Getting Started in Microwaves for the Mt. Airy VHF Club

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Blue Ridge Microwave Society (BRMS)

How to get started in Microwaves

- **Microwaves?**
  - Generally amateur bands above 1 GHz (we will include 902 MHz!)
  - 902 MHz to 300 GHz and beyond
- **Where to get it**
  - Buy it, Build it
  - The transverter
  - IF rigs
- **Microwave DX: Think about DX differently!**
  - Direct path and the not so direct path!
  - Anomalous propagation: tropo bending,
    scatter: rain, tower, air plane & tropo scatter
- **Antennas**
- **Test Equipment**
- **Digital**
- **Information Exchange**

Where to get it: Buy it

- **IC-905: Icom all-mode transceiver with 144/440/1200/2400/5600 MHz coverage. Add 10 GHz with the optional CX-10G transverter.**

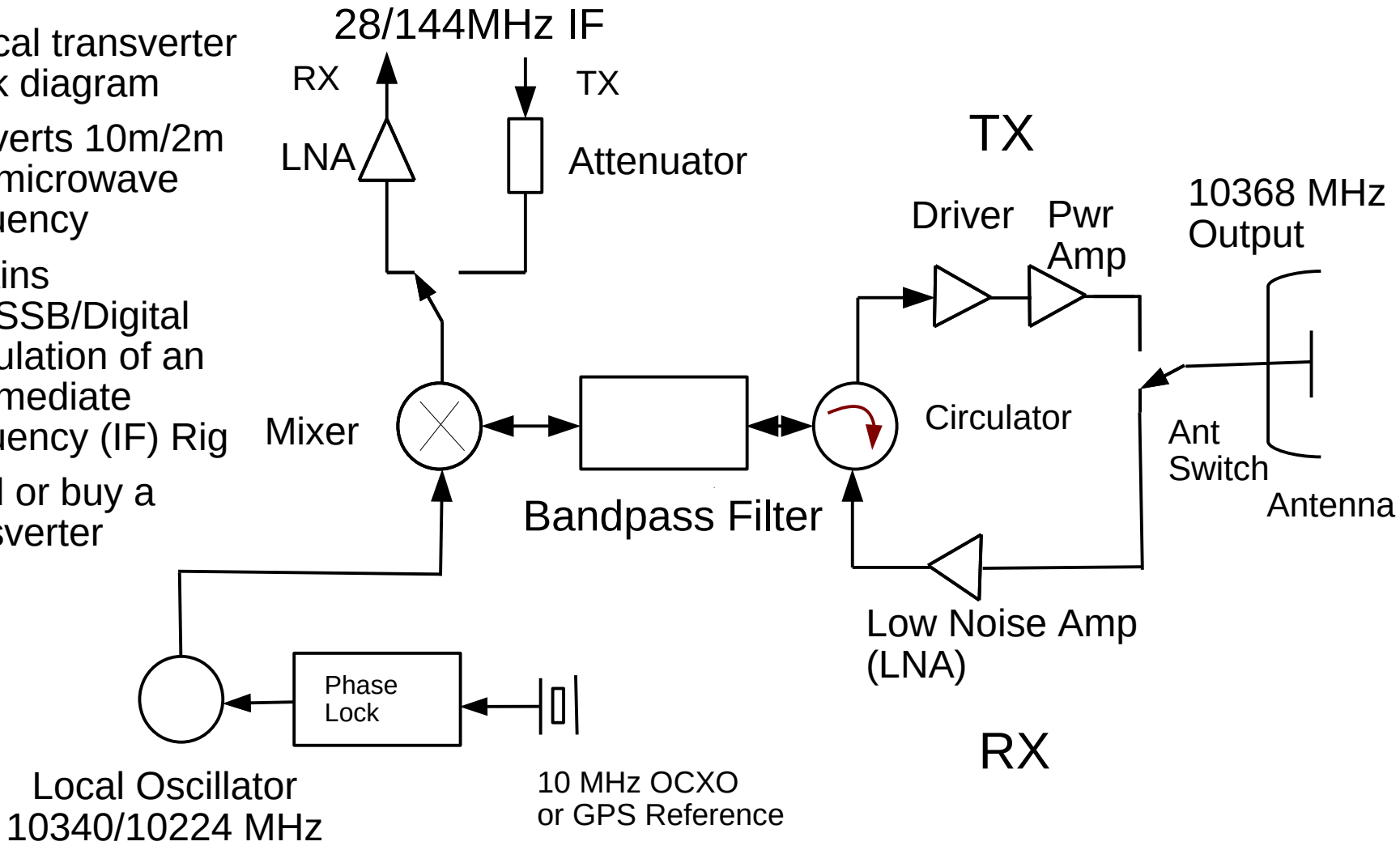
- **This is the future of microwave but expensive: ~ $2900 for radio and ~$1000 for the 10 GHz**
- **24 GHz module coming?**

