

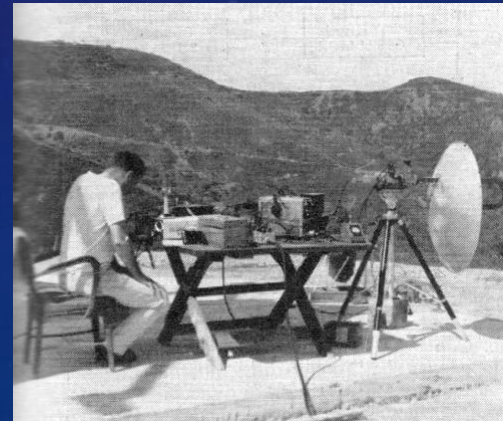
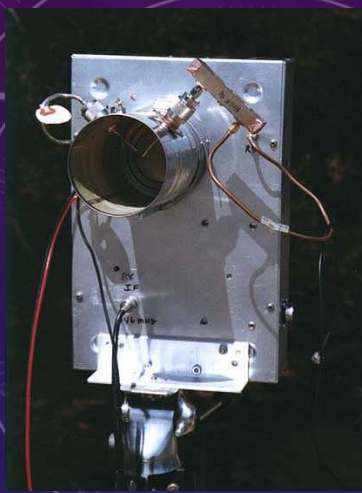
# INTRODUCTION TO AMATEUR MICROWAVE COMMUNICATIONS

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INYOKERN, CA



# MICROWAVES ARE FOR POPCORN, RIGHT?

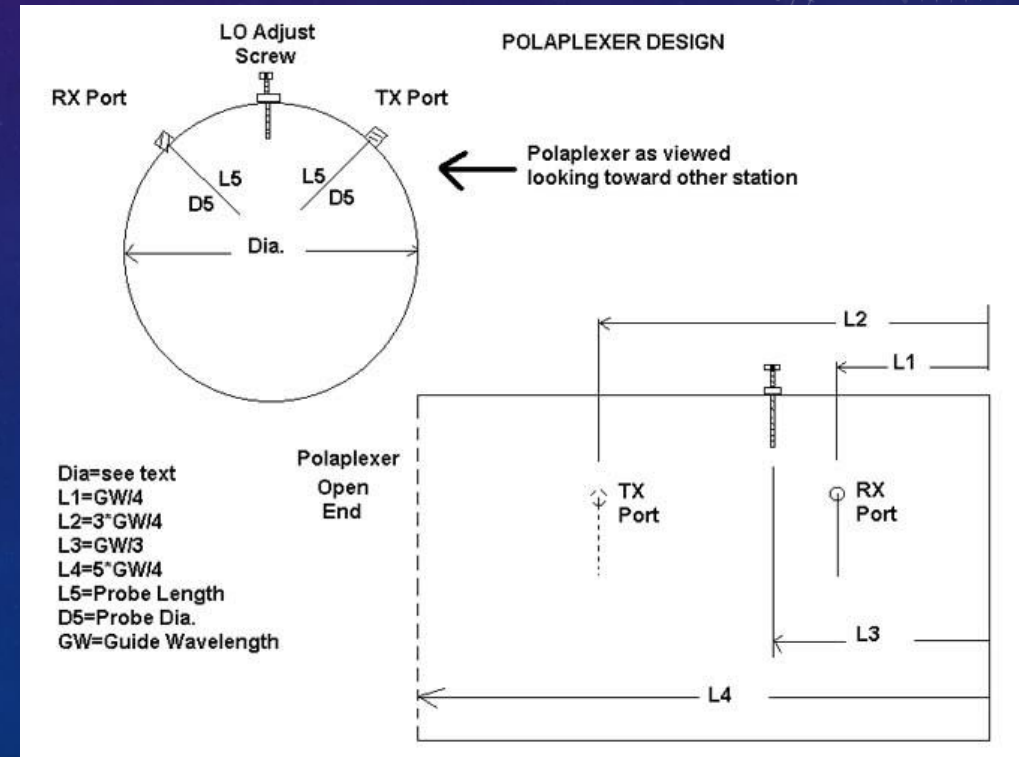
- Hams have always pushed the upper limits of the RF spectrum
- Early days, highly technical and few hams had the technical savvy
- 10 meters was 'SHF' in the 1930's
- WW II surplus RADAR parts spawned new interest
  - APX-6 were converted to 1215 mcs
  - 2K25 Reflex Klystrons meant easy access to X-Band FM
- Early microwave radios were pretty complex
  - W6IFE creates "Polaplexer" in late 1940's
  - Full duplex communications!
  - Used into the 70's





