

Amateur Radio License

Radios, Power, RFI

Today's Topics

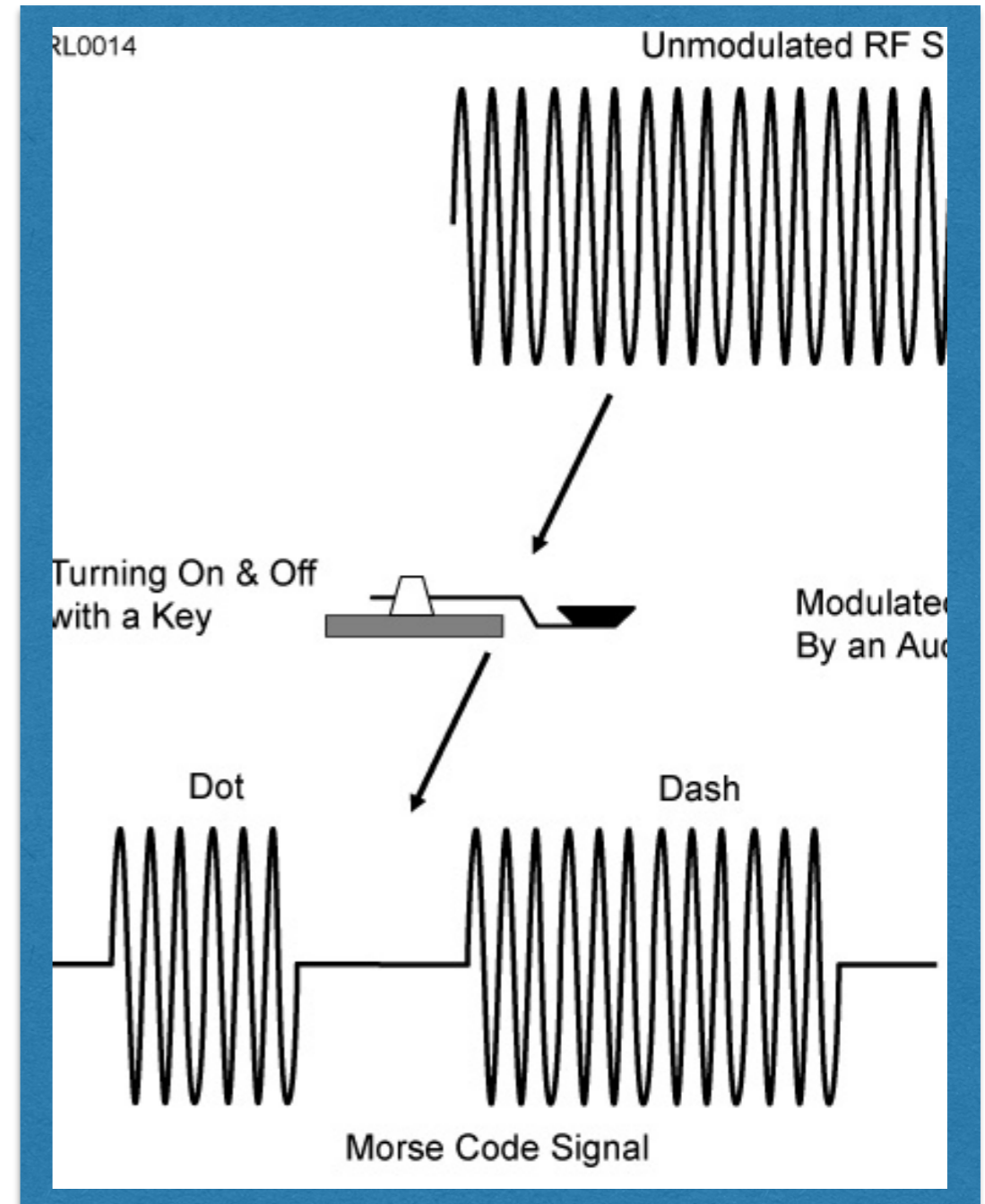
- Types of Modulation : Chapter 2
- Radio Equipment : Chapter 5
 - Radios
 - Digital Communications
 - Power Supplies and Batteries
 - RF Interference, Grounding

Types of Modulation

- Information is encoded in different ways
 - Morse Code (CW)
 - Amplitude Modulation (AM)
 - Frequency Modulation (FM)
 - Phase modulation (PM)
 - Many others

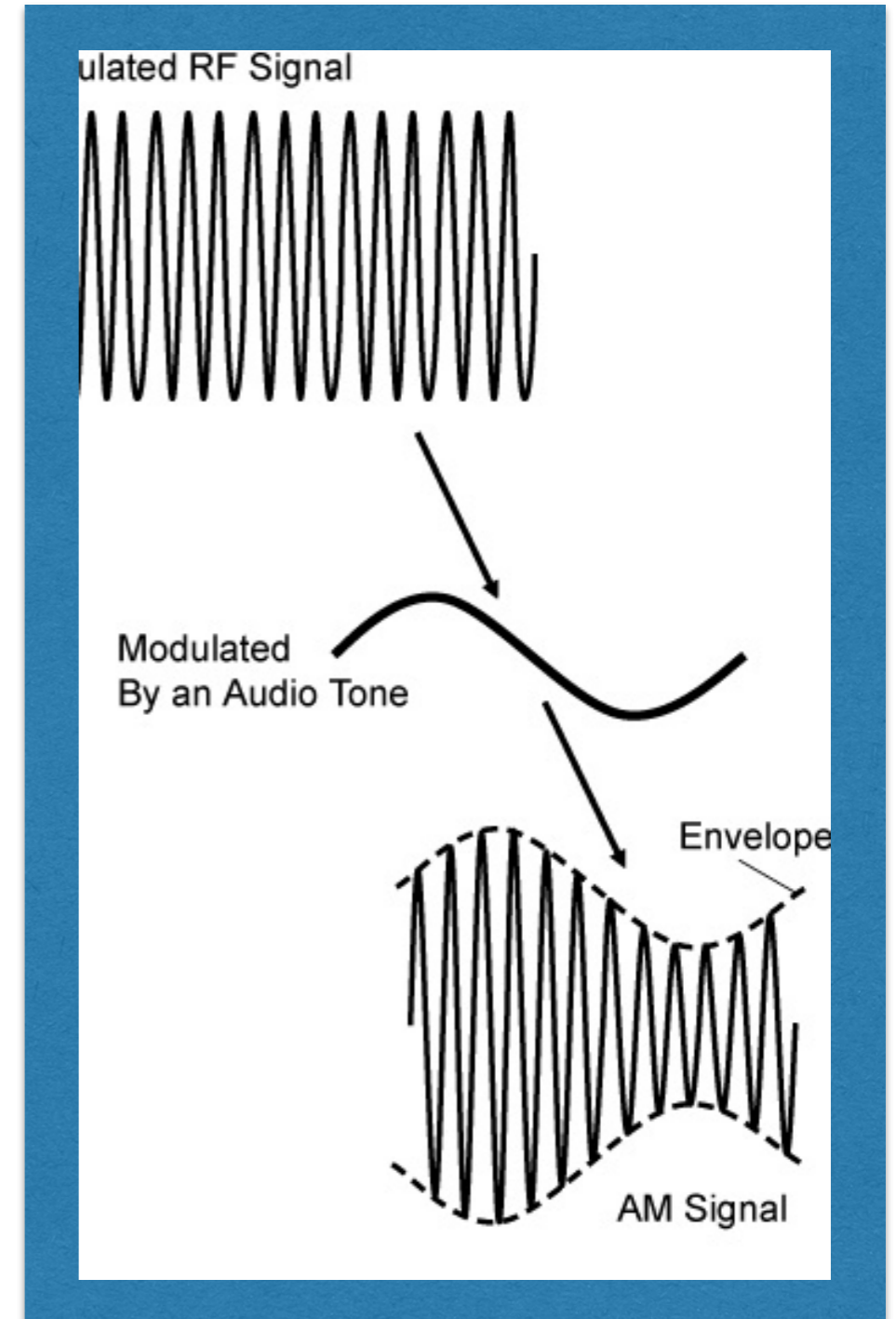
CW (Morse Code)

- Sequence of Dots and Dashes
- A continuous carrier is gated on and off



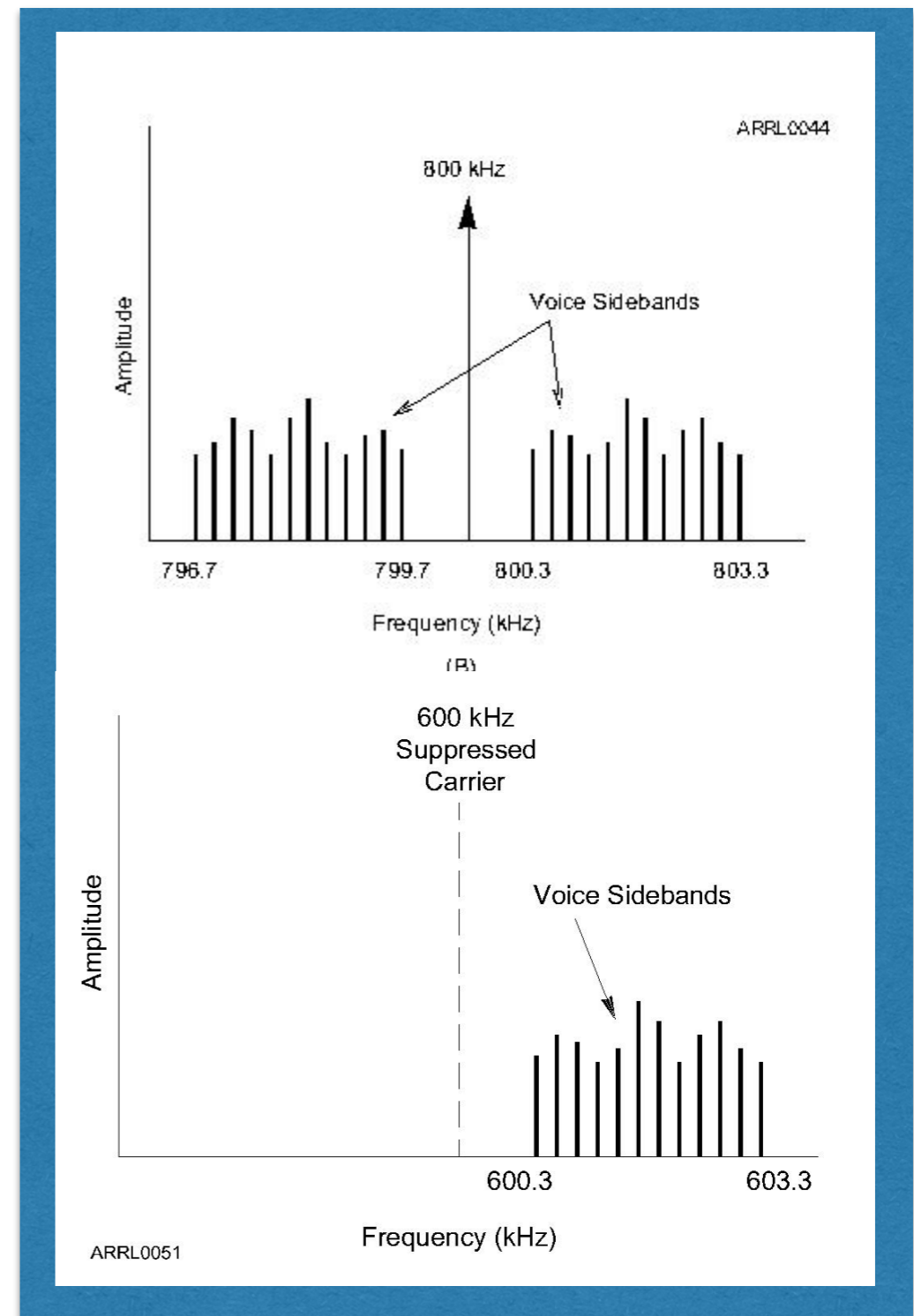
Amplitude Modulation (AM)