Buy it: Icom IC9700

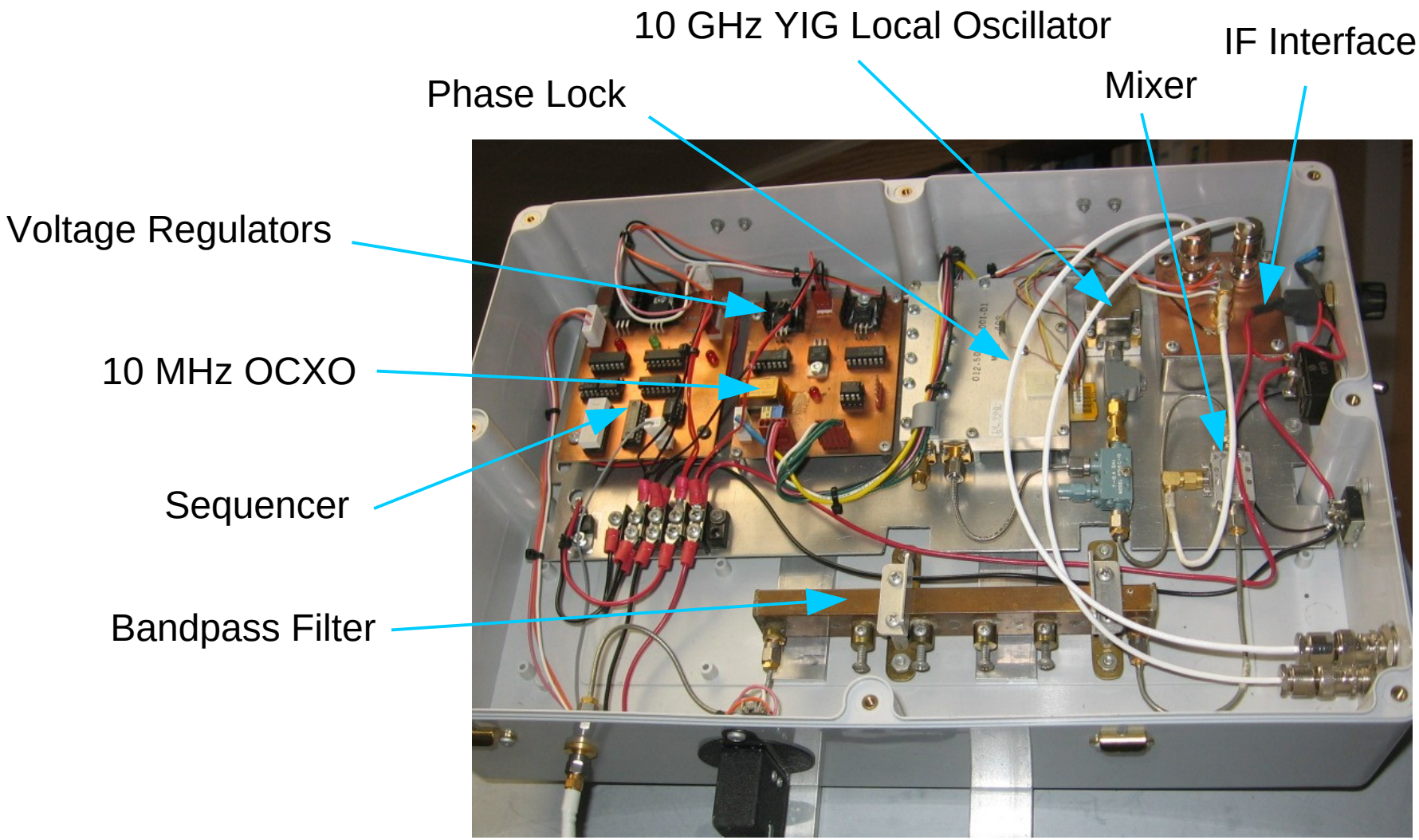
- **All-Mode, 2M/70cm/23cm, SDR, D-STAR**
  - 10 watts on 23 cm
  - ~ $1900

Most Microwave Rigs use a “Transverter”

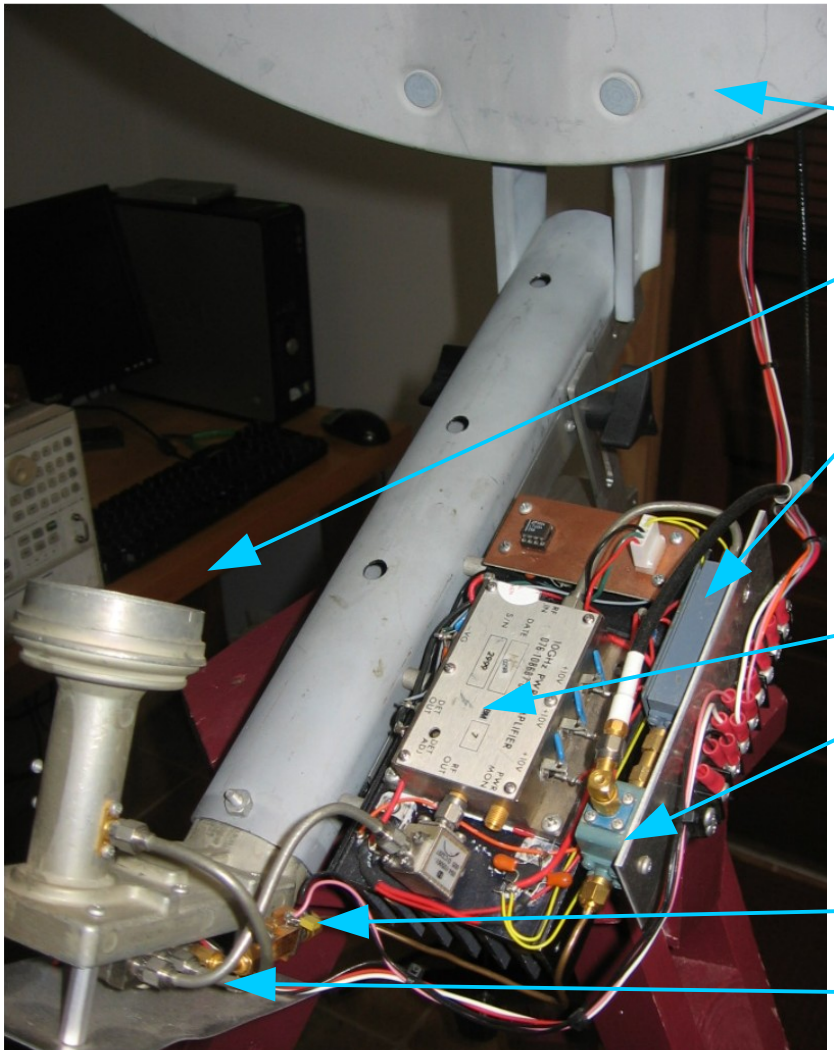
- Typical transverter block diagram
- Converts 10m/2m to a microwave frequency
- Retains CW/SSB/Digital modulation of an intermediate frequency (IF) Rig
- Build or buy a transverter



Home Brew 10 GHz Transverter



Transverter and Antenna



Where to get it: DB6NT Kuhne

- Kuhne: https://shop.kuhne-electronic.com/kuhne/en/
  - German DB6NT
  - State-of-the-art but expensive
  - Wide range of products: LNA's, PA's, transverters through 76 GHz
  - Maybe held up due to tariffs

