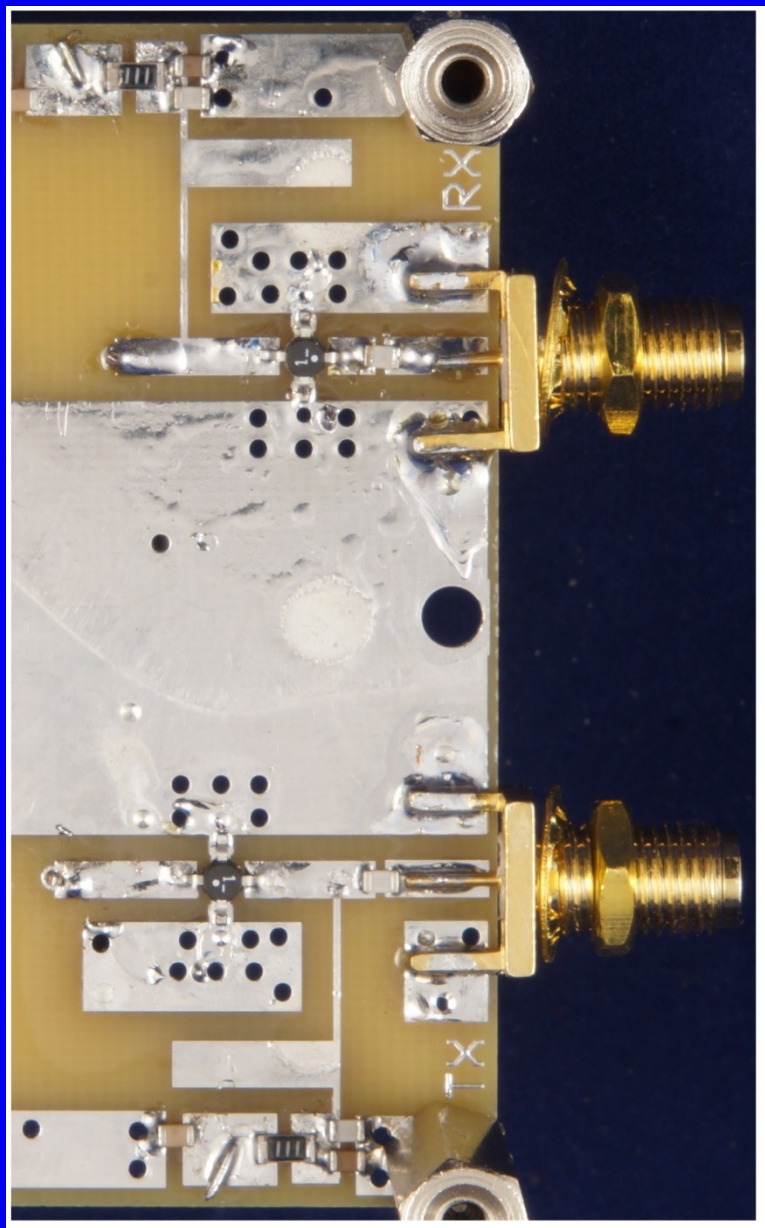
Minimum Part Count

- LO +10 dBm
- TX out ~ +8 dBm
- TX mmic – ERA-1
- RX NF ~ 7 dB
- RX mmic – ERA-1
- LO leakthru ~ -40 dB
- IF = 144 or 432 MHz

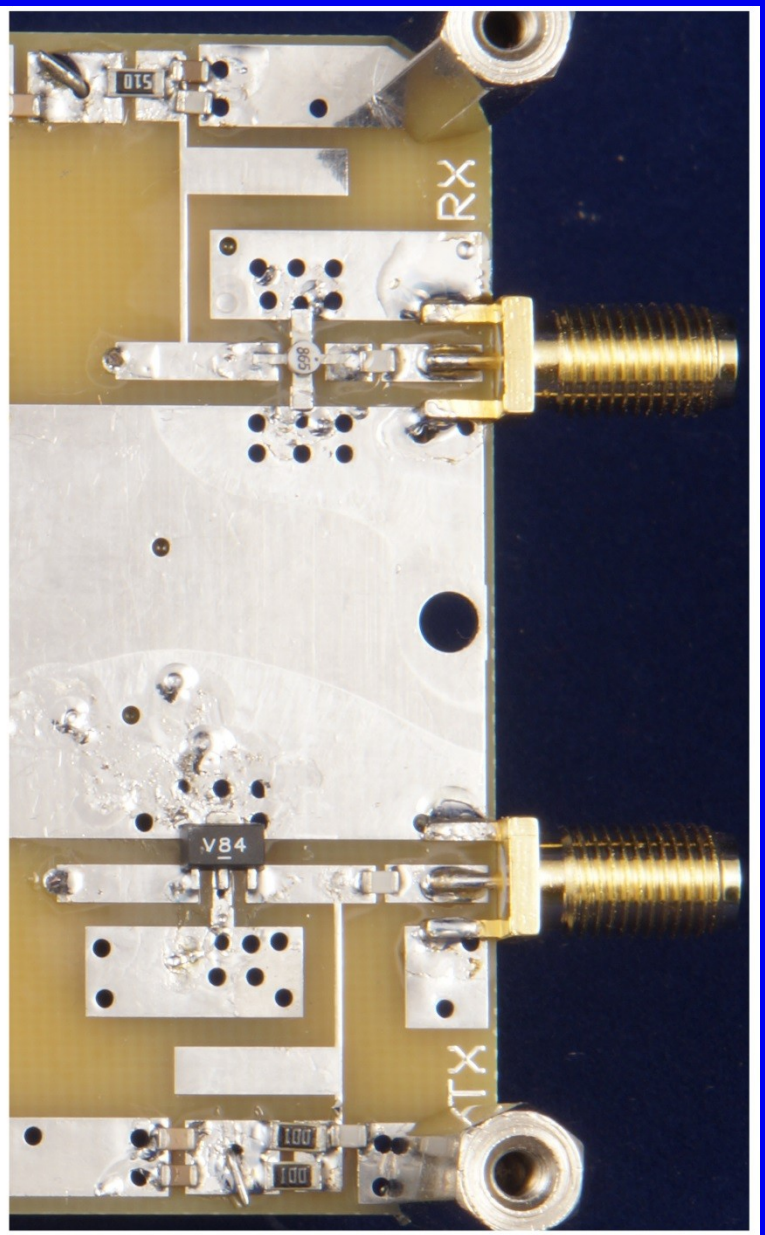
Higher Performance

- LO +10 dBm
- TX out ~ +14 dBm
- TX mmic – GVA-84
- RX NF ~ 3.5 dB
- RX – MGA-86576
- LO leakthru ~ -40 dB
- IF = 144 or 432 MHz

