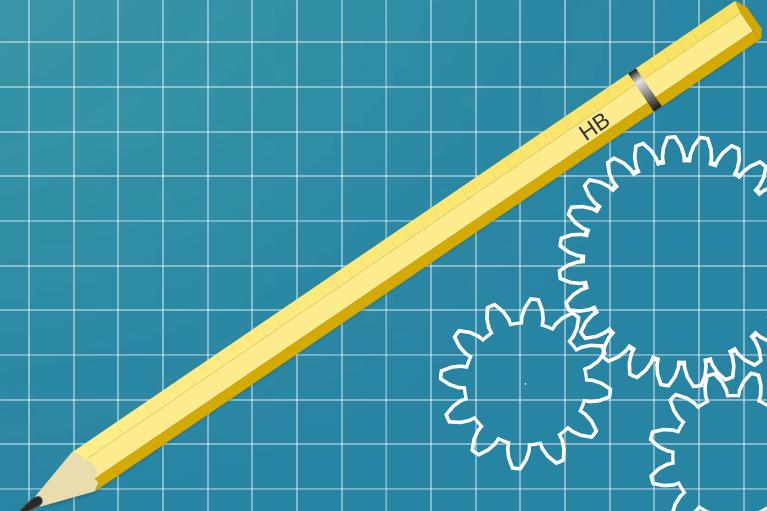


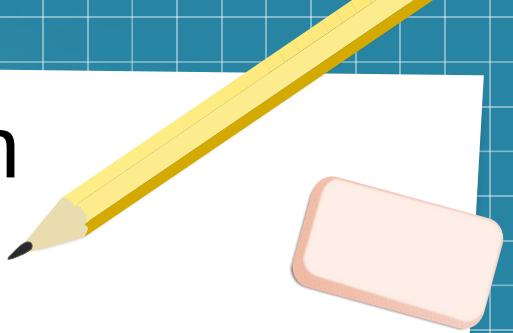
Intro to HAM Radio

KM7CCF

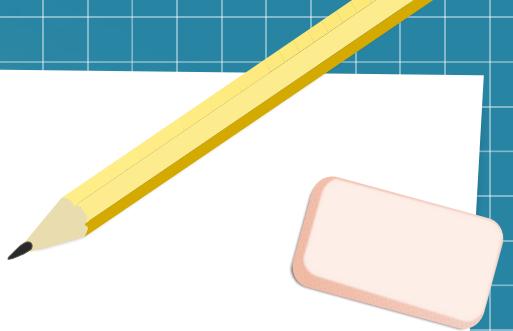


Purpose of This Presentation

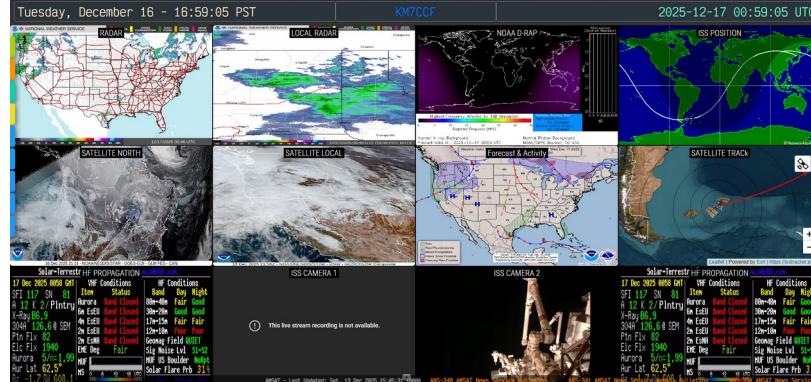
- Knowledge sharing
- Familiarize you with different operational modes
- Establish some foundations for how to explore the radio waves
- Get you started on your HAM radio adventure (or maybe just rekindle some inspiration)
- Introduce a few resources and websites for further exploration



A Bit About Me



- Originally from the Midwest
- Technician Class Radio Amateur
- Active on 2 meters and 70 cm
- Built a Tape Measure Yagi-Uda Antenna
- Check out my HAM Dashboard
<https://km7ccf.github.io/ham-dash/>
- Mainly focused on honeypots, hardware hacking, and working towards a career in penetration testing.
- Fell into a HAM radio rabbit hole and found it rather nice

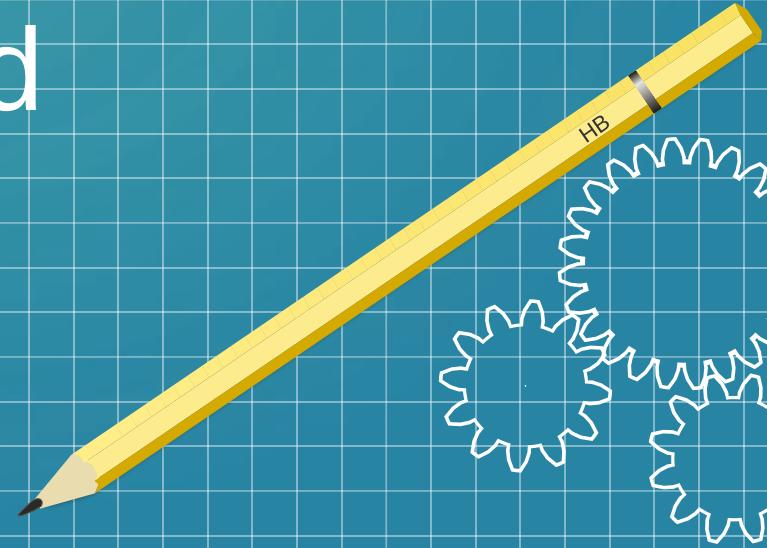




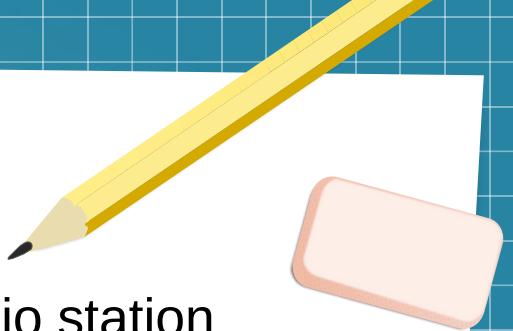
The Iceburg is Large and I am Small

This is not meant to go in depth on any particular area of HAM Radio but is more of a general overview of different things I have picked up on, good things to know, and where to go to learn more

Disclaimers and Things to Keep In Mind



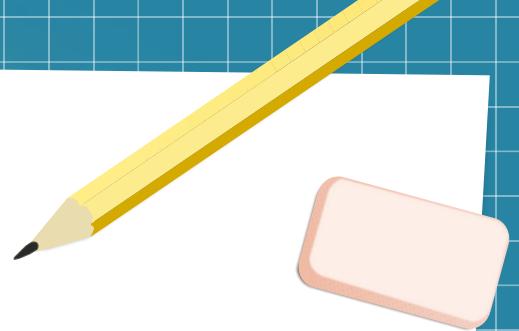
Disclaimers



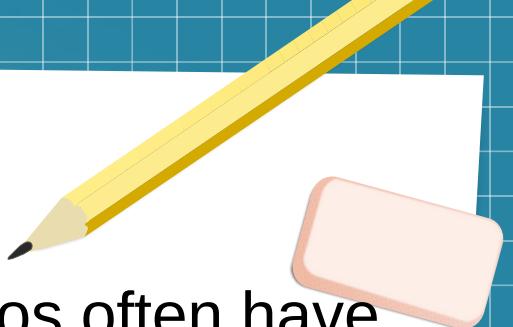
- This is not an endorsement for or against any vendor or radio station
- I do not endorse the use of any software over another
- Jamming is okay to do with a guitar but carries consequences when done with a radio
- Read Part 97 of the FCC rules to know what is allowed and what is not
<https://www.ecfr.gov/current/title-47/chapter-I/subchapter-D/part-97>
- It is entirely up to you to know the rules and test before transmission to ensure proper operation equipment operation and adherence to the law.
- Crime is bad. Fines and jail compound the issue and are generally not fun. Know the rules.

In an Emergency

- You are allowed to call for help if you are in a life threatening situation. Ask yourself:
 - Can I call 911 instead?
 - Am I about to die?
 - If I don't get help soon will I die or loose bodyparts?
- In a natural disaster or other emergency that affects an area listen before transmitting (this generally a good thing to do)



Safety

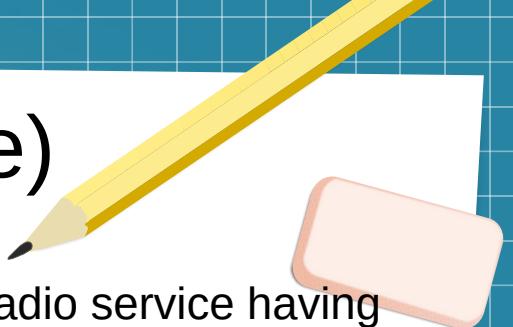


- Treat all equipment as if it were powered on (radios often have large capacitors that are not friendly)
- Radios use non-ionizing radiation which is different than ionizing radiation
- Radio Frequency Burns can happen but are more similar to thermal burns.
- Check documentation that comes with your equipment and electrical safety guidelines for specific details about how to work safely.

