Digital Modes

An Introduction to Equipment, Software, and Operating

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Why use digital modes?

- Fun experimenting with something new
- Equipment for rig-PC connection can be low cost
- Can have good weak signal performance
- Lower bandwidth than voice
- There are many digital mode contests
- Good DX, too

Digital Modes

- ASK, Amplitude Shift Keying of a single frequency, like CW
- FSK, Frequency Shift Keying, uses multiple frequencies, 2 for RTTY, more for other modes
- PSK, Phase Shift Keying, uses 2 phases 180^{o} apart, like PSK31
- others

We will talk about

AFSK and APSK = Audio FSK and PSK (most sound card modes)

Equipment

This presentation assumes Sound Card Interfaces

- SignaLink USB http://www.tigertronics.com/
- RigBlaster http://www.westmountainradio.com/
- RigExpert https://rigexpert.com/products/interfaces/
- And many more https://www.eham.net/reviews/ > Interfaces
- Cost about $70 to $300

Common Soundcard Interface

Computer USB ⟷ Soundcard Interface

Soundcard Interface has built in sound card that shows up on PC

TX is audio from PC USB ➡ Interface ➡ Radio Mic

RX is audio from Radio Phone ➡ Interface ➡ PC USB

CAT (Computer Aided Transceiver)

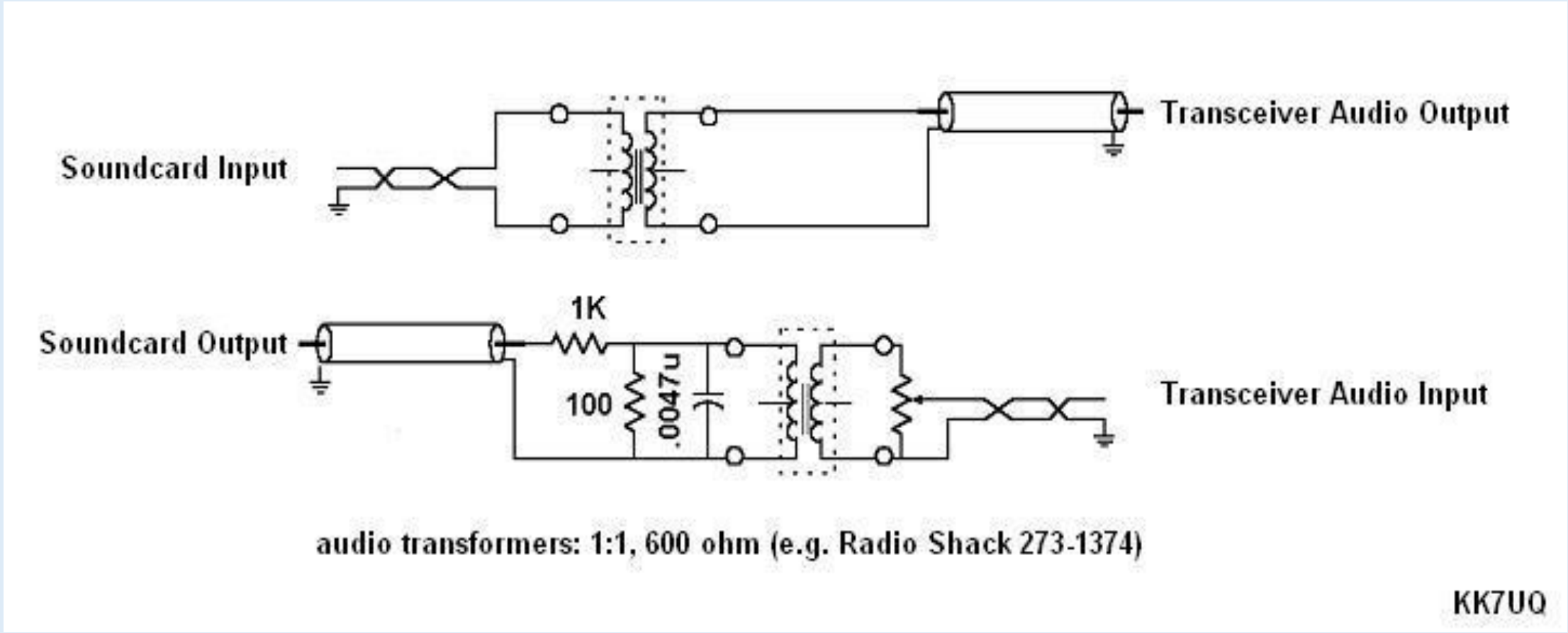
PC USB ⟷ Interface CAT ⟷ Radio Control

Your radio might have a data port for audio and CAT

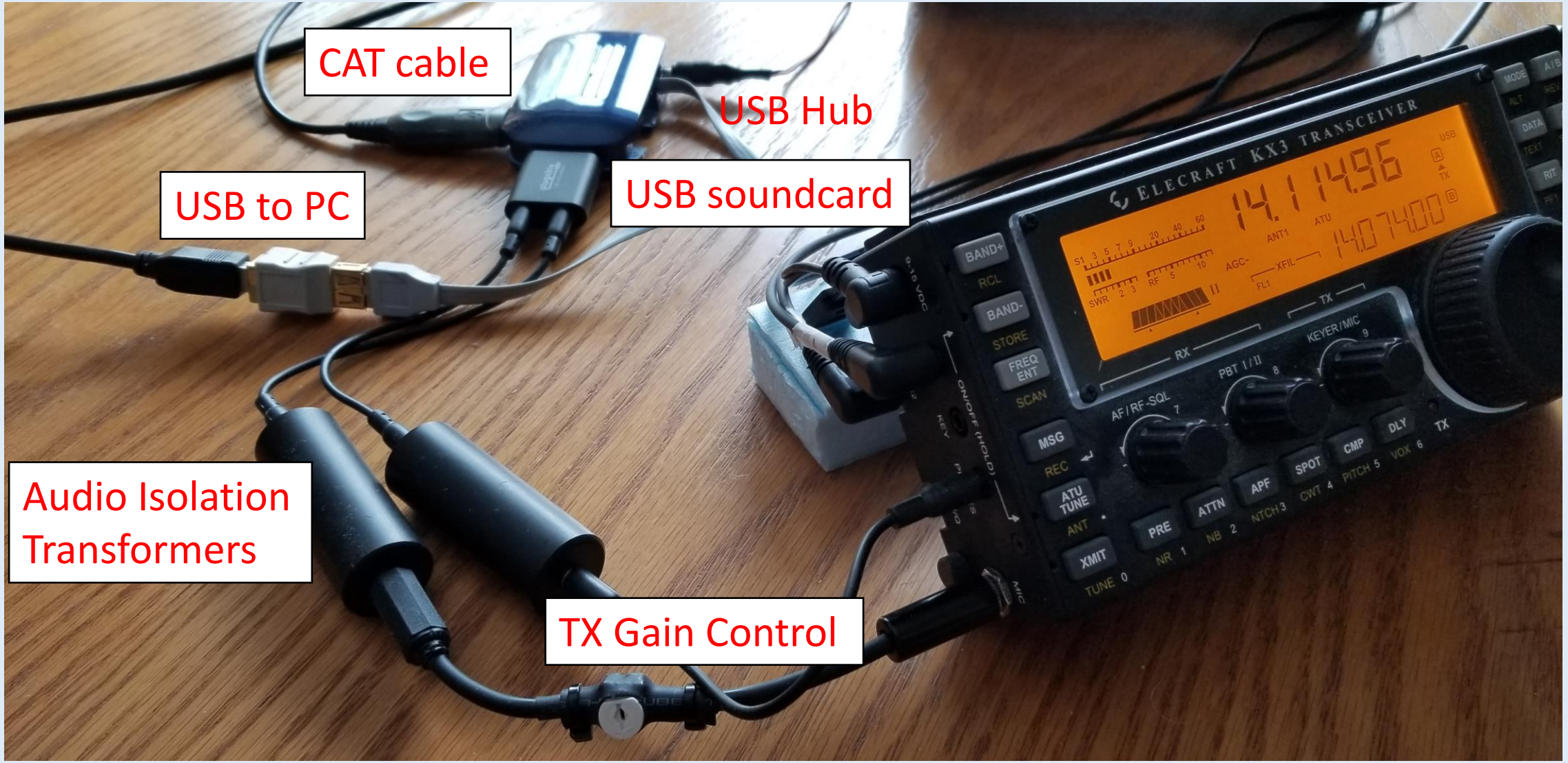
Your interface might have audio to PC instead of USB (use PC sound card)