KUHNE electronic
MICROWAVE COMPONENTS

10 GHz Transverter
200 mW
715€

Where to get it: DownEast Microwave

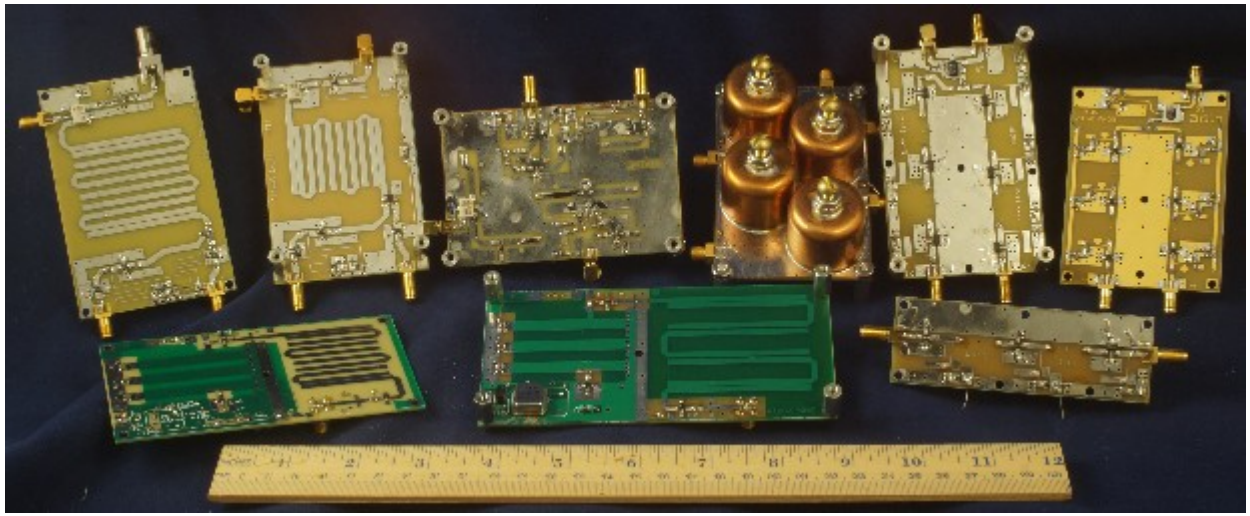
- https://www.downeastmicrowave.com/category-s/1814.htm
- Large selection: LNA's, PA's, transverters & parts 50 MHz to 10 GHz
  - Some available as lower cost kits

10 GHz transverter
3 W
$775

SG Labs

- Low cost 33, 23 and 13 cm transverters
  - Power ~2 watts
  - Power amps available
  - Price ~ $200
- https://www.sg-lab.com/amateur.html
  - From Bulgaria
  - May be held up due to tariffs

Where to get it:
Paul Wade W1GHZ



- Low cost boards and components
  - **www.w1ghz.org**
  - Intermediate between building from scratch or buying a complete transverter
    - — Add a PA and/or a LNA from Downeast Microwave
  - Paul Wade's on-line antenna book not to be missed!

Where to get it: IF rigs

- **Most microwave transverters convert 2m to the desired microwave band**
  - All mode AM/FM/SSB/CW 2m rigs desirable
    - — Newer rigs support digital or use SignaLink interface for digital
- **QRP rig that covers 2m is ideal**
  - IC705: state-of-the-art but $$$
  - FT817/818
  - IC202 & FT290 older, cheaper
  - 28 MHz IF possible with good filters
    - — Flex 1500: SDR (28 MHz)
    - — HTX100 or HR2600 (28 MHz)
  - Inexpensive 28 MHz/2m converters available on eBay or W1GHZ
- **Older rigs available at lower cost**
- **Use LiFePO4 batteries for portable**
  - Relatively safe, lighter/smaller than lead acid but more $$$

IC705

FT-290

FT-818

IC202

Flex 1500

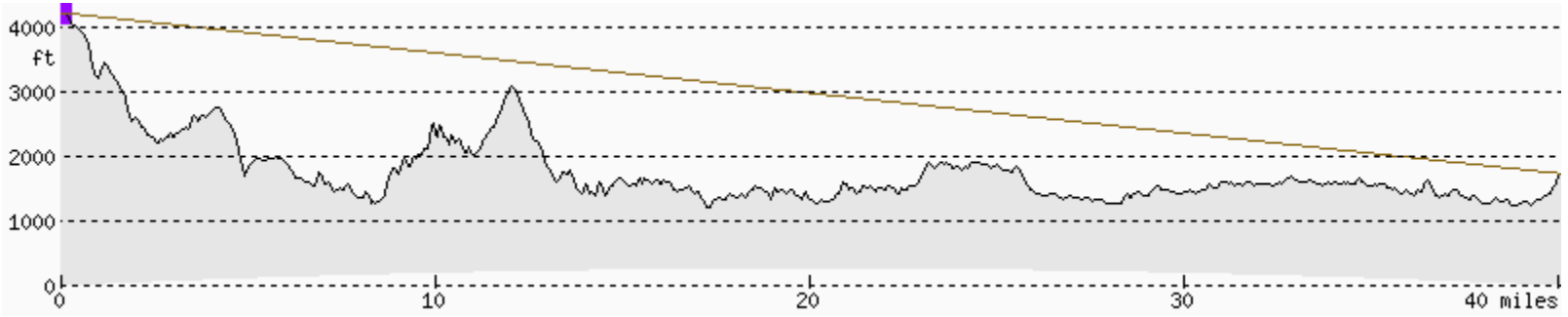
HR2600 or HTX100

Microwave DX

- **Think about DX differently!**
  - There is line of sight (LOS) DX but microwave DX much more than LOS!
  - Microwave DX is all about anomalous propagation..doesn't happen often but when it does….hundreds kilometres (or more) are possible
  - Growing activity: Logs with up to a 100 contacts on 10GHz are being submitted for contests
  - Award for collecting grid squares: VHF/UHF Century Club (VUCC)
    - Different award for each band
    - Only 10 grids needed for 10 GHz VUCC

      https://www.arrl.org/files/file/Awards/VUCC_Rules_July_2023.pdf
  - Look up the distance records: **https://www.arrl.org/distance-records**
- **Propagation**
  - Direct path
  - Rain, tropo bending, tower & aircraft scatter, tropo scatter
  - EME: moon bounce
  - Propagation maps: **vhf.dxview.org/**

