TROUBLESHOOTING

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AGENDA

- How Troubleshooting works
- Case Study: “I can’t hit the local repeater”
- Case Study: “Winlink”
- War Stories

HOW CAN YOU POSSIBLY BE QUALIFIED TO TALK ABOUT THAT?

- I'm totally not
  - … but who is?
- I do fix broken stuff for a living (computers)
  - Big, ungooglable computers
  - With next to no documentation
- I am frustrated with the struggles I see at some radio events
  - Hams are supposed to experiment
  - Experimentation is 99% troubleshooting
  - So… how do we do it?
- I guess I'm going to try to teach you to think.
  - That seems hard
  - Hopefully I'll at least teach something

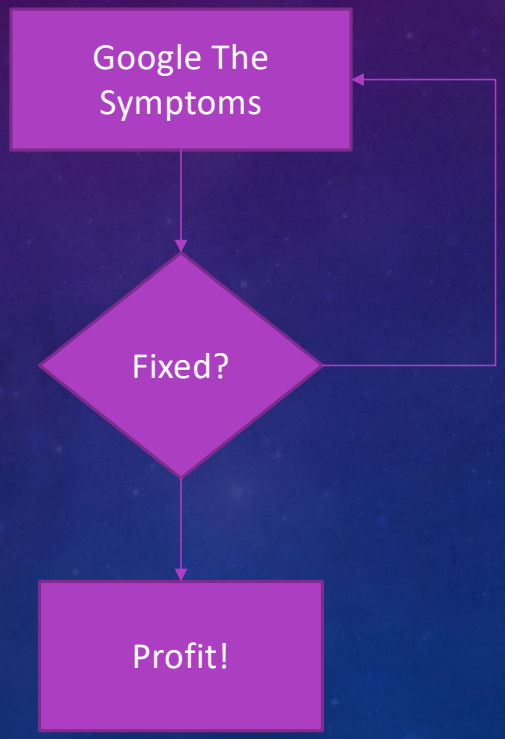
WHAT IS TROUBLESHOOTING?

- Figuring out what's wrong with something and fixing it
- Typically doesn't involve any actual shooting/firearms
  - But that'd be really therapeutic sometimes

APPROACHES TO TROUBLESHOOTING

- Pattern Matching
- Science
- Divide and Conquer
- Random Guessing

PATTERN MATCHING



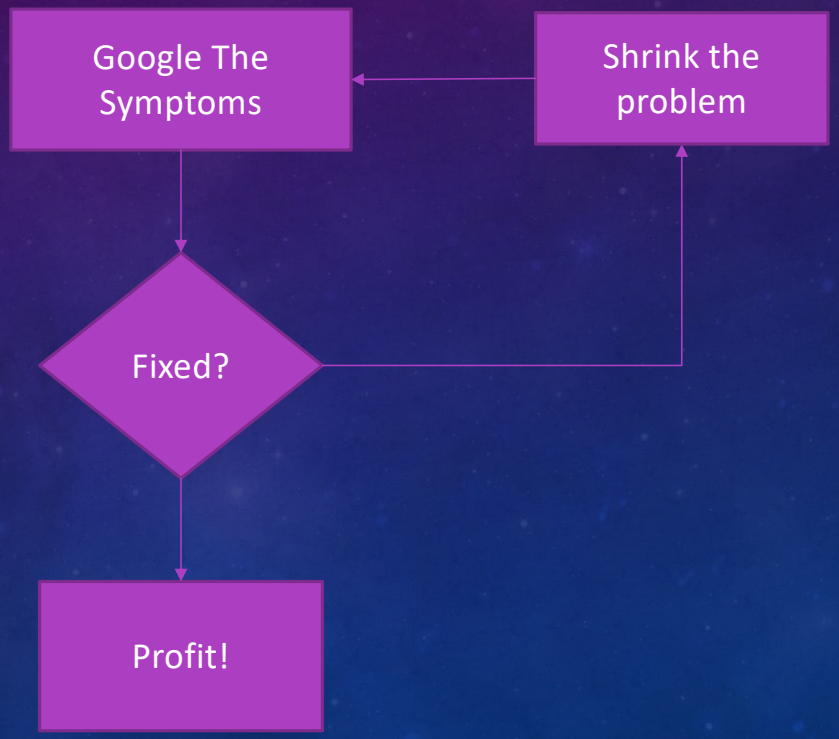
BUT HOW DO WE KNOW IF IT'S FIXED

- Well, what is it supposed to do?
- Is it doing that?
- Great!
- … What do you mean you don't know what it's supposed to do?
- … Probably should start there.

ABSTRACTION AND RECURSION

- Say for example, you think a radio system is broken. That's pretty abstract
  - Is the Antenna broken?
  - Is the RF deck broken?
    - Are the finals broken?
    - Is the MCU working?
  - Is the power supply broken?
    - Fuse?
  - Is the coax broken?
- Find the lowest level abstraction/smallest part of the problem that you can identify as not doing what it's supposed to be doing
- **Prove** that the rest is working
  - But keep an open mind. Mistakes happen

PATTERN MATCHING



HEURISTICS

- Heuristics are imperfect ways of classifying something
- Maybe you've seen a similar problem before (more pattern matching)
- Maybe it's always the same problem (did you charge the batteries?)
  - For the Computer folks in the room: It's always DNS… or at least the network
  - Radio folks only care about the network so this is pretty moot ;-)

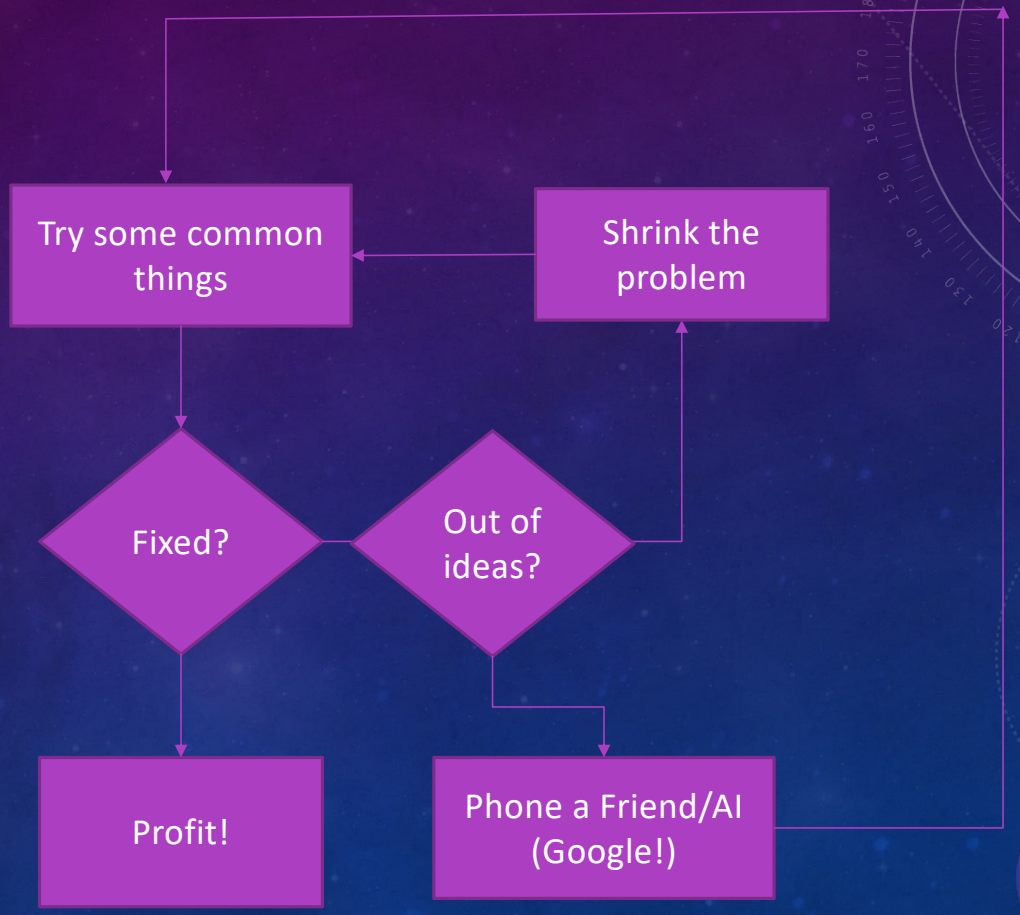
HEURISTICS IN RADIO/ELECTRONICS

- Check the connections
  - Wiggle stuff. Does the behavior change?
- Check for power
  - We'll get to measurement later
- Check for char/burned stuff
- Does it smell funny?
  - Smoke is typically bad. Can you find the source?
- Is it hot? (should it be?)
  - Fire is typically bad. Can you find the source? (do you have an extinguisher?)
- Did you plug in all the parts?
- Are there dents/cracks/physical damage where there shouldn't be?
- Is ___ always the problem? Is ____ the problem now?

HEURISTICS IN RADIO/ELECTRONICS

- Did you try turning it off and on again?
- Did you try physical violence?
  - The problem is always at connections. This is a (fun!) corollary to “wiggle stuff”
- Did any parts fall off after the violence?
  - That’s at least one of your problems
- Can you see any other physical damage?