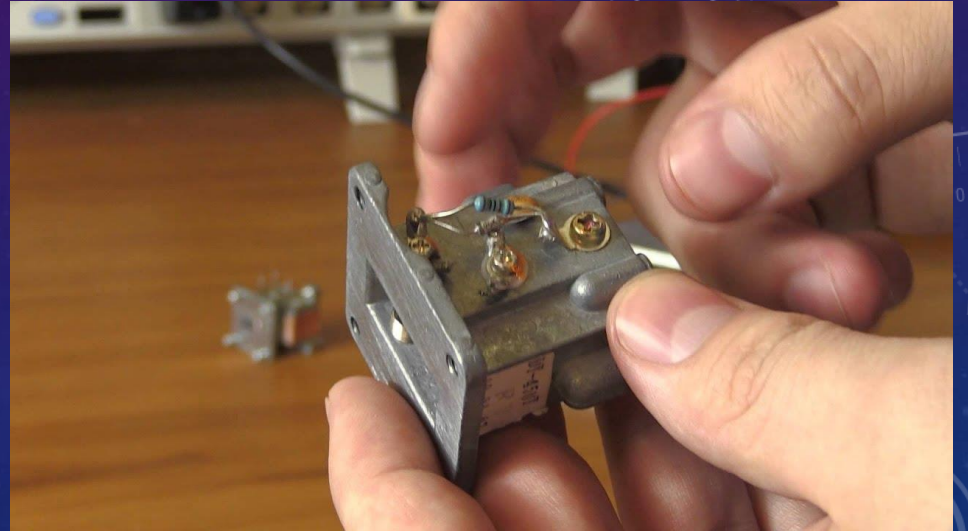
# SIMPLE BUILDS FOR 10 GHZ USING POLAPLEXER

- Design based on attenuation between orthogonal, linear polarizations
- Tin can is used as “antenna” (Circular waveguide)
- Klystron modulated with audio signal transmits wideband FM
  - Provide required DC and modulated voltage
  - Klystron probe penetrates the tin can
- Add microwave mixer diode with probe at 90 degrees
  - Klystron acts as local oscillator
  - IF difference between remote TX and local frequency
- Typical IF was 30 mcs
  - All homebrew
  - FM broadcast receiver can be used as IF (88-108 mcs)



# ENTER THE GUNN DIODE

- Gunn diode with resonant cavity oscillates
  - 10 GHz and up
  - FM modulated
- Microwave Associates “Gunnplexer”
  - Similar idea to polaplexer
  - Allows full duplex communications
  - IF is difference between TX and RX of two Gunnplexers





# FIRST COMMERCIAL AMATEUR GEAR!

- Advanced Receiver Research
  - TR10GA & TR24GA
  - Introduced in 1988
  - Wideband FM on 10 and 24 GHz
- 10 mW through 100 mW models
  - Waveguide output
    - Direct to a horn
    - Waveguide to a dish feed
- 100 mile contacts became common