Homemade Interface

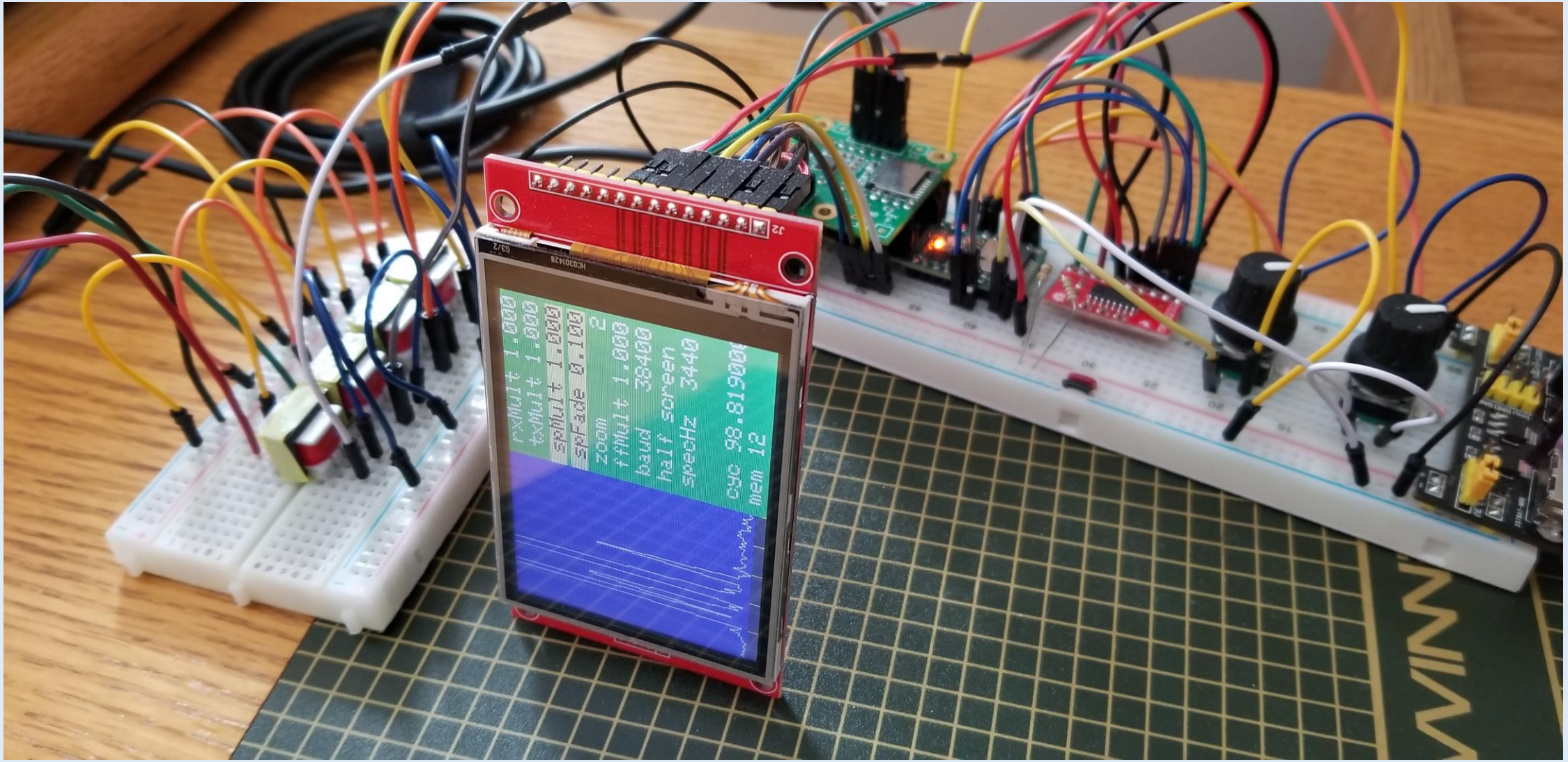
PC Soundcard to Transceiver Audio
Separate CAT Interface