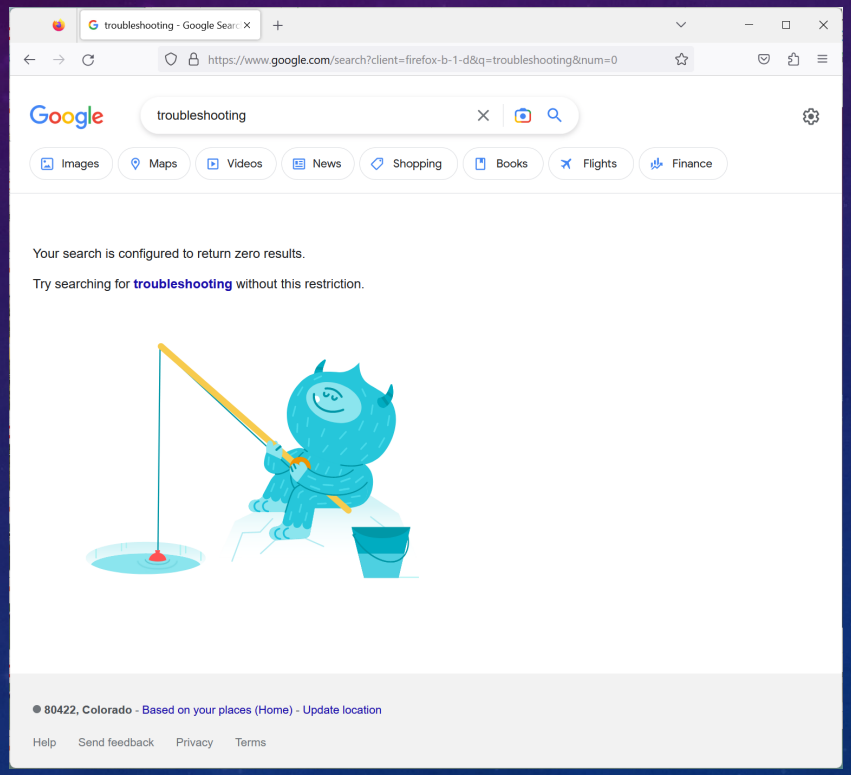
PATTERN MATCHING



HEURISTIC: WHAT CHANGED?

- When did the system last work?
- What did you do?
- Can you undo it?

I'M OUT OF HEURISTICS
ALSO GOOGLE IS NO HELP!



THIS IS GETTING COMPLICATED

- Manage complexity by being methodical
- Take Notes:
  - What do you know?
    - What have you already tried?
    - How did it impact the system?

ARE YOU SURE YOU DON'T HAVE ANY IDEAS?

- Explain it to a friend (or a stuffed animal)
- Computer Scientists call this "rubber duck debugging"
  - Ducks work, but stuffed penguins are free at conferences
- Explain it like I'm 5. What normally goes wrong with your widget? How is it supposed to work? How is the current behavior different from the good behavior?
- Imagine your helper just keeps asking "why"

Troubleshooting Assistants

OTHER MENTAL TRICKS: THE 7 W-S

- Think like a toddler
- What?
- Why?
- Who?
- When?
- Where?
- How?

STILL STUCK

- I’m too lazy for the next step
  - Are you sure you don’t have any more heuristics?
  - Phone a friend?
- Ok, Fine. On to the fun part then: Brute Force ensure that nothing can be wrong

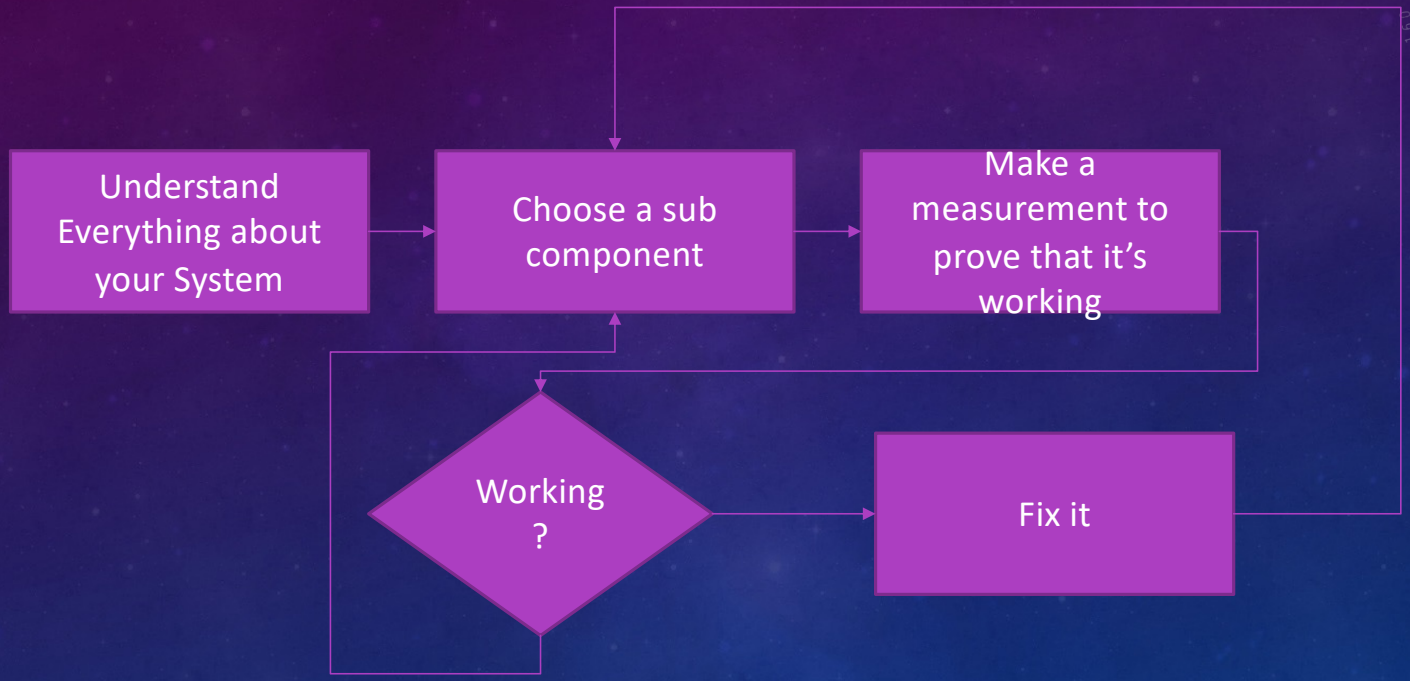
WHEN ALL ELSE FAILS

- Measure All the things
- Decompose the system into the smallest parts available
- Measure each part
  - How is it supposed to be?
  - Is it as such?
- Measure anything that could impact the system and make a note of it
  - Weather?
  - Phase of Moon?
  - Mood of operator?
- Remember, we're desperate: Measure **Everything**
- Take good notes of your measurements
  - Are they interdependent? Can you make them not so?

EVERYTHING?

- Yes, Everything
- Yes, it’s a lot of work
- Yes, you need to be methodical

HARD MODE


Understand Everything about your System
Choose a sub component
Make a measurement to prove that it's working
Working ?
Fix it

BUT HOW DO I UNDERSTAND MY SYSTEM?

- Books/manuals/schematics
- Theory of operation
- Expert Advice
- Experimentation: Try a thing, see how it breaks. Now you have two things to troubleshoot (or perhaps you can undo what you did)
    - This gets you more patterns to match
- Critical Reasoning

I’VE MEASURED EVERYTHING. NOW WHAT?

- Compare to a working system
- Compare to specified tolerances or expected behavior based on first principals
- Make your broken system look like your expectations
  - Square peg? Round hole? Meet sandpaper! Or force!

BUT I DON'T KNOW HOW IT'S SUPPOSED TO WORK

- Fix that?
- Fine. Channel Sesame Street… One of these things is not like the other
- Look for anomalies
  - One part is really hot or particularly important or whatever, start there.

IT LOOKS HOMOGENEOUS AND I HAVE NO INFORMATION ABOUT IT

- Then how do you even know it’s broken?
- Fix your expectations?
- Find another one to compare?
- Design more tests and measure the results

CONCLUSIONS

- Heuristic pattern matching is easy and quick, except when it's not
- When that fails, measure everything and compare to a working system

THEORY QUESTIONS?

- And/Or a quick break if you want…

CASE STUDY: REPEATERS

- This is the quintessential new ham problem
  - Though, it can happen to all of us
- You just got a new HT or mobile, programmed it up, and can't seem talk to anyone
- Maybe because people aren't very friendly?
- Maybe because you've done something wrong?
- Maybe because your shiny new hardware is already broken?
- What to do?
  - I'm going *way* into the weeds here as an illustration. This isn't really this hard (except when it is of course)

SO, WHAT DO WE KNOW?

- How repeater systems work?
- We can't seem to contact anyone or get any feedback from the repeater
- We're trying to do regular old analog FM.
  - Yes, I know this club mostly runs fancy DMR stuff
    - I don't care
      - I'm making a simple thing really complicated.. Do we really need to start complicated?
- We have at least enough power to run the UI on our new radio
  - This could be different from enough power to transmit effectively (more on that in a bit)

YOU DO KNOW HOW REPEATERS WORK, RIGHT?

- We send a signal that the repeater can hear
- The repeater resends the same signal on a different frequency. Usually some filters are utilized ("duplexer") so that the repeater's transmitter doesn't overload its receiver
  - Of course, you could just use two antennas and lots of coax (physical separation). For example, if you're building a 10m repeater, which would require physically large filters
- Usually we also combine our signal with some tone to ensure that the repeater knows we intend for it to repeat
- The repeater encodes a different signal so that we don't have to listen to background noise
- Some repeaters might transmit a beep or something to let you know they heard you (or not… locally, the FunMachine is a good example of "or not")

WHAT ABOUT MY RADIO? WHAT DO WE KNOW ABOUT THAT?

- Radios are devices which slap electrons around in a piece of metal called an antenna
- If you do that just right, you can produce a corresponding current in another piece of metal, potentially hundreds of miles away
- If we modulate that current (“signal”) in some way, we can use it to communicate
- Magic!
  - (oversimplification)
  - Let’s assume we don’t know much. Sometimes that’s part of the fun.