The Purpose of Amateur Radio

- Many people have many definitions and ideas about what Amateur Radio is really about
 - Emergency communications in times of need
 - Testing and experimenting with radios and antennas
 - Making contacts with others using methods other than the internet
- The next slide is the entirety of section 1 part 97 that governs the purpose of the rules and regulations pertaining to Amateur Radio Services

Part 97.1 (Basis and Purpose)

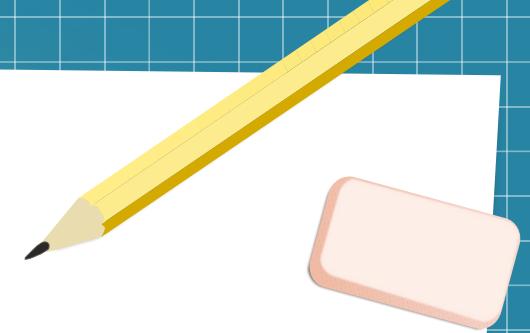


The rules and regulations in this part are designed to provide an amateur radio service having a fundamental purpose as expressed in the following principles:

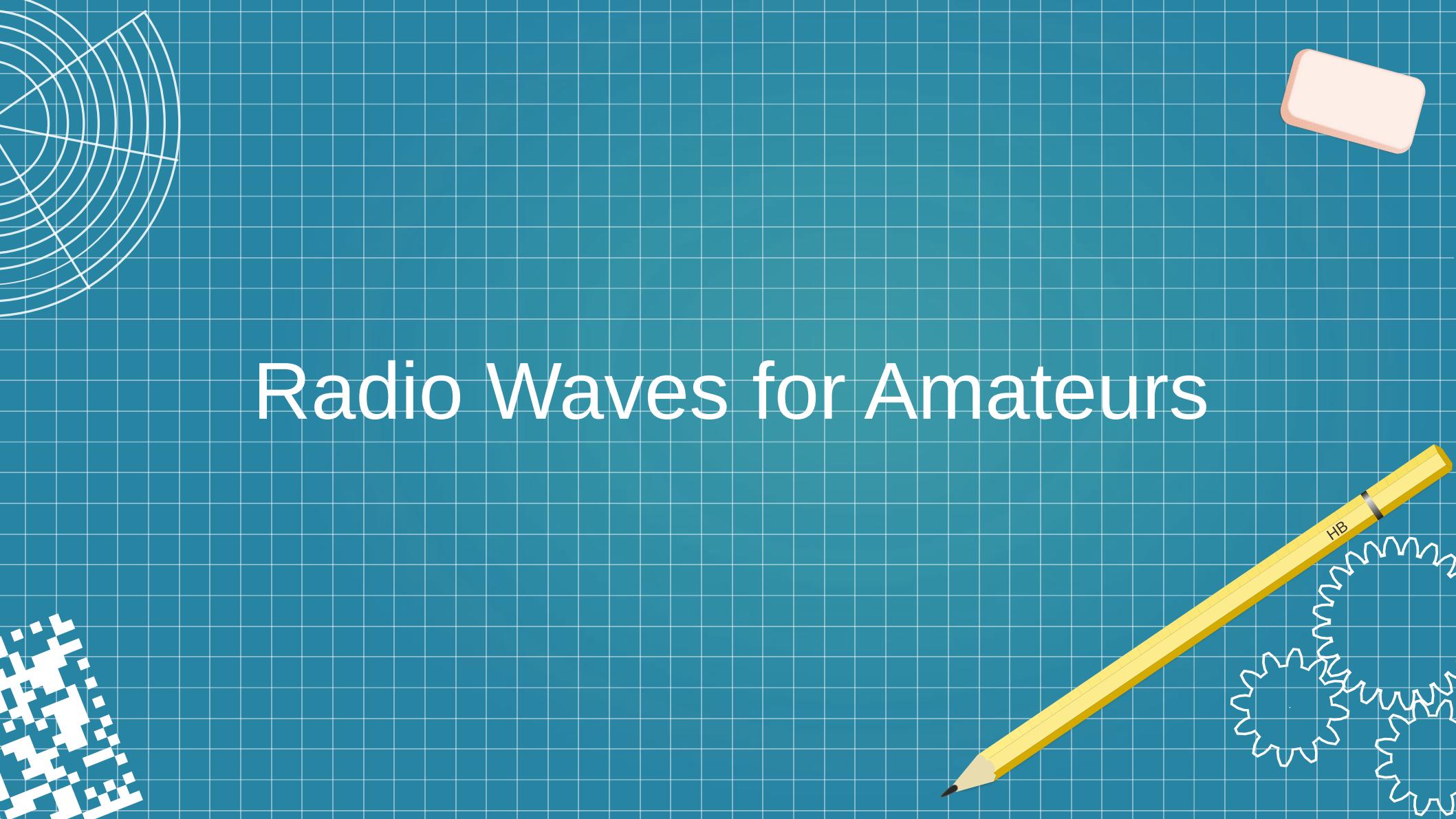
- (a) Recognition and enhancement of the value of the amateur service to the public as a voluntary noncommercial communication service, particularly with respect to providing emergency communications.
- (b) Continuation and extension of the amateur's proven ability to contribute to the advancement of the radio art.
- (c) Encouragement and improvement of the amateur service through rules which provide for advancing skills in both the communication and technical phases of the art.
- (d) Expansion of the existing reservoir within the amateur radio service of trained operators, technicians, and electronics experts.
- (e) Continuation and extension of the amateur's unique ability to enhance international goodwill.

Updates

- The FCC recently updated frequency allocations so be sure to check for changes before going on an adventure.
- The changes mention specific allocations that are being designated outside of and inside of the amateur bands
- Might be worth a read
- <https://docs.fcc.gov/public/attachments/FCC-25-60A1.pdf>



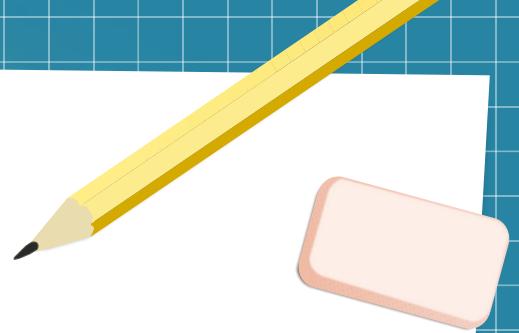
Glad you made it!
On to the interesting stuff....



Radio Waves for Amateurs

Definitions

- Transiever – 2 way Rx and Tx
- Reciever – Rx only
- Transmitter – Tx only
- Meters – The height or amplitude of the wave
- Frequency – the number of peaks a wave will reach in a time slice (measured in Hertz)



Frequencies



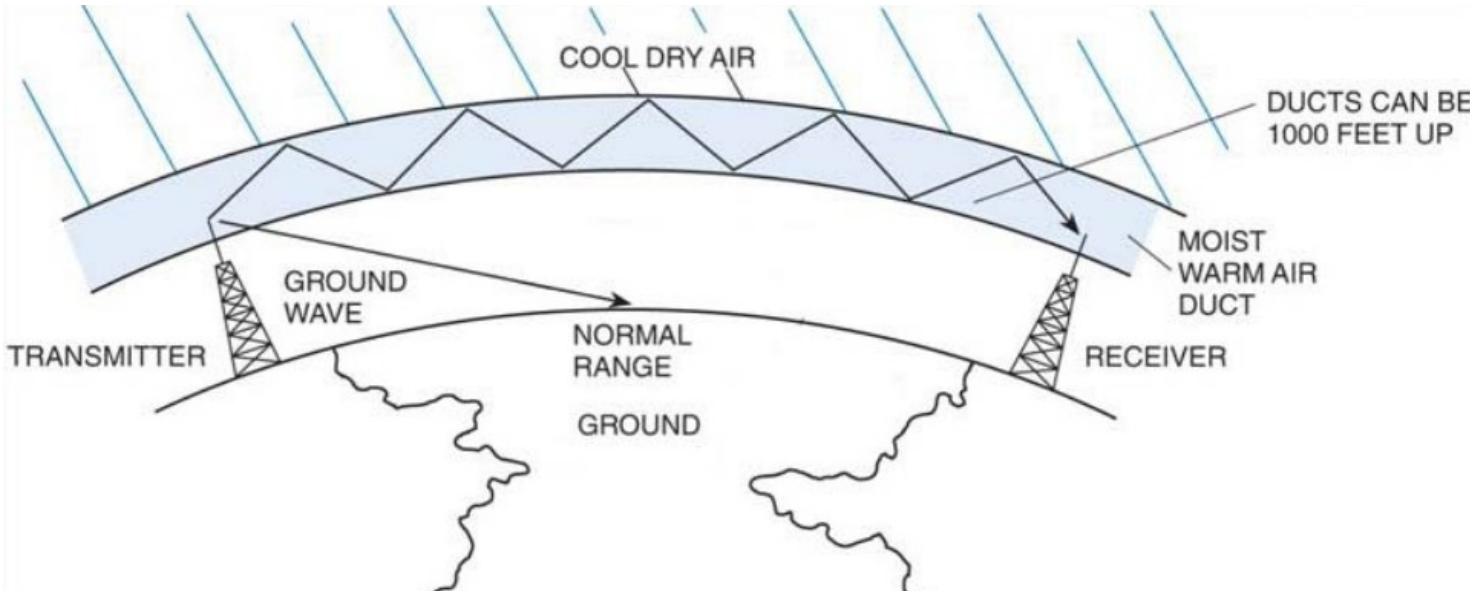
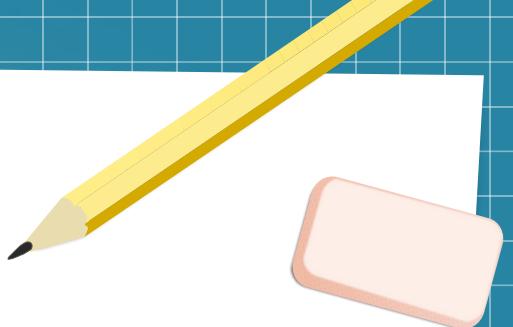
- The meter measurement of a band will increase as the frequency decreases
 - 2m translates to approximately 146.000 Mhz
 - 33cm translates to approximately 900.000 Mhz
 - 6m translates to approximately 50.000 Mhz
- The more the meter the fewer the frequency
- A full printout can be found here

<https://www.arrl.org/files/file/Tech%20Band%20Chart/Tech%20Band%20Chart.pdf>

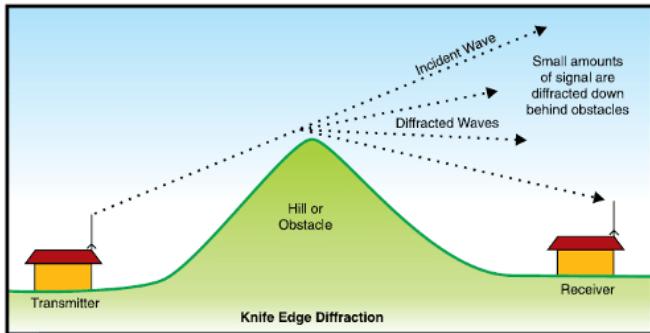
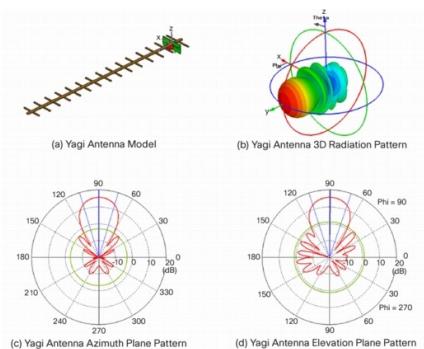
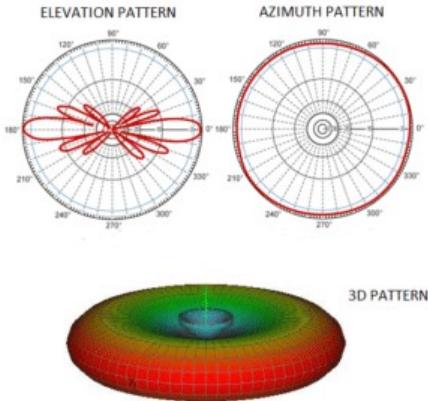
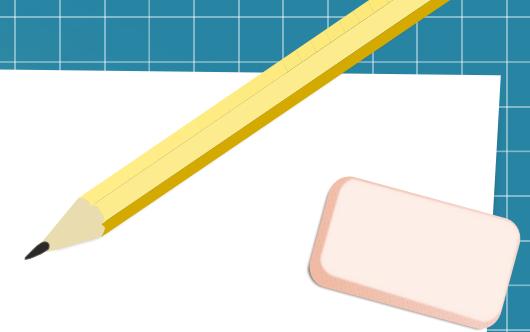
Uses of Different Frequencies

- 2 Meters and 70cm bands are the most common for making contacts with local HAMs and getting into repeaters
- 6 meters coined the “magic band” because it can travel for thousands of miles via Tropospheric Ducting given the right conditions
- 33cm band (~900 MHz) is where Lora/Meshtastic devices operate
- There are a couple overlaps between licensed unlicensed frequencies (be careful).