My current setup



What I’m working on



Note

To listen to digital modes, you can just run a stereo cable from your radio phone output to your PC soundcard mic input

You do not need anything else if you are not going to transmit

Some Digital Mode Characteristics

(you don't need to know all of these)

- Type: ASK, FSK, PSK, AFSK, APSK, MFSK, etc.
- Symbol rate (baud): low of 1 or 2, high over 100
- WPM, words per minute, low about 0.001, high over 100
- Bandwidth from 50 Hz to 400 Hz or so
- Error correcting, yes or no
- TX duty cycle, 20% to 100% ← use 50% power or less
- Coding: Morse, baudot, ASKII, other

Software for Demonstrations
(you will have to install)

Fldigi supports PSK31, RTTY, and many less used digital modes for Windows, Linux, and Mac OS-X. http://www.w1hkj.com/

WSJT-X implements FT8/FT4 and JT modes for Windows, Linux, and Mac OS. http://physics.princeton.edu/pulsar/K1JT/wsjtx.html

NTP (Network Time Protocol) synchronizes the PC clock with Internet time, which is necessary for WSJT-X. Meinberg for Windows https://www.meinbergglobal.com/english/sw/ntp.htm

Other Software

- DX Labs Commander for radio control, WinWarbler for CW, RTTY, PSK http://www.dxlabsuite.com/
- Ham Radio Deluxe for PSK31, RTTY and many less used digital modes. Not free. http://www.hrdsoftwarellc.com/
- Logger32 http://www.logger32.net/index.html
- N1MM Logger http://n1mm.hamdocs.com for contesting
- Amateur Contact Log http://www.n3fjp.com/index.html Not free.
- And many more https://www.eham.net/reviews/ > Ham Logging Software or > Ham Software/Apps

Setting the Audio Levels
These are in Series for RX and TX

RX Radio: AF out or no adjustment if line out (use normal setting)

RX Interface: “RCV” level adjust

RX PC Audio: PC sound card “record” level (keep about 50%)

RX Software: depends on software (keep about 50%)

TX Software: depends on software (keep about 50%)

TX PC Audio: PC sound card “play” level (keep about 50%)

TX Interface: “XMIT” level adjust

TX Radio: power or mic gain (use normal setting)

Adjusting Audio Levels

For RX

- adjust levels to see reasonable spectrum or waterfall and the software can decode signals

For TX

- Adjust levels to get 1 to 4 bars on ALC (depends on radio)
- On many radios, adjust the power
- On KX3 and others, adjust the mic gain

US Amateur Radio Bands

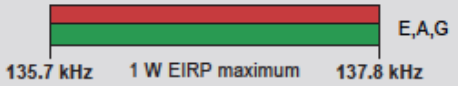
US AMATEUR POWER LIMITS

FCC 97.313 An amateur station must use the minimum transmitter power necessary to carry out the desired communications.
(b) No station may transmit with a transmitter power exceeding 1.5 kW PEP.