HEURISTICS

- Did you try turning it off and on again?
- Is there physical damage?
- Are you pushing the appropriate button?
- Are you on the right frequency/memory channel?
- No help? Good, that'd make this talk even more boring than it already is… Moving on.

ARE YOU EVEN SURE IT'S NOT WORKING?

- Well, we know we need to be producing some RF energy? Can we measure that?
- How about tongue across antenna connector?
  - I'm told RF burns hurt
    - A lot
  - Neither RMHAM-U nor I endorse this approach (though, personal injury aside, it probably would work)
    - Srsly, no!
- Sounds like we need some tools.
- To paraphrase a talk from earlier this year – if you can directly observe electronics, that's usually not a good thing

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TOOLS

- Power meter
- Extra cables (known good)
- Dummy Load (known good)

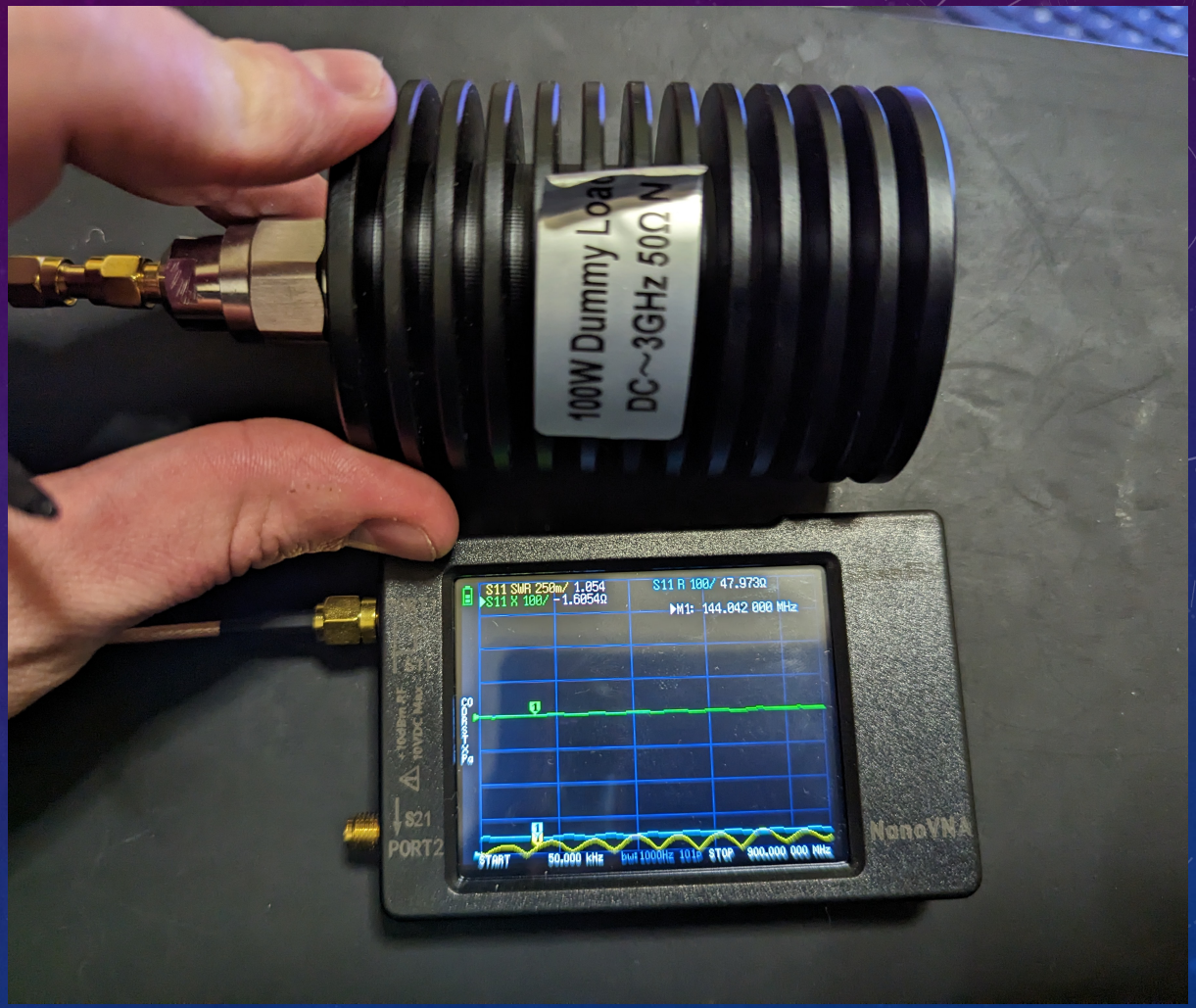
HOW DO I KNOW MY TEST SETUP IS GOOD?

- You don’t
- Let’s test it
- More tools!
  - VNA or Antenna Analyzer
  - Calibration Loads
  - Multimeter
- This can snowball
  - For economic reasons, we could (and usually would) just assume our tools are good until we get stuck
  - This can be an iterative process
  - But I promised a deep dive into the weeds…. So…

RUDIMENTARY PRE-TESTS

- Use your Ohm meter to make sure your cables aren't shorted and aren't broken
- Use your VNA to make sure that your dummy load and cables behave as you'd expect (50ohm?) for the frequency band of interest
  - Each conductor in your cable should, well, conduct
  - But they shouldn't be connected to each other
  - With the dummy load connected, there should be minimal reflected power
    - Assuming the characteristic impedance of the entire system is consistent
- Physically inspect everything for damage/moisture

- Sorry about the dreadful screenshot, I apparently no longer own a small enough uSD for the NanoVNA to use
- Notice that even my dummy load isn't exactly 50ohm at all frequencies
  - Or maybe I moved something since calibration and I'm using a long cable
  - The real world is messy



WHAT IS THIS DUMMY LOAD THING ANYWAY?

- An overpriced high power dissipation resistor (R=Z0)
- Antennas are Magic™ so we want to remove that bit of complexity and use a (hopefully) pure resistive load to check out everything except the antenna
- For bonus points, the dummy load doesn't radiate too well, so whatever testing we do shouldn't annoy the locals as much
  - Seriously kids, enough with the kerchunking
  - They do radiate some though, so still be mindful of what you're doing
  - Unless you have access to an adequate anechoic chamber, in which case, go wild, I guess
    - (but if you did, you probably wouldn't be needing this talk)

TESTING POWER

- Connect the Dummy load to the antenna port on the power meter
- Connect the radio port on the power meter to the radio
- Key the radio
- You should see negligible reflected power but plenty of forward power (whatever you have your radio configured to put out, give or take a few percent)

POWER TESTING TRAP: SSB

- In order to test for power output, you're going to need to output some power (duh)
- For modulation schemes without a constant carrier of some sort, you won't have much if any power output without data (audio or whatever)
- Putting the radio in FM or CW mode should work. For other modes, YMMV
- **The moral here is to make sure you know what to expect from anything you test**

WHAT IF I DON'T SEE MUCH POWER

- Are you supplying enough power? Garbage in Garbage out.
- Batteries and other power supplies have internal resistance. It usually doesn't take much power to run the UI, but under transmit, you'll need more
- Use your multimeter to measure the supply voltage under load as near the radio as possible (i.e. you want the supply wires in the measurement)
- Is your 13.8V radio seeing ~13V, or is it more like 8-10?
  - If 12-14, probably good to go
  - If less, use shorter/bigger wires or a better power source

I MEASURED A LOW VOLTAGE, HOW DO I KNOW IF MY POWER SOURCE IS GOOD?

- Key down for a few seconds, are your power wires getting warm?
  - If so, they're probably too small
- Are all the connections clean and well connected?
- Is your power supply rated to provide the required energy?
- If it's a battery, we can test it, but we must do so under load
  - Batteries behave differently with and without load sometimes
    - Especially worn out batteries

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BATTERY TESTERS

- Apply a load, ideally somewhat representative of your application
- Monitor voltage over time
- Compare to the original specifications
- Lead batteries should slowly drop in voltage (and should not be tested to below ½ capacity or so)
- Lithium batteries should produce most of their energy at approximately their nominal voltage and then the voltage should drop off a cliff for the last few percent

ALL GOOD ON POWER, IN AND OUT, NOW WHAT?