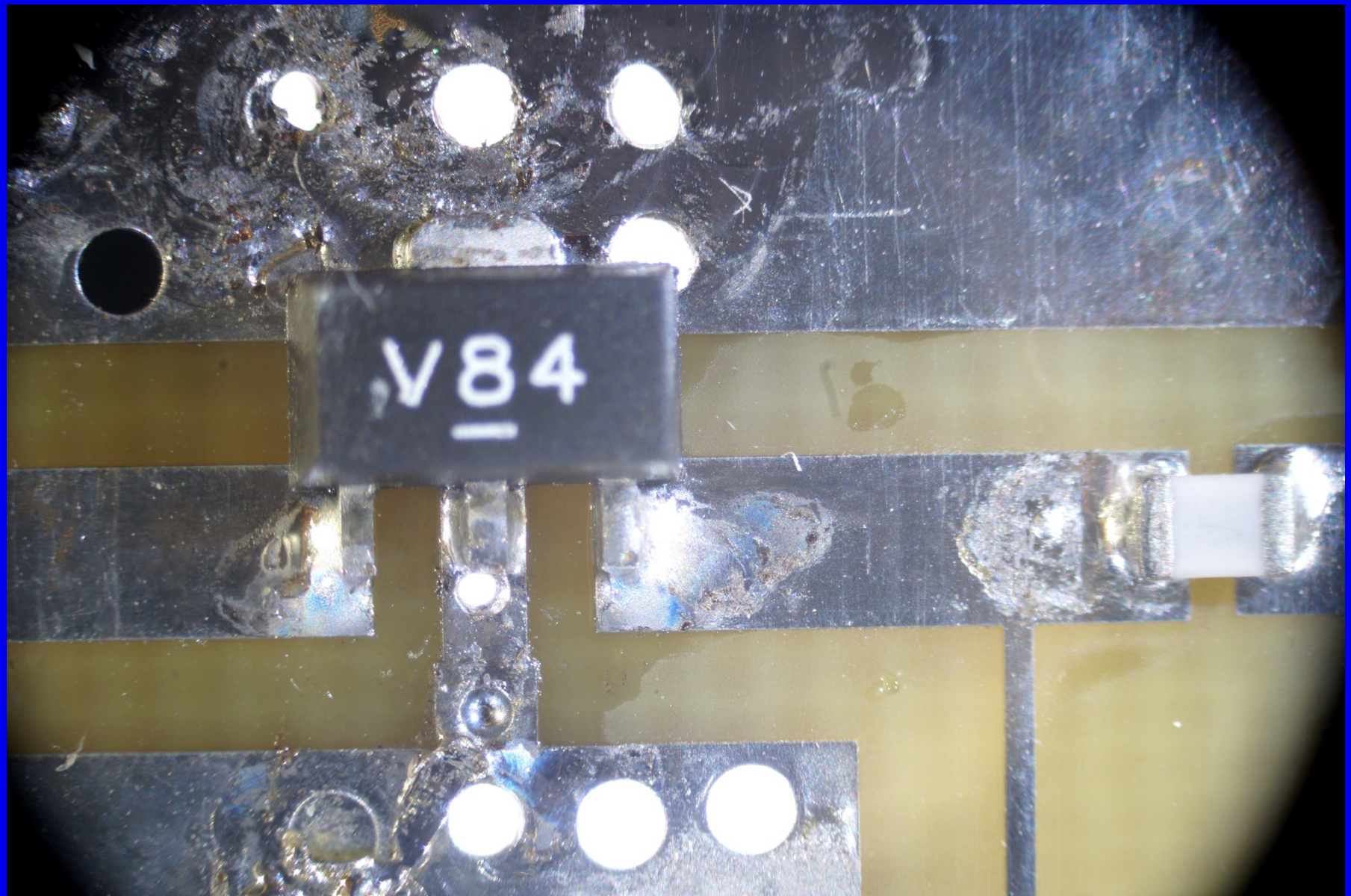
Minimum Parts



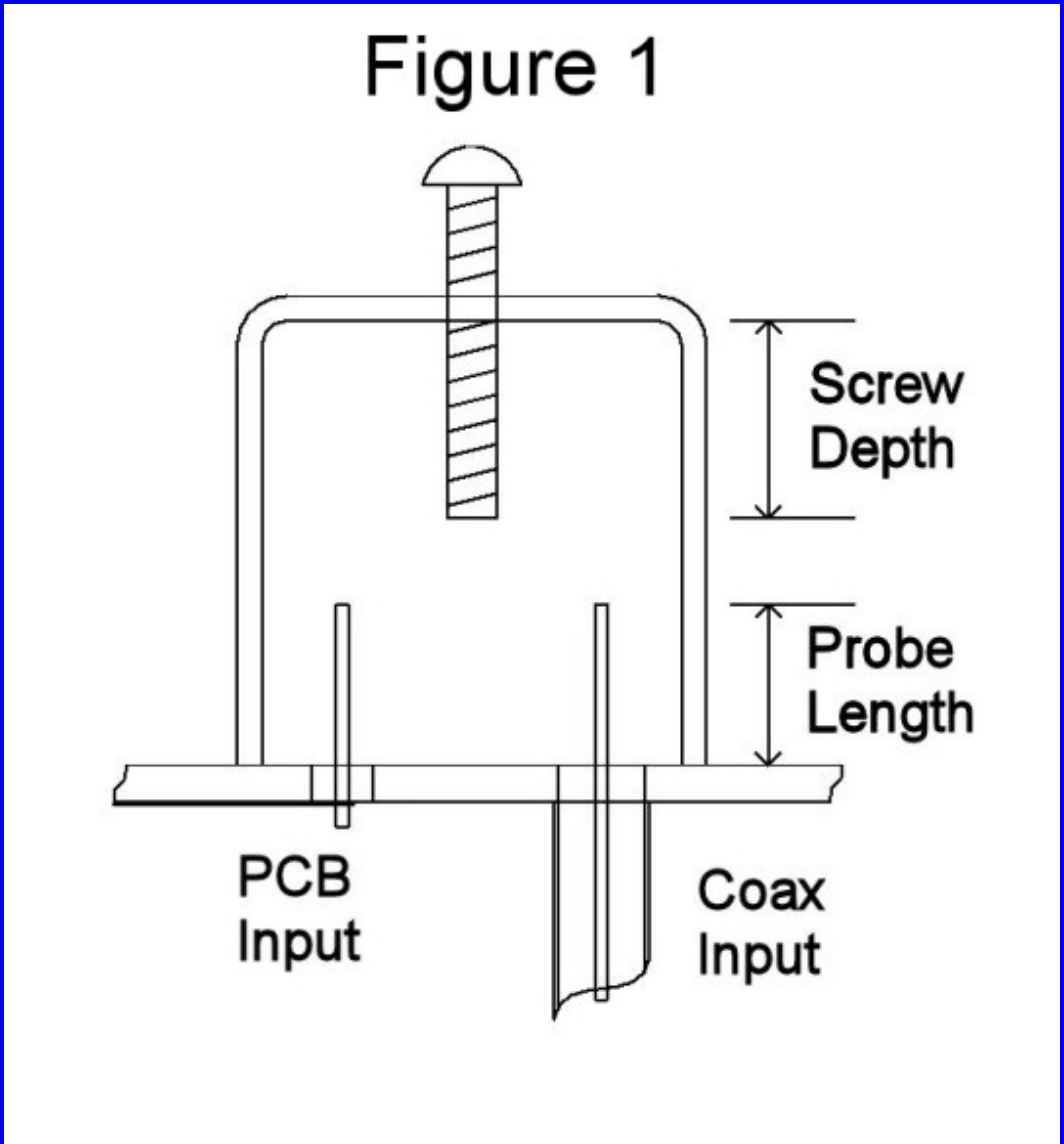