- The amplitude of a carrier is modulated (multiplied) by the signal we want to transmit.
- Several variations



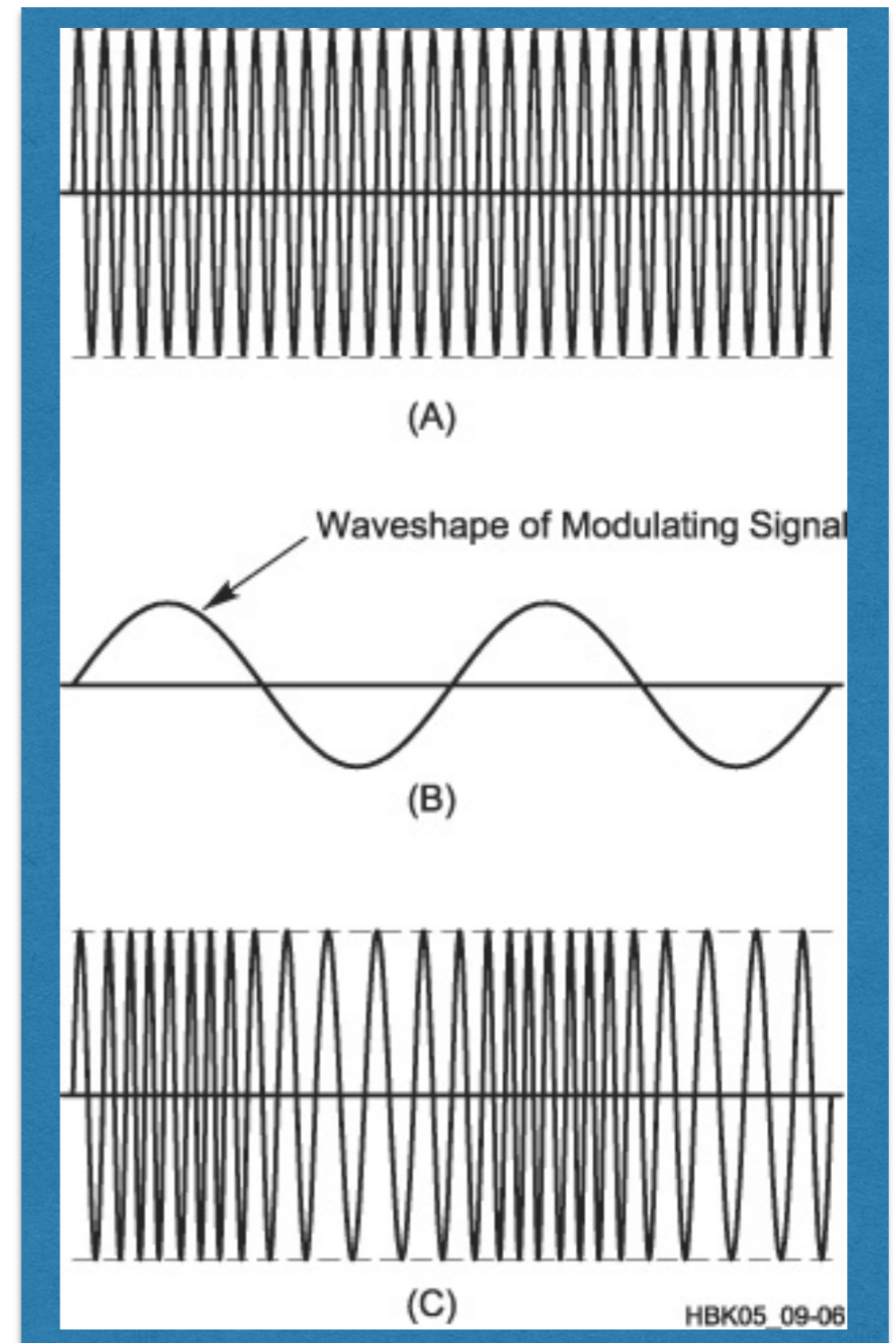
AM Signal Spectrum

- Carrier
- Upper side band (USB)
- Lower side band (LSB)
- Either sideband sufficient
- Voice bandwidth 300 Hz to 3 kHz, full bandwidth 6 kHz
- With SSB need 3 kHz
- Common for HF
Also weak signal VHF, UHF



Frequency Modulation

- Information encoded in frequency of carrier
- Wider bandwidth than AM
Voice 5-15 kHz
- More resistant to propagation effects
- Common for VHF/UHF handhelds and mobiles
- Also digital packet, voice



Typical Questions

- Why should you not set your transmit frequency to be exactly at the edge of an amateur band or sub-band? (T1B09)
- What might be the problem if a repeater user says your transmissions are breaking up on voice peaks? (T2B05)
- Which type of modulation is most commonly used for VHF and UHF voice repeaters? (T8A04)
- Which type of voice modulation is most often used for long-distance or weak signal contacts on the VHF and UHF bands? (T8A03)

Signal Bandwidths

Signal Type	Bandwidth
AM Voice	6 kHz
AM Broadcast	10 kHz
Commercial Video	6 MHz
SSB Voice	3 kHz
SSB Digital	0.5-3 kHz
CW (Morse Code)	150 Hz
FM Voice	5-15 kHz
FM Broadcast	150 kHz

Which of the following types of emission has the narrowest bandwidth? (T8A05)

A. FM voice

B. SSB voice

C. CW

D. Slow-scan TV

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Which sideband is normally used for 10 meter HF, VHF and UHF single-sideband communications? (T8A06)

- A. Upper sideband
- B. Lower sideband
- C. Suppressed sideband
- D. Inverted sideband

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Remember “USB above 10 MHz”

What is the primary advantage of single sideband over FM for voice transmissions? (T8A07)

- A. SSB signals are easier to tune
- B. SSB signals are less susceptible to interference
- C. SSB signals have narrower bandwidth
- D. All of the choices are correct