- How about the antenna?
- Connect it to a VNA or analyzer
- Apply a test signal at the frequency, measure the return energy
  - It should be minimal
  - SWR=<2 should be fine generally
- Antennas are tricky, anything around the antenna could impact measurements of it
  - Distance from the ground (you know, that thing made up of dirt/rock, may or may not be the electrical ground)
  - Other objects in the near field
  - Other nearby transmitters
  - Do your best to control your experiments

ANTENNA TESTING

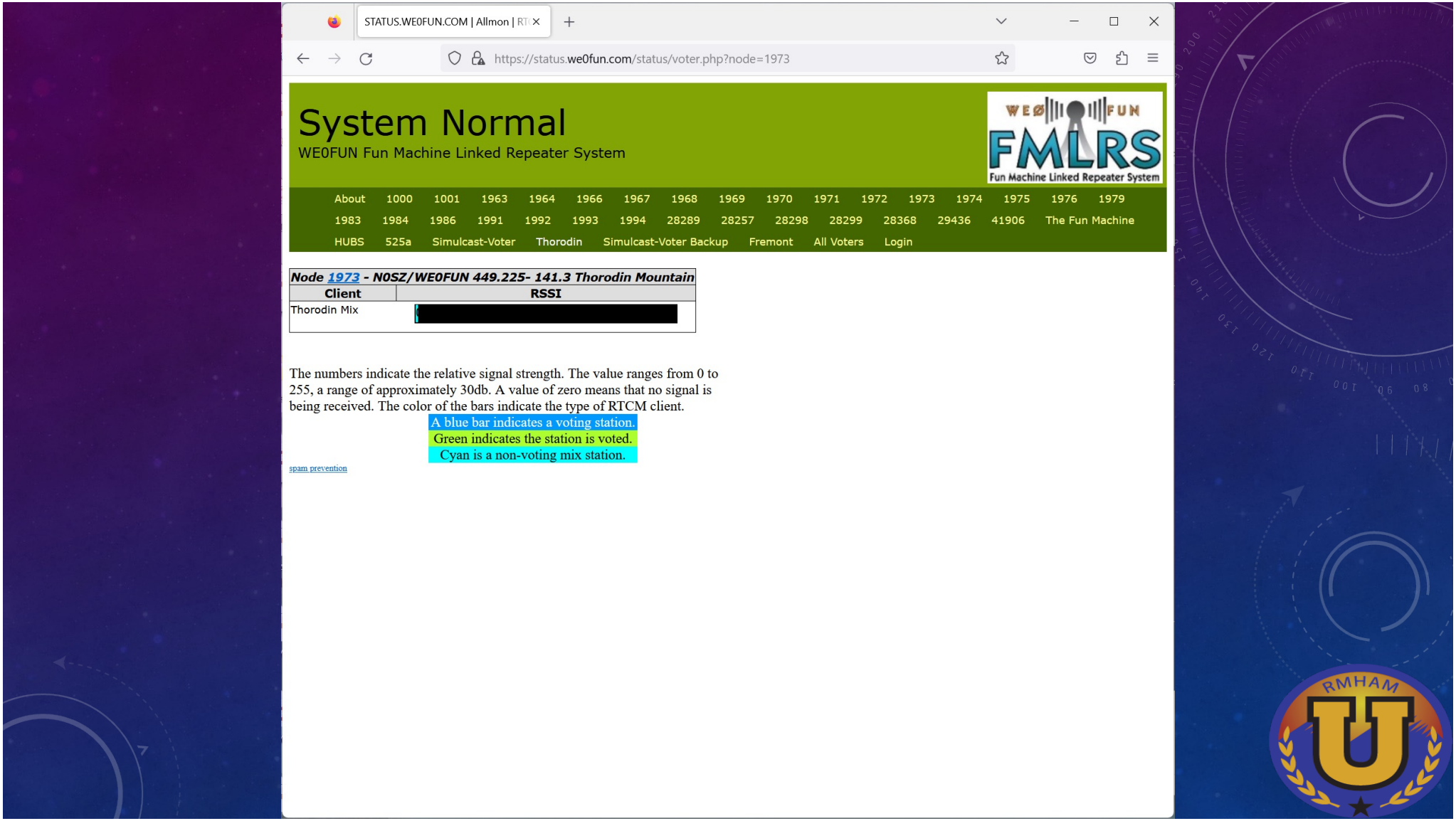
- Reflected power can be a good indicator that something is wrong with an antenna but it doesn't mean that it radiates well
- So what can we do?
- Listen for a test transmission with another radio
  - Careful here, if your receiver is too close, you could overload it and then you won't hear your test transmission
  - Listen with a near(ish) WebSDR
  - Field Strength Meter

MY HARDWARE IS FINE!!!

- If you say so. People who are certain of this are typically wrong in my experience
  - But if you've really tested everything, we can move on
  - Remember, keep track of what you've tested and what you just think you know in case we need to revisit the hardware
- What other things could be wrong?
  - Access control methods (tone?)
  - Frequency
  - Modulation Type
  - Out of range

ARE YOU IN RANGE OF THE REPEATER?

- This one is tricky to measure
- Sometimes you can see the repeater's antenna (especially around the front range)
  - In this case, the answer is probably "yes"
- Some repeaters can tell you what they're hearing
- Otherwise, we'll skip this for now because it's hard
  - Test the easy stuff first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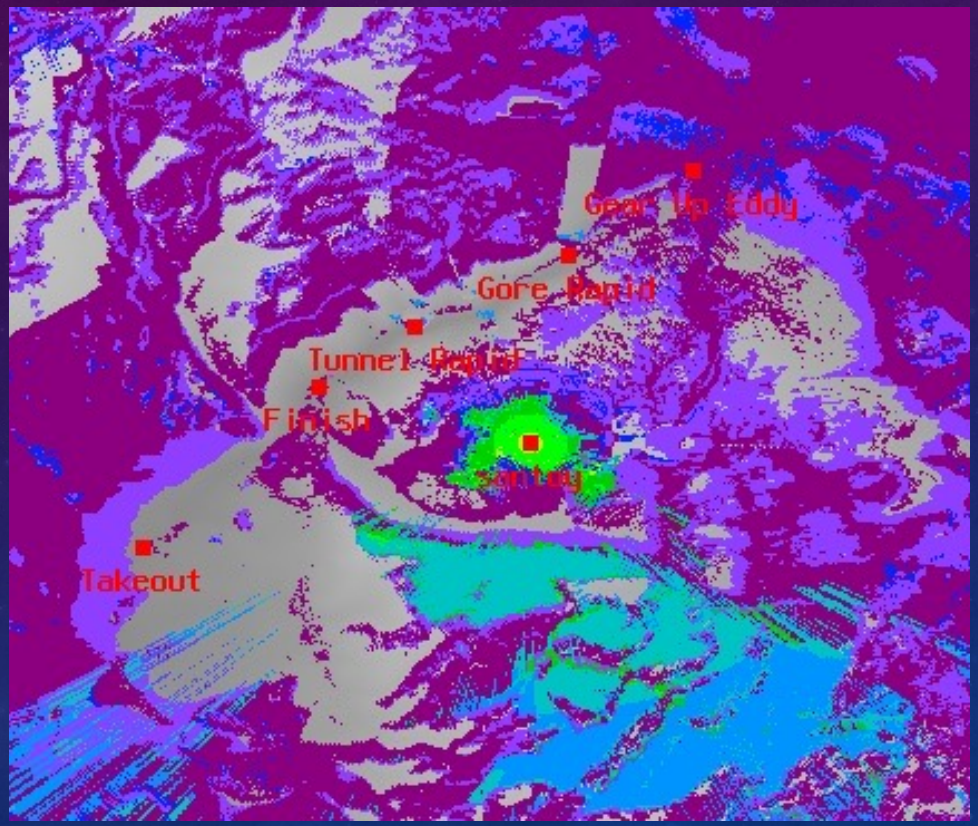
The numbers indicate the relative signal strength. The value ranges from 0 to 255, a range of approximately 30db. A value of zero means that no signal is being received. The color of the bars indicate the type of RTCM client.
A blue bar indicates a voting station.
Green indicates the station is voted.
Cyan is a non-voting mix station.
spam prevention

ARE YOU IN RANGE?: PROPAGATION MODELING

- Not necessarily an exact science, but…
- Most of RMHAM seems to use a web-based thing for this called radio-mobile online: https://www.ve2dbe.com/rmonline_s.asp
- If you're stubborn like me and insist on free/open-source, try SPLAT! (https://www.qsl.net/kd2bd/splat.html)
  - I wrote a tutorial on SPLAT a couple years ago: https://blog.kc2vjw.com/posts/rf_propagation_with_splat/

SPLAT!



MORR POWER?

- No. It probably won't help
- If the repeater hears you but you don't hear it, what's the point?
- (this is maybe a fun way to measure attention though)
- (offensive to everyone and technically wrong!)
- (silly Motorola with their non-standard connectors)

FREQUENCIES

- Are you sure you're on the right frequency?
- Are you sure you're transmitting on the frequency upon which the repeater listens
- And listening on the frequency where the repeater transmits?

FREQUENCIES

- Really sure?
- Did you test?

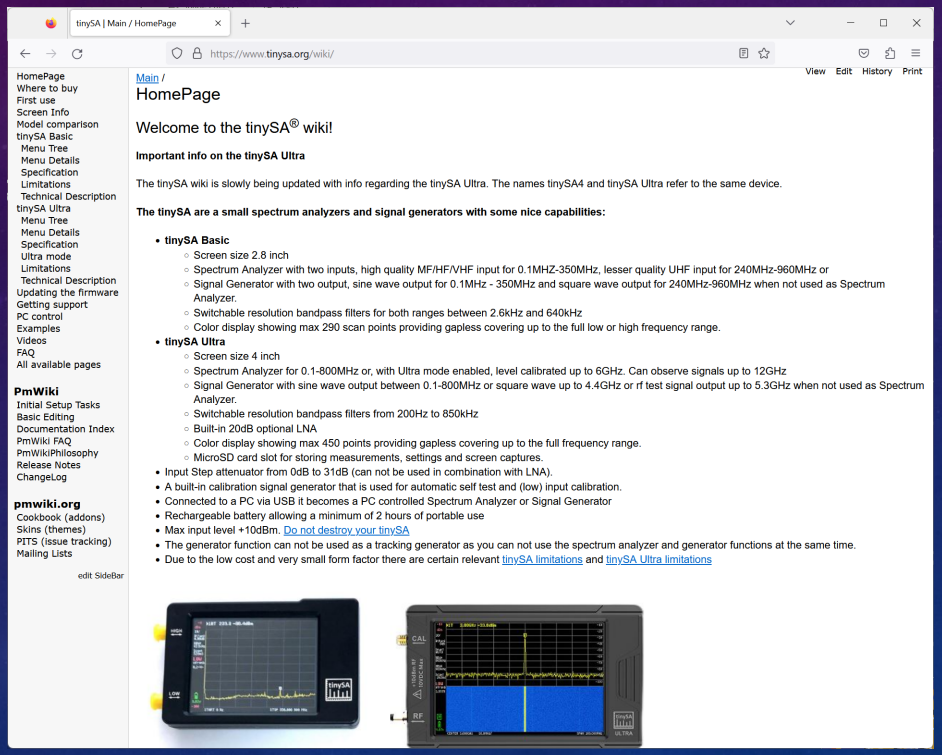
FREQUENCIES

- Do you have another radio that can communicate with the repeater?
  - Put it in “reverse” mode
  - Walk a couple hundred feet away
  - Can the good radio hear the misbehaving radio?
    - If so, you’re probably on the right frequencies
- No?
  - Guess we have to break out the SpecAn (or another SDR?).