Higher Performance



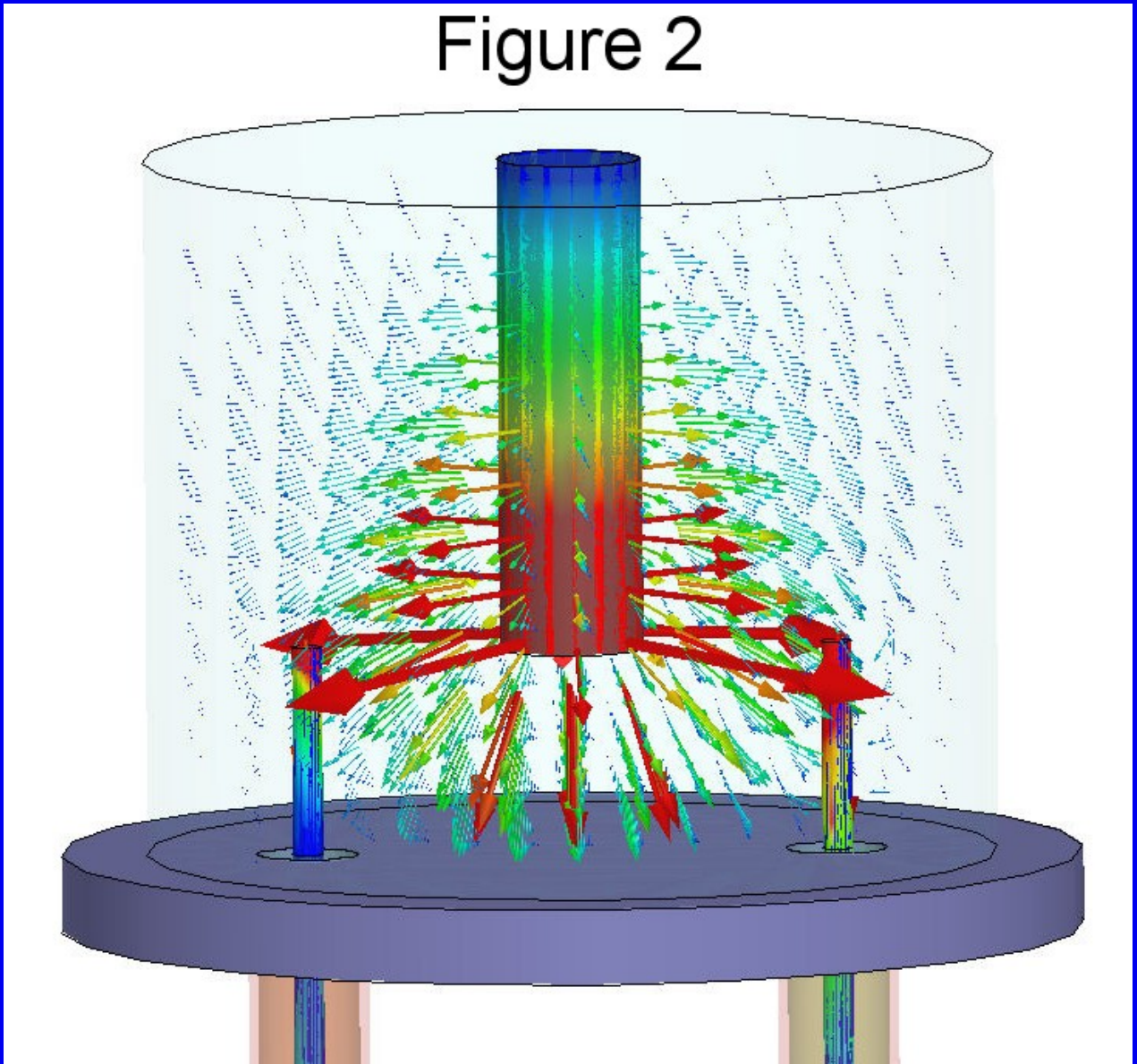
GVA-84 TX Amplifier (SOT-89)