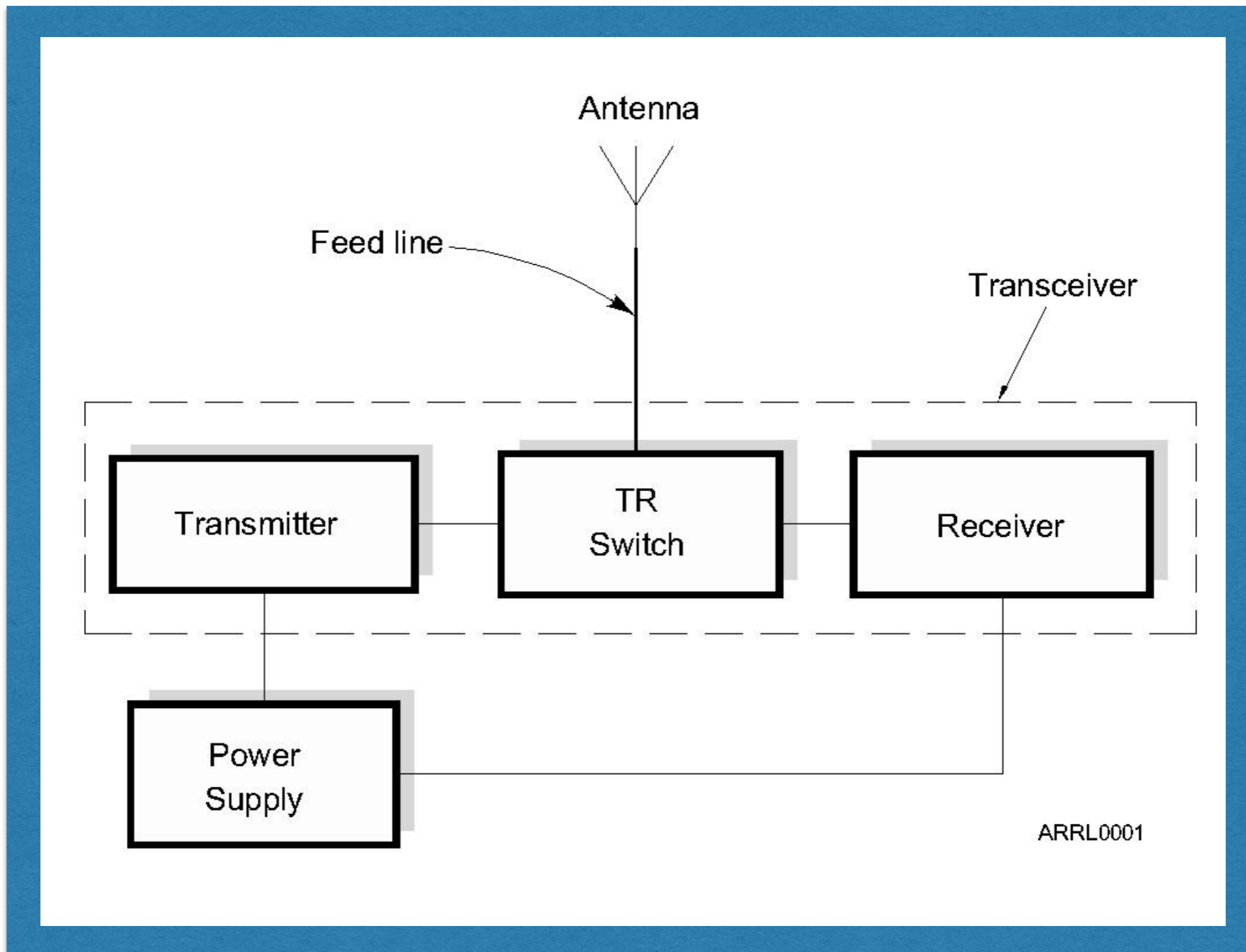
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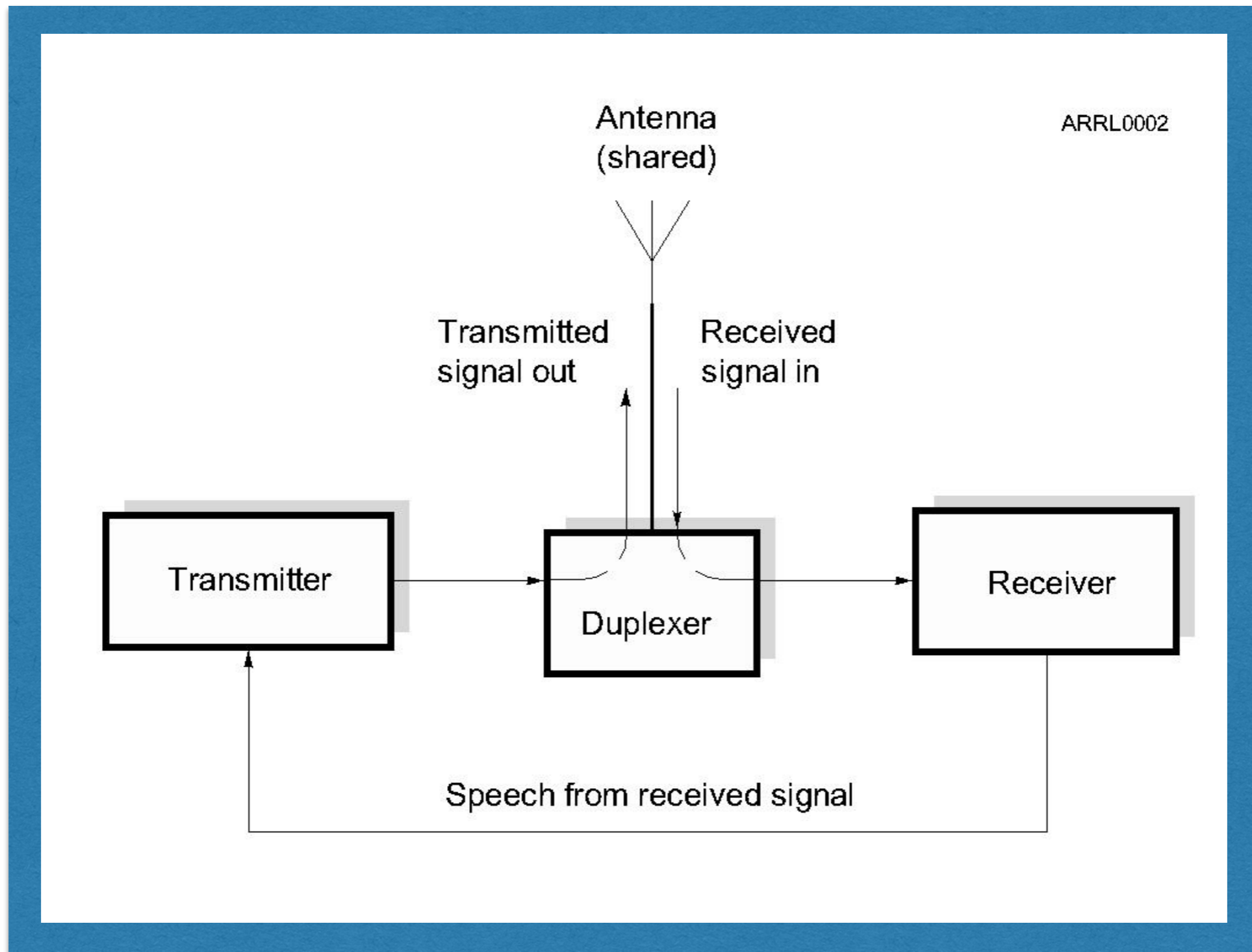
Other Questions

- What is the approximate bandwidth of a single sideband voice signal? (T8A08)
- What is the approximate bandwidth of a VHF repeater FM phone signal? (T8A09)
- What is the typical bandwidth of analog fast-scan TV transmissions on the 70 cm band? (T8A10)
- What is the approximate maximum bandwidth required to transmit a CW signal? (T8A11)

Basic Radio Components



Repeaters



Radios

- Desktop Radios :
 - Many modes, complex
 - Mostly HF, 100W + Power Amps
- Mobile
 - FM, one or more bands
 - 50 W
- Handheld
 - FM, one or more bands, 5W
 - Simple, but lots of options

Desktop Radio

- HF, may have VHF, UHF
- Lots of modes (FM, SSB, Digital Voice and Data)
- 100 Watts (+ power amps to 1500 W)



Mobile Radio

- Car or fixed
- One, two, more bands
VHF, UHF
- 50 Watts
- Always FM, may have
digital voice, data



Handheld Radios

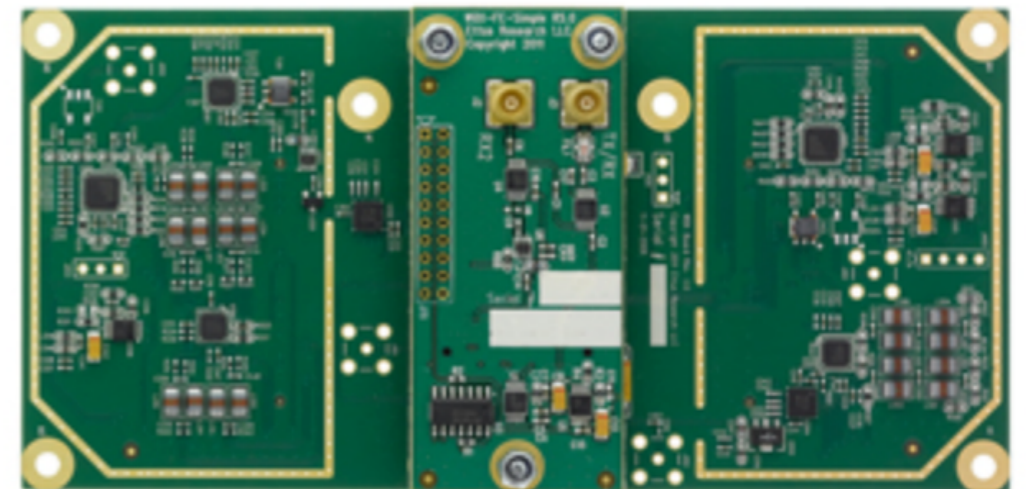
- VHF and/or UHF
sometimes 220 MHz, 1.2 GHz
- 5 Watts
- Always has FM, may have digital voice and data
- Can be complex to operate
Every button does three things
Programmed with a PC, software



SDR's

- Software defined radios
- USB peripheral
- Chassis + TX/RX daughtercards
- Direct digital synthesis and detection
- Needs amp, antenna, PC

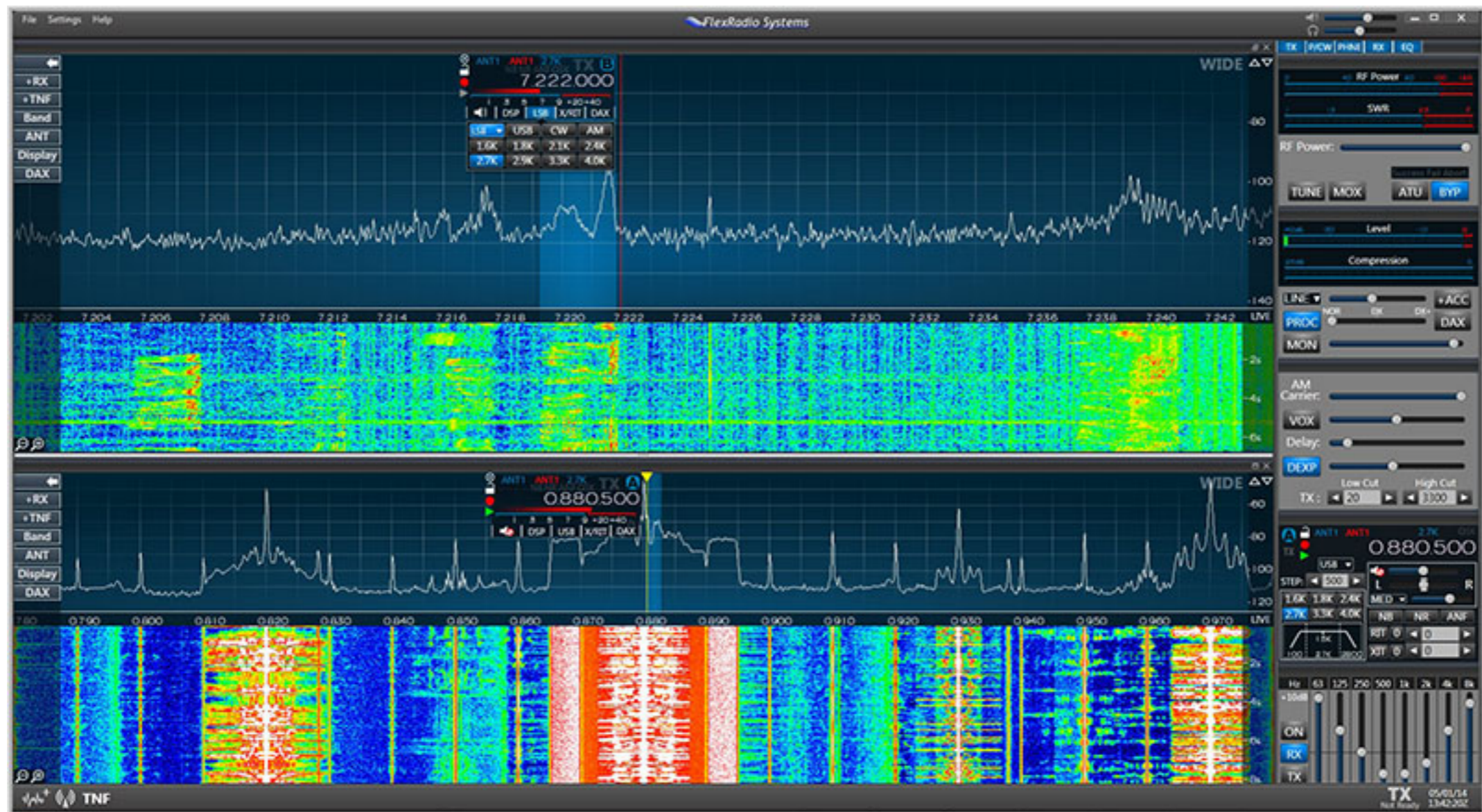
Ettus B100



WRX : 50 MHz to 2.2 GHz



Flex Radio



Major Transmitter Controls

- Tuning (VFO Dial, numeric input)
- Mode switch (FM, SSB, etc)
- Microphone : push-to-talk (PTT), voice activated (VOX), key
- Automatic level control
- Morse key