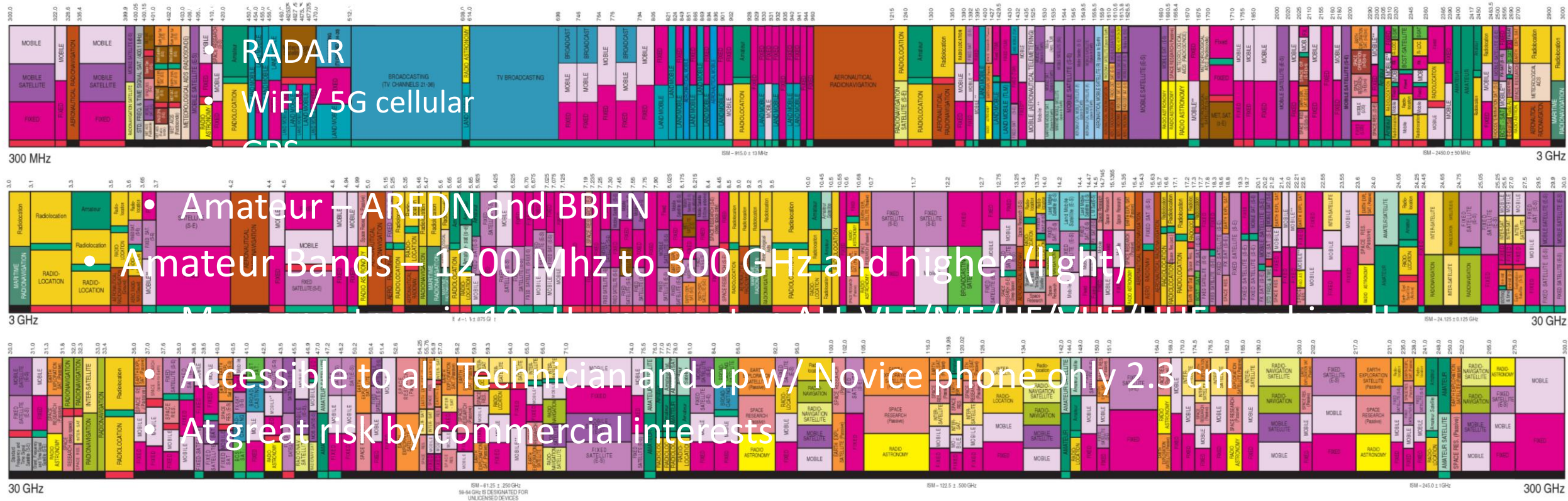




# AMATEUR MICROWAVE SPECTRUM

- Microwave is considered anything above 1000 MHz

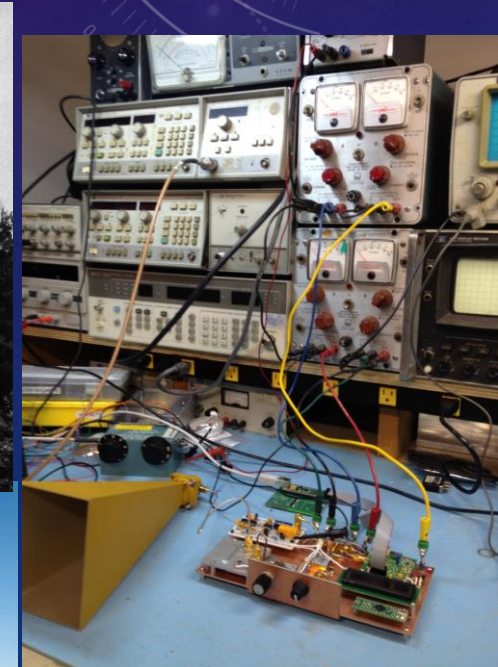
Comparison commercial/military





# MICROWAVE ACTIVITIES

- Weak signal (SSB, CW and Digital)
  - Contesting!
    - ARRL and CQ V/UHF contests include microwaves
    - Microwave specific
      - ARRL 10 GHz and Up
      - SBMS 2 GHz and up cumulative club contest
  - Moonbounce
    - Digital modes dominating today (WSJT-X)
    - 1296 through 76 GHz
  - Satellite
- Amateur Television (High Def Digital Color!)
- Experimentation