Pipe-cap Filter

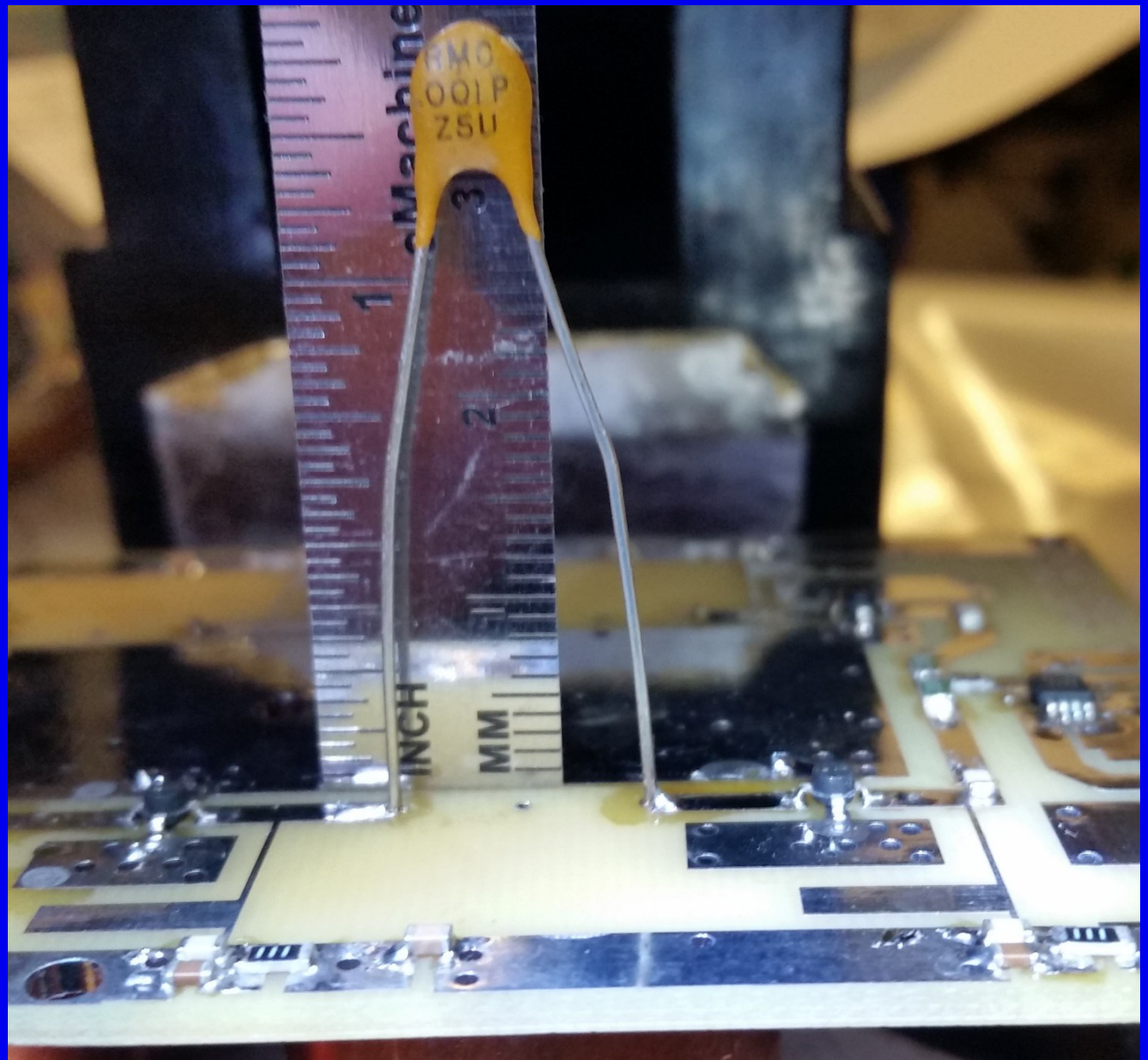


Pipecap Screw is Quarter-wave Resonator

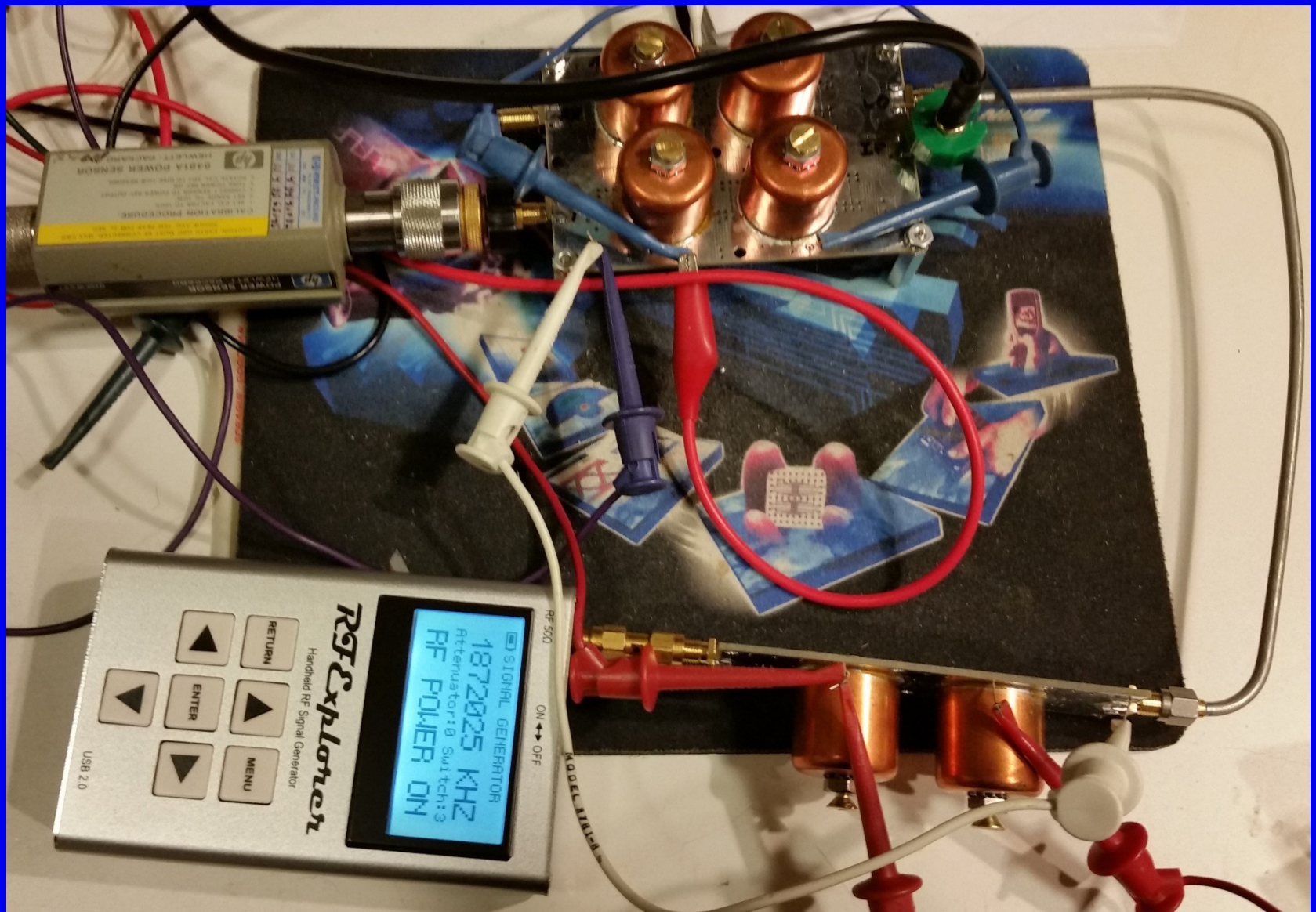


Pipe-cap testing

Pipe-cap Probe Length



Tuneup – TX


RF Explorer
Handheld RF Signal Generator
RF 500
SIGNAL GENERATOR
1872025 KHZ
Attenuator:0 Switch:3
RF POWER ON
RETURN
ENTER
MENU
ON
OFF
USB 2.0