Tropospheric Ducting



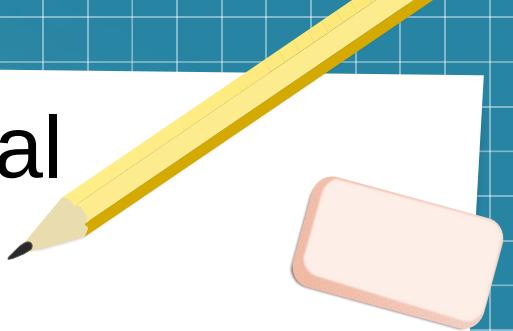
Radiation Patterns Knife Edge Diffraction and Shadow Zones



From left to right

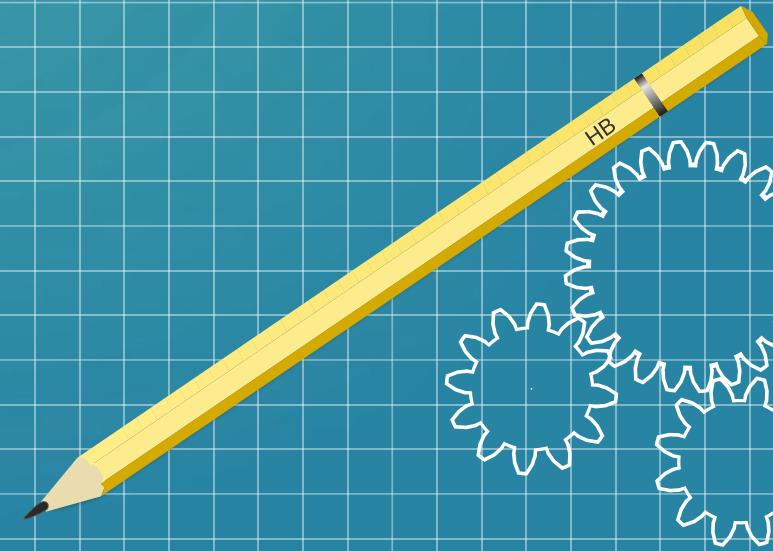
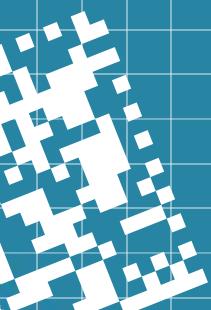
- [1] <https://www.mpantenna.com/omnidirectional-antenna-radiation-patterns/>
- [2] <https://www.raymaps.com/index.php/some-common-antenna-radiation-patterns/>
- [3] <https://vk3ph.net/propagation/>

Other Things That Affect Signal



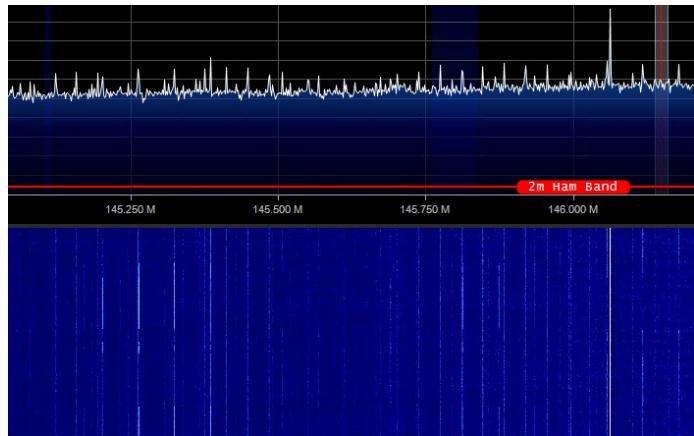
- Absorbs Signal:
 - Vegetation
 - Water in the air
 - Large dense objects like hills/mountains/buildings
 - Can bounce signal off of buildings
- Antenna considerations
 - Antenna design and length
 - SWR of the antenna
 - Height of antenna off the ground
- Operation mode (CW goes further FM is more friendly)

RTL-SDR



RTL SDR

- A small usb device that allow you to receive radio signals.
- A multitude of software exists for viewing and listening to the radio through this receiver
- Very handy piece of equipment

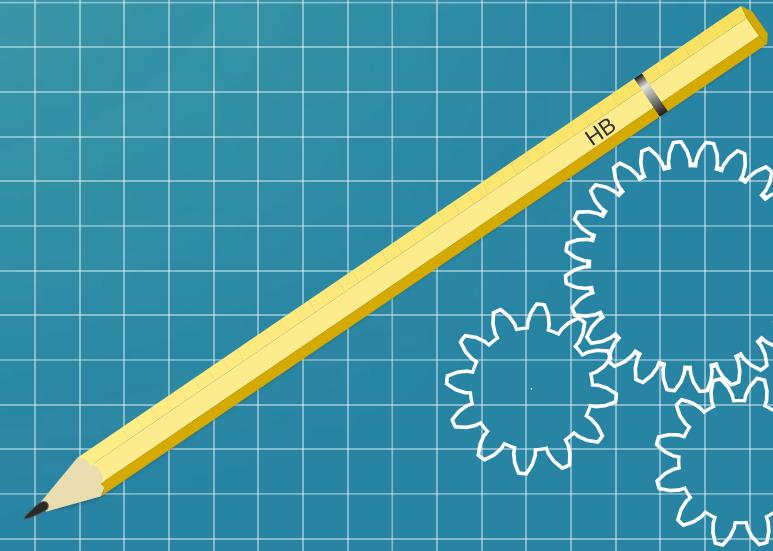
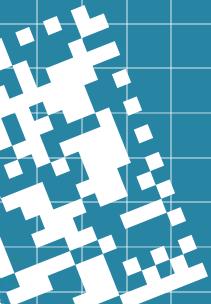


RTL-SDR things to know

- After a while it will heat up and get less accurate as it heats up
- You may also want to invest in a filter to eliminate interference/mixing of FM/AM stations on other bands
- Programs include *SDR Sharp* if you're on Windows and *SDR Angel* for Linux, Android and/or Apple
- Output can be piped through SDR Sharp or directly into a program via the audio card for digital signal processing



Waterfalls Visualizing the Radio

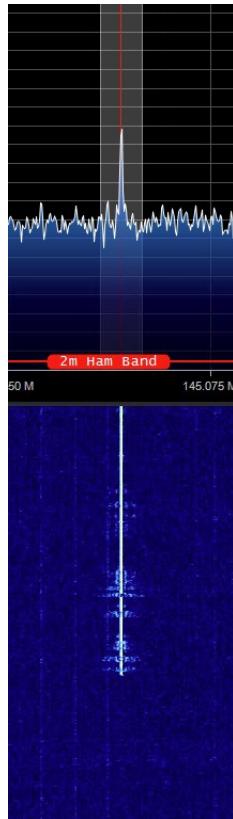
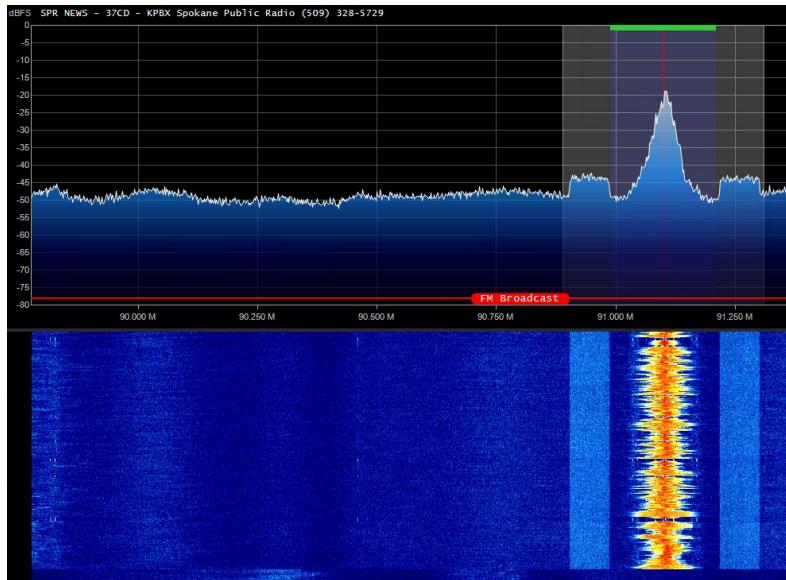


Waterfalls

- This is a visual display of the power at a point in time of a received signal.
- When radio was young people had to listen for distinct changes or use oscilloscopes to find transmissions.
- Different types of signaling look different visually
- Encoded/Text transmissions will look like blips
- Voice will be long and vary in intensity along the edges