**Santiago Peak**

# BUT MICROWAVES ARE LINE OF SIGHT, RIGHT?

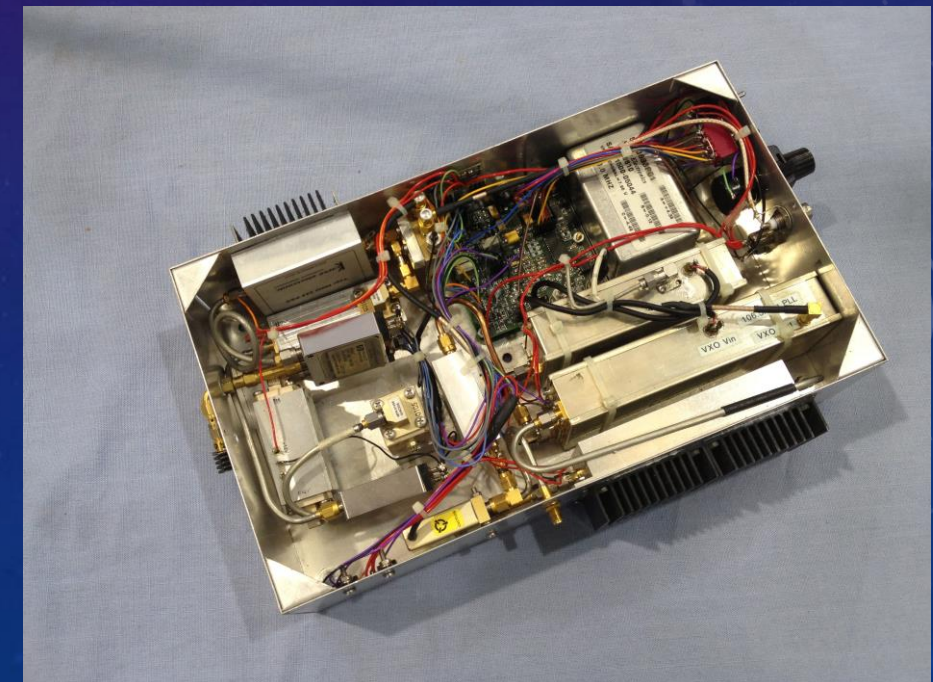
- North American terrestrial distance record on 10 GHz: >1000 MILES!
  - My personal best: ~600 mi on 10GHz / 82 mi on 24 GHz
  - Less than 1 Watt and a two-foot dish
- How is this possible?
  - Propagation enhancements
    - Ducting and Scattering
    - Reflections and diffraction
    - “Boeing Bounce”
    - Location, location, location!
  - Low noise receivers, modest antenna and power
  - Hawaii with Mainland USA (2500 mi) up to 5.7 GHz!





# WHAT EQUIPMENT IS NEEDED?

- Easy on 1296 / 23 cm
  - Commercial amateur gear
  - TS-2000, IC-9700 and others + hi-gain antenna
  - Very accessible
- Other bands require some 'integration'
  - Typically not available commercially
  - Roll-your-own
    - Commercial modules
    - Surplus and 'hand-me-downs'
  - Great way to start 'homebrewing'



# WHAT EQUIPMENT IS NEEDED (CONTINUED)?

- Typical 10 GHz radio
  - Transverter – converts 2.3 cm to a popular IF (like 144 or 432 MHz)
    - FT-817 popular IF radio
    - Any multi-mode transceiver, 28 Mhz and up)
  - Antenna and feed (Typical: small parabolic dish)
  - Power source for portable operation (12 V battery)
  - Something to mount it on (tripod)
- Microwave contesting means portable (lug-able?)