Tuneup

- Set screws to approximate depth
- Power transmit side
- Apply LO power, tune for max TX output
- Add ~ 0dBm IF drive, back screws out for max output
- Set RX screws same as TX screws
- Power receive side
- Add weak signal at input, tune for max IF output
- Tweak for best Noise Figure

Tuneup – RX


RF Explorer
Handheld RF Signal Generator
RETURN
ENTER
MENU
USB 2.0
RF 50Ω
ON OFF
SIGNAL GENERATOR
5760025 KHZ
Attenuator:1 Switch:0
RF POWER ON
ANSOFT
RF Explorer
Handheld Spectrum Analyzer
RETURN
ENTER
MENU
USB 2.0
RF 50Ω
ON OFF

Summary

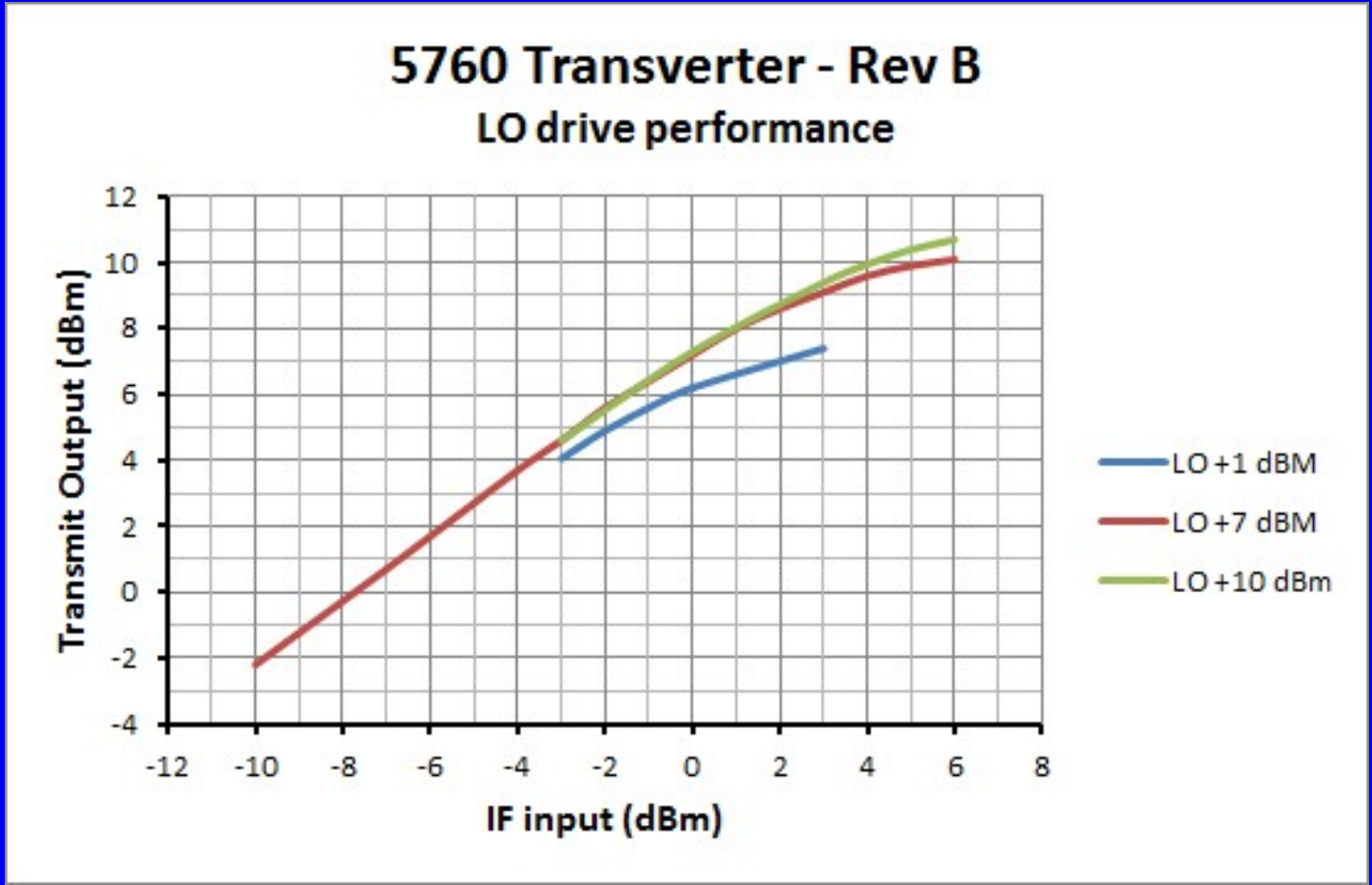
- Good performance
- Low cost
- Easy to build
- PC boards available
- Add amplifier, filter, and preamp for higher performance
- *BUT high LO drive required > +10 dBm*