REPEATER BASICS

- Repeaters are usually specified as a frequency, tone, and direction (+ or -)
- What's really happening is that the specified frequency is the frequency upon which the repeater transmits. The repeater is listening some standard amount higher (+) or lower (-) in frequency
- The specific second frequency is *usually* determined by a per-band (sometimes per-state or region) convention
  - 10m: 100kHz
  - 2m: 600kHz
  - 1.2m: 1.2MHz
  - 70cm: 5MHz
  - 33cm: 25MHz
- Be sure you're staying inside the band
- Newer radios usually know the conventions.. Usually (for example, Yaesu and Colorado have a disagreement about parts of the 70cm band plan)

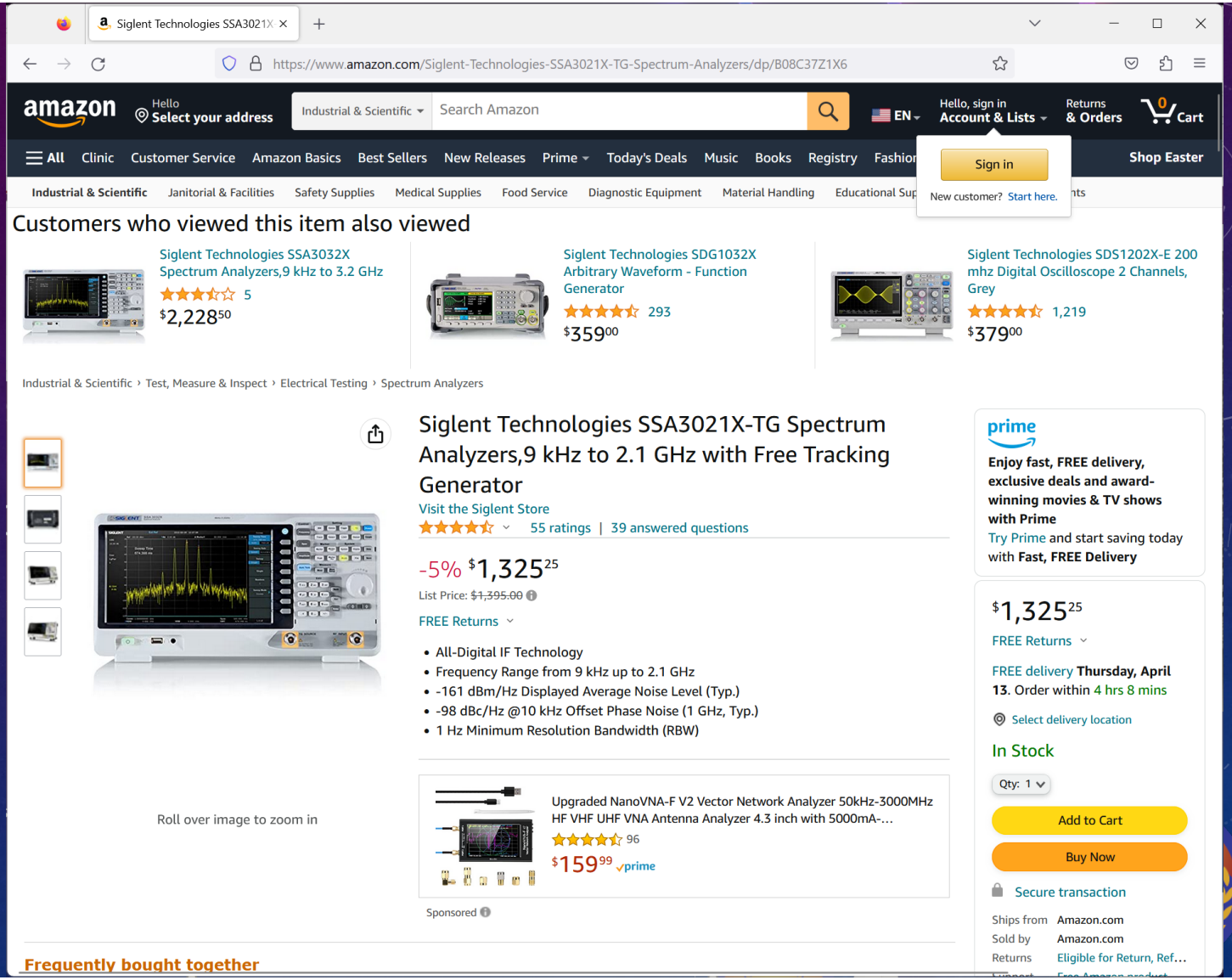
MEASURING FREQUENCY



MEASURING FREQUENCY

- One quick note on the TinySA:
  - They're great, and cheap, but while writing this talk I discovered that the resolution isn't good enough to resolve audio phenomena
  - Consider your needs – there's still something to be said for real instrumentation grade stuff if you have the funds
  - They're also tiny, which could be great for those of us who are dumb enough to backpack to radio sites (seems to keep happening ¯_(ツ)_/¯)

- I used one of these for some of this talk
- Bit more expensive but very capable
- If you get one of the cheaper versions, the hardware is more capable than the software
  - Can buy licenses as you need features
  - (or, those good at Google might find that they're pretty hackable)
- Rigol makes something very similar



SPECTRUM ANALYZERS

- Replace your antenna with an appropriate attenuator (or two, or three.. verify what the SA input can handle)
- Connect your spectrum analyzer to the other side of the attenuator
- Make a test transmission
- Is the frequency drifting more than a few kHz over time?
  - Is your radio older than me?
  - This mostly shouldn't be a thing anymore
- Does the SpecAn think your carrier is centered on the dial frequency of the radio?
  - Calibration can be an issue here so it doesn't have to be 100% perfect but it's going to be pretty close

SQUELCH

- Turn it off/open it while testing
  - This is an easy variable to eliminate, so do so

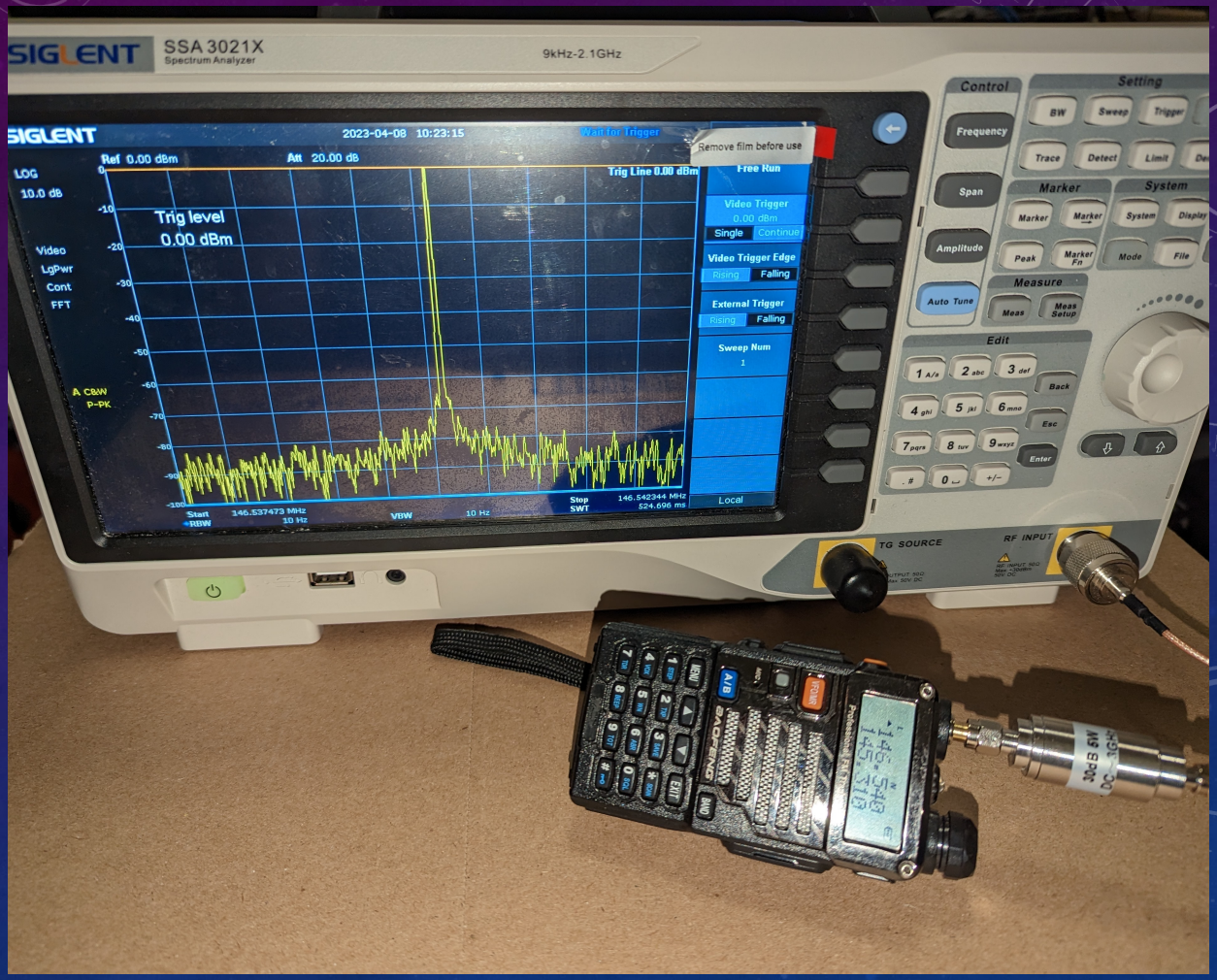
ACCESS CONTROL TONES

- Are you sure you're sending the right tone?
- What about receive?
  - Try turning off local tone decoding. This is often the difference between "ctcss" and "tone" modes.