Direct Path



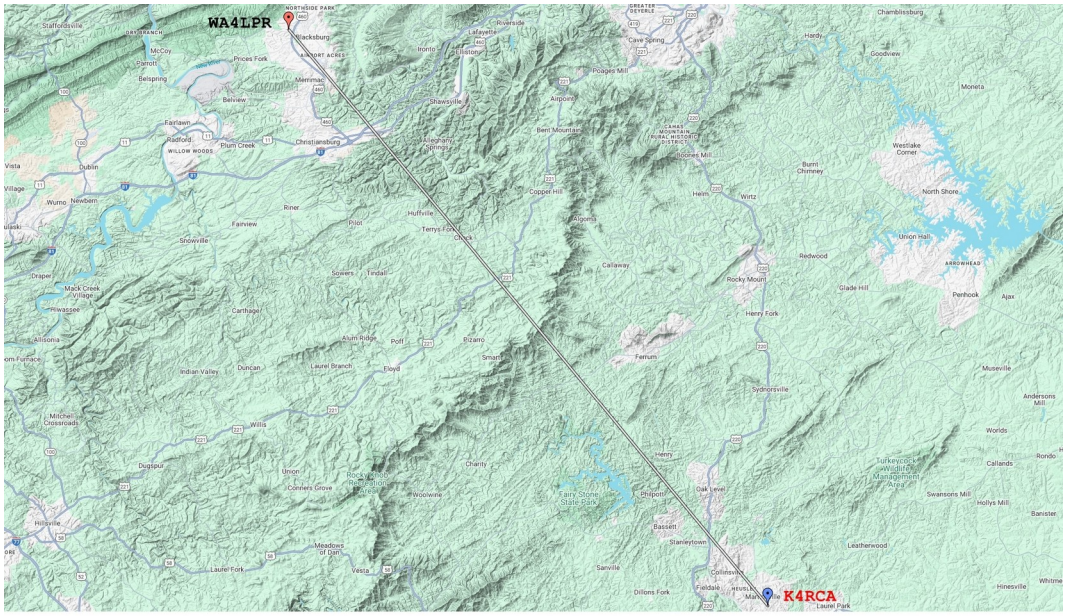
LOS Path from Bald Knob (Warm Springs Mt.) to the Mill Mt. Star in Roanoke

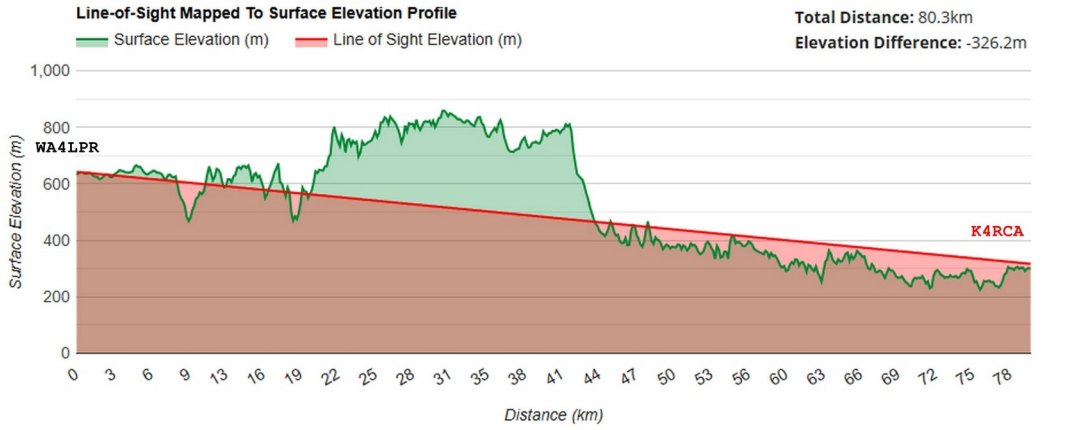
- **Line of Sight (LOS) or direct path**
  - **https://www.heywhatsthat.com/**
  - Be sure to choose “curved earth”
- **Usable for Non LOS paths**
  - “Knife Edge” scattering over mountain ridges
- **Direct path useful for testing and just having fun!**
  - Paths over 160 km possible in VA
  - Good for getting started on 24 GHz

WA4ZRP and WA4LPR work 10 GHz LOS from Roanoke Mill Mt. Star to WA4PGI on Bald Knob

And the Not So Direct Path!