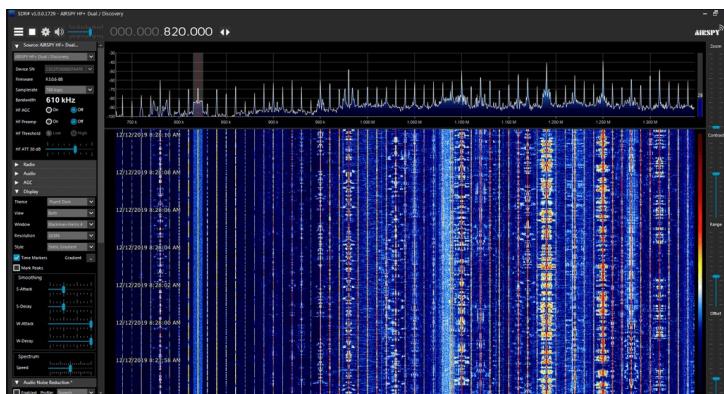
Voice Transmission Examples

FM Radio



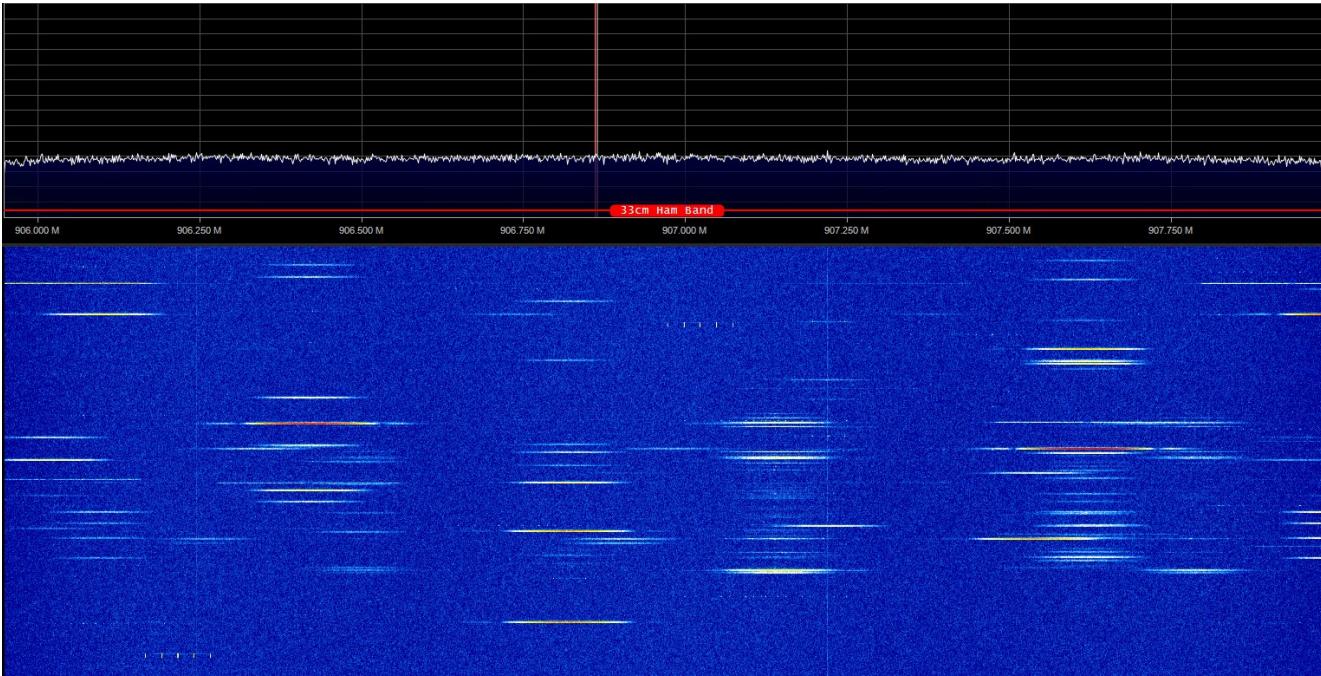
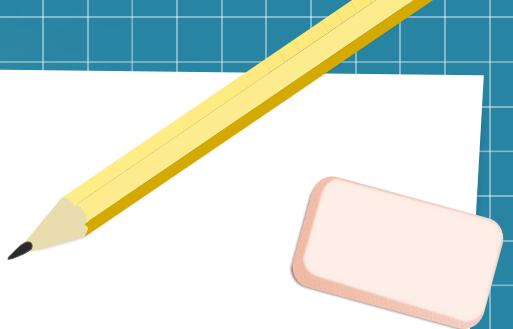
FM Ham Radio

Single Sideband

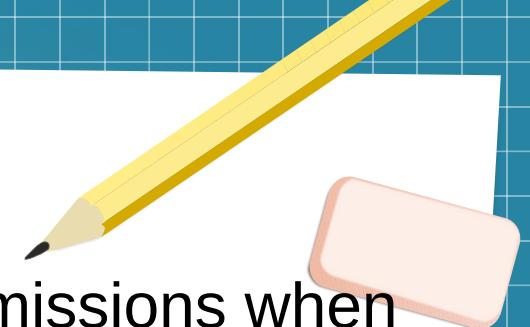


(Courtesy of w4va.org)

Meshtastic / LoRa

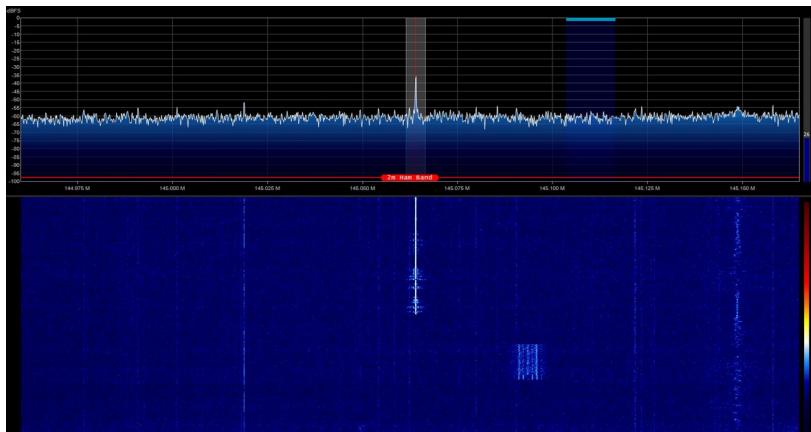


Spurious Emissions

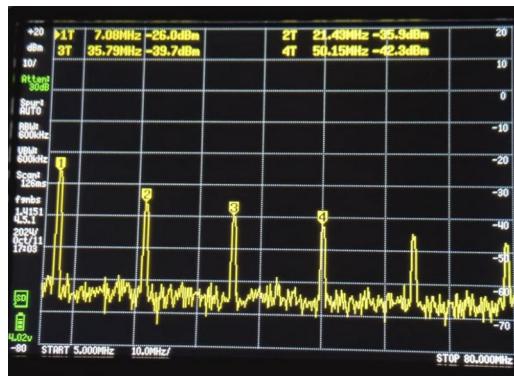


- Cheaper radios have had a history of spurious emissions when transmitting. Because the transceivers are not always the best quality. When it comes to life and death a cheap radio is better than no radio, but avoid if possible.

Normal Transmissions



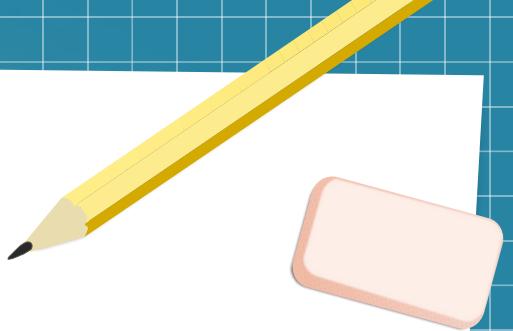
Spurious Emissions



<https://www.youtube.com/watch?v=RrYnqFzILMg>

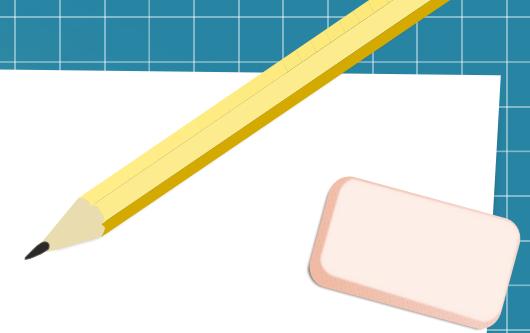
Radios and Antennas

Starter Radios



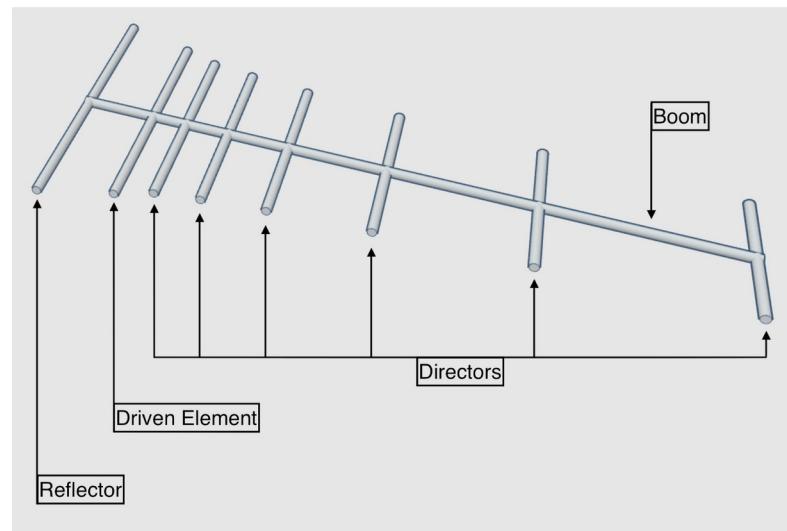
- The Baufang UV-5R is okay for listening
- A significant upgrade is the BTech UV-PRO
 - Comes with an application to easily save channels, record transmissions, Decode and Send APRS, Send CW aka Morris Code, and Track Satellites
- It really depends on what you want to do, short wave, digital modes, local voice communication, satellite stuff
- ICOMM, Kenwood, and Yaesu are all mentioned on the air as being reputable

Antennas

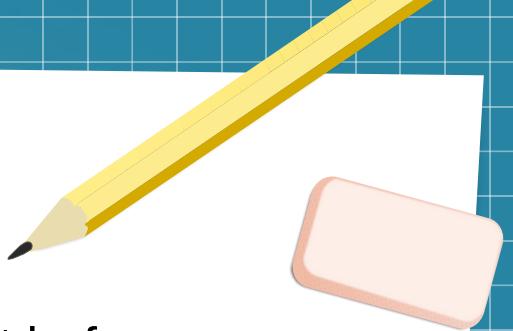


- Yagi-Uda Antennas

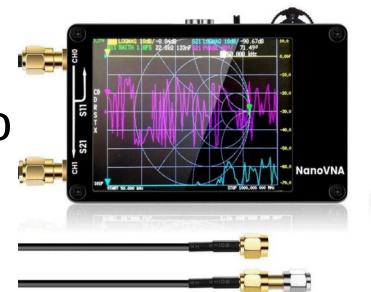
- Directional antennas that allow for focusing transmission and reception
- Director elements will direct received signal to the reflector
- The reflector will then reflect signal to the driven element
- A single driven element is the only powered part of the antenna
- Many flavors for 2m 70cm 33cm and so forth.