HOW DO I VERIFY THE TRANSMIT TONE?

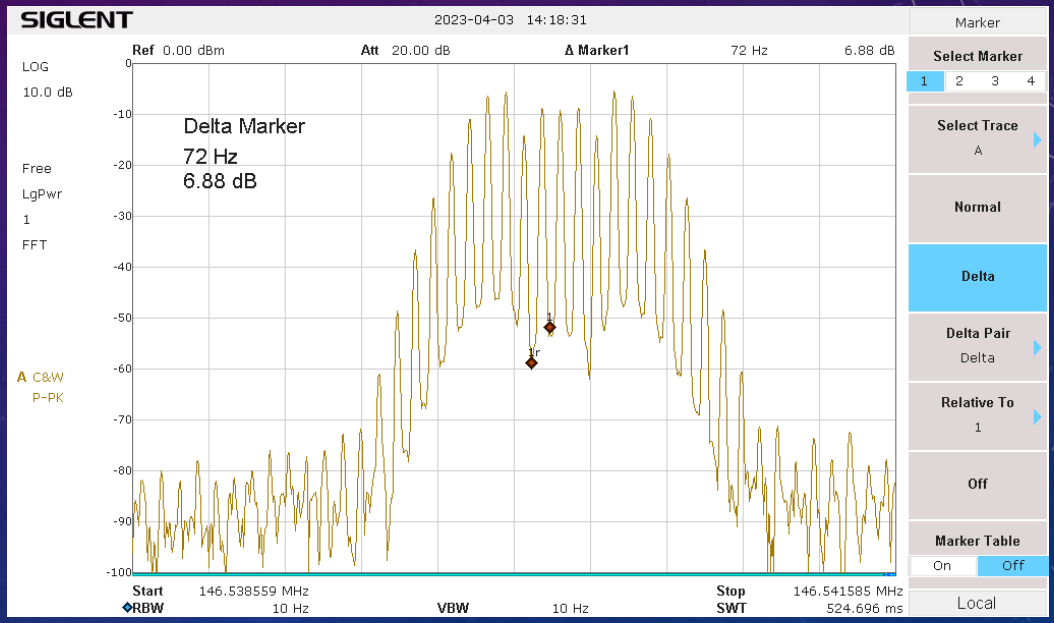
- Feed the output from another radio into your spectrum analyzer (or scope)?
- Use a fancy SA or SDR to decode your transmission and FFT the audio?
- Modern radios usually don’t have problems with this.. It’s user error. Just check the setting again ;-)

- Yes, I know I’m supposed to remove the screen protector
  - But it protects the screen!



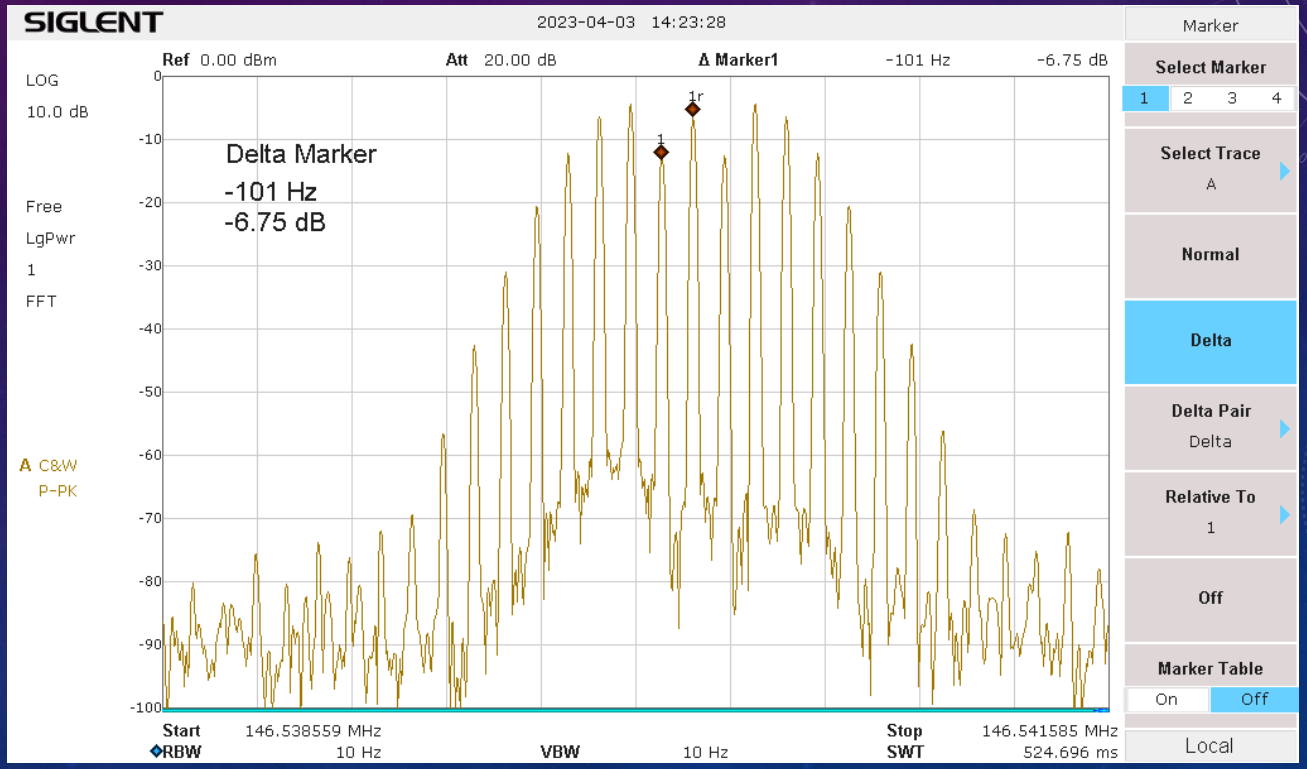
INTO THE WEEDS: VERIFYING TONE WITH THE SA

- BFTech UV-5R, Tuned to 146.54, 71.9Hz tone, “low” power
- Siglent SSA3021X
  - The TinySA doesn’t have enough resolution
- 30db (ish) attenuator (+20db built into the SA) (cheap amazon attenuator)
  - This is overkill, but better safe
- No audio fed into the radio
- We’d expect therefore the carrier to be modulated by only the 71.9Hz tone
- We choose two sidebands at random and measure the frequency difference between them: 72Hz
  - Close enough!

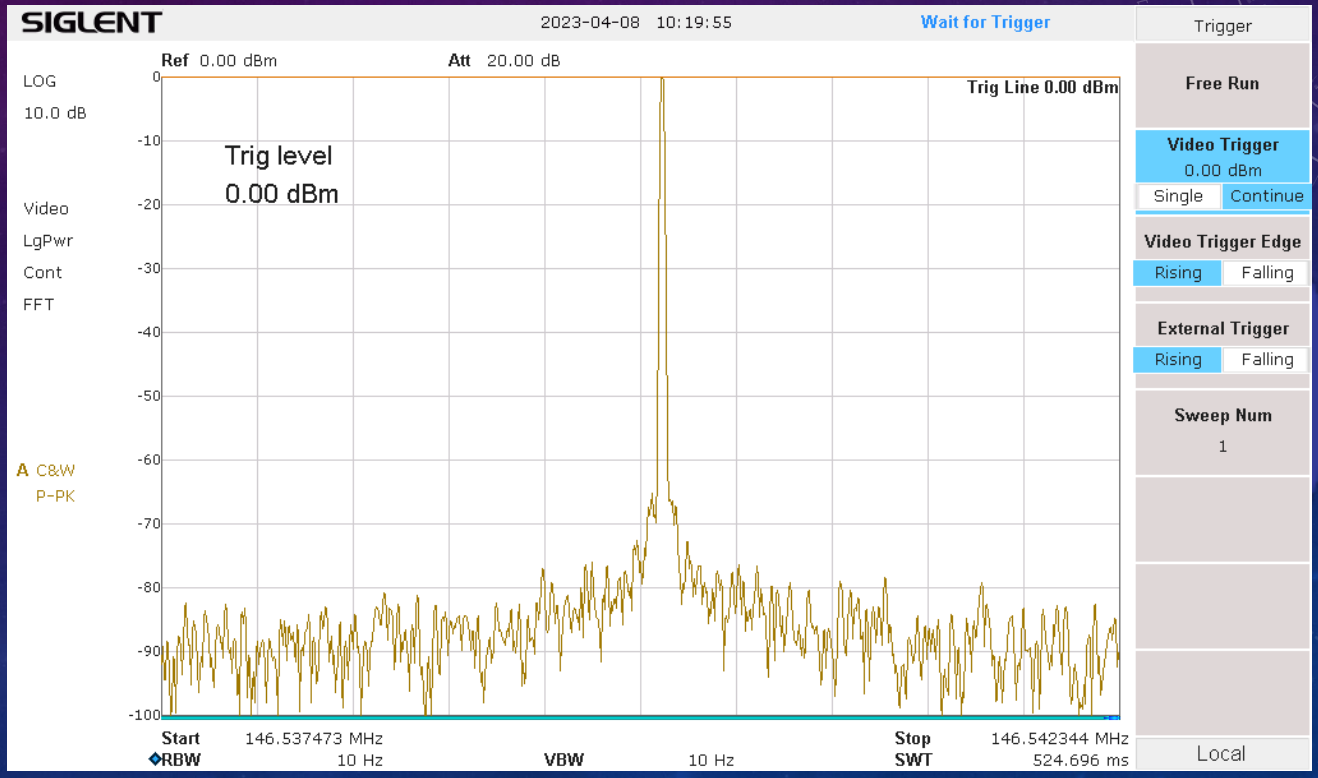


SAME SETUP, 100HZ TONE (NOT A FLUKE ;-))

- It's tricky to get the markers right at the peaks
- (and I have the resolution turned down a bit in order to get reasonable sweep times – the attenuator was getting warm)
- +-1Hz is probably good enough anyhow
- **Always verify your assumptions**



SAME SETUP, NO TONE



MORE THINGS TO CHECK

- Is your volume turned up?
- Is the output audio going to the right place? (gunk in the speaker port?)
- Is the speaker or mic muffled by external factors (water? Dirt?)
- Are all the connectors making good contact? Any sign of arcing?
- Are you in some funny mode that filters audio (“packet decode” or some fancy internet thing?)