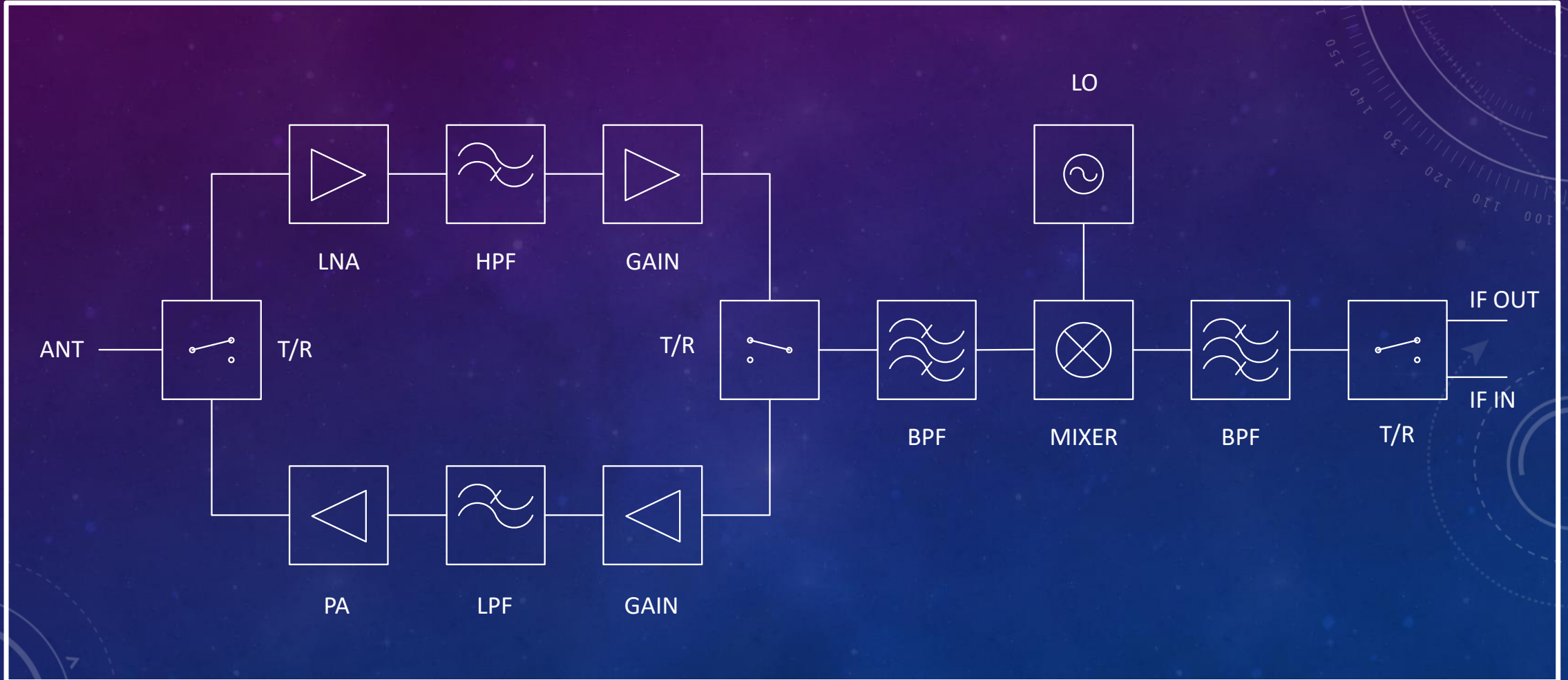


# TRANSVERTER BASICS

- Transverter = TRANSmitting conVERTER
  - Receive: Down-convert microwaves to Intermediate Frequency (IF)
  - Transmit: Up-convert IF to microwaves
- Components
  - Stable local oscillator (input frequency minus or plus IF)
    - For 10 GHz:  $10.368 \text{ MHz} \pm 144 \text{ MHz} = 10.244 \text{ GHz}$
    - Typical method: 2556 MHz with 4X multiplier
    - Typically a PLL with a TCXO or OCXO for a reference
  - Mixer
  - Relays, power source and control to switch from receive to transmit