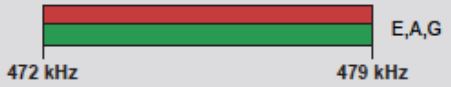
ARRL The national association for AMATEUR RADIO

Amateurs wishing to operate on either 2,200 or 630 meters must first register with the Utilities Technology Council online at **https://utc.org/plc-database-amateur-notification-process/**. You need only register once for each band.

2,200 Meters (135 kHz)



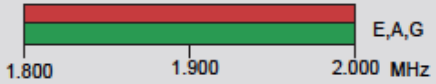
630 Meters (472 kHz)



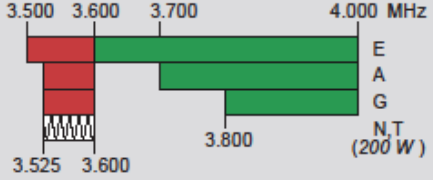
5 W EIRP maximum, except in Alaska within 496 miles of Russia where the power limit is 1 W EIRP.

160 Meters (1.8 MHz)

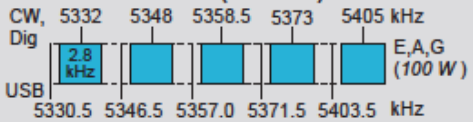
Avoid interference to radiolocation operations from 1.900 to 2.000 MHz



80 Meters (3.5 MHz)

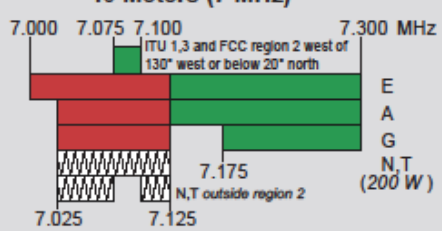


60 Meters (5.3 MHz)



General, Advanced, and Amateur Extra licensees may operate on these five channels on a secondary basis with a maximum effective radiated power (ERP) of 100 W PEP relative to a half-wave dipole. Permitted operating modes include upper sideband voice (USB), CW, RTTY, PSK31 and other digital modes such as PACTOR III. Only one signal at a time is permitted on any channel.

40 Meters (7 MHz)

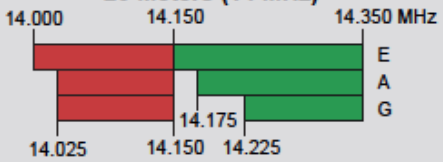


See Sections 97.305(c), 97.307(f)(11) and 97.301(e). These exemptions do not apply to stations in the continental US.

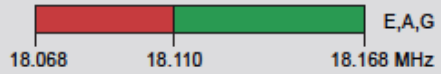
30 Meters (10.1 MHz)

Avoid interference to fixed services outside the US.

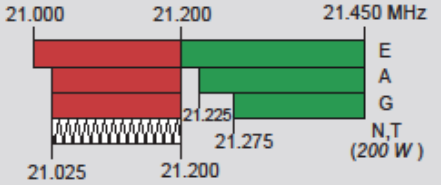
20 Meters (14 MHz)



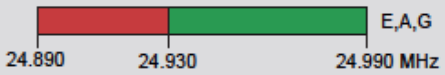
17 Meters (18 MHz)



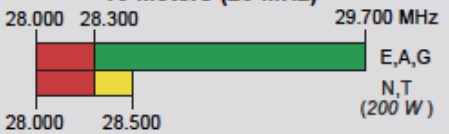
15 Meters (21 MHz)



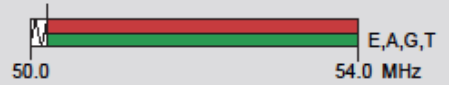
12 Meters (24 MHz)



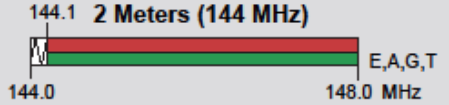
10 Meters (28 MHz)