Antenna Building



- A poorly built antenna can damage equipment so be sure to test before you transmit.
- A Standing Wave Ratio meter is used to determine how well an antenna will operate
 - The closer to 1 the better reception on a particular band the antenna will do
 - Science class video on SWR: <https://www.youtube.com/watch?v=DovunOxIY1k&t=83s>
 - I use the Nano VNA to measure SWR (seen on the right)
- Antennas are tuned for specific bands
- Water is not good if it gets into Coaxial Cables and can lead to shorts or signal degradation so keep them clean and dry
- Manual from 1984 ARRL Handbook on building Antennas
<https://www.qsl.net/kb7tbt/manuals/arrl/ARRL%20HANDBOOK%20-%20Antenna%20Project.pdf>



Antennas are Purpose Built

- The length of the antenna will determine the frequencies that are accepted by the antenna
- Without an SWR meter its very difficult to measure how well an antenna will do.
- Exact measurements are usually provided in designs
- Example: Tape Measure Yagi-Uda

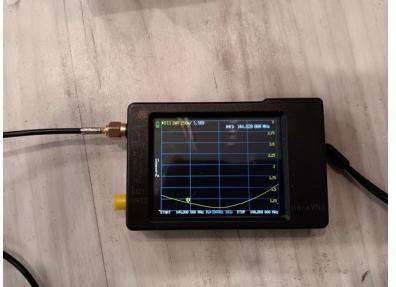
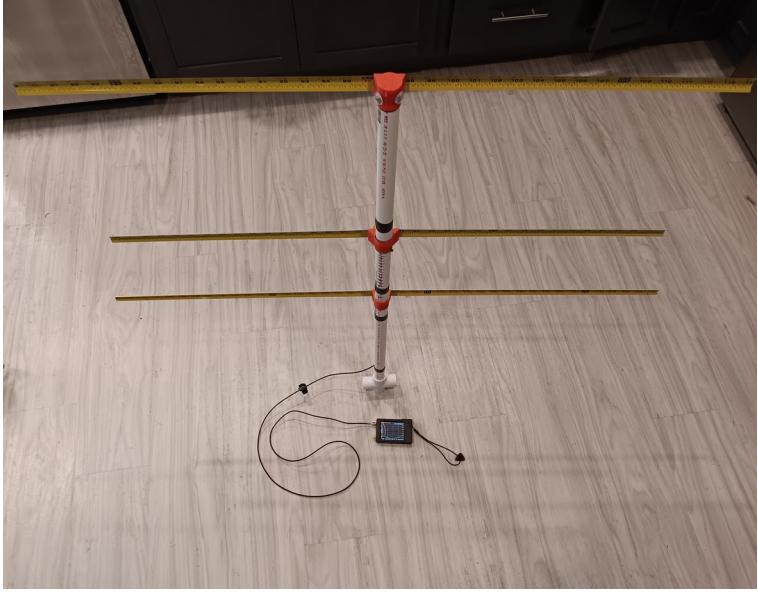
• Director - 35 1/8"

• Driven - 35 1/2" (cut in half to 17 3/4" each)

• Reflector - 41 3/8

Favorite Design: <https://beckystern.com/2021/03/29/tape-measure-yagi-antenna/>

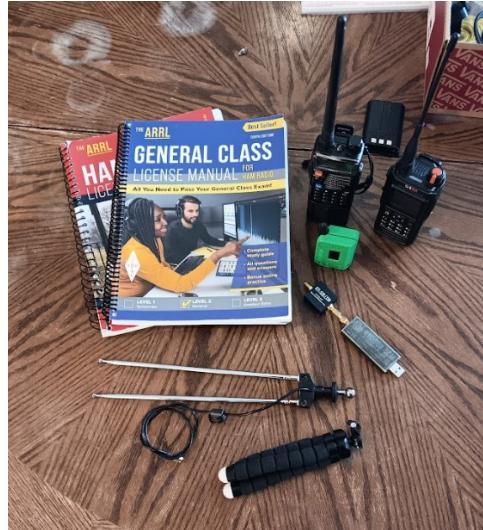




← Steve is good

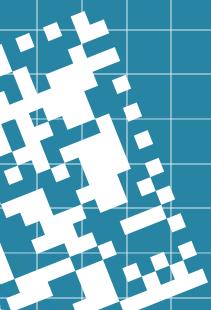
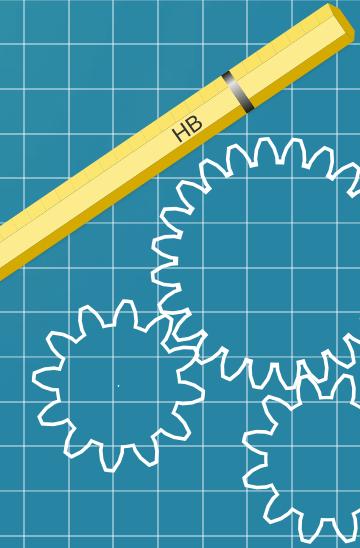
Steve and Friends

← This is Steve

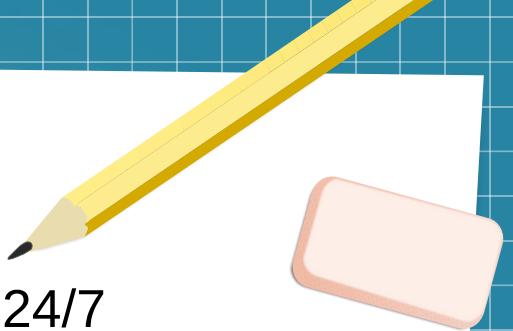


Side note: The
RTL-SDR
antenna is only
good for
reception not
transmission.

Modes of Operation

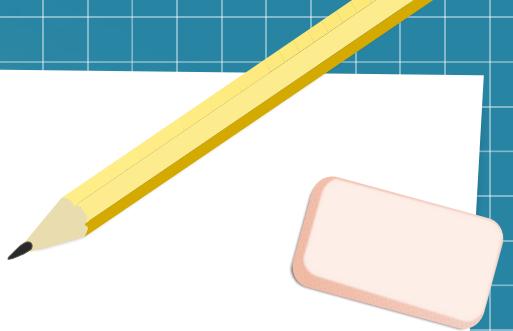


Voice Modes



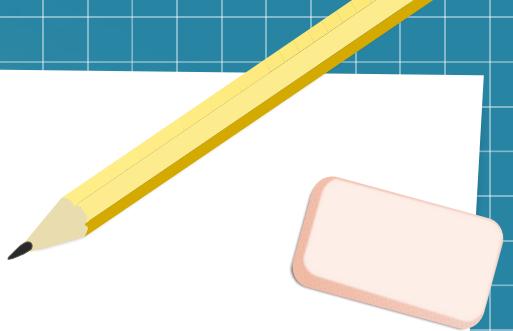
- Easiest way to access and test equipment, NOAA operates 24/7 (162.400 MHz and 162.550 MHz)
- FM – Low complexity transmission mode most radios support it
- SSB – (Single Side Band) used for long distance or short wave transmissions, some radios support it
- Digital Voice – There are a number of protocols out there such as D-Star specialty filtering and processing is required and built into higher end radios
- Internet Relays also exist to allow licensed operators to transmit on remote repeaters all over the world over the internet

Listening and Learning



- HAM radio is an art as much as a science
- Listening is the best way to learn
- 2m and 70cm bands are the most active for FM voice
(144.1-148 Mhz) (430-450 Mhz)
- FM reception is the easiest to get started with
- Finding a consistent net or busy repeater system is the best way to learn from experienced operators

National Frequencies

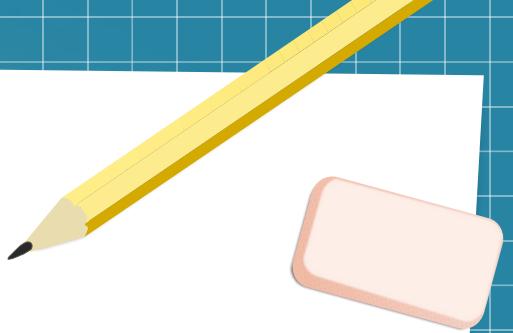


- National Calling Frequencies
 - 146.520 MHz
 - 432.10 MHz
- APRS
 - 144.390 MHz
- FT8
 - 144.174
 - More found at: <https://www.dxzone.com/ft8-frequencies/>

Repeaters

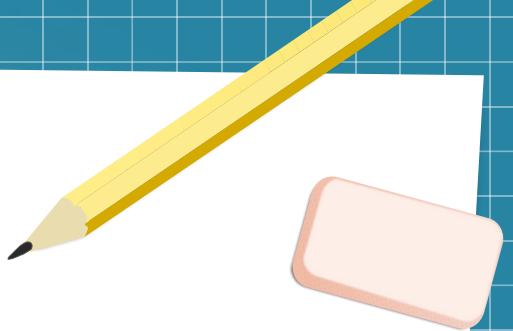
- These are systems of linked radio towers that rebroadcast voice and data traffic in areas they cover.
- Have a high power output, and sensitive reception
- The frequency is often paired with an offset and a PL tone to ensure that nobody gets “stepped on”
- You can find a number of repeaters by looking them up online
- Conceptually you may find commonly used local frequencies the longer you listen

Ways to Communicate



- Q-Signals or Q-Codes
 - were widely used when Morris code was the only way to realistically communicate over the air.
 - Used for brevity not secrecy.
<https://www.arrl.org/files/file/Get%20on%20the%20Air/Comm%20w%20Other%20Hams-Q%20Signals.pdf>
- Morris Code
 - Used to be part of the licensing process but this is not so anymore
 - If you want to practice below is a pretty good website but there are dozens out there.
<https://lucassedberg.com/tools/morse>