Modes

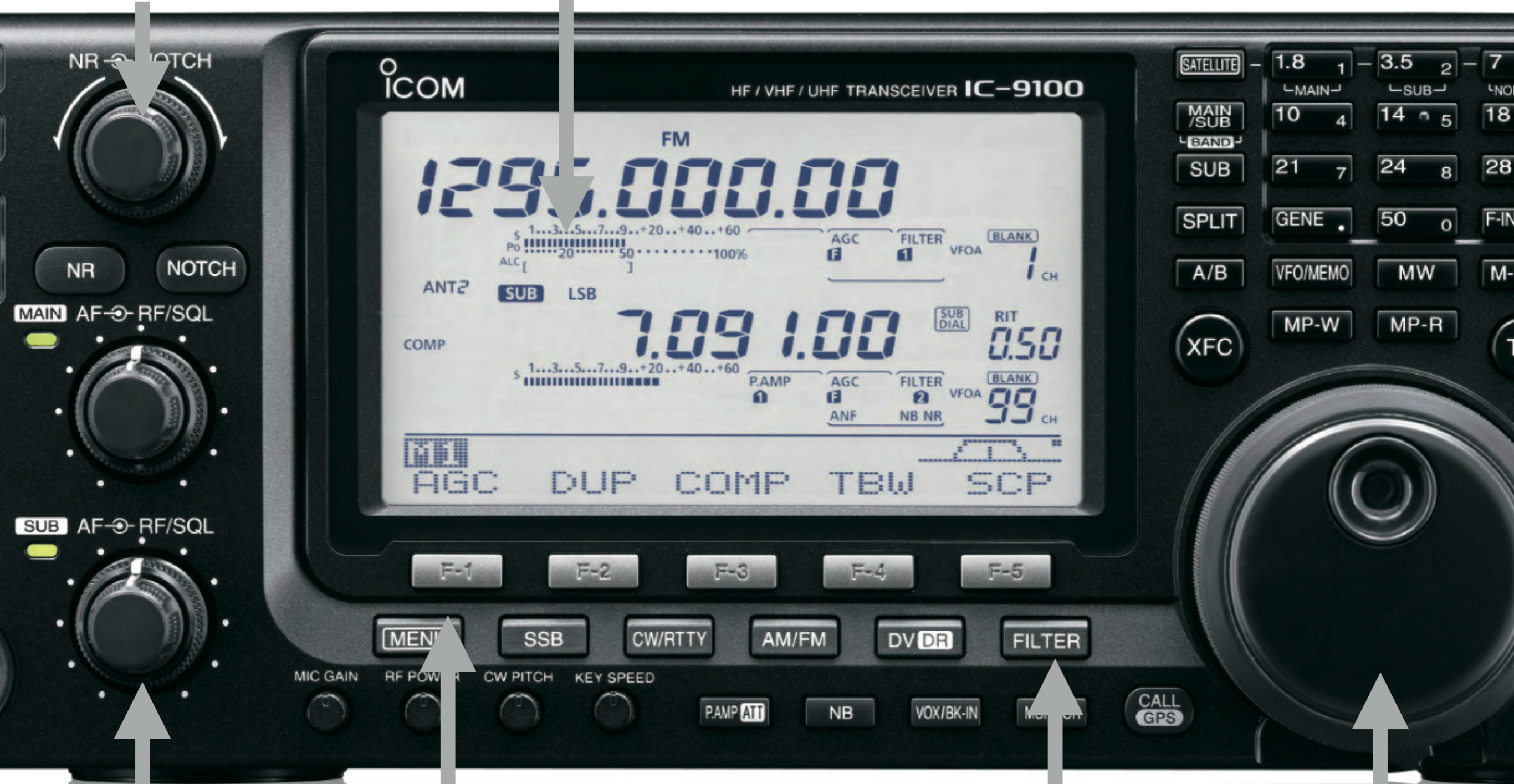
VFO

Major Receiver Controls

- Tuning (VFO dial, numeric input)
May be independent of transmit
- Automatic gain control (AGC), but not for FM
- Squelch control : shuts off speaker if signal too low
Common for FM
- Noise filters : match bandwidth of signal, suppress adjacent signals, blank spike noise
- Signal strength meter : S-meter from 1-9, with additional steps. Log scale with 6 dB per S unit (factor of 4 in power)

Filter

S-Meter



Squelch

AGC

Filter

VFO

What term describes the use of a sub-audible tone transmitted along with normal voice audio to open the squelch of a receiver (T2B02)

- A. Carrier squelch
- B. Tone burst
- C. DTMF
- D. CTCSS

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A. Carrier squelch

B. Tone burst

C. DTMF

D. **CTCSS**

or PL code

What is the advantage of having multiple receive bandwidth choices on a multimode transceiver? (T4B08)

- A. Permits monitoring several modes at once
- B. Permits noise or interference reduction by selecting a bandwidth matching the mode
- C. Increases the number of frequencies that can be stored in memory
- D. Increases the amount of offset between receive and transmit frequencies

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Which of the following receive filter bandwidths provides the best signal-to-noise ratio for SSB reception? (T4B10)

- A. 500 Hz
- B. 1000 Hz
- C. 2400 Hz
- D. 5000 Hz

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What can you do if you are told your FM handheld or mobile transceiver is over deviating? (T7B01)

- A. Talk louder into the microphone
- B. Let the transceiver cool off
- C. Change to a higher power level
- D. Talk farther away from the microphone

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Digital Data Modes

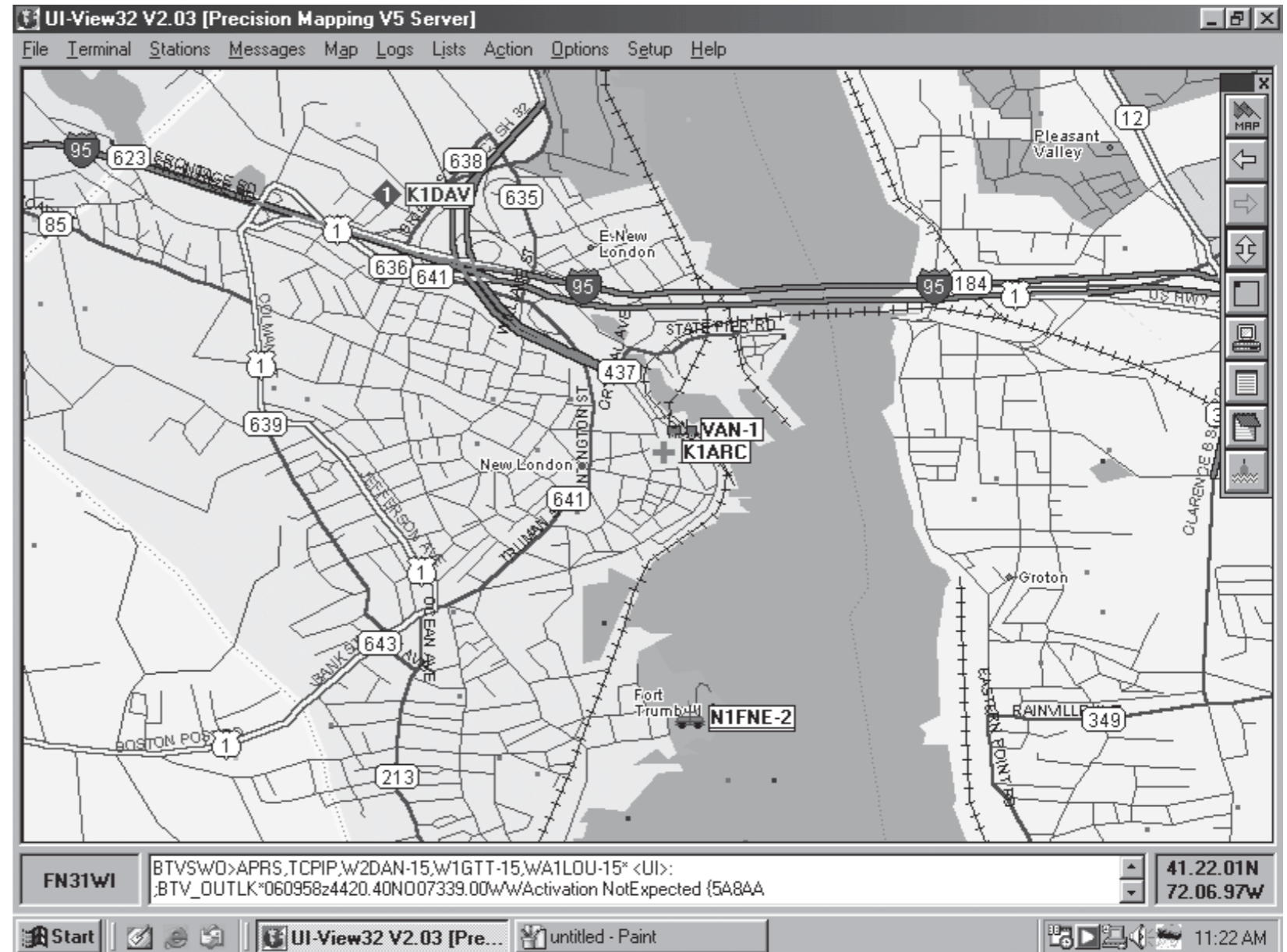
- Modem or sound card generates digital signals
Terminal Node Controller (TNC)
- Many different modes
 - Radioteletype (RTTY)
 - PSK31
 - Packet AX.25
 - APRS
 - Winlink

Packet Radio

- AX-25 : radio version of X-25, packet switched networks
- Packets have headers, checksums, and request for repeats (ARQ)
- Direct connections, or relayed through digipeaters (digital repeaters)
- Lots of packet repeaters around here, with connections to the internet (mail, ftp, etc)
- Your PC, radio, and packet modem software (Direwolf on Linux, for example).