INTERMISSION/QUESTIONS

CASE STUDY 2: WINLINK

- Seems to be the quintessential more-experienced ham problem (and ColoradoARES seems to have a thing for it)
- A bit more complexity than voice, but not much
- Computers! Something I am qualified to talk about! :-)

WINLINK: BASICS

- FM Radio, just like before (could be SSB or whatever, but let's stick to VHF/UHF and FM for now – legal restrictions on symbol rate and all)
- Some sort of modem. Could be hardware ("TNC") or software
  - AX.25 over Bell 202 (VHF/UHF FM) or Bell 103 (HF/SSB) (two tones)
  - Proprietary magic like VARA (QAM) or PACTOR
  - Any other transport of ASCII bytes (ex: Iridium or TCP ("telnet"))

START WITH THE RADIO

- Let's start by making sure the radio is functional. See the last section
- You're probably going to be in simplex mode
- You probably should be hearing other Winlink stations beaconing occasionally
  - Those of you who played with the internet in the 90s know what this sounds like
- The correct frequency varies by region. Around Denver, try 145.05MHz or 144.95MHz (1200 baud) or 441.075 MHz (9600 baud)
- All good? On to new material then

WINLINK: COMMON APPROACHES

- Hardware modem connected via some serial protocol (almost always RS-232)
- Software modem sending tones out a sound card or radio interface (still basically a sound card)
- In either case, a computer sends data to the modem and handles the (very simple) protocol

HARDWARE MODEM: WHAT COULD GO WRONG?

- The hardware modem its self
- The modem's configuration
- The connection between the computer and the modem
- Power
- The radio
- Software

SOFTWARE MODEM: WHAT COULD GO WRONG?

- Software!
- Audio paths
- The radio
- OS notification noises on the air (don’t be that individual)

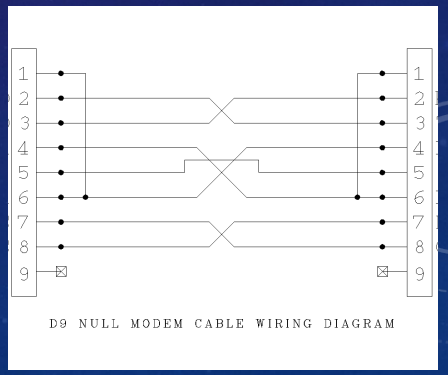
AUDIO LEVELS

- Regardless of the approach, you need to make sure that audio levels between the radio and the modem are reasonable
- Too high and you might loose data to clipping
- Too low and you might not have a high enough SNR
- Is the modem even putting out any audio?
  - Test and see.. It's just audio. A speaker is all the test equipment you need to get an idea

SETTING AUDIO LEVELS

COMPUTER <> MODEM CONNECTION

- Start by checking your cable
  - Depending on your modem, you might need a cable that crosses the transmit and receive wires (“null modem”) or you might need a straight cable. Be sure of which you have and which you need (or try both)
    - You can buy/build null modem adapters
- Make sure both sides (the modem and the computer) agree on serial parameters
- Check for physical damage and good connections
  - Ohm meter?
  - A null modem between two computers should let the computers communicate



https://en.wikipedia.org/wiki/Null_modem#/media/File:D9_Null_Modem_Wiring.png

SERIAL PARAMETERS

- Baud: This is the number of symbols per second
  - And usually the problem
  - Not super difficult to infer by looking at the transmit pin on a scope but you can also just guess common values
  - If you guess these one of them will typically be right (but it's better to know): 1200/9600/38400/111500
- Stop bits: Used to indicate the end of a frame. The right answer is usually "1" (but both sides need to agree)
- Parity bits: Used for ensuring the integrity of data. Rarely used (try "none") but both sides need to agree.

USB<>SERIAL CONVERTERS

- Many modern computers don't have a real serial port
- You can use a USB<>Serial converter but USB uses a packet based protocol so the timing may not be perfect
- Sometimes the drivers are buggy, so it may not like baud rate changes, for example. When in doubt, unplug and replug on the USB side
- Make sure you get the voltage right. May USB serial adapters are putting out 3V or 5V, not the +-15V that they should. Many devices don't care. Some do.
- If you can use a real serial port, things are more likely to "just work"

HOW DO I KNOW IF MY MODEM IS WORKING

- If you're using a hardware TNC, it's easy. Start up a terminal emulator and connect to the modem (PuTTY, GNU Screen, Minicom, etc)
- Type "c [callsign of your local winlink gateway]"
- If your radio keys, that's a good sign
- If you get back some sort of banner or an authentication request, you're good to go

KISS TNCS AND SOFTWARE MODEMS

- Are your computer and modem speaking the same language?
- Some modems have a human friendly mode and a “kiss” mode
  - Usually modems that have both have some escape sequence that the software has to send to change modes
  - Is your software configured to send the right one?
- Some modems only speak one or the other

I CAN CONNECT MANUALLY, BUT I CAN'T GET RMS EXPRESS TO WORK

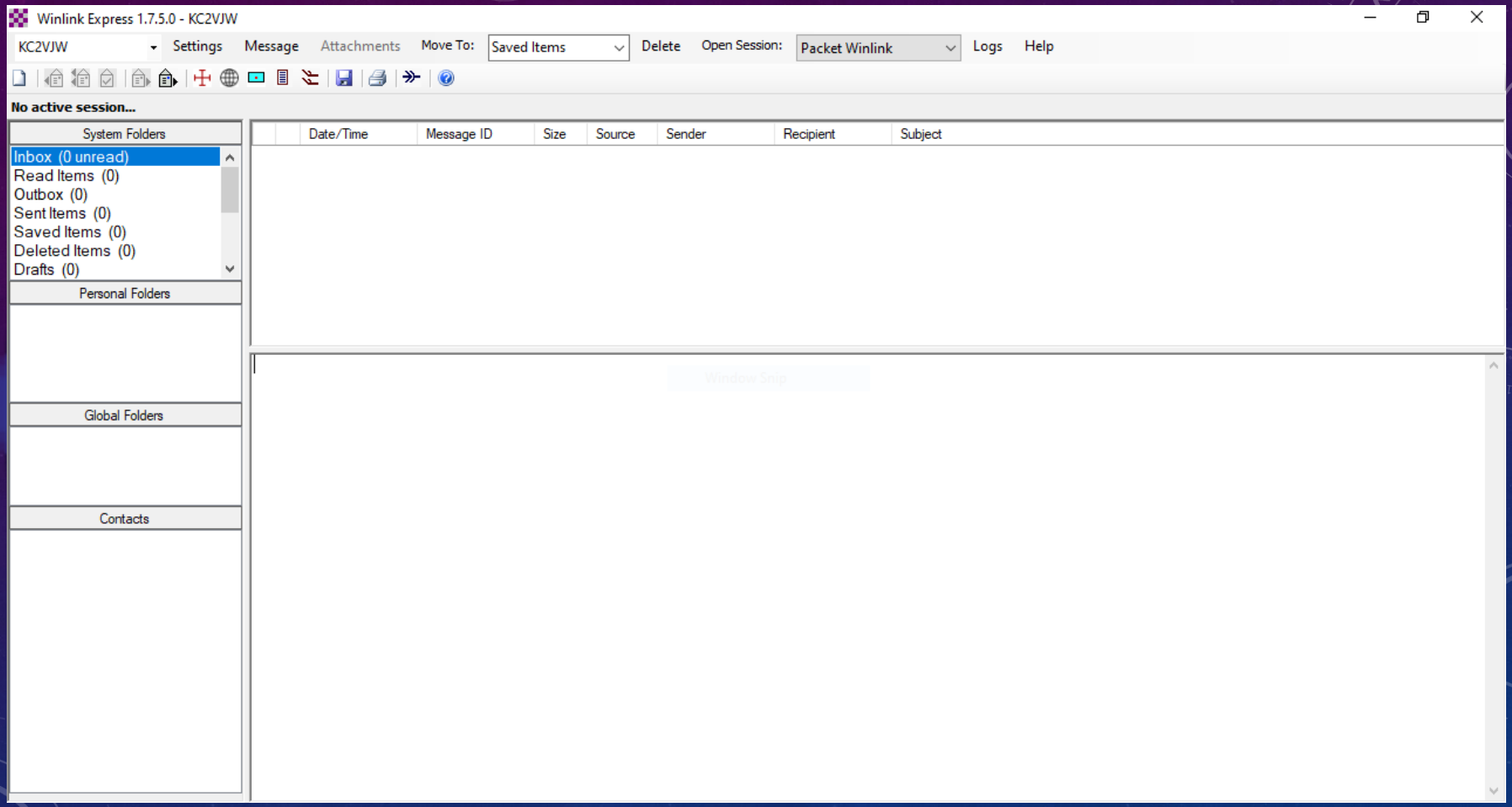
- Why would you want to? https://getpat.io/
- There are various slightly different ways of talking to modems, did you choose the right one?
- Did you tell RMS Express the same serial settings as the ones that worked?
- If you're sure you have it right, let's man-in-the-middle and see what RMS Express is doing
  - You could use a scope or logic analyzer that understands rs-232
  - Or you could use a passive tap. These are commercially available for obscene sums, or you need three DE9s and a couple of diodes to build one
  - Tinker with settings until RMS Express is doing what your modem expects

ARE YOU SURE YOU'RE TALKING TO THE RIGHT THING?