K4RCA-WA4LPR
1296 MHz 80 km Path

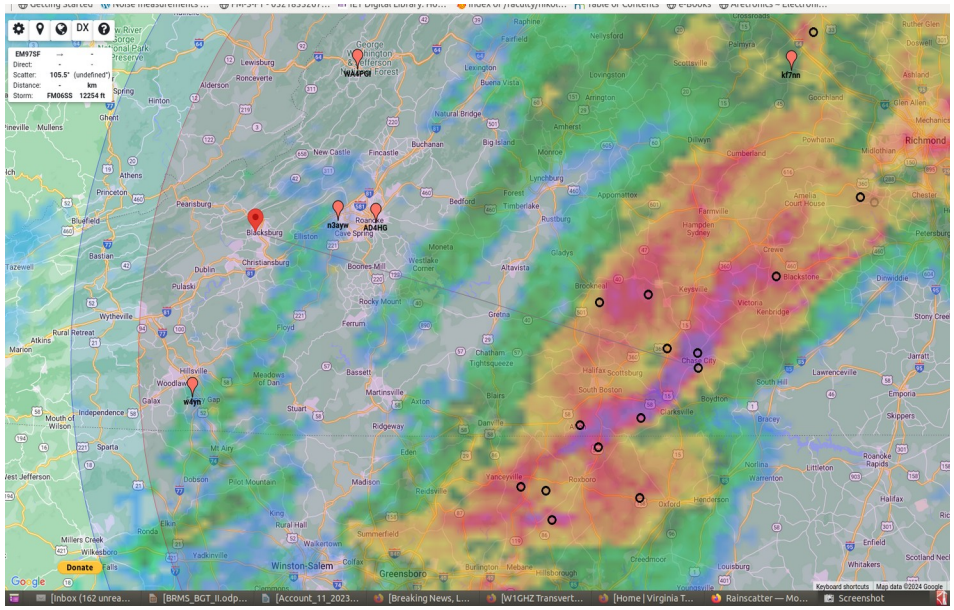




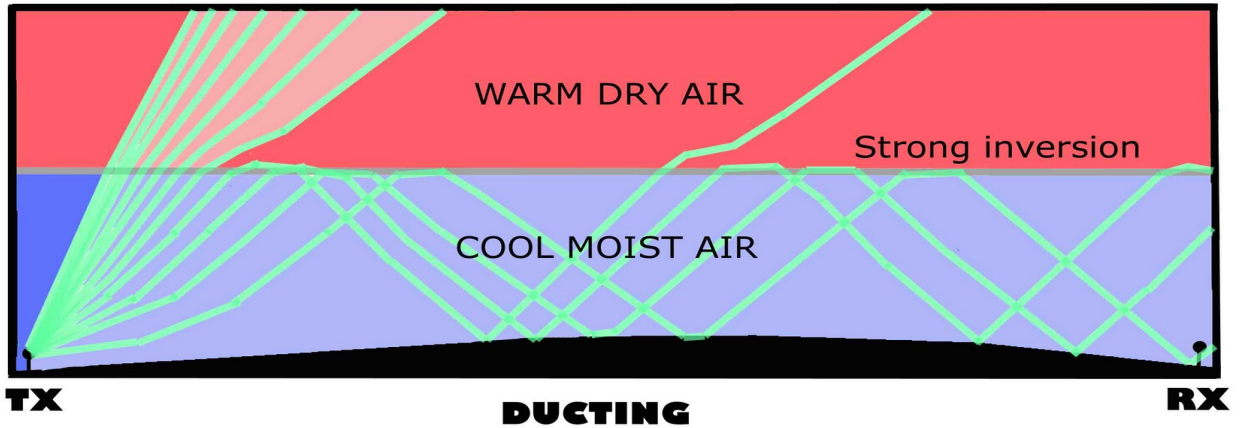
Rain Scatter: if it rains it propagates

- **Rain scatter**
  - Popular on 10 GHz but should work on most microwave bands
  - W4DEX holds the rain scatter record in 4 call area on 10GHz at 1008km
  - Works well with FM and CW
    - — Tends to distort SSB
  - Many stations active on 10 GHz
- **Website:**

  www.rainscatter.com
  - Register call, location & contact data
    - — Folks will call you for potential contact
  - Gives rain storm location & potential contact radius



TROPOSPHERIC DUCTING



DUCTING

Signals bend down and reflect off the ground.
RX receives signal from TX. Radar shows strong ground clutter.

W. HEPBURN

- **Website: Hepburn maps: tropo forecasts**
  - **https://www.dxinfocentre.com/**
  - http://www.dxinfocentre.com/propagation/tr-modes.htm
  - **https://www.youtube.com/watch?v=YUmyuoivGjk**
  - The mode used to bridge the Hawaii-West Coast path on every microwave band through 6 cm.
  - Signals can be very strong
  - Our Poor Mt. 1296 beacon copied in Illinois (FN41) on tropo ducting

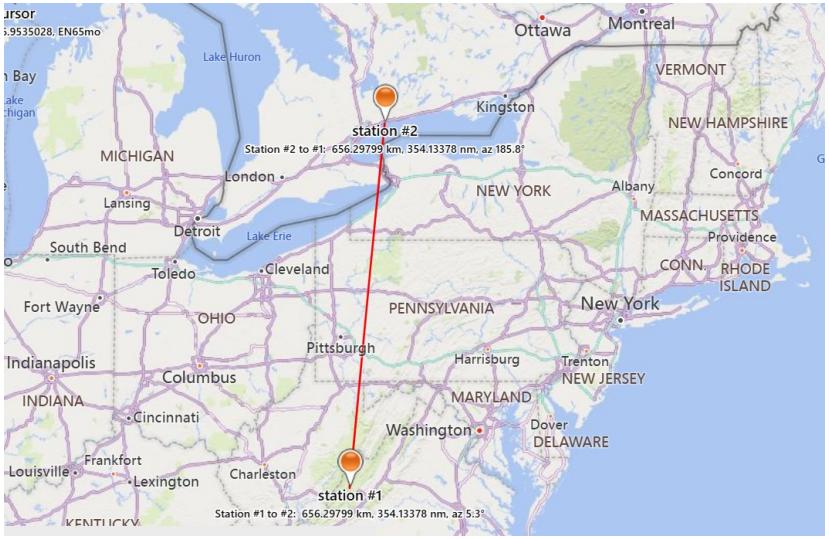
WA4PGI Tropo Ducting Contacts

10 GHz – tropo QSO – August 2023

WA4PGI FM07cw

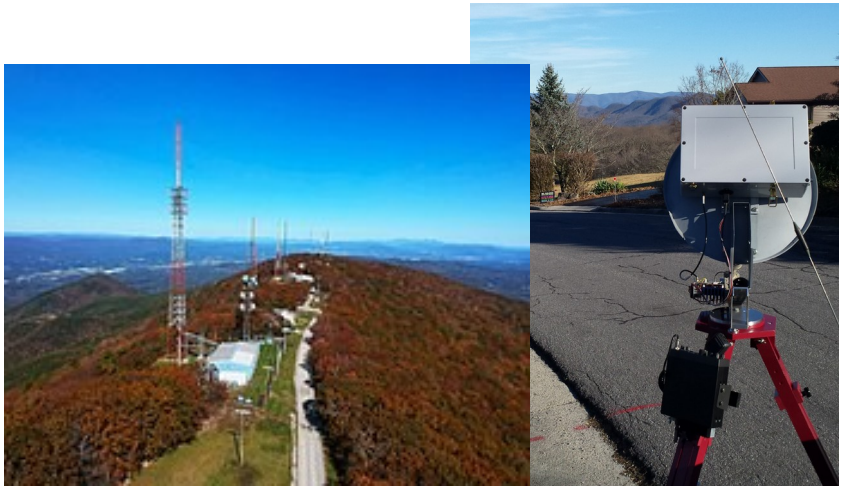
VA3ELE
VE3SST FN03lt
VA3TO
VE2UG

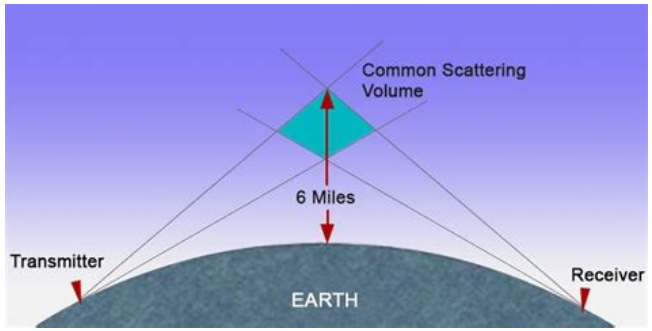
656 km distance



Scatter

- **Anything that reflects!**
- **Air planes**
- **Tower scatter**
  - WA4PGI's 10 GHz Bald Knob beacon detected in Blacksburg, VA reflected off Roanoke Poor Mt. TV towers
  - "10 GHz TV tower reflections" talk by Ben K4QF, see BRMS "Files"





- **Tropo scatter**
  - Stations illuminate common scattering volume
  - Used by the military up to 500km
  - Normally requires high pwr and large antennas, but more modest pwr levels and antennas possible with amateur narrowband systems

EME: Moon Bounce: the Ultimate DX

- **Earth Moon Earth (EME)**
  - Done on every band from 10m through 47 GHz
  - Everything you want to know about EME: **https://www.bobatkins.com**
    - DL0SHF runs a 10GHz EME beacon
  - Used to take large antennas and high power
    - Still a challenge, but digital modes and new technology make it more doable than you think
- **Small Dish EME by Rex VK7MO**
  - **www.youtube.com/watch?v=9iDlL0X73WA**
  - Work a lot of different grids!