APRS

- Radio + GPS
- Reports your position to internet servers
- Based on AX-25

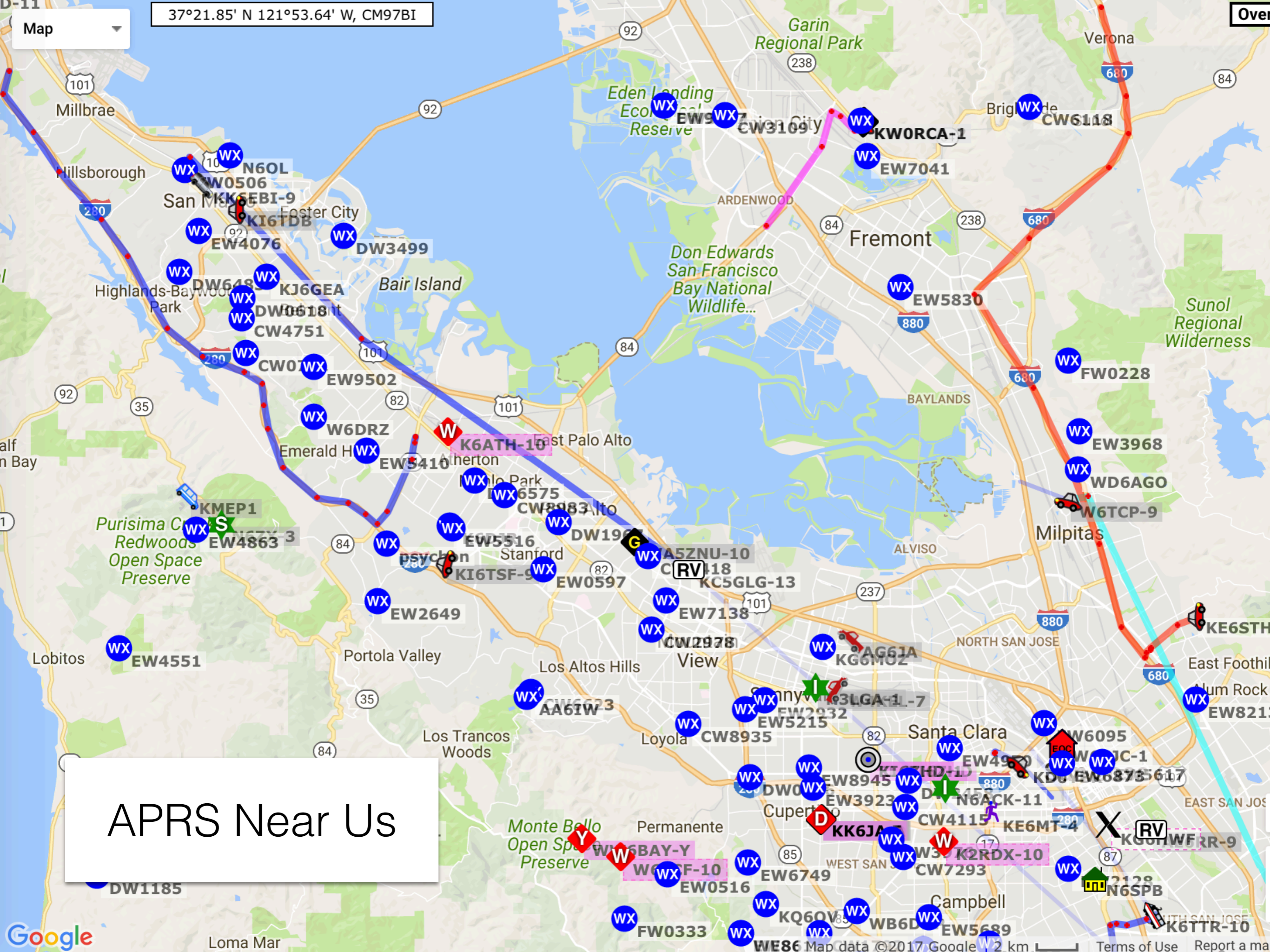


- APRS : Automatic Position Reporting System
- Also text, email, weather
- iPhone, Android apps (must have license)

37°21.85' N 121°53.64' W, CM97BI

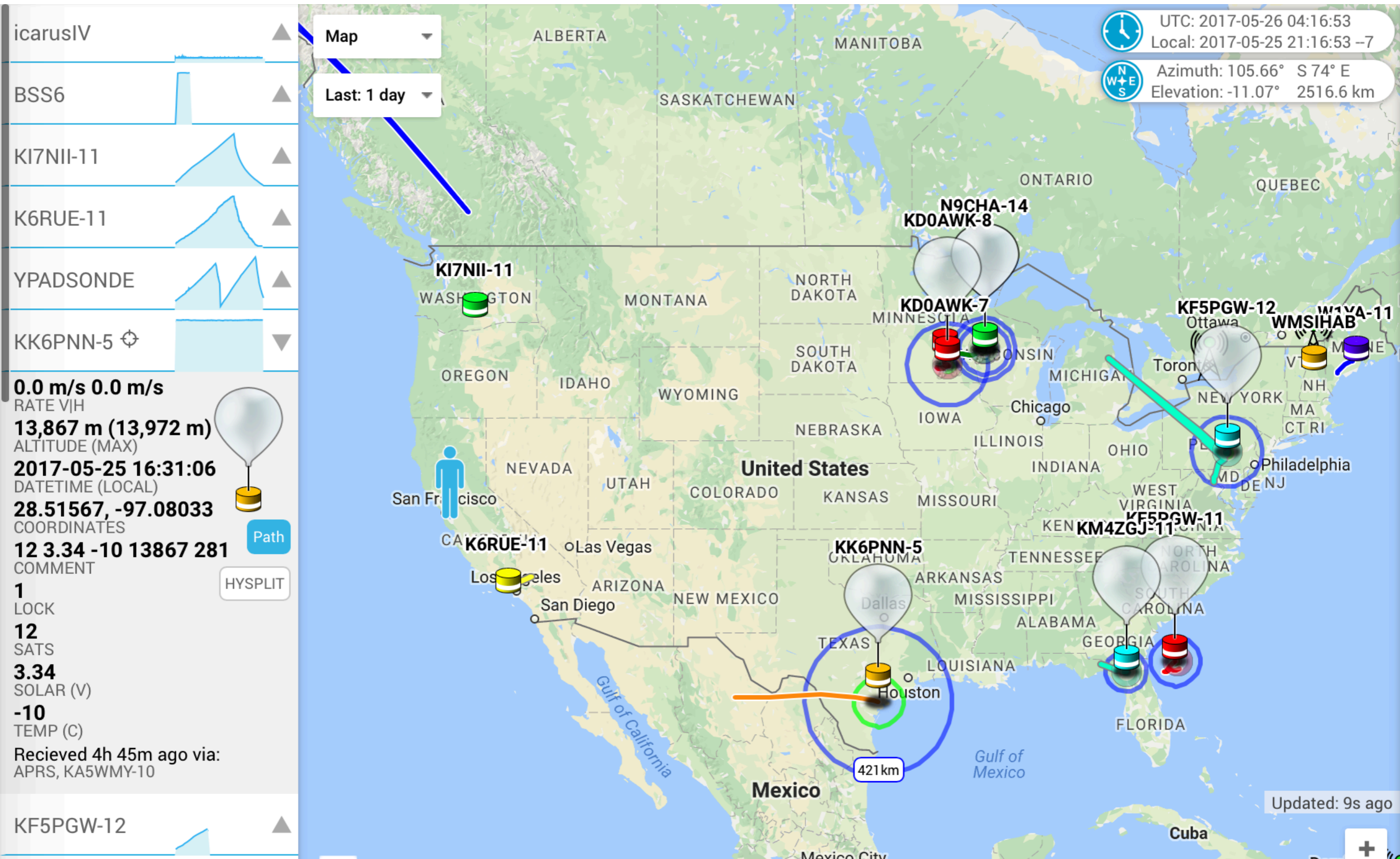
Map

Over



APRS Near Us

High Altitude Balloon Tracking



What Day Was This?

KB3ZFF-1

0.0 m/s 0.0 m/s
RATE V/H

3,076 m (3,076 m)
ALTITUDE (MAX)

2017-08-23 13:26:00
DATETIME (LOCAL)