- Many packet stations have multiple SSIDs that do different things
- P2P vs "Winlink" mode
- Digipeaters?

P2P VS CENTRALIZED

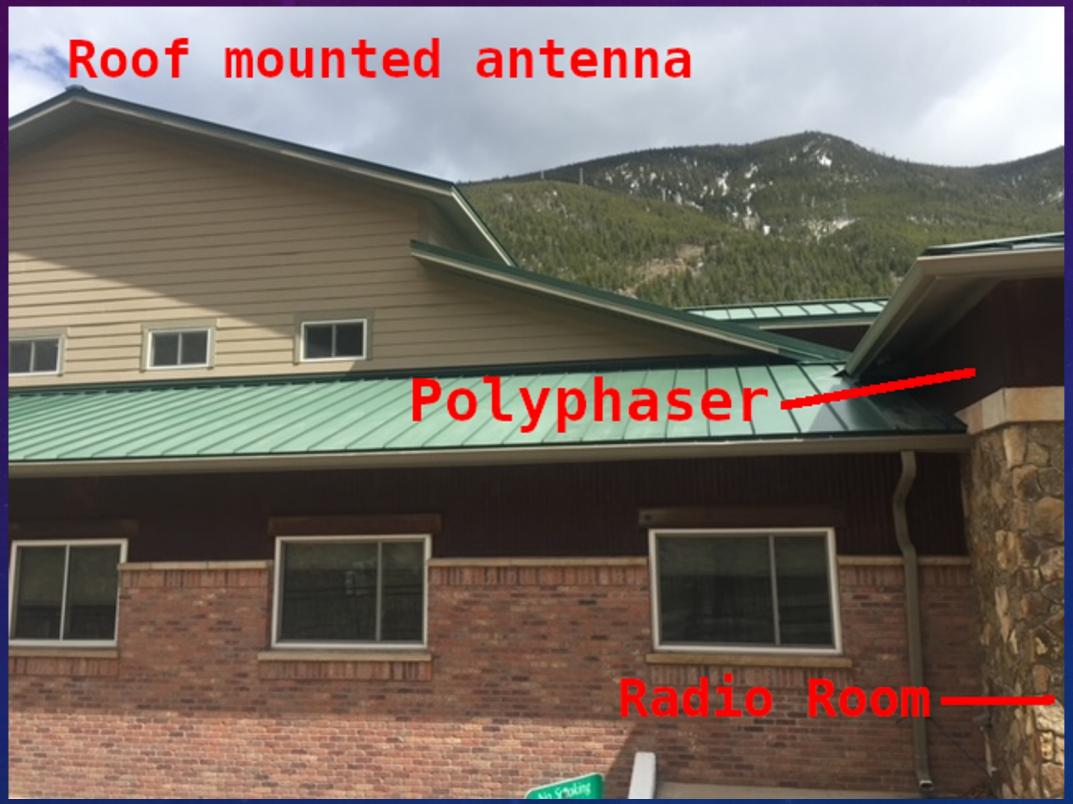
- The official Winlink software has a “peer to peer” mode which allows you to communicate directly with another copy of the software
- This is great if you’re far from any infrastructure
- Totally useless if you think you’re talking to a BBS
- Be sure you’re in the mode you think you are
- Telnet probably won’t work in the woods (without internet) either


Winlink Express 1.7.5.0 - KC2VJW
KC2VJW
Settings
Message
Attachments
Move To:
Saved Items
Delete
Open Session:
Packet Winlink
Logs
Help
No active session...
System Folders
Inbox (0 unread)
Read Items (0)
Outbox (0)
Sent Items (0)
Saved Items (0)
Deleted Items (0)
Drafts (0)
Personal Folders
Global Folders
Contacts
Date/Time
Message ID
Size
Source
Sender
Recipient
Subject

WAR STORIES

WILLEM’S CONNECTOR STORY

SET at EOC: DMR radio cannot hit repeater



DMR RADIO RX OK BUT NO REPLY ON TX

- No change to programming
- Receives OK
- Current draw ~10A on transmit
- Antenna show ~50Ω on analyzer
- SWR 1.5-2 on analyzer

HYPOTHESIS: BAD POLYPHASER

- Protects against lightning by becoming conductive as voltage rises
- Blocks DC
- Test hypothesis bypassing with N-N union

TEST ANTENNA AND UPPER COAX

- DC open circuit
- Analyzer shows ~50Ω and good SWR
  - Bad antenna? ✗
  - Bad coax? ✗
- Can't bring the radio on the roof to test

TEST LOWER COAX AND POLYPHASER

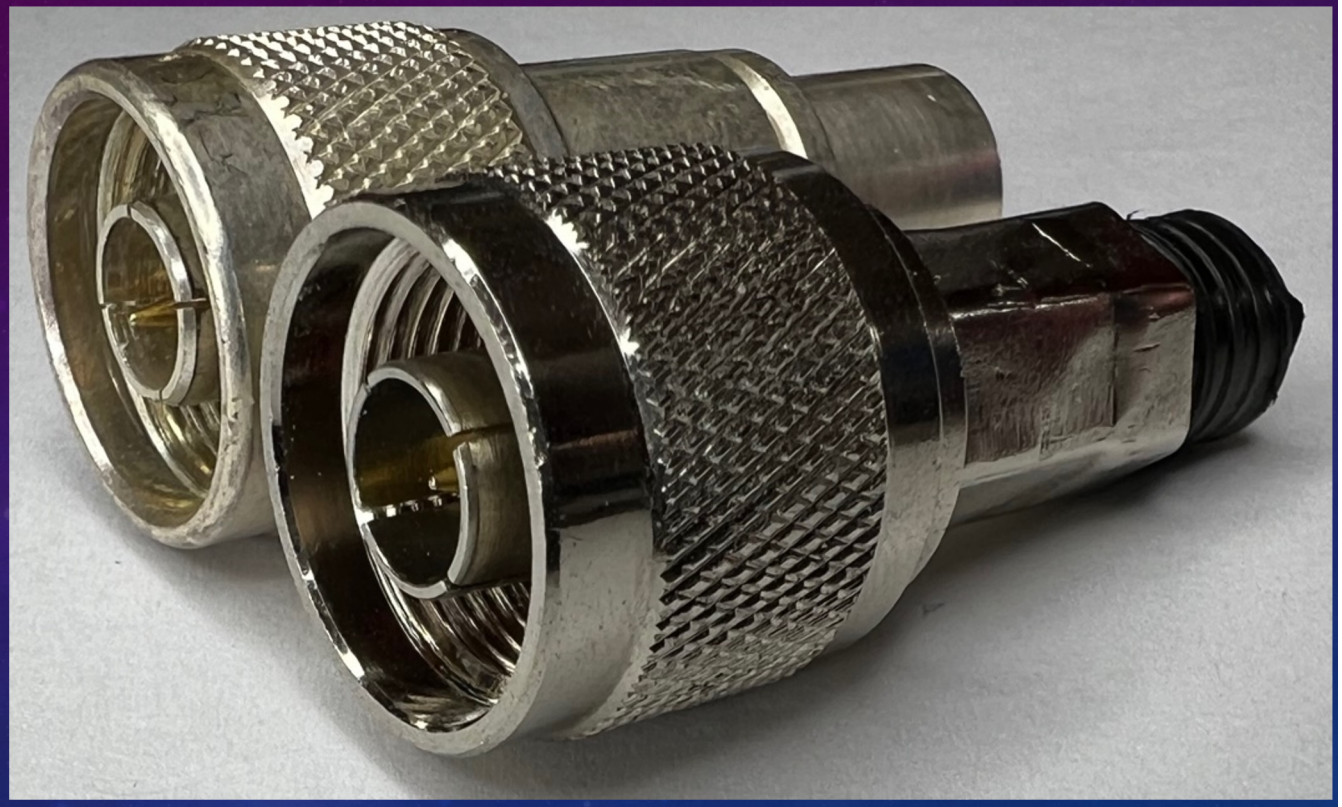
- DC open circuit unless shorted
- Dummy load show 50Ω on analyzer
- How can everything test good, but it still does not work? It used to work...

WHAT WORKS AT LOW POWER BUT NO HIGH?

- Capacitive coupling on N center in?
  - Center pin too deep
  - Does not mate properly
- Cut and recrimp upper N
- Analyzer still tests clean
- DMR radio works!!!

✓ ✓ ✓

ANALYSIS



- Center pin slightly too short!!!
- An end to end DC test would have diagnosed the problem

WAR STORIES: ANYONE ELSE?

QUESTIONS?

- Thank you
- See you next year. For now get out, enjoy the nice(er) weather and operate!