W5LUA small dish
(1m) 10 GHz EME

Antennas

- **Important part of your station**
  - W1GHZ on-line antenna book
    - — **http://www.w1ghz.org/antbook/preface.htm**
    - — Everything to know about microwave antennas
  - 1296 – 3400 MHz loop yagis widely used
    - — **https://directivesystems.com**
  - Great place for home brew
    - — WA4PGI's 3 sided corner reflector: cheap, easy to build, see BRMS "Files"
    - — Good performance up to 3400 MHz
  - Horns: see W1GHZ antenna book
  - WiFi antennas: Hanna Wireless WiFi antenna

    http://www.w4dex.com/microwave/5760_mhz/5.7ghz_antenna_test/5760_mhz_antenna_test.htm
- **For portable operation 30 dB gain antennas**
  - Offers high gain but not too difficult to aim

WA4PGI Corner Reflector

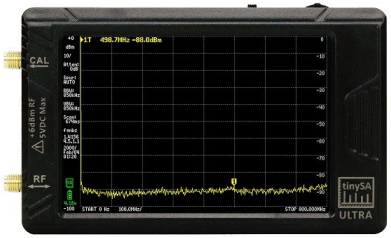
Hanna Wireless Reflector

More Antennas

- **Satellite TV dish good for 10 GHz**
  - Cheap from your neighbour's backyard or eBay
  - About 30 dB gain, good for portable operation
  - Easy to modify for 10 GHz
    - See W1GHZ antenna book
    - W1GHZ sells a 10/24 GHz TV dish feed
  - Original feed horn usable but requires modification
    - DSS LNB Modified for 10Ghz.pdf by W4YN in BRMS “Files”
  - Clever tweak by WA4PGI: add symmetric spots of reflective tape, point at sun to find horn focus
- **Need low loss microwave cables and connectors**
  - Don’t even think about using that RG58 cable with UHF connectors!
- **Larger offset reflectors (for EME?) may be available**

Test Equipment

- **You don’t need a bench full of HP test equipment**
  - It is nice and some of that is available through BRMS….but...
- **Low cost battery powered equipment handy for field use**
  - NanoVNA usable through 1.5 GHz, newer ones to 4 GHz or even 6 GHz
    - — Good for checking/adjusting antennas and filters
  - TinySA Ultra: Spectrum analyser:
    - — good through 6 GHz usable to 10 GHz
  - Caution: get a genuine unit, subpar clones exist out there
  - Variants of AD8317 power detector usable through 10 GHz
    - — See W4YN’s AD8317 pwr measurement presentation on BRMS
- **Add a directional coupler and some attenuators**
  - Good for adjusting antennas and measuring power
  - Obtain on eBay



TinySA Ultra

NanoVNA

Digital

- **Digital Modes offer extended weak signal performance**
- **WSJT**
  - FT-8 and FT-4 popular, but other modes better for microwave
  - Q65: recommended for EME, scatter, and other weak signal VHF, UHF & microwave work. **https://wsjt.sourceforge.io/Q65_Quick_Start.pdf**
  - JT4 and JT65 were designed for EME ("moon bounce")
- **Olivia**
  - MFSK keyboard to keyboard communication: almost as good as WSJT but you can have a real QSO
  - Fldigi: free software for Olivia
  - K4RCA & WA4LPR have successfully used it on 1296 MHz, going higher!
- **PSK reporter - map view of digital modes received by other stations**
  - **pskreporter.info/pskmap.html**
- **Digital**
  - Requires frequency stability/precision: OCXO's or GPS lock desirable

Information Exchange

- **BRMS: Blue Ridge Microwave Society**
  - Our local group: **groups.io/g/brms**
  - Skeds, activity, technical help
  - Technical archive: 23 cm amp, microwave filters, antennas, phase noise measurement, EME, beacon descriptions, more!
  - Over 240 (!) registered members world wide