40.48917, -79.97267
COORDINATES

0011104gflvctvat.org
COMMENT

Recieved 14d 21h ago via:
APRS, N3SQY-1

KI7PAC-9

AA4VU-11

NM5SS-6

KD9IEA-11

HELIOS

KK4POC-11

W3RAE-11

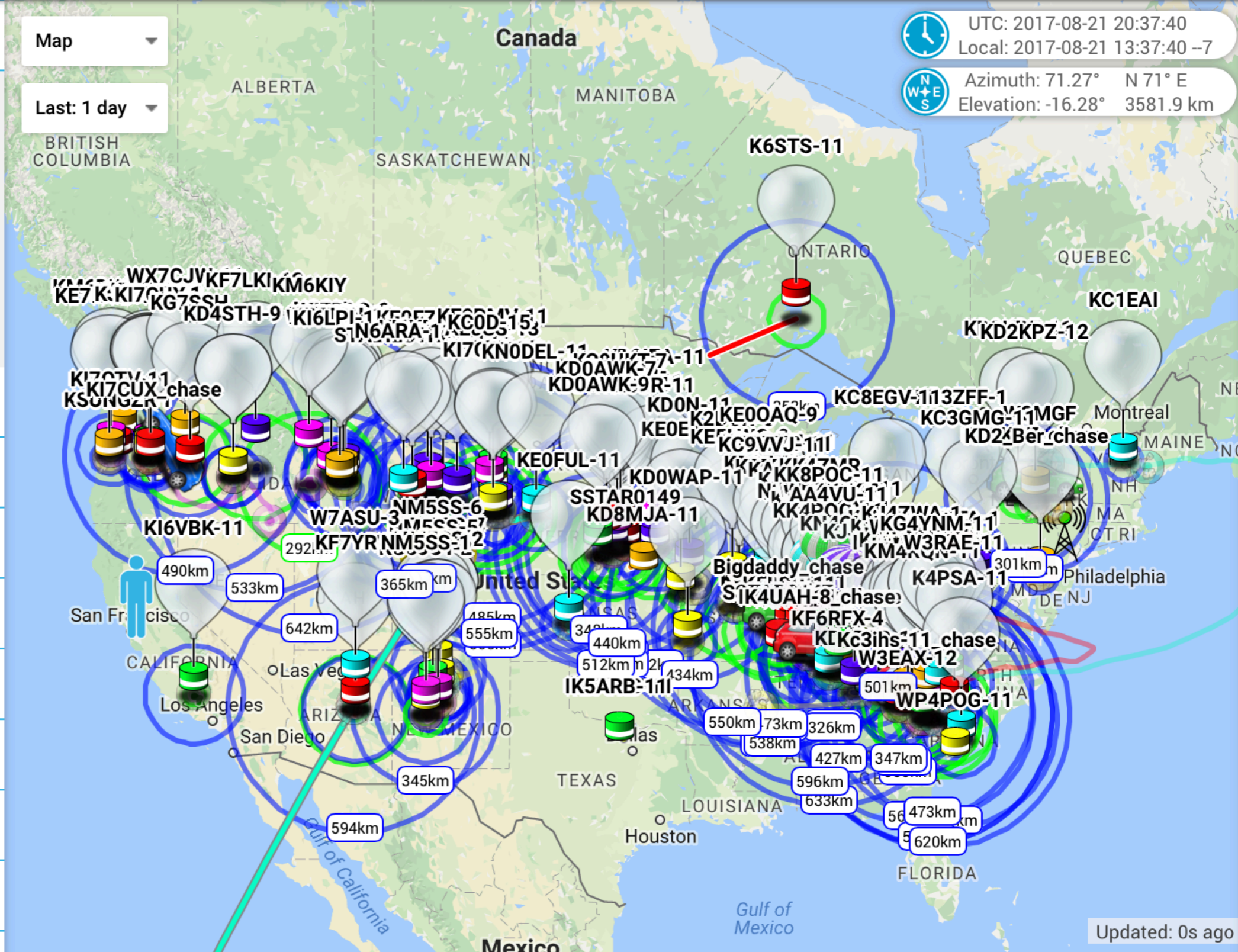
KI7CUX_chase

Map

Last: 1 day

UTC: 2017-08-21 20:37:40
Local: 2017-08-21 13:37:40 -7

Azimuth: 71.27° N 71° E
Elevation: -16.28° 3581.9 km

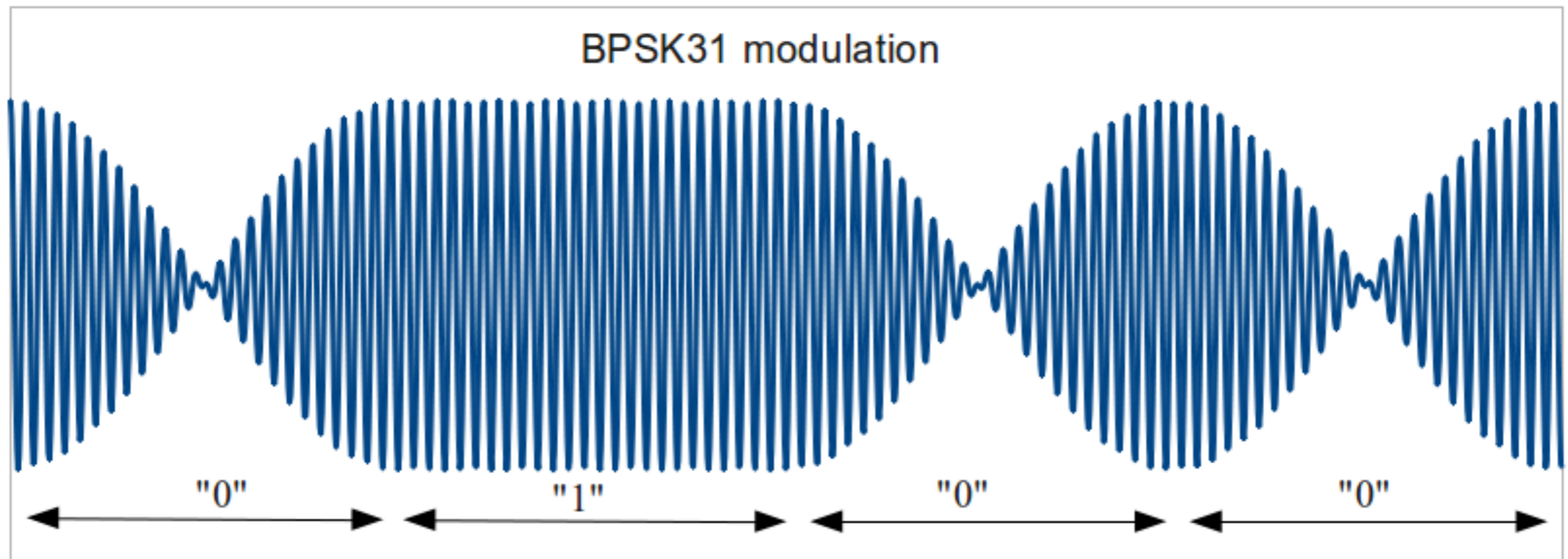


Updated: 0s ago

Other Digital Modes

- RTTY : radio teletype, keyboard to keyboard
- PSK31 : low data rate digital mode, mostly HF
- JT65, JT9, FT8, FT4: very low data rate (73 bits/min!) but very sensitive.
- Winlink : radio email systems, used in emergency communications. Radio Message Servers (RMS) relay messages

BPSK31 Waveform



PSK 31 with fldigi

The screenshot displays the fldigi software interface, titled "fldigi - AG6WH". The interface is divided into several sections:

- Top Panel:** Contains menu options (File, Op Mode, Configure, View, Logbook, Help) and status indicators for Spot, RxID, TxID, and TUNE. The frequency is set to 14071.461, and the mode is USB.
- Frequency and Call Information:** Shows the current frequency as 14070.000 (highlighted in green) and the call sign as Hamlib K3/KX3.
- Message Log:** A yellow background area containing a report from station 599 599KYLG DE WB7CYO. The message includes a QSO log entry for station n tK9ZJ K9ZJ CQ k k, with a Qth of 14071.26. The message text reads: "Report : 599 599KYLG DE WB7CYO WB7CYO K tte*etetemaw@et hts otes ot t t v oet eg t e n tK9ZJ K9ZJ CQ k k e,... a ecte te Oq o>:il9~u kn teno3o'Aj tt%St Ĩ x1Dr1 e oi=0 ayee-S AF7ES CQ CQ CQ de AF7ES AF7ES AFE IS LEE IN SOUTH CENTRAL IDAHO TOWN OF TWIN FALLS. UR 559 559, 25 WATTS, ATTIC DIPOLE (N/".
- Waterfall Plot:** A large area at the bottom showing a waterfall plot of the received signal. The plot shows a strong signal at approximately 14071.461, with a vertical red line indicating the current frequency. The plot is color-coded from blue (low power) to yellow (high power).
- Bottom Panel:** Contains various control buttons and settings, including TX, CQ, RX, TX ANS, RX, TX QSO, BTU, RX II, Close, RX II, Me/Qth, Brag, T/R, Tx, Rx, and TX. It also shows the current mode as BPSK31, signal-to-noise ratio (s/n) as 30 dB, and other parameters like imd -30 dB, NORM, 1461, QSY, Store, Lk, Rv, T/R, AFC, and SQL.

JT65, JT9

JTAlert-X 2.4.10 - IU4APC on 20M [HRD] | Alerts | Settings | Sound ON | 160 80 60 40 30 20 17 15

UN7ID **PA3EUJ** **MWOMKG - B4** **RA4FAU**

WSJT-X v1.2, r3563 by K1JT

File Setup View Mode Decode Save Help

Band Activity					Rx Frequency				
UTC	dB	DT	Freq	Message	UTC	dB	DT	Freq	Message
1613	-9	0.5	1434	# CQ MWOMKG IO81	1613	-1	0.3	1195	# IU4APC ON1AEY -09
1613	-1	0.3	1195	# IU4APC ON1AEY -09	1614	Tx		1195	# ON1AEY IU4APC R-01
1615	-1	0.3	1187	# IU4APC ON1AEY RRR	1615	-1	0.3	1187	# IU4APC ON1AEY RRR
1615	-7	0.5	1430	# CQ MWOMKG IO81	1616	Tx		1195	# ON1AEY IU4APC 73
1617	-1	0.8	1187	# IU4APC ON1AEY 73	1617	-1	0.8	1187	# IU4APC ON1AEY 73
1617	-9	0.5	1427	# CQ MWOMKG IO81	1617	-9	0.5	1427	# CQ MWOMKG IO81
1617	-13	0.5	1974	# CQ RA4FAU LO33	1618	Tx		1427	# MWOMKG IU4APC JN64
1617	-3	-0.1	2442	# CQ RD7P LN23	1619	-5	0.5	1426	# IU4APC MWOMKG -10
1619	-5	0.5	1426	# IU4APC MWOMKG -10	1620	Tx		1426	# MWOMKG IU4APC R-05
1619	-1	0.8	1186	# CQ ON1AEY JO11	1621	-11	0.4	1420	# IU4APC MWOMKG RRR
1619	-11	0.4	1973	# CQ RA4FAU LO33	1622	Tx		1426	# MWOMKG IU4APC 73
1619	-13	0.5	2000	# XV2M DH8BAO JO43	1623	-7	0.5	1420	# IU4APC MWOMKG 73
1619	7	0.2	3394	@ GP 60 W TKS O	1623	-1	0.1	1179	# CQ PA3EUJ JO32
1619	-15	0.2	3578	@ CQ EA7AH IM67	1624	Tx		1179	# PA3EUJ IU4APC JN64
1621	-11	0.4	1420	# IU4APC MWOMKG RRR					
1621	-1	0.2	1183	# CQ ON1AEY JO11					
1621	-8	0.3	1970	# CQ RA4FAU LO33					
1621	-10	0.1	1996	# XV2M DH8BAO JO43					
1623	-7	0.5	1420	# IU4APC MWOMKG 73					
1623	-10	0.5	752	# SQ5CZL UN7ID LO80					
1623	-1	0.1	1179	# CQ PA3EUJ JO32					
1623	-9	0.6	1964	# DG7EL RA4FAU -13					