# TRANSVERTER BLOCK DIAGRAM

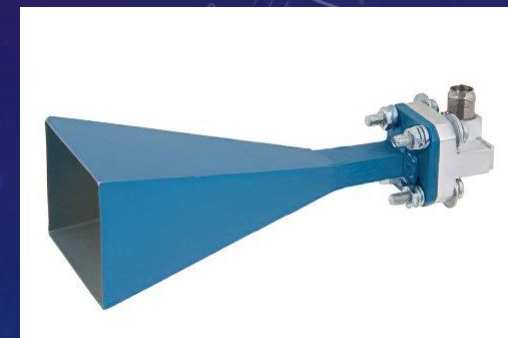






# SOURCES FOR MICROWAVE RADIO PARTS

- Commercial
  - Kuhne Electronics (DB6NT) \$\$\$
  - Down East Microwave \$\$
  - Microwave specialty clubs
  - Other microwave hams (these last two are important!)
- Surplus (eBay, etc)
- Second-hand from another ham!
- Hamfests and swap meets



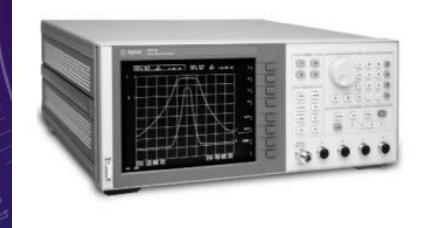
# THE IMPORTANCE OF NETWORKING

- Microwaves are still a somewhat niche activity
  - Not for everybody
  - But, if your interest is piqued ...
- Find a microwave amateur radio club (they DO exist)
  - Easy with online virtualization of ham radio meetings
  - Clubs provide guidance & assistance in building, testing, operating
  - Ask to “ride along” in a contest
  - Obtain a “loaner” radio for same



# OTHER ASPECTS OF NETWORKING

- What about test equipment?
  - Don't I need a \$100K worth of test equipment
  - Many microwave hams have established very capable home labs
    - And they welcome visitors
    - And they are knowledgeable and helpful (can you say "Elmer")
  - Elmering is an important aspect of microwave radio
- Why are mw hams so willing to help?
  - A means to getting more hams active on the bands!
  - And no, it's not just a way to get rid of stuff you no longer need



# A LITTLE ON CONTESTING



- In microwave contesting
  - All about unique calls, distance & different locations on multiple bands
  - “Grid Squares” for location e.g. DM15bs
  - Work the same station in different grid squares (just like V/UHF contests)
  - Requires at least one of the two stations to be able to relocate (roving)
  - Distance is the key multiplier
    - 10 contacts at 50 miles is the same as 1 contact at 500 miles
    - Get 10 hams roving together ... easy 10 contacts at 500 miles