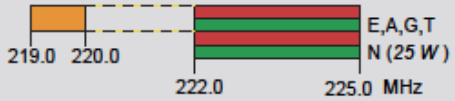
6 Meters (50 MHz)



2 Meters (144 MHz)



1.25 Meters (222 MHz)

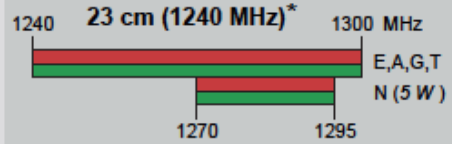


*Geographical and power restrictions may apply to all bands above 420 MHz. See *The ARRL Operating Manual* for information about your area.

70 cm (420 MHz)*

33 cm (902 MHz)*

23 cm (1240 MHz)*



All licensees except Novices are authorized all modes on the following frequencies:

2300-2310 MHz	10.0-10.5 GHz ‡	122.25-123.0 GHz
2390-2450 MHz	24.0-24.25 GHz	134-141 GHz
3300-3500 MHz	47.0-47.2 GHz	241-250 GHz
5650-5925 MHz	76.0-81.0 GHz	All above 275 GHz

‡ No pulse emissions

KEY

Note:
CW operation is permitted throughout all amateur bands.

MCW is authorized above 50.1 MHz, except for 144.0-144.1 and 219-220 MHz.

Test transmissions are authorized above 51 MHz, except for 219-220 MHz

- = RTTY and data
- = phone and image
- = CW *only*
- = SSB phone
- = USB phone, CW, RTTY, and data
- = Fixed digital message forwarding systems *only*

E = Amateur Extra
A = Advanced
G = General
T = Technician
N = Novice

See *ARRLWeb at www.arrl.org* for detailed band plans.

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https://www.iaru-r2.org/wp-content/uploads/2020/02/IARU-Region-2-Band-plan.pdf

Frequencies (kHz)	BW (Hz)	Mode	Applications and observations
14000-14025	200	CW	Priority for intercontinental operation (DX window)
14025-14060	200	CW	CW Contests preferred, CW QRS Center of Activity 14055 kHz
14060-14070	200	CW	CW QRP Center of Activity 14060 kHz
14070-14089	500	CW, DM	
14089-14099	500	CW, DM	ACDS
14099-14101	200	CW	IBP (exclusive)
14101-14112	2700	All Modes	ACDS
14112-14190	2700	All Modes	SSB Contest preferred
14190-14200	2700	All Modes	SSB Priority for intercontinental operation (DX window), SSB Contest preferred
14200-14285	2700	All Modes	SSB Contest preferred, Image Center of Activity 14230 kHz, SSB QRP Center of Activity 14285 kHz
14285-14300	2700	All Modes	AM Calling QRG 14285 kHz
14300-14350	2700	All Modes	Global Emergency Center of Activity 14300 kHz

Suggested Digital Mode Frequencies

FT8	**PSK31**	**RTTY**
3573 kHz	3580 kHz	3580to 3600 kHz
7074 kHz	7070 kHz	7080 to 7100 kHz
10136 kHz	10140 kHz	
14074 kHz	14070 kHz	14080 to 14100 kHz
18100 kHz	18100kHz	
21074 kHz	21070 kHz	21080to 21100 kHz
24915 kHz	24920 kHz	
28074 kHz	28120 kHz	28080 to 28100 kHz

Demonstration of fldigi

Menus

flrig > Config > Setup > Transceiver

fldigi > Configure > Config Dialog > …

… > Operator-Station

… > Rig Control > flrig

… > Soundcard > Devices > PortAudio

Macros

Demonstration of WSJT-X

Need to set up NTP first (Meinberg or other)

Not included in demo

Menus:

WSJT-X > File > Settings > General

WSJT-X > File > Settings > Radio

WSJT-X > File > Settings > Audio