High LO drive

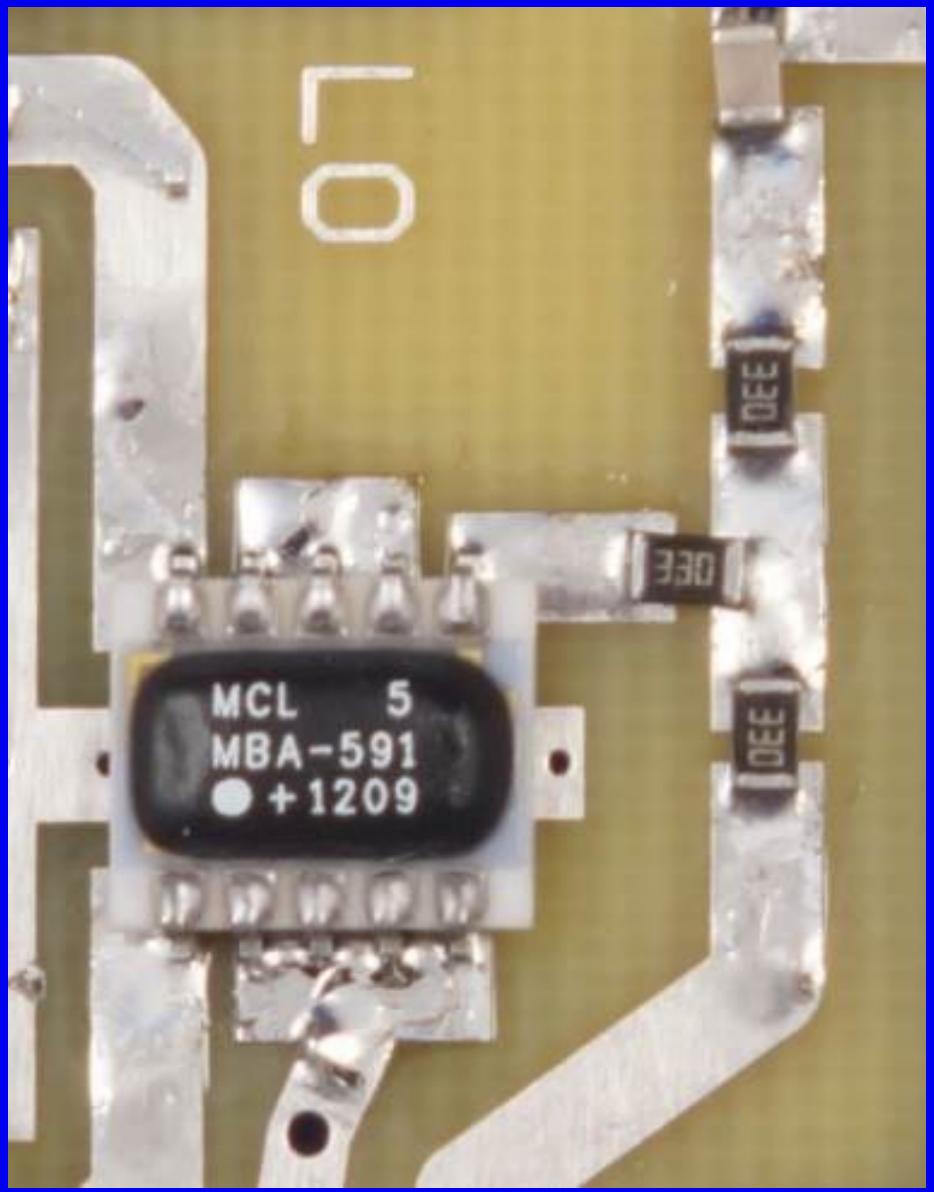
- > +10 dBm required
- Limits choice of LO sources
- Things change when roving
- *Need more forgiving mixer*

Revision B Transverter

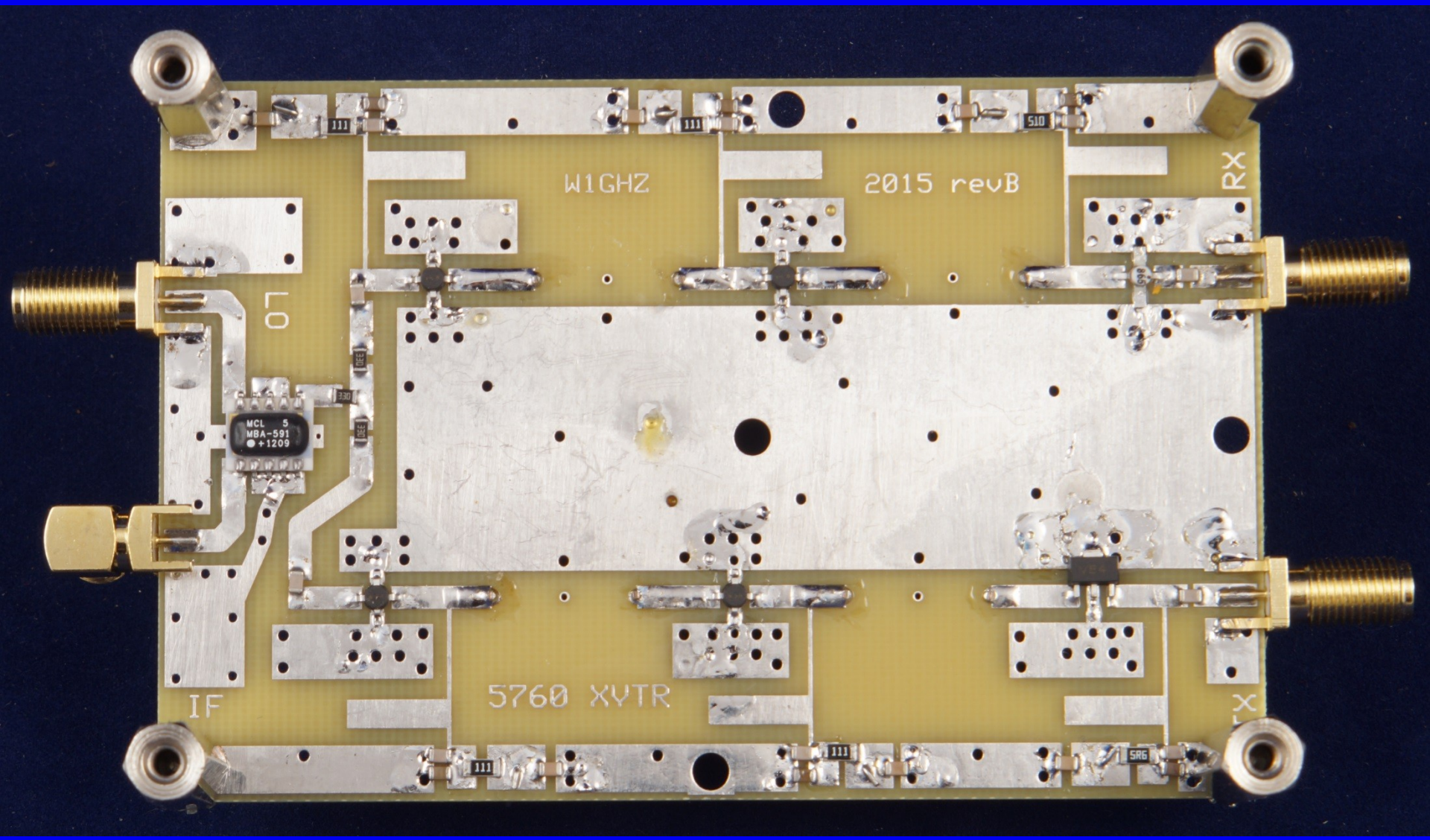
- Change mixer to Minicircuits MBA-591
- Works down to +1 dBm LO drive
- Easier to solder