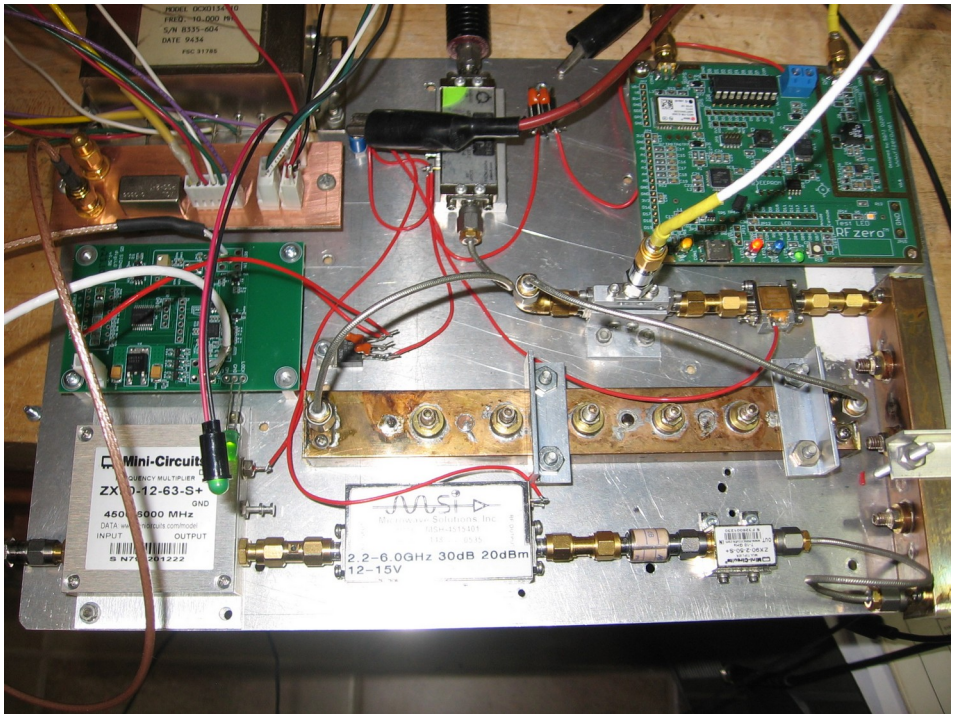
Information Exchange

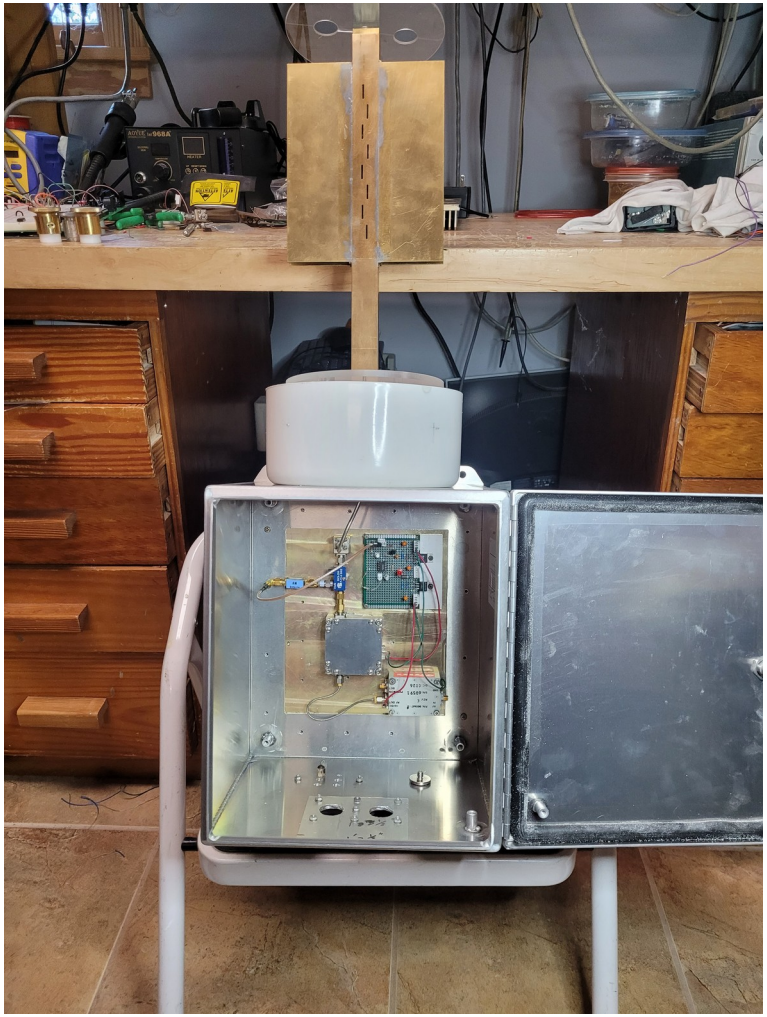
- **Microwave Conferences**
  - Yearly Microwave Update: **https://microwaveupdate.org/**
    Sponsored by the PackRats: 2000 & 2007!
- **Publications**
  - **DUBUS: German/English: European vhf/uhf/microwave**
  - **QEX: ARRL technical information exchange**
- **NETS**
  - **East coast 70 cm net (432.09 MHz): Wednesdays @ 2100 local time**
  - **BRMS 2 m SSB net (144.190 MHz): Mondays @ 2100 (2030?) local time**
  - **Chat room: www.w4dex.com**
- **Microwave Organizations**
  - **San Bernardino Microwave Society: w6ife.com groups.io/g/SBMS**
  - **North Texas Microwave Society: http://www.ntms.org/**
  - **Mt. Airy VHF Radio Club (PackRats): http://www.packratvhf.com/**
  - **Rochester VHF Group: http://www.rvhfg.org/**

Information Exchange

- **Chat Rooms: find activity & skeds**
  - ON4KST - **www.on4kst.com/chat/start.php**
  - East Coast 70 cm Net Chat - **www.w4dex.com/qso/account.php**
- **Activity Days:** 1st Saturday of the month
  - Coordination NTMS Slack "General" channel at **ntmsworkspace.slack.com**
  - Watch BRMS group site, if you are going mountain topping, post to BRMS
- **Contests**
  - **ARRL 10 GHz & UP** - **http://www.arrl.org/10-ghz-up**
  - **June, September, January VHF/UHF contest**
  - **EME: https://www.arrl.org/eme-contest**
- **Local Beacons**
  - BRMS(K4RCA/b) 1296.240 MHz EM97we - Poor Mt, Roanoke - 3800' msl
  - WA4PGI - FM07bw - Warm Springs Mtn - Bath County, VA – 4300' msl
    432.303 MHz 1296.210 MHz 5760.070 MHz 10,368.070 MHz
  - BRMS 10 GHz Q65/CW beacon for Poor Mt. currently under construction
- **Beacons US/Canada - www.newsvhf.com/beacons2.html**