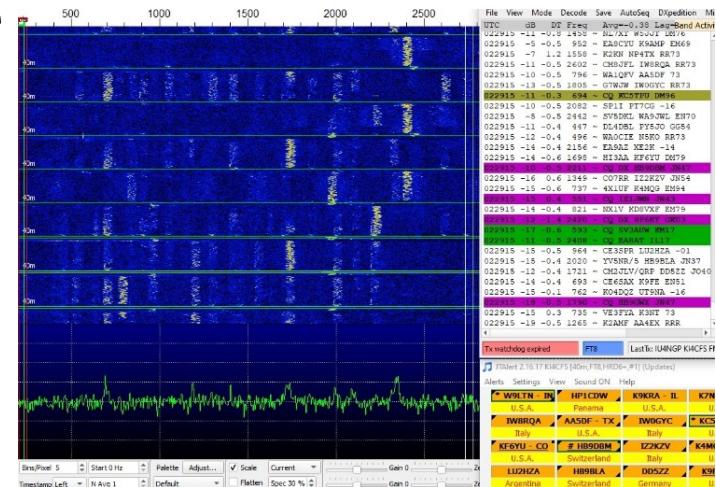
Digital Modes



- APRS – Packet Radio on 144.39 MHz
 - Allows for telemetry and text communication
 - Mainly you will see GPS data come through for weather balloons, repeaters, and vehicles
- FT8 – Direct Keyboard Transmissions
 - Designed for human to human communications
 - Mainly found on the 6 meters and up bands
 - WSJT-X software is used to transmit through a sound card on a computer

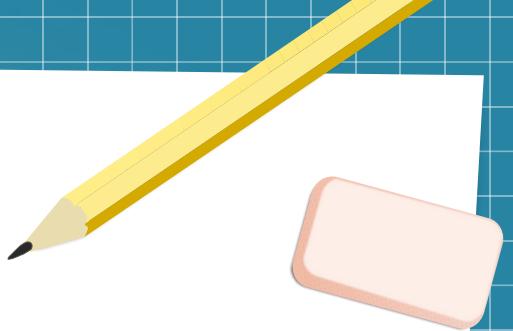
FT8

- Mainly used for making long distance contacts via text
 - This is focused on long distance and text based transmissions
 - Comparable to Morris code just has more steps and computers translate data to text instead of people
 - Also commonly called keyboard to keyboard communication
 - I have not had the chance to play with this



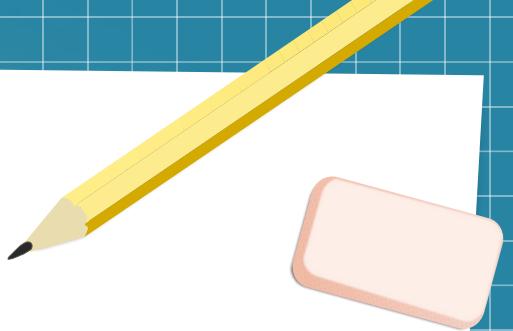
HAM Radio Activities

Many Many Activities



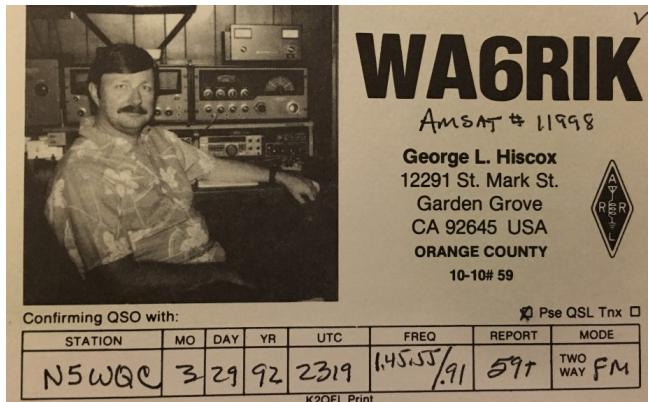
- Moon bouncing
- Making contact through the ISS and other AMSATs
- DXing (distance contacting), most effective on 6 meters and up (technicians are limited to CW on the higher meter bands)
- Contesting – Participating in contests like the 13 colonies
- Science projects that rely on telemetry and retrieval when they are in the air like weather balloons, rockets, and amateur satellites

Collecting QSL Cards



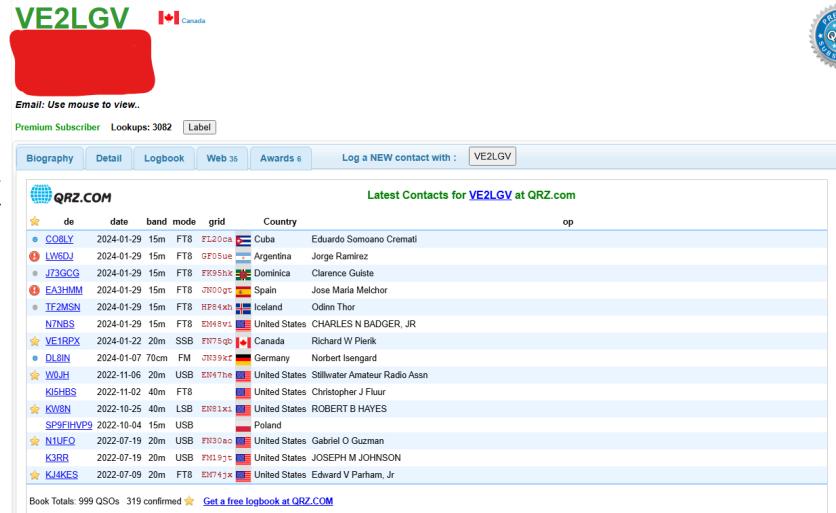
- Physical cards sent out by some stations
- Its a whole thing

<https://www.arrl.org/files/file/QSL/QSL%20Bureau%20NEW%205%20May%202023.pdf>



Modern Version of QSL Cards

- QRZ is a free to use website that allows you to log contacts and receive awards and confirmations.
- Once you get a license you can sign up for free
<https://www.qrz.com/>
- There are various sites for contact tracking that use the FCC database to pull in recent information about a callsign.

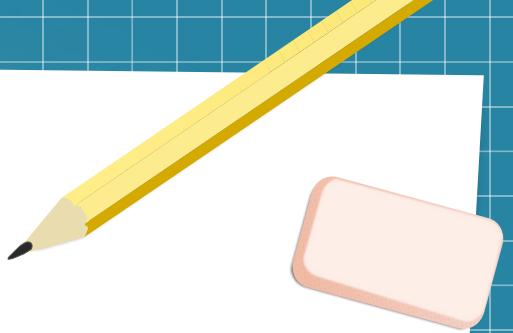


The screenshot shows a QRZ.COM search results page for the callsign **VE2LGV**. At the top, there's a small profile picture placeholder and the text "Email: Use mouse to view...". Below it, the user is identified as a "Premium Subscriber" with 3082 lookups. A "Label" button is also present. The main content area displays a table of recent contacts, each with a star icon, date, band, mode, grid, country, and operator name. The table includes columns for de, date, band, mode, grid, and Country. The footer of the page shows "Book Totals: 999 QSOs 319 confirmed" and a link to "Get a free logbook at QRZ.COM".

de	date	band	mode	grid	Country	operator
CORBY	2024-01-29	15m	FT8	FI20ca	Cuba	Eduardo Somoano Cremati
LWSDJ	2024-01-29	15m	FT8	GR05ue	Argentina	Jorge Ramirez
J73CGG	2024-01-29	15m	FT8	FF95hx	Dominica	Clarence Guiste
EA3HMM	2024-01-29	15m	FT8	JN00gt	Spain	Jose Maria Melchor
TF2MSN	2024-01-29	15m	FT8	HP84kh	Iceland	Odinn Thor
N7NBS	2024-01-29	15m	FT8	EM48vi	United States	CHARLES N BADGER, JR
VE1RPX	2024-01-22	20m	SSB	FF75gb	Canada	Richard W Pierik
DL8IN	2024-01-07	70cm	FM	JN39kf	Germany	Norbert Isengard
W0JH	2022-11-06	20cm	USB	ED94he	United States	Stillwater Amateur Radio Asn
K5HBS	2022-11-02	40m	FT8	ED94he	United States	Christopher J Fluor
KW8N	2022-10-25	40m	LSB	EN81xi	United States	ROBERT B HAYES
SP9FHVP9	2022-10-04	15m	USB	EN30ao	Poland	Gabriel O Guzman
NTUEQ	2022-07-19	20m	USB	EN743k	United States	JOSEPH M JOHNSON
K3RR	2022-07-19	20m	USB	EN157j	United States	Edward V Parham, Jr
KM1KES	2022-07-09	20m	FT8	EN743k	United States	Edward V Parham, Jr

Transmitter Hunting

- AKA Fox Hunting
- Two teams Hunters and Foxes
- Activity where low power transmitters will be hidden in a public place for a specific amount of time
- The hunters attempt to find the transmitter
- Steve the antenna could be good for this

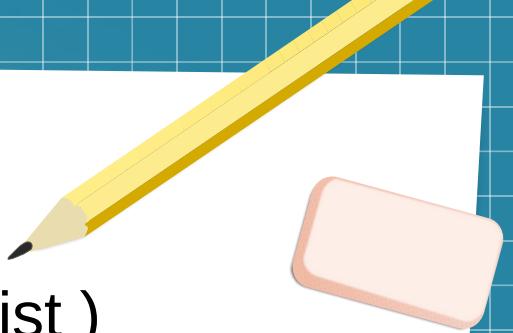


POTA – Parks on the Air

- Community event where amateurs will gather in public parks to test equipment
- Good way to get a lot of contacts all at once
- Fun way to meet other operators, practice skills and touch grass
- Might also be a good way to practice DXing because you know people will be in a location and listening

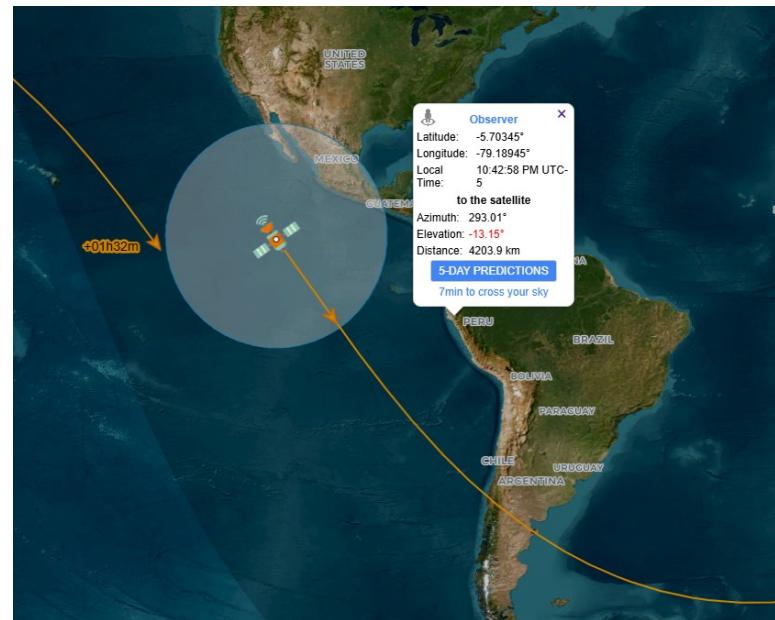
HAM Radio Nets

- Not a traditional data Network (although those exist)
- Operators agree to come together at a specific time to share
 - Recent events
 - Upcoming events
 - Test Equipment
 - Promote other clubs and nets
 - Talk about life events
- Its the OG forum/Bulletin Board System