MBA-591 Mixer

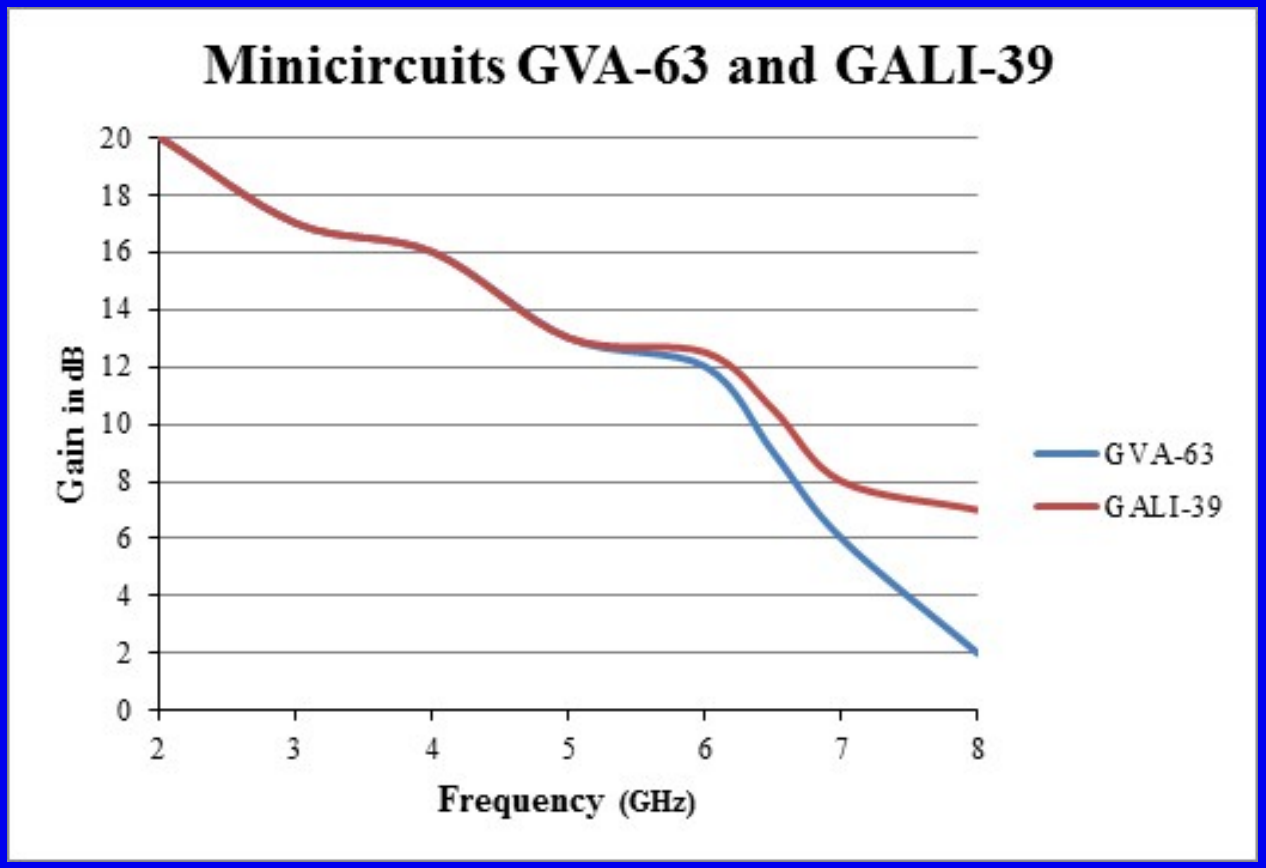


2015 Rev B Transverter



Newer MMICs

- 4-leaded -86 package becoming obsolete
  - Minicircuits still has parts available
- Newer SOT-89 package with ground tab



5760 MHz 2015 RevB Performance

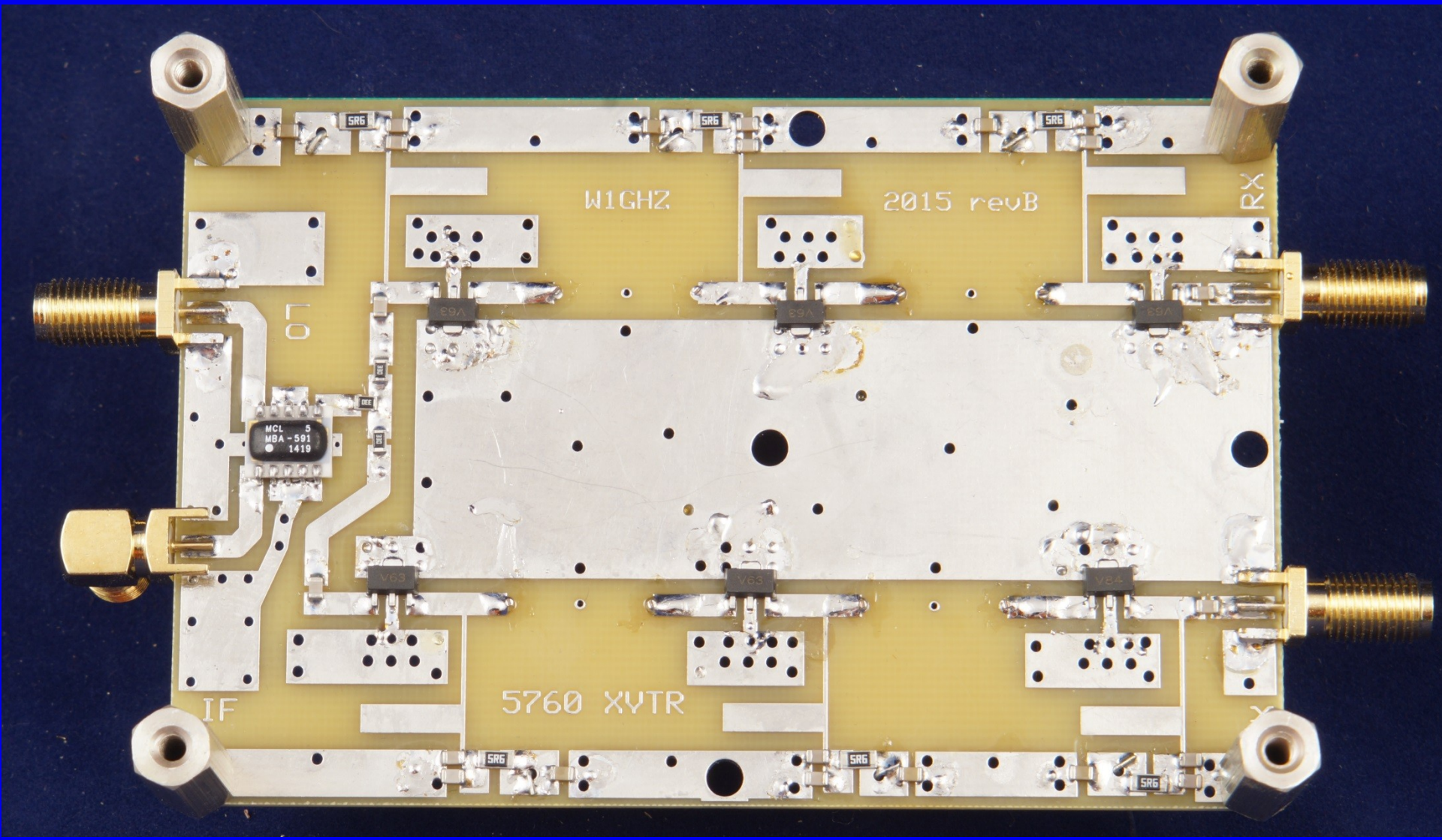
ERA-1 MMICs (4-lead)