Log QSO Stop Monitor Erase Decode **Enable Tx** Halt Tx Tune

20 m **14.076 000** Tx even

+2 kHz DX Call DX Grid

PA3EUJ JO32 Tx JT65 #

Az: 339 1009 km Tx 1179 Hz Rx 1179 Hz

Lookup Add Tx=Rx Rx=Tx Lock Tx=Rx

Report -1

2013 ott 01 16:24:04

Tx: PA3EUJ IU4APC JN64 JT9+JT65 Last Tx: PA3EUJ IU4APC JN64

Wide Graph

Bins/Pixel 7 Start 0 Hz Zero -23 N Avg 1 Palette

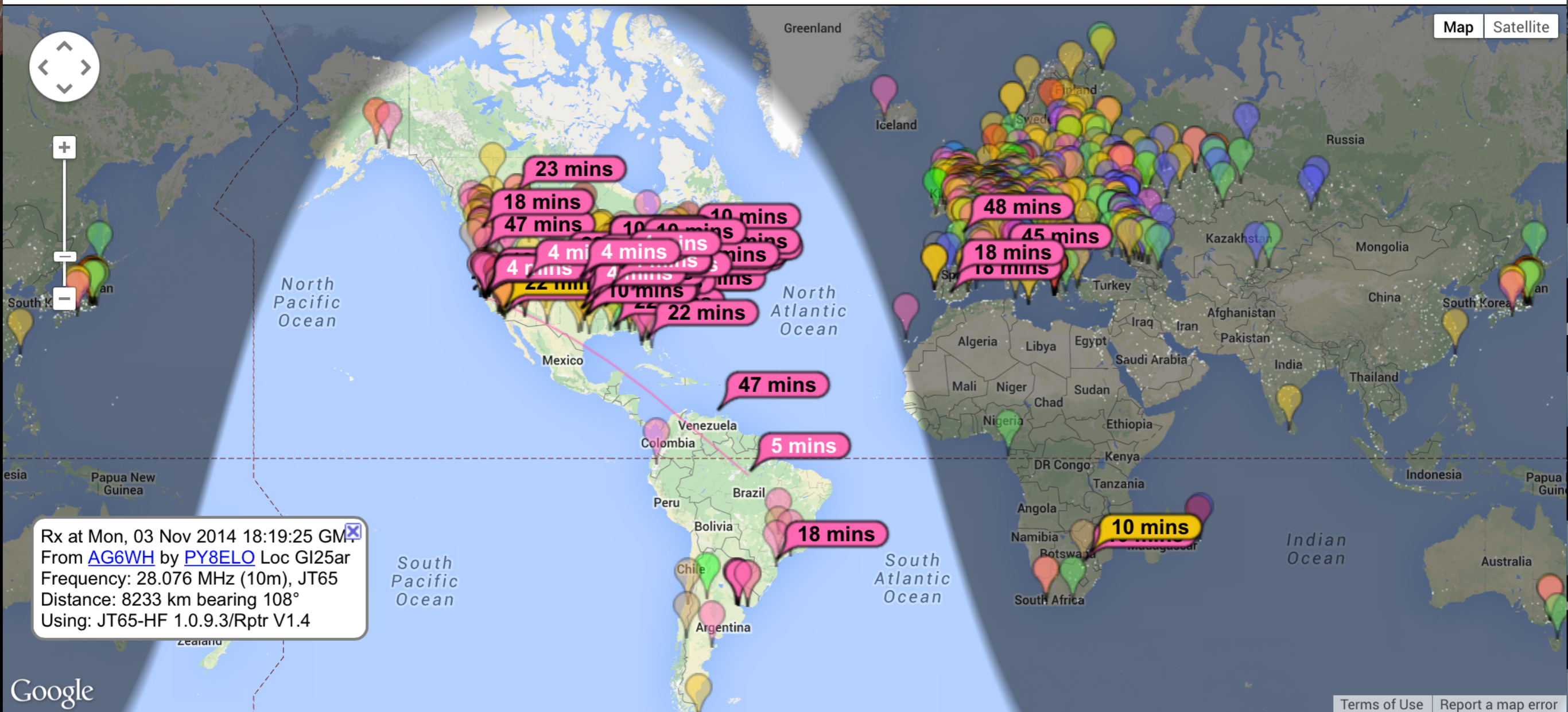
JT65 2500 JT9 Slope -0,0 Gain 0 Cumulative Default

PSK Reporter

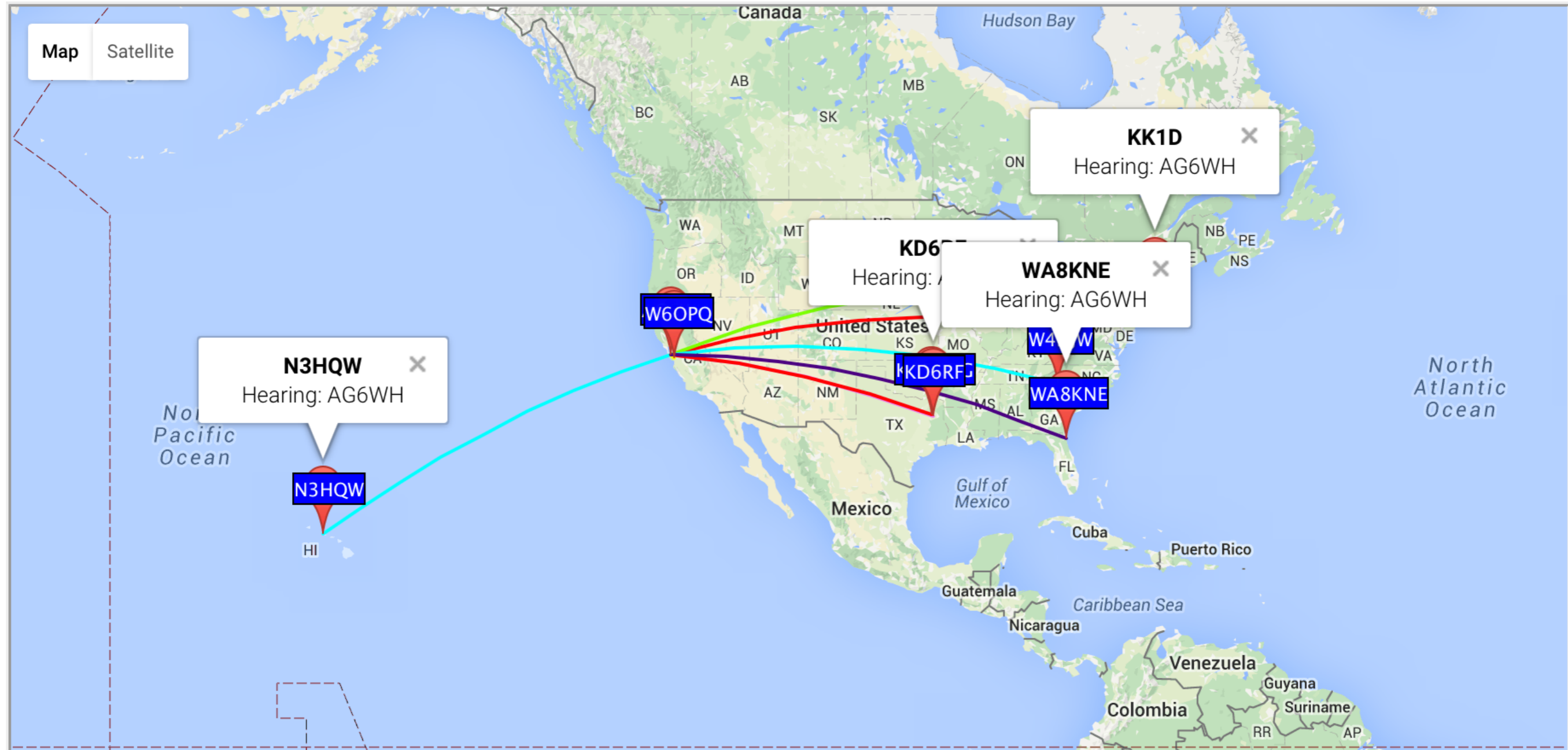
On , show sent by using over the last [Display options](#)

Monitoring AG6WH (last heard 4 mins ago). Automatic refresh in 5 minutes. Reception reports for AG6WH are shown as times ([show logbook](#)).

There are **875 active monitors**: **286 on 20m**, **194 on 10m**, **83 on 40m**, **79 on 15m**, **72 on 30m**, **26 on 80m**, **23 on 12m**, **19 on 2200m**, 14 on unknown, **12 on 11m**, **8 on 600m**, **6 on 160m**, **5 on 2m**, **2 on 6m**, **2 on 17m**. [Legend](#)