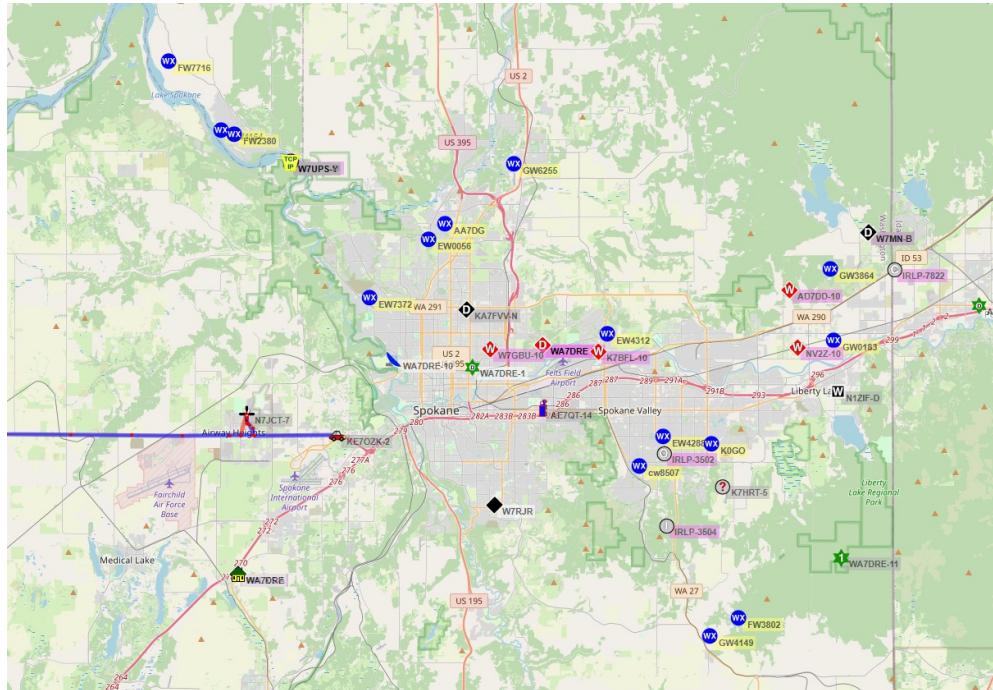
Unlicensed Activities

- Listening is free on the amateur bands
- Technically WiFi and Bluetooth
- Meshtastic – decentralized data networks
- Online activities
 - APRS Viewer: aprs.fi
 - ISS Tracker: orbtrack.org
 - KIWI SDR: kiwisdr.com



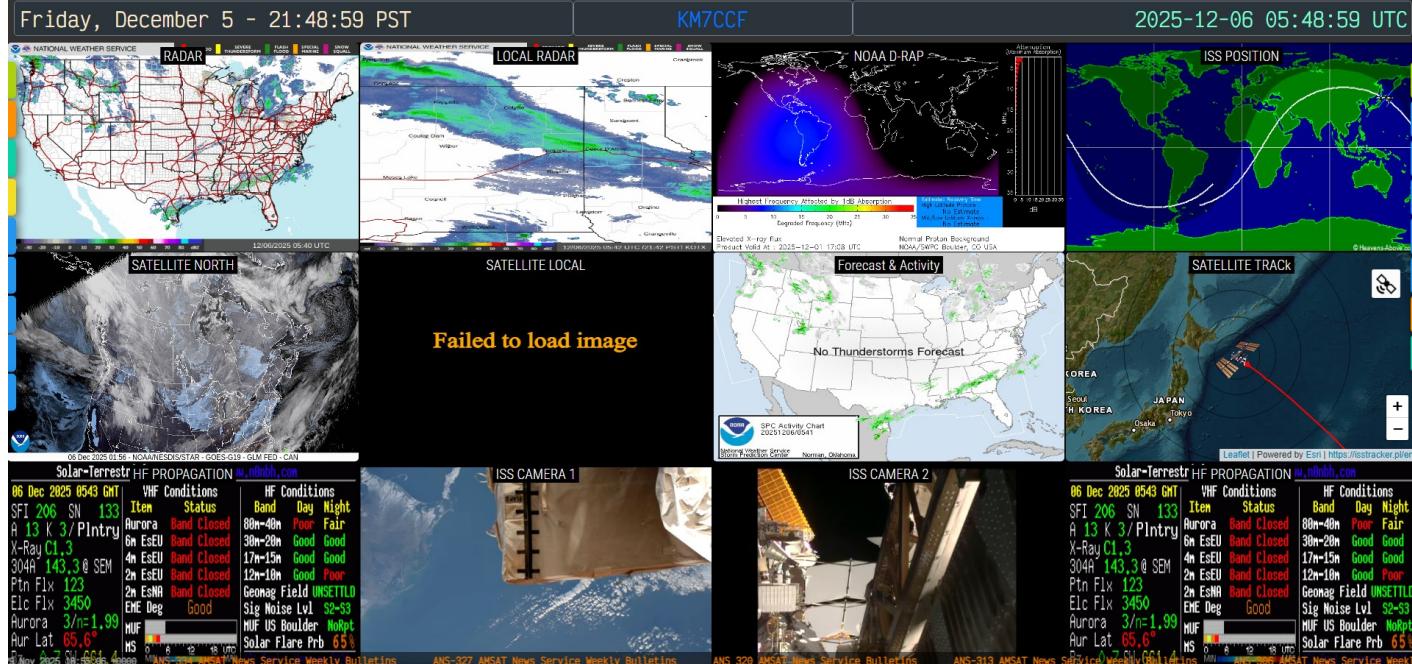
APRS map

- Aprs.fi has a list of devices
- This data is sent to the site through an internet gateway
- Sometimes the site will go dark when the local gateway goes down :(
- Used for tracking things that will go far, like weather balloons

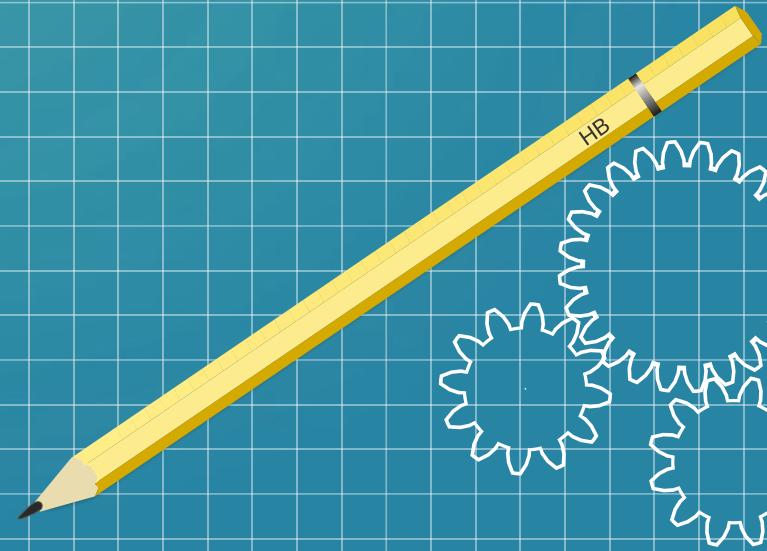
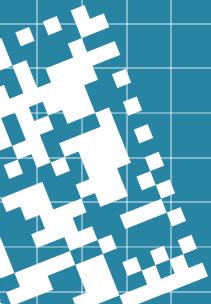


HAM Dash

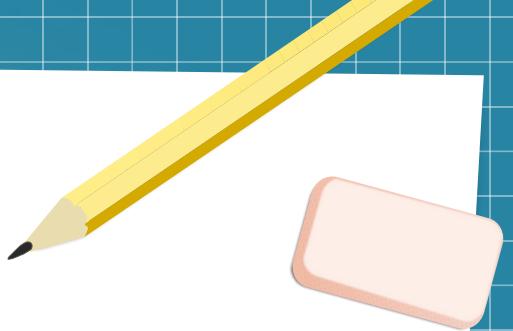
- A free activity that could really spruce up any SOC
- Highly customizable, each pane can be linked to a different resource.



Satellites



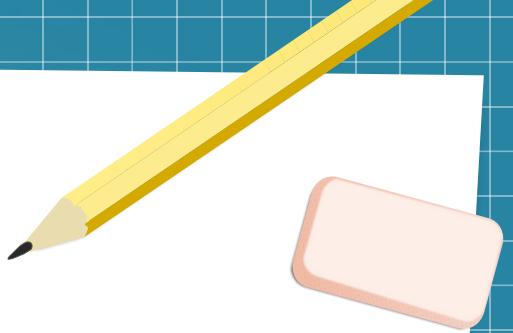
How to Find them



- Online resource for finding amateur satellites:
<https://www.amsat.org/track/index.php>
- Finding your Grid Location: <https://www.qrz.com/gridmapper>
- ISS Tracking: <https://orbtrack.org>
- ISS Frequencies: <https://www.amsat.org/amateur-radio-on-the-iss/>
- A number of other resources, the BTECH UV app will auto calculate pass times and will show real time information based on your current location

How to Talk Through Them

- They are just repeaters that are in space.
- Steve the antenna has been helpful
- Point and listen on the appropriate frequency
- There are often offsets and PL tones just like repeaters
- Transmitting to a satellite works just fine with a low Wattage transiever with a directed antenna