BRMS 10 GHz Q65/CW Beacon



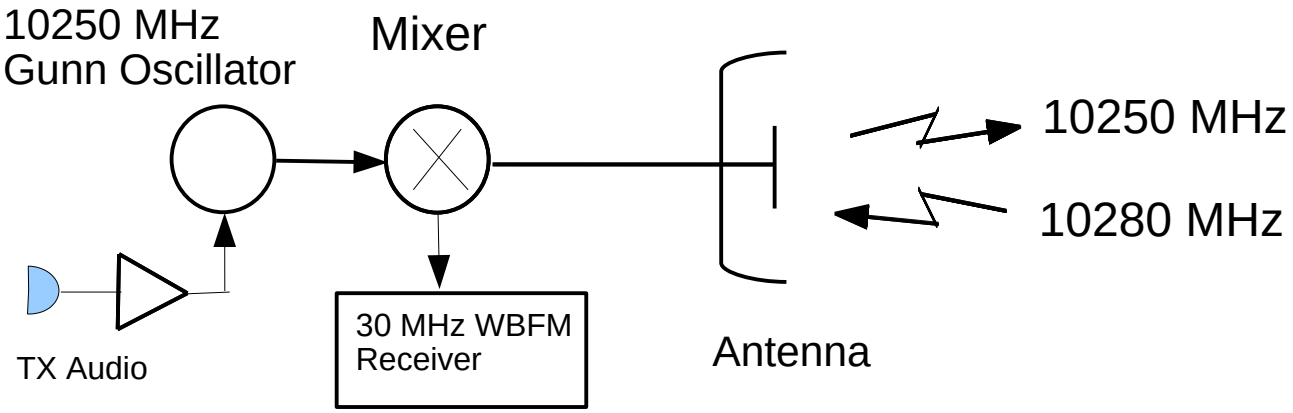


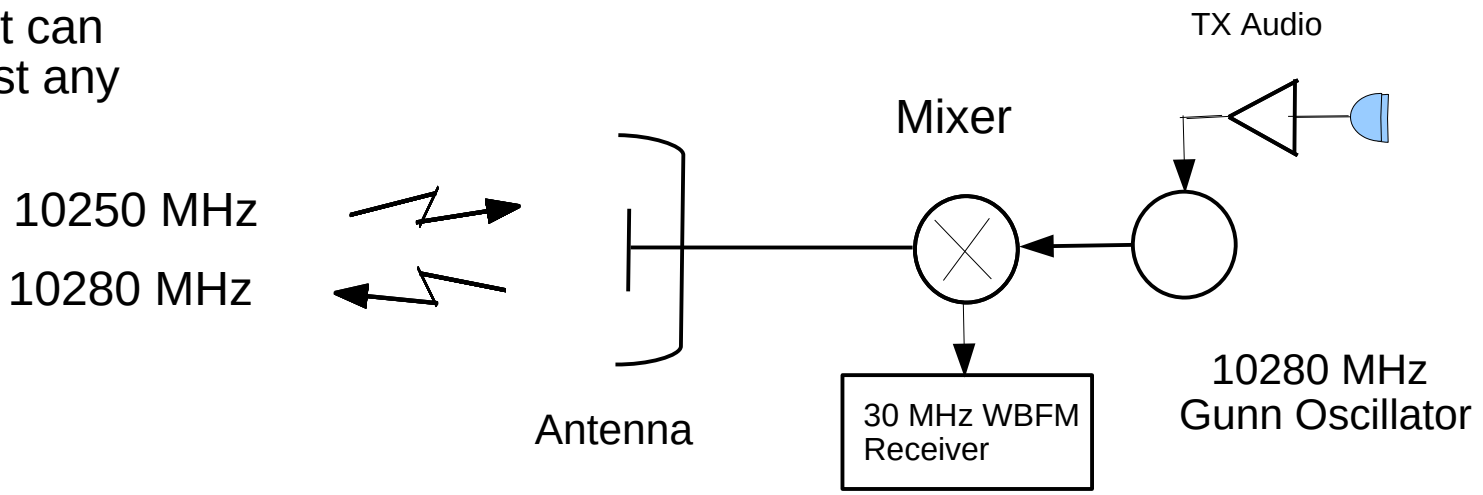
We May be Looney Tunes but That Ain't All Folks!

Work Some Microwave!

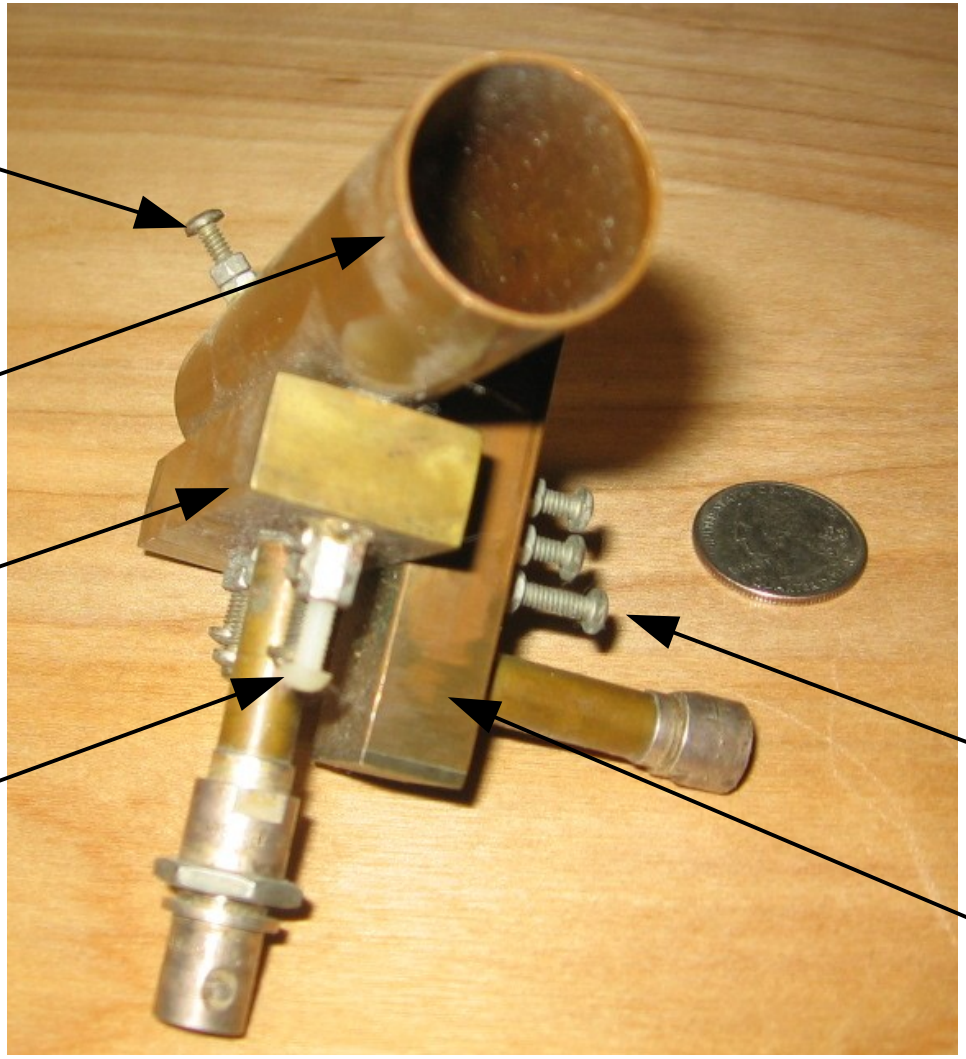
Gunnplexer/Polaplexer

- Uses simple single oscillator, TX is RX LO
- TX/RX isolated by different polarization or circulator
- RX is 30/100 MHz WBFM
- Simple, but can work almost any LOS path





Gunnplexer/Polaplexer



Mixer and Gunn Oscillator set 90 degrees around circular waveguide so they operate in orthogonal polarizations.