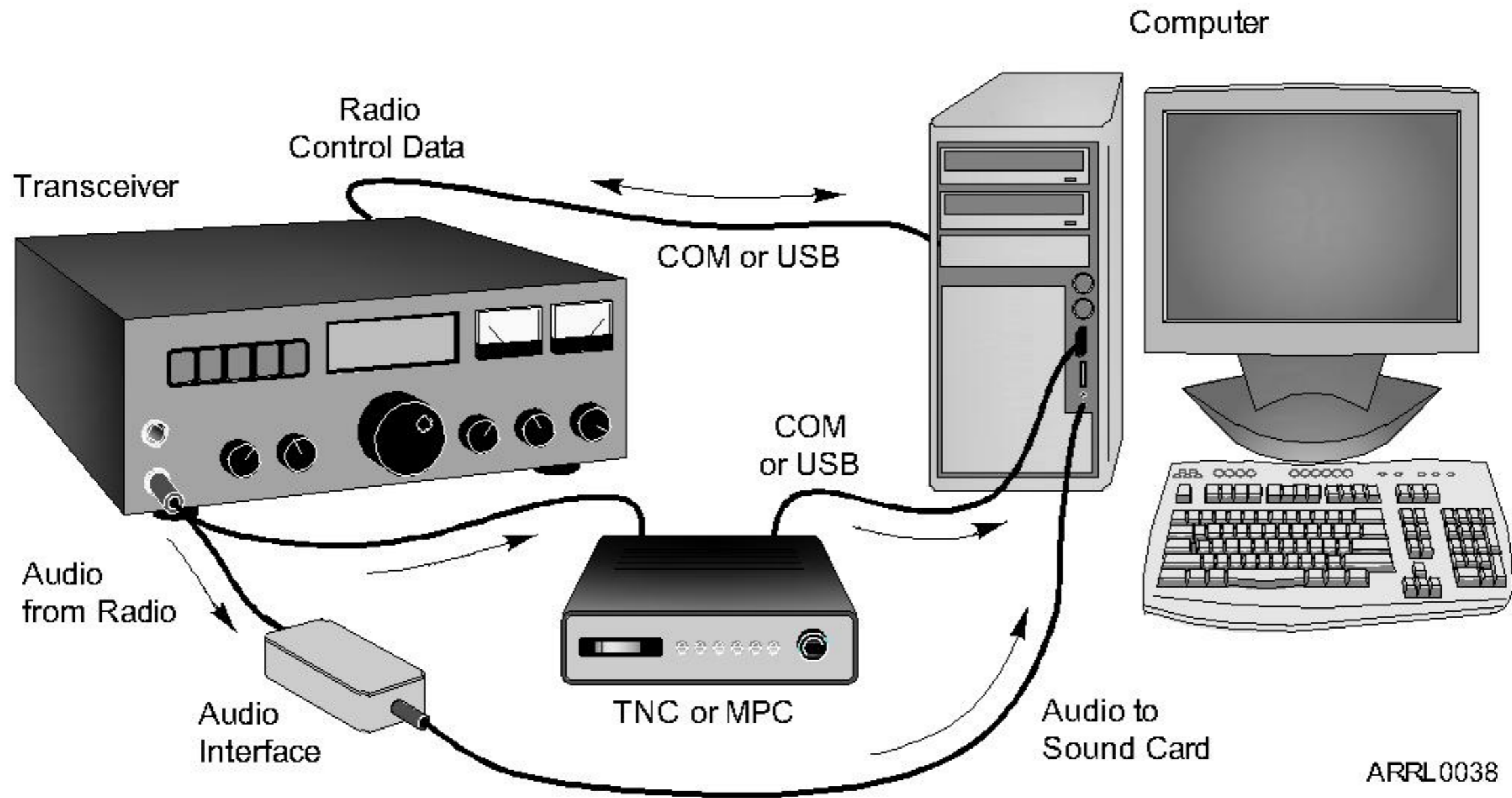


WSPR

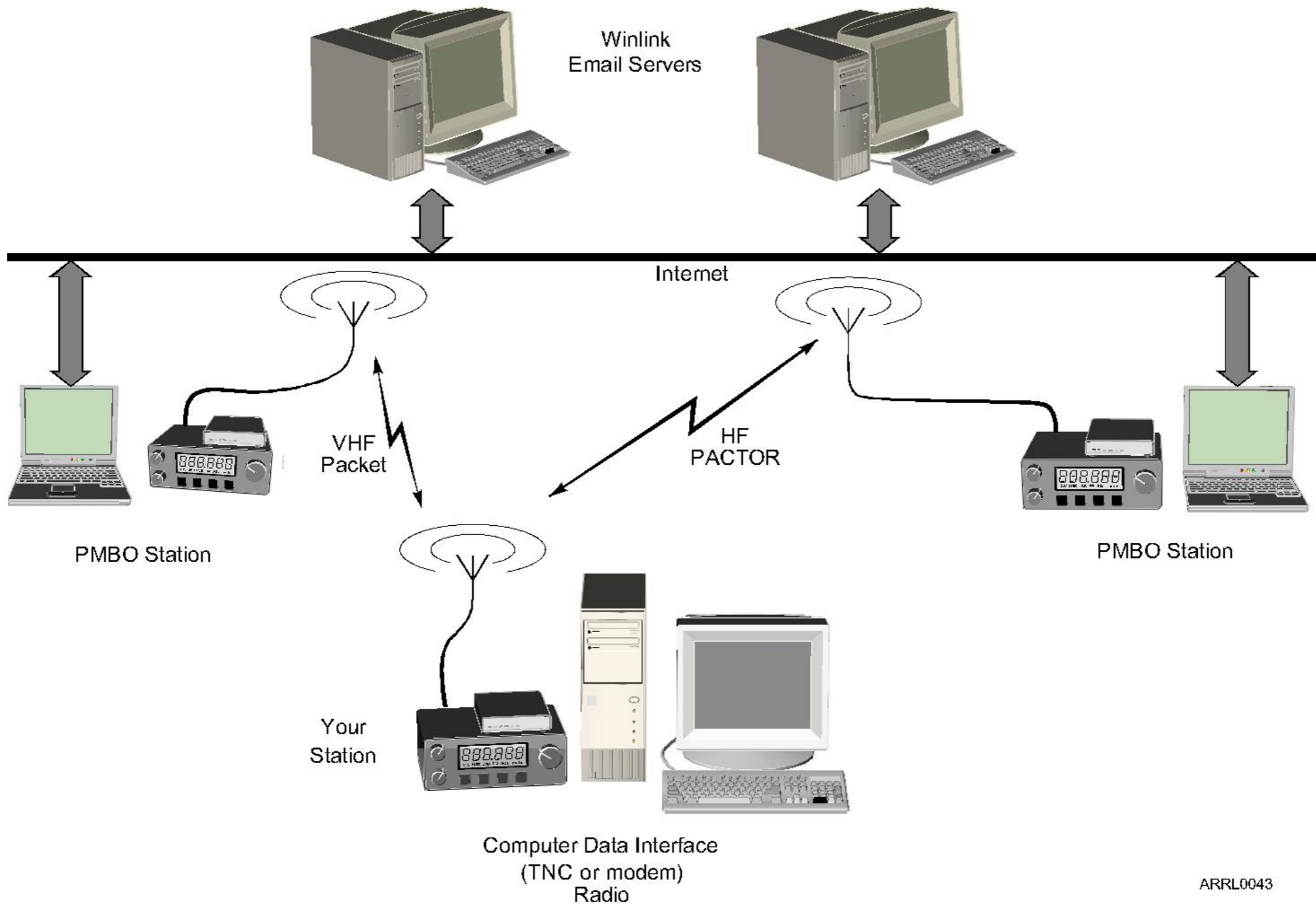


200 mW on 40 m
100 mW on 20 m

Digital Radio Connections



Internet Gateway



Which of the following is an example of a digital communications method? (T8D01)

A. Packet radio

B. IEEE 802.11

C. JT65

D. All of these choices are correct

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What does the abbreviation
PSK mean? (T8D06)

- A. Pulse Shift Keying
- B. Phase Shift Keying
- C. Packet Short Keying
- D. Phased Slide Keying

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Which of the following may be included in packet transmissions? (T8D08)

- A. A check sum which permits error corrections
- B. A header which contains the call sign of the station to which the information is being sent
- C. Automatic repeat request in case of error
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Power

- Most radios use 12 Volts
 - DC power supplies
 - Batteries

12 V DC Power Supplies

- Linear : big transformers
 - Heavy : iron core transformers
 - Expensive
 - Very clean power
- Switchers : small transformers
 - High frequency switching before transformer
 - Lightweight, small, inexpensive
 - Often very noisy

Batteries

- Disposable, rechargable, and storage
- Power storage measured in amps X hours
- Storage batters (car batteries) have a whole set of potential issues.

Battery Types

Style	Chemistry	Rechargeable	Voltage	Energy
AAA	Alkaline	No	1.5 V	1000 mAh
AA	Alkaline	No	1.5 V	3000 mAh
AA	Carbon-Zinc	No	1.5 V	600 mAh
AA	Nickel-Cadmium	Yes	1.2 V	700 mAh
AA	Nickel-Metal Hydride	Yes	1.2 V	2000 mAh
C	Alkaline	No	1.5 V	7500 mAh
D	Alkaline	No	1.5 V	14000 mAh
9 V	Alkaline	No	9 V	580 mAh
9 V	Nickel-Cadmium	Yes	9 V	110 mAh
9 V	Nickel-Metal Hydride	Yes	9V	150 mAh

Mobile, Storage Batteries

- Large amounts of stored energy
- If shorted, can overheat, produce hydrogen gas, and explode
- Should be well fused (both leads), and well ventilated

Radios in Cars

- Where do you get power, how do you connect
- Where does all the interference come from?
- Where do you put your antenna?
- Are you even allowed to use a radio in a car?

Where should the negative return connection of a mobile transceiver's power cable be connected? (T4A11)

- A. At the battery or engine block ground strap
- B. At the antenna mount
- C. To any metal part of the vehicle
- D. Through the transceiver's mounting bracket

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Radio Frequency Interference (RFI)

- Two situations:
 - Your radio interfering with other devices
 - Other devices interfering with you
- Many unlicensed RF devices (Part 15)
 - Must not cause interference with licensed users (you)
 - Must accept interference from users of properly operating equipment (you)
- Be diplomatic, first make sure your equipment is working, and then try to help them solve their problems

Types of RFI

- Direct detection – offending signals get into the electronics circuits to cause interference.
- Overload – strong signal that overwhelms the weaker, wanted signal.
- Harmonics – multiples of the offending signal that coincide with the wanted signal

RFI Mitigation

- Filters
 - Highpass : receive
 - Lowpass : transmit, eliminates harmonics
 - Notch : suppress particular signals to reduce overload
- Ferrites
 - RF chokes

RFI Sources

- Electrical arcs (motors, thermostats, electric fences, neon signs).
- Power lines.
- Motor vehicle ignitions or alternators.
- Switching power supplies.
- Computers, networks, and TV sets.

What should you do if something in your neighbor's home is causing harmful interference to your amateur station? (T7B08)

A. Work with you neighbor to identify the offending device

B. Politely inform your neighbor about the rules that require him to stop using the device if it causes interference

C. Check your station and make sure it meets the standards of good amateur practice

D. All of these choices are correct

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Which of the following actions should you take if a neighbor tells you that your station's transmissions are interfering with their radio or TV reception? (T7B06)

- A. Make sure that your station is functioning properly and that it does not cause interference to your own television
- B. Immediately turn off your transmitter and contact the nearest FCC office for assistance
- C. Tell them that your license gives you the right to transmit and nothing can be done to reduce the interference
- D. Install a harmonic doubler on the output of your transmitter and tune it until the interference is eliminated.

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Electrical Grounding and Circuit Protection (in the home)

- Make sure your home is “up to code.”
- Most ham equipment does not require special wiring or circuits.
- Use 3-wire power cords.
- Use circuit breakers, circuit breaker outlets, or Ground Fault Interrupter (GFI) circuit breakers.
- Use proper fuse or circuit breaker size.
- Don't overload single outlets.

Next Time

- Safety
- Digital radio