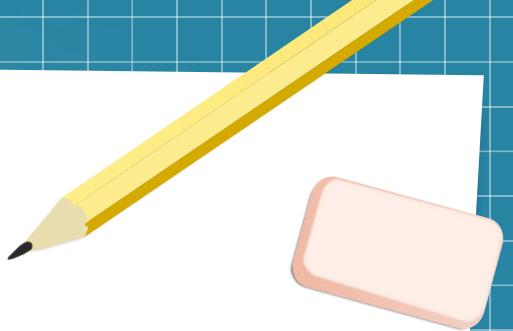


Direct Reception and Communication

- Using the RTL-SDR you can pipe sound into another program
- It was/is possible to use programs like WXtoImg to view satellite imagery, see the following article for more details:
<https://www.rtl-sdr.com/rtl-sdr-tutorial-receiving-noaa-weather-satellite-images/>
- Be aware the images are not likely to be high quality and reception will depend heavily on what the weather is like that particular day.
- For ISS imagery the following resource may be of use:
<https://www.ariss.org/contact-the-iss.html>



Contacting the ISS



Frequencies in Use

The following frequencies are currently used for Amateur Radio ISS contacts (QSOs):

Voice and SSTV Downlink: 145.80 (Worldwide)

Voice Uplink: 144.49 for ITU Regions 2 and 3 (The Americas, and the Pacific and Southern Asia)

Voice Uplink: 145.20 for ITU Region 1 (Europe, Russia and Africa)

VHF Packet Uplink and Downlink: 145.825 (Worldwide)

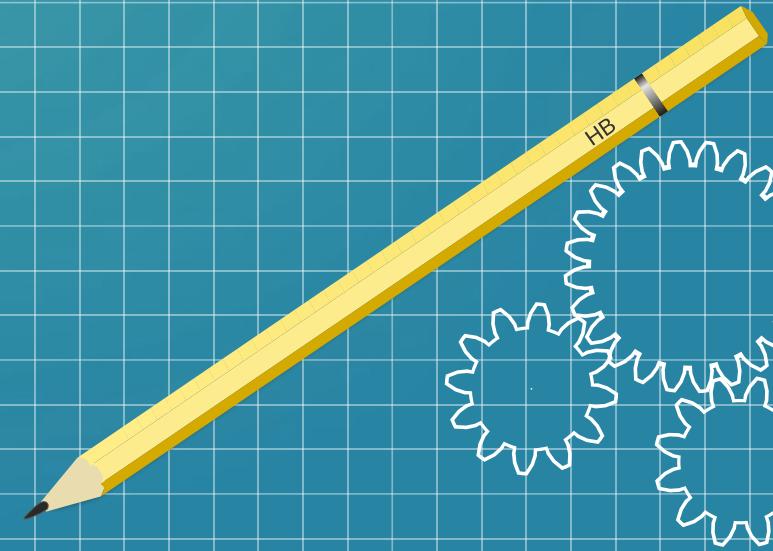
UHF Packet Uplink and Downlink: 437.550

VHF/UHF Repeater Uplink: 145.99 (PL 67 Hz)

VHF/UHF Repeater Downlink: 437.80

Courtesy of: <https://www.ariss.org/contact-the-iss.html>

Getting Certified and References



Gettin' Certified



- Get a good manual, take practice exams, and/or find an elmer



- The pool of questions is available online and practice exams can be found at HamStudy.org or at the ARRL website
- Exam centers can be found here:

<https://www.arrl.org/find-an-amateur-radio-license-exam-session>

* note there are a number of small fees after you pass the test that must be paid to the FCC (~50\$)
Once you have a technician license all you need to do is pass the exam and you can start operating with
General and Extra class

Privacy

- Getting a License requires a physical address and email as well as a full legal name
- Use a PO box and an email address you check regularly.
- Keep it current. This is how:
 - QSL cards get to you.
 - The FCC communicates important things.
 - For ARRL publications if you choose to become a member.

Privacy

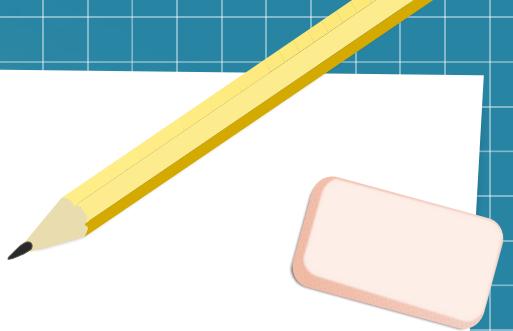


- Treat every transmission on the amateur bands as public communications. Ask yourself: “If I were standing next to a security guard in a crowded mall in late 2001, what would be acceptable to speak loudly about?”
- Encrypted transmissions are not allowed except for control or telemetry, Morris code and Q-codes/signals does not count as well as FT8

Benefits of A License

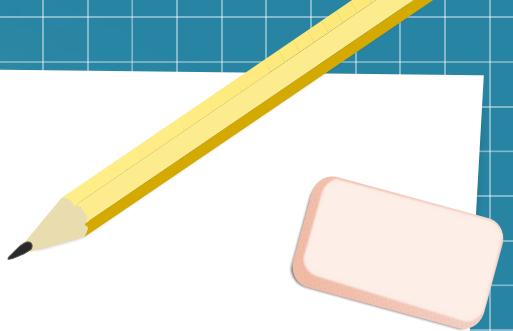
- Getting a license gives you the ability transmit on authorized bands and talk to the people you have heard.
- Upgrading a license will also unlock the ability for you to use more frequencies and modes.
- Fancy thing to carry in your wallet and you get your own callsign
- Once you have a technician license your in, after passing the test for the next level you can start operating at that level immediately.

Getting Practice in the Area



- The national calling frequency
- If you are local the KARS group has a fantastic repeater system that is very active a list of repeaters and frequencies can be found here: <https://k7id.org/repeaters/>
- There is also the Spokane Repeater Group which covers North Idaho and most of Eastern Washington. Frequencies and info can be found here: <https://srgclub.org/>
- The Inland Empire VHF club also exists and holds a weekly net <https://www.vhfclub.org/>

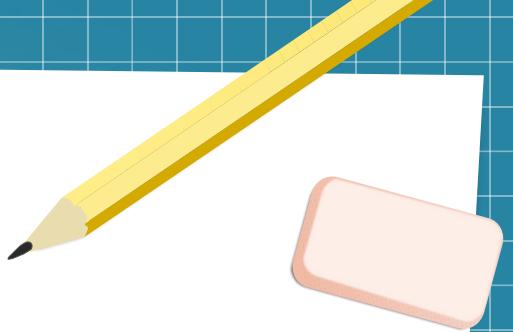
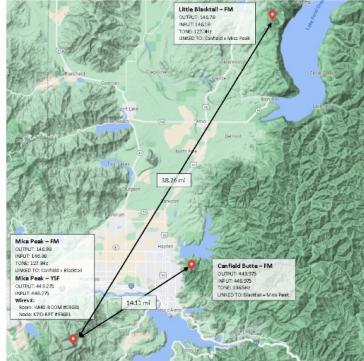
Technical Resources



- Technician Frequency Printout
<https://www.arrl.org/files/file/Tech%20Band%20Chart/Tech%20Band%20Chart.pdf>
- FT8 Further Reading
<https://www.arrl.org/digital-data-modes>
- Tape Measure Yagi With 3d Printed Parts (KD2SSU)
<https://beckystern.com/2021/03/29/tape-measure-yagi-antenna/>
- Tape Measure Yagi with Hose Clamp Brackets (KB9GBR)
<https://www.jpole-antenna.com/2017/02/07/build-it-2-meter-tape-measure-yagi-beam-antenna/>
- Understanding Spurious Emissions
<https://www.youtube.com/watch?v=RrYnqFzLMg>

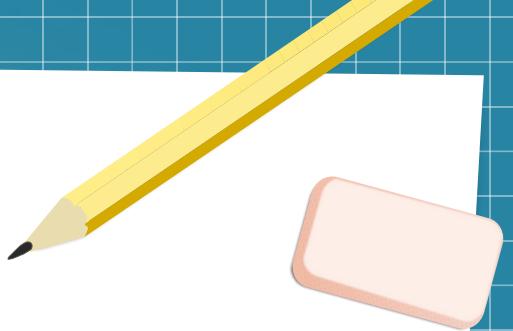
Local Resources

- KARS repeater Group
 - <https://k7id.org/repeaters/>
- Spokane Repeater Group
 - <https://srgclub.org/>
- Inland Empire VHF Radio Amateurs
 - <https://www.vhfclub.org/hall-of-fame/>
- The most useful resource after you get comfortable listening will be
 - A receiver or full fledged radio
 - Your ears and what is in between them
 - A decent note taking system



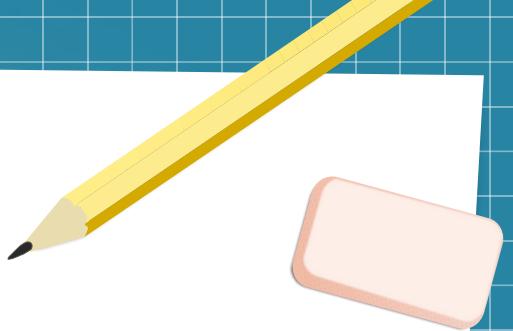
KI7D
Repeaters

National Organizations



- ARRL - American Radio Relay League
<https://arrl.org>
- ARES – Amateur Radio Emergency Services
<https://www.arrl.org/ares>
- RACES – Radio Amateur Civil Emergency Service
<https://www.arrl.org/ares-races-faq>

Respects



Thanks To

K7ID Repeater System for maintaining a solid system

The North West Traffic Net for the consistency

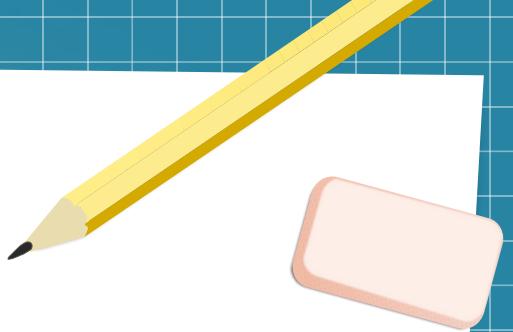
Glenn and the Washington Digital Radio Enthusiasts
^free licensing testing sessions every month^

HAM Radio Crash Course for the review videos

ARRL ARES and RACES volunteers

All of the Local Operators and Elmers

Questions



Questions? Clarifications? Comments?

* slides will be available, link can be found in the discord *

Bonus Content

- “Voluntary Interceptors” were responsible for listening into Nazi communications during World War II in Great Britain
- There is a patron saint of radio operators Maximilian Maria Kolbe
- Guglielmo Marconi is attributed as the inventor of wireless radio (many people have shacks and tinker so who knows who the first truly was)
- Russian Woodpecker
- “The Thing”