- LO +1 dBm
- TX out ~ +10 dBm
- TX mmic GVA-84
- RX NF ~ 3 dB
- RX mmic MGA-86576
  - Obsolete, ~$10
- LO leakthru ~ -45 dB
- IF = 144 or 432 MHz

GVA MMICs (SOT-89)

- LO +1 dBm
- TX out ~ +14 dBm
- TX mmic – GVA-84
- RX NF ~ 5 dB
- RX mmic GVA-63
  - 99 cents
- LO leakthru ~ -45 dB
- IF = 144 or 432 MHz

5760 Transverter with newer MMICs



5760 Rev B Summary

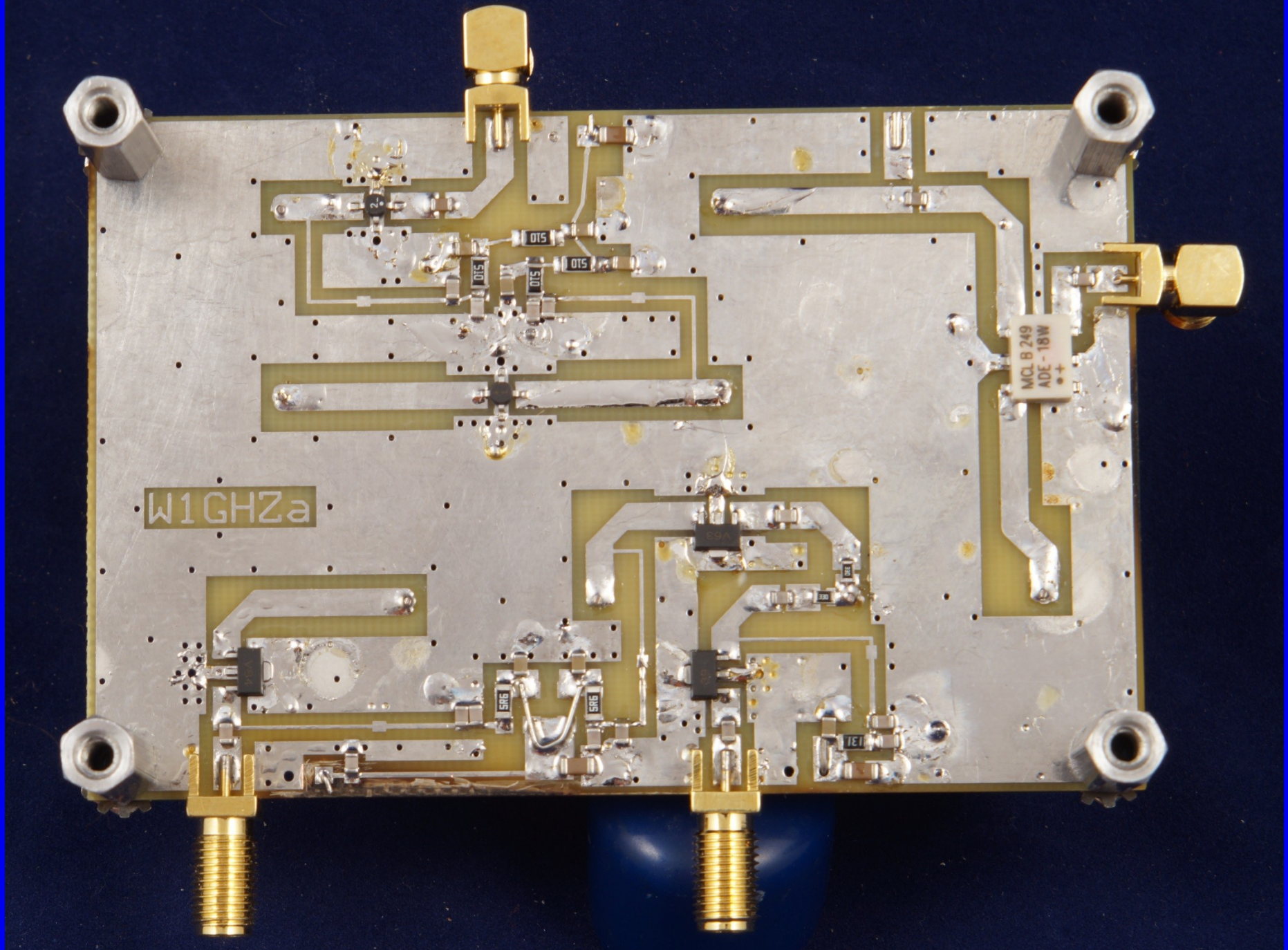
- Good performance
- Low cost, inexpensive parts
- Easy to build
- Works with low LO drive
  - A-32 Synthesizer with Multiplier board
- PC boards available
- Add amplifier, filter, and preamp for higher performance

Then what about 3456 MHz?

- 5760 with longer screws – retune Pipe Caps
- Same Mixer
  - Minicircuits MBA-591 works down to 2.8 GHz
- No change to bias stubs
- ----------
- TX ~ 15 dBm (GVA-84)
- RX ~ 5dB NF
- Low LO drive OK
- Tune to 3400 for EME

And 2304 MHz

- Cheap and Simple Rover Transverter
- Update
  - Modify MMIC footprints for SOT-89
- Assemble with newer MMICs
  - TX – GVA-64 driving GVA-84
  - RX – GALI-39 (low noise at 2.4 GHz)
- *Multiplier works, don't fix it!*


W1GHZa
MCL B 249
ADE-18W

Updated 2304 MHz Performance

- TX output ~ 18 dBm (70 mW)
- RX Noise Figure ~5 dB (single gain stage)
- LO drive from multiplier ~5 dBm
- LO leakage ~ -35 dB

Conclusion

- Simple, Cheap Transverter for 5760 MHz
- Also works at 3456 (or 3400)
- Easy to build, *Learn by Doing*
- 2304 MHz Transverter Upgrade

- Simple and Cheap struggling at 10 GHz
  - *More to come*

- *Get some rovers on the air!*

www.w1ghz.org