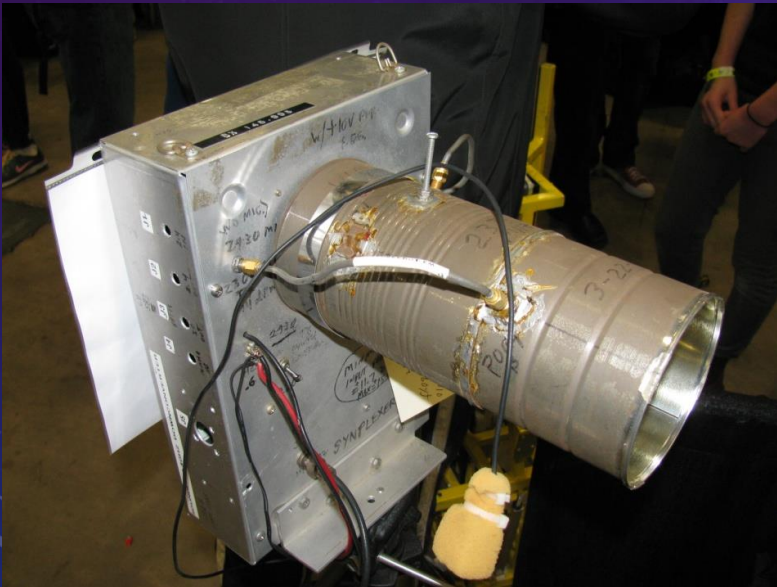




# SOME FUN STUFF!

N6IZW's  
"Quick and Dirty"  
10 GHz rig

- Harmonic mixer
- 440 MHz HT



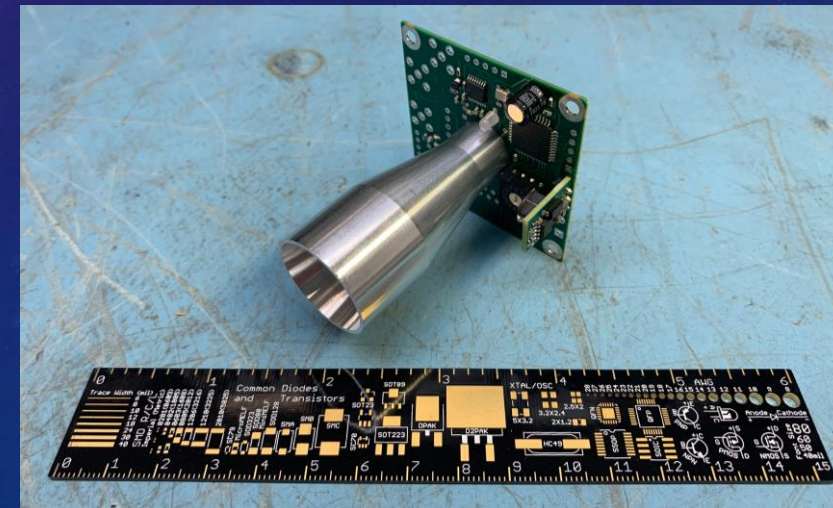
2304 radio

- 2 M XCVR
- LO
- Mixer



# FOR THE ADVENTUROUS – 122 GHZ

- Crowd-funded project from Australia
- First appeared in QEX in 2019
- Core component of 122 GHz radio
  - Based on Automotive RADAR chip
  - Requires some additional bits
- Over 100 units were sold
- Dozens are on the air now
- On Facebook: “122GHz and mmWave activity”





What about EME on 1296 and 10 GHz?  
SBMS at Caltech's Owen Valley Radio Observatory  
40 meter antenna



Other groups have activated BIG antennas:  
Arecibo (sadly destroyed), Jamesburg (Cal) Comsat Station,  
AMSAT-DL, 8N1EME in Japan



# RADIO CLUBS ACTIVE IN MICROWAVES

- San Bernardino Microwave Society
  - Old website with old technical papers – <http://www.ham-radio.com/sbms>
  - New website - <https://w6ife.com/>
- San Diego Microwave Group – Contact Kerry Banke: [kbanke@sbcglobal.net](mailto:kbanke@sbcglobal.net)
- 50 MHz and Up Group -- <http://www.50mhzandup.org/>
- North East Weak Signal Group – <http://www.newsvhf.com/>
- Southeastern VHF Society – <http://svhfs.org/wp/>
- Mt. Airy VHF Radio Club – <http://www.packratvhf.com/>
- North Texas Microwave Society -- <http://www.ntms.org/>
- Roadrunners Microwave Group -- <https://k5rmg.com/>
- Florida Weak Signal Society -- <http://flwss.net/>
- UK Microwave Group -- <https://www.microwavers.org/>
- Heelweg Microwaves (Netherlands) -- <http://www.pamicrowaves.nl>
- Don't forget the ARRL and QST, and QEX magazines